4.0 ENVIRONMENTAL CONSEQUENCES

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4.0 ENVIRONMENTAL CONSEQUENCES

This Chapter analyzes the potential environmental impacts that may result from construction, operation, and maintenance of the proposed Project and the alternatives. Construction impacts are those impacts resulting from construction activities over the anticipated 5-year construction period; operational impacts are those resulting from operation and maintenance of the alternatives during the 50-year analysis period. The 50-year analysis period is typically used for USACE water resources planning analyses and corresponds with the Delft3D Basinwide Model simulations, which were run over five decades (beginning in 2020[31] and run through 2070). The potential impacts of each alternative are then compared to one another. This comparison is done by first comparing the anticipated consequences of the No Action Alternative to existing conditions to understand the anticipated changes in the environment that would occur irrespective of the proposed Project. Thereafter, the anticipated environmental consequences of the Project action alternatives are compared to the results of the No Action Alternative analysis to isolate the potential impacts of the action on the environment. The results of the analysis for each resource are summarized in a table at the end of each resource section.

4.1 APPROACH TO EVALUATION OF ENVIRONMENTAL CONSEQUENCES

Under NEPA, federal agencies must consider the potential environmental impacts, both beneficial and adverse, of the proposed Project and its reasonable alternatives, including direct, indirect, and cumulative impacts.[32] CEQ regulations (40 CFR 1508.7 and 1508.8) define these impacts as follows:

- direct impacts are caused by the Project and occur at the same time and place as the Project;
- indirect impacts are caused by the Project and occur later in time or farther removed in distance, but are still reasonably foreseeable. Indirect impacts may include growth inducing impacts and other impacts related to induced changes in the pattern of land use, population density or growth rate, and

[31] The year 2020 was chosen as the starting point of modeling before schedule shifts were known. Although proposed MBSD operations, if authorized, would commence after year 2020, this does not affect the outcome of the analysis of the Delft3D Basinwide Model. This EIS analyzes five decades of MBSD operations referred to herein as 2020 through 2070.

[32] USACE recognizes that on July 16, 2020, CEQ published a Final Rule revising its NEPA-implementing regulations at 40 CFR Parts 1500 - 1508 (85 FR 43304). The revised regulations apply to NEPA processes begun after their effective date, September 14, 2020, although agencies may apply the revised regulations to ongoing NEPA evaluations begun before that date. 40 CFR 1506.13. USACE has chosen to proceed under the regulations in effect at the time the MBSD EIS process began in 2017 (The Notice of Intent was published on April 27, 2017 [82 FR 19361]). The USACE public interest review and EPA's CWA 404(b)(1) guidelines both currently require evaluation of cumulative effects (33 CFR 320.4; 40 CFR 230.11).

related impacts on air and water and other natural systems, including ecosystems; and

- cumulative impacts are the impacts on the environment that result from the incremental impact of the Project when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time and must be analyzed in terms of the specific resource, ecosystem, and human community being affected. The purpose of the cumulative impacts analysis is to ensure that a decision on the proposed Project is not made without considering other past, present, and reasonably foreseeable future influences on resources affected by the proposed Project.

One consideration for environmental reviews under NEPA is whether an action would cause a significant adverse or beneficial impact on the human environment (defined as the natural and physical environment and the relationship of people with that environment [40 CFR 1508.14]). The CEQ regulations require consideration of both context and intensity when determining whether an effect is significant (40 CFR 1508.27).

4.1.1 Context

The context of impacts refers to the geographic area of potential impacts for each environmental resource and the duration of impacts. For the geographic area, an action must be analyzed in several scales such as society as a whole, the affected region, the affected interests, and the locality and may vary somewhat by resource area (40 CFR 1508.27(a)). The duration of impacts can be temporary, short-term, long-term, or permanent as described here:

- temporary impacts generally occur during construction, with the resources returning to preconstruction conditions almost immediately afterward;
- short-term impacts would be expected to return to No Action Alternative conditions within approximately 3 years following construction of the Project;
- long-term impacts would continue for more than several years, but would be expected to return to No Action Alternative conditions during the life of the Project; and
- permanent impacts would modify resources to the extent that they may not return to No Action Alternative conditions during the life of the proposed Project.

Note that both the geographic area of potential impact and the duration of impacts are resource-dependent and may change in scope and scale from resource to resource. To examine the geographic context of potential impacts of the proposed

Project and the alternatives, an area of potential impact has been defined for each resource. Chapter 3 described the existing conditions in the defined Project area that could be affected by the Applicant's Preferred Alternative (proposed Project) and a reasonable range of alternatives, including the No Action Alternative, all of which are described in Chapter 2. The Project area defined in Chapter 3, Section 3.1.1 includes approximately 3,541.9 square miles, all or portions of 10 Louisiana parishes, and extends throughout the Barataria Basin watershed and the Lower Mississippi River watershed (which includes the birdfoot delta) (see Figure 3.1-1).

The basis for the area of potential impacts is the area directly impacted by Project construction and the area directly impacted by Project operations. The construction footprint is shown in Chapter 2, Figure 2.8-1. The area of potential operational impacts has been established on a resource-specific basis as described in Sections 4.2 through 4.24 below. The area of potential operational impacts may be smaller than the entire Project area for some resource areas and larger than the Project area for other resource areas. For example, the area of potential impacts for the evaluation of construction impacts on air quality is the immediate vicinity (within about 0.5-mile) of active construction because construction emissions are highly localized. Conversely, the area of potential impacts for the examination of operational impacts of the proposed Project and alternatives on hydrology is based on a larger, basin-wide spatial boundary.

4.1.2 Intensity

For intensity, an action must be analyzed with respect to the severity of impact (40 CFR 1508.27(b)). The following should be considered in evaluating the intensity of potential impacts (40 CFR 1508.27(b) (1)-(10)):

- impacts that may be both beneficial and adverse. A significant impact may exist even if the federal agency believes that on balance the impacts would be beneficial;
- the degree to which the proposed Project impacts public health or safety;
- unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas;
- the degree to which possible impacts on the quality of the human environment are likely to be controversial;
- the degree to which possible impacts on the human environment are uncertain or involve unique or unknown risks;
- the degree to which the Project may establish a precedent for future actions with significant impacts or represents a decision in principle about a future consideration;

- whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts;
- the degree to which the Project may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP or may cause loss or destruction of significant scientific, cultural or historic resources;
- the degree to which the Project may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the ESA; and
- whether the Project threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment.

The intensity of potential impacts, either beneficial or adverse, is characterized by the following terms:

- no impact: no discernible or measurable impact;
- negligible impact: the impact would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[33]
- minor impact: the impact would result in a detectable change, but the change would be slight;
- moderate impact: the impact would result in a clearly detectable change, with measurable or quantifiable consequences; or
- major impact: the impact would be readily apparent and, depending on its context and intensity, has the potential to meet the threshold for significance set forth in CEQ regulations (40 CFR 1508.27) and, thus, warrants heightened attention and examination.

More specific impact definitions are included for each resource in the corresponding sections of the EIS. Proposed measures to avoid, minimize, and mitigate impacts on resources are summarized in Section 4.27 Mitigation Summary and detailed in Appendix R1 Mitigation and Stewardship Plan. Some of these avoidance and minimization measures were considered in the impact analyses, such as those required under applicable permits. For example, implementation of a Stormwater Pollution Prevention Plan (SWPPP) during construction of the proposed Project, as

[33] The term “negligible” will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

required under a Construction Louisiana Pollutant Discharge Elimination System (LPDES) permit, was assumed in the impact analysis for resources such as water quality. The impact analyses for each resource indicate whether any avoidance or minimization measures were considered. A summary table of the direct, indirect, and cumulative impacts of each alternative on each environmental resource is included in Chapter 2.

4.1.3 Overview of Delft3D Basinwide Model for Impact Analysis

As explained in more detail in Appendix E, using the Delft3D modeling software, the Water Institute, under contract to CPRA and with input from the MBSD Project Modeling Working Group, developed the two-dimensional Delft3D Basinwide Model to simulate changes in hydrodynamics, sediment transport, water quality, and vegetation within the Mississippi River Delta and its estuaries. The Delft3D Basinwide Model was used to assess impacts of the Project alternatives in the Barataria Basin and the birdfoot delta from implementation of the Project alternatives, as well as the impacts of the No Action Alternative. The model focuses on horizontal changes (across the basin) and averages the vertical variations in the water column (from water surface to water bottom). The model does not account for potential density stratification and assumes the vertical water column is mixed. This approach makes sense in the Barataria Basin, which is shallow and not typically prone to stratification (Orlando et al. 1993).

The Delft3D Basinwide Model was run for a modeling timeframe of five decades (2020 to 2070), which approximates the 50-year analysis period of the proposed Project alternatives. Observed large-scale processes, including subsidence (based on a rate that varied across the basin) and sea-level rise (based on the Gulf of Mexico regional sea-level rise rate), were included in the model setup along with smaller-scale processes, such as tidal fluctuations, atmospheric and wind forcing, and rainfall. The model setup also incorporates the hydrologic, bathymetric, topographic, water quality, and vegetation impacts from completed and ongoing restoration projects, dredging operations, rivers, and natural and man-made Mississippi River diversions, such as the Bonnet Carré Spillway, Davis Pond Freshwater Diversion, Caernarvon Diversion, Mardi Gras Pass, West Pointe A La Hache, and various passes in the birdfoot delta (see Appendix E for further details about the Delft3D Basinwide Model).

The Delft3D Basinwide Model does not capture changes to the landscape from all potential future projects in the simulations for each alternative. Simulations were completed, however, that included a suite of “reasonably foreseeable” projects to understand potential cumulative impacts of the MBSD Project. More details regarding cumulative impact modeling are provided in Section 4.25 Cumulative Impacts and in Appendix E.

As explained further below and in Appendix E, readers of this EIS should not consider the model outputs either as absolute values or predictions of actual future conditions. While the Delft3D Basinwide Model represents the best tool currently available to inform the impact analysis in this EIS, the model outputs are projections generated using defined inputs, often based on historical conditions. Because it is not possible to precisely predict future conditions (for example, weather patterns, sediment load transported by the Mississippi River, degree of sea-level rise, and other projects that may be developed on the landscape, but which are not included in the model set up), the model inputs are necessarily based on trends, averages, and best professional judgment. Correspondingly, model outputs are also based on past experience and trends, and represent reasonable assumptions about future behaviors. Equally important, the model projections are subject to varying degrees of uncertainty depending on the particular category of output (for example, salinity, water surface elevation, water quality constituents), and the extent to which defined inputs are representative of existing and future conditions in the Project area. As a result, for the purposes of this EIS, it is best to only compare between results for different alternatives, and not to try to compare the modeled outputs to existing or future conditions.

The next two sections discuss the hydrographs and sea-level rise projections used as model inputs. The model also relies on other parameters to predict impacts mentioned above, such as sediment transport, water quality, and vegetation; those aspects of the model are discussed in more detail in Appendix E.

4.1.3.1 Hydrographs

The Delft3D Basinwide Model was set up based on 50 years of observed Mississippi River flow hydrographs[34] (1964 to 2013) to project impacts on the system from Project operations over a 50-year analysis period (assuming initiation of operations in 2020 continuing through 2070). The Mississippi River flows from years 1964 through 1973 were applied for the projected model years of 2020 through 2029 and so on, as shown in Table 4.1-1. Each projected model decade was run consecutively to show developing trends in the system, as well as to project longer-term impacts on morphology and vegetation change for each alternative. The projected landscape at the end of each decade during operations is the product of 10 modeled years of impacts from sea-level rise, subsidence, Project operations, sediment transport, and vegetation changes.

To determine potential impacts of the Project alternatives on water levels and water quality, the Water Institute selected one Mississippi River hydrograph from the historical decadal hydrographs that was representative of conditions for each decade, resulting in a total of five historical representative hydrographs, one for each decade of model simulations (see Table 4.1-1 and Figure 4.1-1). Impacts on hydrology/ hydrodynamics and water quality discussed in Sections 4.4 and 4.5 of this chapter focus on these historical representative hydrographs unless otherwise noted.

[34] A hydrograph is a graph showing the rate of flow (discharge) versus time past a specific point in a river, channel, or conduit carrying flow. The rate of flow discussed in this EIS is expressed cfs as measured at the USACE Tarbert Landing gauge (located at Mississippi River mile 306 AHP).

Table 4.1-1
Summary of Mississippi River Historical Representative Hydrographs for each Modeled Decade of Operations

Decade	Period of Model Time	Mississippi River Hydrograph	Representative Hydrograph	Peak Flow	Average Annual Flow	Days above 450,000 cfs (Diversion Flows Greater Than 5,000 cfs Base Flow)
First	2020 to 2029	1964 to 1973	1970	957,000	437,000	158
Second	2030 to 2039	1974 to 1983	1975	1,216,000	563,000	193
Third	2040 to 2049	1984 to 1993	1985	1,128,000	591,000	231
Fourth	2050 to 2059	1994 to 2003	2002	1,116,000	532,000	163
Fifth	2060 to 2069	2004 to 2013	2008	1,456,000	642,000	224
2070[a]	2070	--	2008	1,456,000	642,000	224

[a] This scenario was not run for the decadal bed change scenarios. It was run to evaluate the final impact of the 50 years of land building on the hydrographs for water level, salinity, and other constituents.

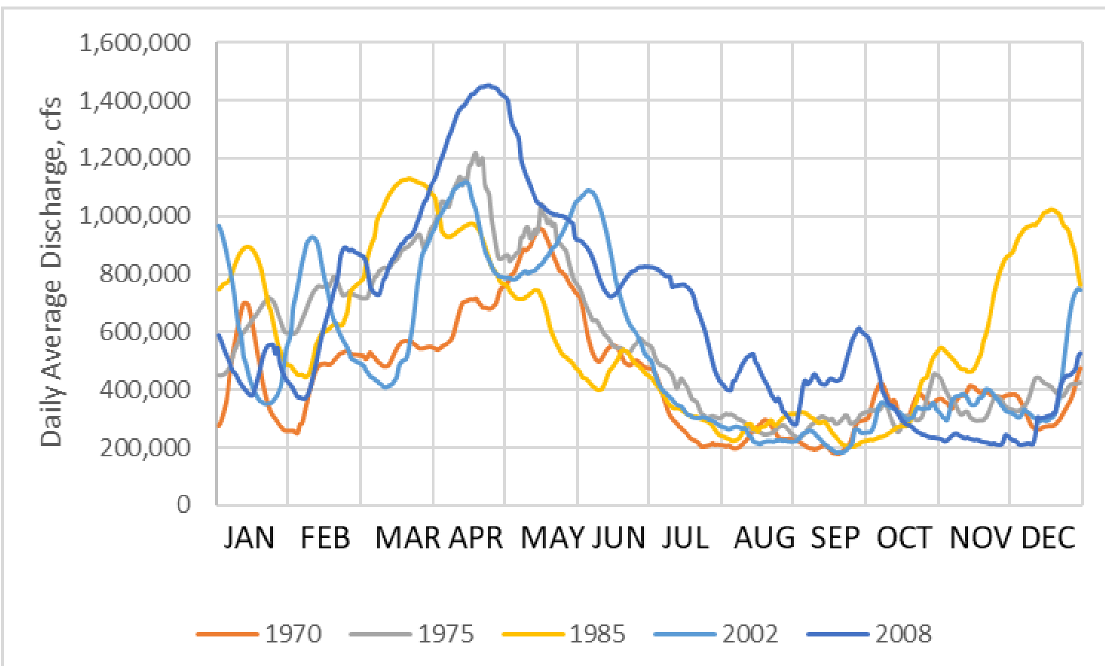


Figure 4.1-1. Mississippi River Hydrograph for Five Historical Representative Flow Regime Years for Each Decade used in the Delft3D Basinwide Model.

Additionally, the Water Institute identified four historical hydrographs that showed various high- and low-flow conditions. The four hydrographs chosen to represent various Mississippi River flow scenarios were 1994 (high, consistent spring flow), 2006 (low, multiple peak spring flow), 2010 (high, multiple peak spring flow), and 2011 (high, late spring flood flow) (see Figure 4.1-2). Table 4.1-2 lists peak annual flow, annual average flow, and number of days with flow greater than 450,000 cfs, which is the trigger flow rate for operating the diversion above base flow. The Water Institute provided model outputs based on each of these four hydrographs for each of the five decades of the model run. Because future Mississippi River flow scenarios may vary from the five historical representative hydrographs (shown in Figure 4.1-1), model outputs from these additional four historical hydrographs (shown in Figure 4.1-2) were utilized for some resources in the EIS to project potential variations in future scenarios. For example, Section 4.5 Surface Water and Sediment Quality provides projected salinities in the Project area under the representative hydrograph for each decade, as well as the four additional hydrographs, to understand how salinity shifts may differ between different Mississippi River flow regimes.

Table 4.1-2
Summary of Mississippi River Additional Hydrographs

Year	Description	Peak Flow	Average Annual Flow	Days above 450,000 cfs (Diversion Flows Greater Than 5,000 cfs Base Flow)
1994	high, consistent spring flow	1,164,000	556,000	165
2006	low, multiple peak spring flow	735,000	345,000	70
2010	high, multiple peak spring flow	1,020,000	571,000	230
2011	high, late spring flood flow	1,619,000	613,000	184

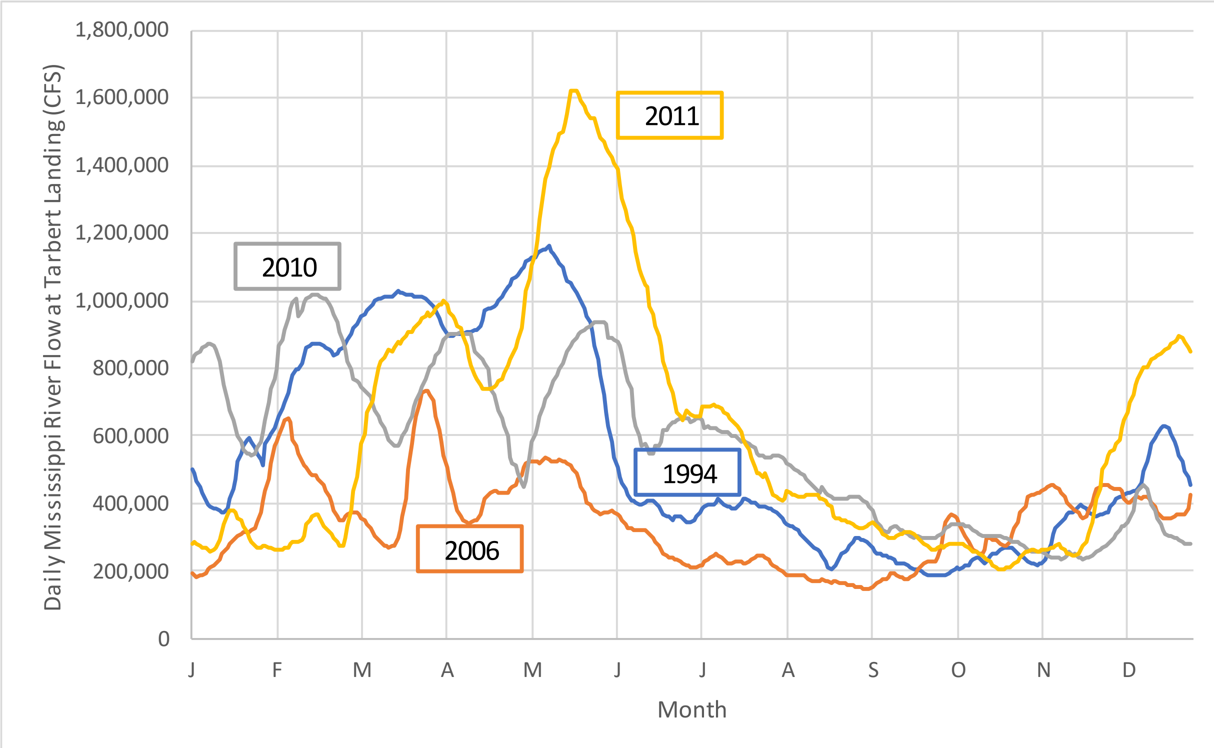


Figure 4.1-2. Mississippi River Hydrographs for Four Additional Flow Regime Years for Each Decade used in the Delft3D Basinwide Model.

Under the action alternatives, when the Mississippi River flows at a rate of 450,000 cfs at the Belle Chasse water gauge, the diversion structure gates would be opened to pass the maximum amount of water considering the stage or elevation of the river in relation to water elevations in the Barataria Basin receiving area. The diversion structure would be operated to discharge maximum flows of 50,000 cfs, 75,000 cfs, or 150,000 cfs (depending on the action alternative) when the river flow reaches 1 million cfs or higher. When the Mississippi River flow rate falls below 450,000 cfs, the diversion would be operated to maintain a not-to-exceed base flow of 5,000 cfs to the extent practicable. The diversion structure would be closed when the relationship between the water levels in the Mississippi River and the Barataria Basin would create a reverse flow or when other stop triggers or “Emergency Operations” are met. Under the Applicant’s Preferred Alternative, using the 1964 through 2013 historical Mississippi River hydrographs to represent projected flows from 2020 through 2069, the model projects that the diversion would operate at base flow (up to 5,000 cfs) or higher (from approximately 25,000 cfs up to a maximum of 75,000 cfs, depending on river water stages) as shown in Table 4.1-3. See Appendix F for the Applicant’s Preliminary Operations Plan. Throughout this EIS, the term “base flow” is used to refer to flows of up to 5,000 cfs through the diversion. The terms “open” or “operating above base flow” are used to refer to flows through the diversion beginning at approximately 25,000 cfs when the Mississippi River is flowing at 450,000 cfs at Belle Chasse up to the maximum capacity of the diversion (50,000 cfs, 75,000 cfs or 150,000 cfs, depending on the alternative) when the Mississippi River reaches 1 million cfs at Belle Chasse.

Table 4.1-3
Mean Number of Days Diversion is Projected to be Operational by Decade

	2020 to 2029			2030 to 2039			2040 to 2049			2050 to 2059			2060 to 2069		
	Mean Days at Base Flow	Mean Days Open Inter-mediate Flow	Mean Days at Max Flow	Mean Days at Base Flow	Mean Days Open Inter-mediate Flow	Mean Days at Max Flow	Mean Days at Base Flow	Mean Days Open Inter-mediate Flow	Mean Days at Max Flow	Mean Days at Base Flow	Mean Days Open Inter-mediate Flow	Mean Days at Max Flow	Mean Days at Base Flow	Mean Days Open Inter-mediate Flow	Mean Days at Max Flow
	5K cfs	5K to 75K cfs	75K cfs	5K cfs	5K to 75K cfs	75K cfs	5K cfs	5K to 75K cfs	75K cfs	5K cfs	5K to 75K cfs	75K cfs	5K cfs	5K to 75K cfs	75K cfs
January	12	19	0	11	18	3	7	21	3	15	15	1	10	20	1
February	13	14	2	10	16	2	4	23	1	5	21	2	7	20	2
March	7	23	1	6	23	2	0	25	6	3	22	5	4	27	1
April	5	22	3	4	18	8	1	24	6	2	23	4	3	24	3
May	3	24	3	7	18	6	8	14	9	3	23	5	4	20	7
June	19	10	1	9	19	2	10	17	3	4	21	5	12	16	3
July	24	7	0	20	11	0	18	13	0	15	16	0	13	18	0
August	31	0	0	28	3	0	26	5	0	29	2	0	27	4	0
September	30	0	0	28	2	0	27	3	0	30	0	0	29	1	0
October	31	0	0	30	2	0	25	6	0	31	0	0	27	4	0
November	28	3	0	27	3	0	19	11	0	27	3	0	24	6	0
December	19	12	0	16	13	2	10	20	1	18	13	0	18	13	0

4.1.3.2 Sea-level Rise

The Delft3D Basinwide Model factors in sea-level rise projections. Based on agreement of the MBSD Project Modeling Working Group, the regional Gulf of Mexico sea-level rise value simulated for all model runs was an increase of 2.2 feet (0.7 meter) by 2070 compared to year 2020 sea levels, or 4.9 feet (1.5 meters) by year 2100. This value, which does not consider subsidence, was selected to reflect scenarios used in the 2017 Coastal Master Plan (CPRA 2017a) and is close to the USACE Intermediate predicted 2070 value for sea-level rise of 2 feet (0.6 meter) estimated between 2020 to 2070 (Huber and White 2017; USACE 2019d). Using the same sea-level rise calculator (see Chapter 3, Section 3.4 Surface Water and Coastal Processes) for the Grand Isle gauge, the NOAA predictions for sea-level rise from 2020 to 2070 are 1.8 feet (0.54 meter), 2.8 feet (0.85 meter), and 4.8 feet (1.45 meters) for low, intermediate, and high predictions, respectively. Figure 4.1-3 shows the sea-level rise curve utilized in the Delft3D Basinwide Model, as compared to the USACE (dashed lines) and NOAA (points) sea-level rise predictions from 2020 through 2070 estimated from the USACE sea-level rise calculator for Grand Isle. Table 4.1-4 below gives the projected Delft3D Basinwide Model sea-level rise values that correspond with Figure 4.1-3. Notice that the decadal sea-level rise rates and values increase per decade, indicating accelerated sea-level rise rates over the analysis period.

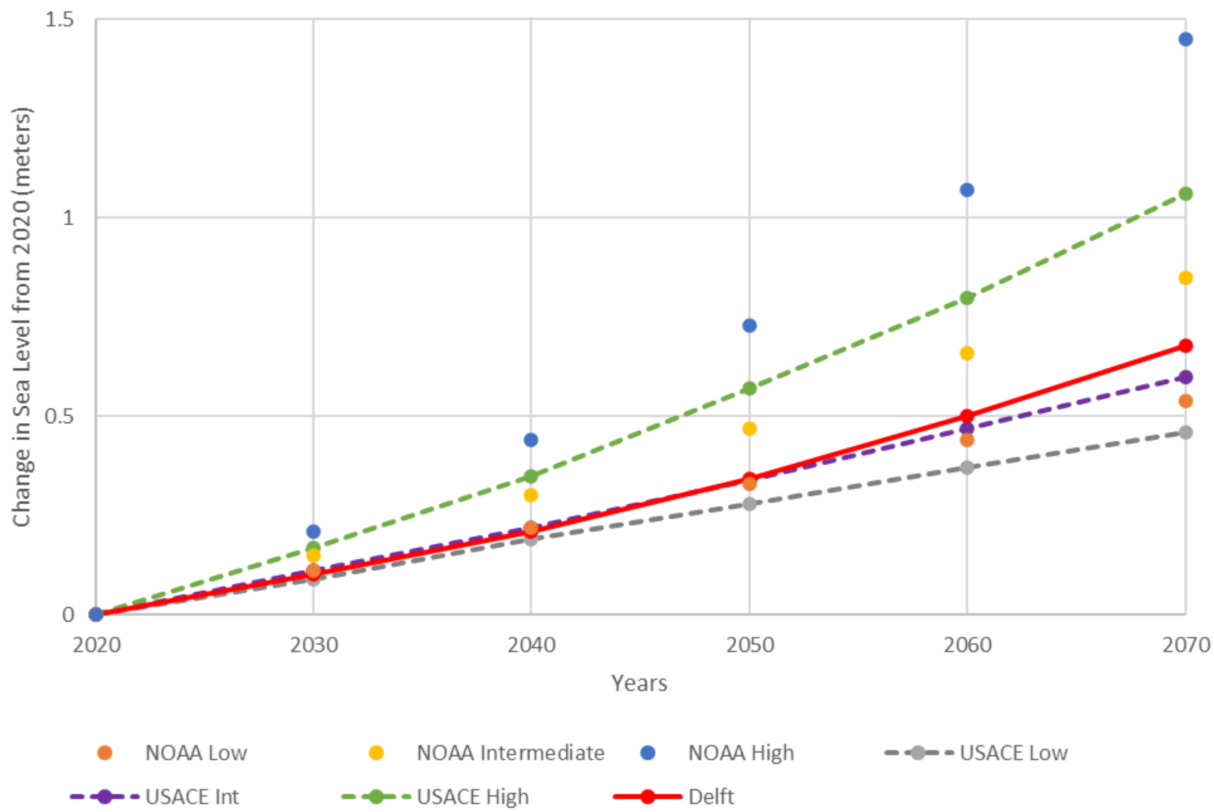


Figure 4.1-3. Sea-level Rise Curve Comparison: Delft3D Basinwide Model, with USACE, and NOAA (USACE 2019d).

Table 4.1-4 Sea-level Rise Rates used in Delft3D Basinwide Model			
Year	**Base Water Level (feet/meters)**	**Change by Decade (feet/meters)**	**Total Change from 2020 to 2070 (feet/meters)**
2020	0.000/0.000	--	--
2030	0.335/0.102	0.335/0.102	--
2040	0.685/0.209	0.348/0.106	--
2050	1.129/0.344	0.446/0.136	--
2060	1.644/0.501	0.515/0.157	--
2070	2.221/0.677	0.577/0.176	2.231/0.68

Project impacts on water level and land area changes in the Barataria Basin would differ from those projected by the Delft3D Basinwide Model depending on actual sea-level rise that occurs in the basin during the analysis period. If actual sea-level rise through 2070 is lower than the value used in the model, water levels and land loss would likely be lower. If actual sea-level rise is higher (as is predicted by Sweet et al. 2017) than the value used in the Delft3D Basinwide Model, water levels would be higher and land loss and land gains would be different than the model projections reported in this EIS (Sweet et al. 2017, Church et al. 2013).

To understand how different sea-level rise scenarios could influence model outputs, the Water Institute prepared an additional set of simulations, or Model Production Runs, using a lower sea-level rise value (2.6 feet [0.8 meter] by year 2100) to evaluate the impacts of the proposed Project in the event of lesser sea-level rise. The model projected that using a lower sea-level rise value would generate larger acreage above water – nearly double – compared to the Project under the higher sea-level rise scenario. By comparison, water level differences between these two scenarios were almost negligible at the beginning of the 50-year analysis period and gradually increased to a maximum water level difference of 1.0 foot (approximately 0.3 meter) across the whole basin at the end of the 50 years. Salinity differences between these two scenarios were negligible for the first 4 decades of analysis. For the 2060 to 2069 decade, a small difference in salinity (approximately 0.5 parts per thousand [ppt]) is observed between the two sea-level rise scenarios, in the saline and fresh zones. In 2070 this difference increased to approximately 1 part per thousand, for both saline and fresh zones.

4.1.3.3 Model Limitations and Uncertainty

Predictive numerical models are useful tools to analyze how a specific system, the estuarine environment in this case, evolves or responds to changes over time. All models are a simplified representation of actual processes (that is, how a system would respond to external drivers), and as such have varying degrees of limitations and uncertainties. Knowledge and awareness of these limitations is very important when interpreting model results and predictions.

Uncertainty in models comes from many sources – uncertainty in the observed data used for model calibration, validation, and initialization; assumptions and numerical averaging in the computer model; and sensitivity to model parameters. These uncertainties can impact model results, changing where and by what amount impacts are projected. In the case of the Delft3D Basinwide Model, the grid resolution (that is, size of every computational grid cell), the spatial and temporal resolution of the atmospheric forces, the temporal frequency of the boundary conditions (that is, information provided at the edges of the model domain), and the time step used to solve the model equations and to store the outputs, all contribute to model limitations and capabilities.

To quantify uncertainty, confidence intervals are placed on a model projection. Typically, a model is tested with various changes to observed data and model parameters to demonstrate how sensitive a model is to the data and parameters (validation). By conducting this analysis, a modeling team can be confident that if typical errors are present in observed data, the model results would not be unduly impacted. The Water Institute conducted this analysis to calculate the degree of uncertainty in the Delft3D Basinwide Model for several parameters, including salinity, land change, temperature, water level, and various water quality parameters. The Water Institute calculated an overall Root Mean Square Error (RMSE) of 2.7 ppt for salinity, with a bias of –1.0 ppt (meaning that the model has an overall tendency to under predict salinity by 1.0 ppt). Land area model results were calculated with a precision of approximately 3.8 acres near the diversion outfall and 35 acres elsewhere in the model domain, based on computation mesh dimensions. Land area results are estimated by the Water Institute to be accurate within ±200 acres. The calculated uncertainties are reported in tabulated and text presentations of the results. The Water Institute also calculated an RMSE of 0.6 foot (0.2 meter) and a bias of –0.3 foot (–0.1 meter) for water level predictions, and an RMSE of 36.1°F (2.3°C) and a bias of 29°F (–1.5°C) for temperature predictions. These uncertainties are spatially variable; specifically, the Water Institute calculated lower uncertainty closer to the diversion, and greater uncertainty farther from the diversion (for example, in the Lower Barataria Basin near the barrier islands). Because of these uncertainties, outputs from the Delft3D Basinwide Model should not be understood as absolute values. More details regarding these uncertainties and their impacts on the numeric Delft3D Basinwide Model results reported in this EIS are explained in Section 8 Model Limitations and Uncertainties in Delft3D Basinwide Modeling Report in Appendix E.

In addition, regardless of model skill as reported by RMSE and bias, these values do not capture additional model uncertainties, as well as additional uncertainties that may exist among the model inputs and model boundary conditions used to drive the model. These include parameters or physical processes where it is not possible to predict with certainty what would occur over the 50-year analysis period. For example, certain man-made changes and other physical processes that would affect the landscape (for example, dredging, levee repairs, construction activities, or restoration projects that were not foreseeable at the time of the Production Runs; impacts of hurricanes; and marsh edge erosion caused by waves) are not included in the Delft3D Basinwide Model. Similarly, some inputs are not possible to predict with certainty (for example sea-level rise, variable rainfall and other weather conditions, the Mississippi River hydrograph, and sediment and nutrient loads from the Mississippi River over the 50-year analysis period), so certain historical or "average" conditions are used in the model. These were considered reasonable assumptions by the MBSD Project Modeling Working Group for purposes of conducting the EIS analyses. For more information about these additional uncertainties, see Section 8 Model Limitations and Uncertainties in Delft3D Basinwide Modeling Report in Appendix E.

Overall, these additional uncertainties and their impact on the model predictions are difficult to assess or quantify. One way to manage the lack of a quantitative metric for the uncertainty is to focus on the comparison among alternatives and/or between the No Action Alternative and a selected action alternative, instead of analyzing absolute model predictions. Although models undergo rigorous testing and evaluation, model outputs are conditional projections, and not an exact match to the real world. As a result, the Delft3D Basinwide Model projections should be taken as general trends and not exact changes. Similar limitations and uncertainties apply to other models used throughout this analysis. Details regarding the limitations of those models are included in the relevant resource sections (for example, limitations on HSIs are discussed as part of Section 4.10 Aquatic Resources). Nonetheless, these models represent the best predictive tools currently available and therefore are used to support the impact analysis in this EIS.

4.2 GEOLOGY AND SOILS[51]

4.2.1 Area of Potential Impacts

The area of potential construction impacts on geology and soils is within and immediately adjacent to (within 0.5 mile), the proposed construction footprint (see Figure 2.8-1 in Chapter 2). During operations, the proposed Project would have the potential to impact geology and soil resources in the diversion complex and outfall area, as well as throughout the Barataria Basin and the Mississippi River birdfoot delta. Basin-wide direct and indirect impacts during ongoing operations would start in the outfall area and build outward over time.

4.2.2 Guidelines for Geology and Soils Impact Determinations

Impact intensities for geology and soils are based on the definitions provided in Section 4.1 and the following resource-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;

[51] Land acreage impacts discussed in this discussion are applicable to the acreage of land created, lost, or sustained above the water surface. For Project impacts on land below the surface of the water, see the *Bed Elevation* section in Section 4.4.4 Hydrology and Hydrodynamics.

- negligible: the impact on geology and soils would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[52]
- minor: disturbance to geologic features or soils would be detectable, but would be small and localized. There would be no changes to local geologic features or soil characteristics. Erosion and/or compaction would occur in localized areas;
- moderate: disturbance would occur over local and immediately adjacent (within 0.5-mile) areas. Impacts on geology or soils would be readily apparent and result in changes to the soil character or local geologic characteristics. Erosion and compaction impacts would occur over local and immediately adjacent (within 0.5-mile) areas; and
- major: disturbance would occur over a widespread area. Impacts on geology or soils would be readily apparent and would result in changes to the character of the geology or soils over a widespread area. Erosion and compaction would occur over a widespread area. Disruptions to substrates or soils may be permanent.

4.2.3 Geology, Topography, and Geomorphology

4.2.3.1 Construction Impacts

4.2.3.1.1 No Action Alternative

Under the No Action Alternative, the geology, topography, and geomorphology in the Project area would not be affected by construction of the Applicant's Preferred Alternative or any of the action alternatives. The geology and soil conditions in the Mississippi River, Barataria Basin, and birdfoot delta would continue as described in Chapter 3, Section 3.2 Geology and Soils. Ongoing trends of sea-level rise and subsidence would continue, but only limited changes to geology and soils are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse effect on geology, topography, and geomorphology. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25 Cumulative Impacts for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal environmental standards.

[52] Throughout Chapter 4, the term "negligible" will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

4.2.3.1.2 Applicant's Preferred Alternative

4.2.3.1.2.1 Geology and Geomorphology

Substantial excavation and dredging for the proposed Project construction are expected to cause permanent, moderate (readily apparent, local), adverse direct impacts on the existing geology and complex geomorphology that characterize much of the construction footprint between the NOV-NFL and MR&T Levees, including point bar deposits, natural levees, abandoned distributary channels and marsh deposits (see Chapter 3, Section 3.2 Geology and Soils for more information about the existing geology of the Project area). Additional dredging and placement of fill and dredged material in the Project outfall area would cause both short-term, moderate, adverse impacts and permanent, moderate, beneficial, impacts on the geology and geomorphology of existing open water, shallow-bay bottom, and emergent marshes. The direct impacts from dredging and placing fill in existing subtidal shallow-bay bottom or on top of wetland habitat as part of construction activities would be adverse initially, as these activities would permanently and substantially modify these areas. By contrast, dredged material placed for the purposes of creating wetlands would revegetate and provide wetland habitat, representing a permanent beneficial direct impact because emergent wetlands provide higher ecological productivity and would likely be a less common intertidal landform in the face of future land loss as compared with submerged shallow-bay bottom.

Table 4.2-1 summarizes approximate impact acreages of material excavated or dredged for Project components that would require substantial excavation within the construction area, as well as where dredging in the Barataria Basin would occur. Approximately 342 acres within the construction footprint would be excavated or dredged for construction of the intake system, conveyance channel, outfall transition feature, and basin access channels. Approximately 1,376 acres, outside of the proposed beneficial use areas, would be impacted by construction (see Chapter 2, Table 2.8-2), involving substantial earthwork on existing open water, wetlands, agricultural land, forested land, and other existing land cover types (see Section 4.18 Land Use and Land Cover for further details about existing land use and land cover that would be impacted by the proposed Project construction). Proposed earthwork would include excavation, compaction, grading, or filling as part of the construction of levees and berms, the concrete manufacturing plant, contractor yards, haul roads, and borrow laydown areas.

Table 4.2-1
Approximate Area of Excavation/Dredging during Construction[a]

Location	Area (ac)
Intake System[a]	20.1
Conveyance Channel	180.3
Outfall Transition Feature[b]	75.6
Access Dredging	66.3

[a] Does not include all components of the construction footprint shown in Chapter 2.
[b] Includes the intake channel, gated control structure, and transition channel.
[c] Excludes areas within both access channel dredging and outfall transition area footprint and other general areas of construction in the basin.

Most of the material excavated or dredged for the conveyance channel and outfall transition feature would be used for fill associated with construction of the diversion complex structures and conveyance channel levees. Material unsuitable for this use would be deposited in designated beneficial use placement areas for marsh creation or used to infill nearby borrow pits (see Figure 2.8-1 in Chapter 2). The grain size distributions of excavated or dredged material that would be deposited in the areas that would serve as beneficial use placement areas would differ to some extent from the grain size distributions of the sediments there presently.

Construction materials and equipment would be delivered via barges through the Barataria Basin. This would likely require dredging access channels from Bayou Dupont to the construction area (see Figure 2.8-1 in Chapter 2), which would constitute a short-term, minor, direct adverse impact. The estimated area of these access channels and dredge disposal would be more than 300 acres based upon preliminary designs.

4.2.3.1.2.2 Topography

Construction would also cause permanent, moderate, adverse, primarily direct impacts on the existing topography of the construction area on land northeast of the NOV-NFL Levee and permanent, moderate, primarily beneficial impacts on the open water, shallow-bay bottom, and emergent marshes in the outfall area. Existing surface elevations within the proposed footprint of the intake channel, gated control structure, conveyance channel, and outfall transition feature would be substantially lowered, and elevations of the proposed conveyance channel berms and guide levees would be substantially higher than the existing topography (CPRA 2018b). The placement of excavated and dredged material for use in the beneficial use areas would elevate water bottom elevations (bathymetry) in the beneficial use areas. These direct impacts would be primarily beneficial in that the expected resulting emergent wetlands provide higher ecological productivity and would likely be a less common intertidal morphology in the face of future land loss as compared with submerged shallow-bay bottom.

The Mississippi River thalweg (the line of lowest elevation within the river) is located along the river's eastern bank with elevations below -120.0 feet. The river's west bank is protected with articulated block mat river revetment that rises from a toe elevation of approximately -60.0 feet to a typical top-of-revetment slope elevation of 4.0 feet. The bank then slopes up to the top of the MR&T Levee at 15.5 feet. The land between the MR&T Levee along the Mississippi River and the existing NOV-NFL Levee to the west ranges from elevations of 4.0 to 6.0 feet along the eastern side to an elevation of -3.0 to -5.0 feet along the existing NOV-NFL Levee. The existing NOV-NFL Levee itself has a typical crown elevation of 3.0 to 5.0 feet. The planned construction of the NOV-NF-W-05a.1 Project is described in the cumulative impacts analysis (see Section 4.25 Cumulative Impacts).

Across this profile, the proposed intake channel immediately adjacent (within 0.5-mile) to the Mississippi River would be excavated to an elevation of -25.0 feet at the bottom of the conveyance channel. Permanent changes in elevations of the Mississippi River bottom and bank due to construction activities would generally be limited to a lowering of elevation immediately (within 0.5-mile) within the excavated footprint of the intake channel and training walls. Other elevation changes in the Mississippi River and bank would result from excavation or infill for the construction of seepage cutoff walls, temporary setback levees, the cofferdam perimeter, the gated control structure, and adjoining concrete transition channel sections.

Much of the material excavated for construction of the intake system and conveyance channel is expected to be used to construct the berms and channel guide levees adjacent to the proposed conveyance channel. The sides of the channel would rise to a berm elevation of 2.0 feet and extend laterally 97.0 feet, increasing to an elevation of 4.0 feet. The berms would be necessary to provide a stable platform for the channel guide levees, which would confine the diversion's discharge and serve as hurricane flood protection levees. Based on preliminary Project designs, these levees would have a 7:1 side slope with a 10.0-foot wide crown at an elevation of 15.85 feet (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for further details about flood risk reduction levees of the proposed Project).

Bottom elevations in the marshes, ponds, and bays in the immediate outfall area in the Barataria Basin currently range from -1.0 to -4.0 feet (CPRA 2018b, HDR Engineering Inc. 2014b). The preliminary design concept for the beneficial use of excavated and dredged materials estimates a target marsh elevation of 2.0 feet, which would increase elevations in the proposed beneficial use sites by 3.0 to 7.0 feet, although these estimates may be revised as designs progress and ongoing marsh inundation assessments are completed (CPRA 2018b). Minor, indirect, adverse and beneficial impacts on topography of areas adjacent to beneficial use areas from increased sedimentation may occur.

Dredging access channels within the proposed outfall area from Bayou Dupont to the diversion complex construction area would deepen existing dredged channels or shallow open water areas. The proposed access channels would be approximately 50.0 feet across and dredged to an elevation of -9.0 feet, though the specific routes and dredging footprints would be determined as the proposed Project designs are refined. These areas are shallow open water, comprising organic-rich and fine mineral deposits.

Prior to commencement of proposed Project operations, dredged channels would be backfilled to the greatest extent practicable with native material that was side cast. Additional infilling of dredged channels would be expected after commencement of operations, so impacts from dredging, while direct and adverse, would likely be minor and short-term.

4.2.3.1.3 Other Alternatives

Similar long-term to permanent, moderate, adverse direct and indirect impacts on the geology, topography, and geomorphology in the proposed construction footprint would occur under the five additional alternatives. The primary difference among the other alternatives during construction would be marsh terraces proposed under three of the alternatives (see Table 4.2-2) and differences in channel widths. The alternatives would also differ in maximum flow volume, but flow through the diversion would occur once the proposed Project is constructed and would not impact construction (see Section 4.2.3.2 for operational impacts of the alternatives).

Table 4.2-2
General Description of Project Alternatives

Alternative	Location (RM)	Trigger (Belle Chasse Gauge)	Base Flow[a]	Maximum Flow	Outfall Features[b]
75,000 cfs Applicant's Preferred Alternative	60.7	450,000 cfs	5,000 cfs	75,000 cfs	OTF
75,000 cfs + Terraces	60.7	450,000 cfs	5,000 cfs	75,000 cfs	OTF + Marsh Terraces
50,000 cfs	60.7	450,000 cfs	5,000 cfs	50,000 cfs	OTF
50,000 cfs + Terraces	60.7	450,000 cfs	5,000 cfs	50,000 cfs	OTF + Marsh Terraces
150,000 cfs	60.7	450,000 cfs	5,000 cfs	150,000 cfs	OTF
150,000 cfs + Terraces	60.7	450,000 cfs	5,000 cfs	150,000 cfs	OTF + Marsh Terraces

[a] Depending on river flow and head differential
[b] OTF = Outfall Transition Feature (see Chapter 2)

The construction of marsh terraces would involve long-term to permanent, moderate, adverse and beneficial primarily direct impacts on geology and soils. Under the three marsh terrace alternatives, dredged material excavated from adjacent shallow-bay bottom would be used to create approximately 18 chevron features oriented into the diversion discharge current. These features would have an elevation of approximately 4.8 feet. These features and the adjacent excavated areas would have a footprint of approximately 80.0 to 90.0 acres. This would require the excavation and emplacement of approximately 450,000 cubic yards of material. The direct impacts on the geology and soils of existing emergent marsh and shallow open water from the construction of terraces would be both beneficial and adverse in that they would modify the existing natural topography but would result in higher-value emergent wetlands and other intertidal habitat. Minor, adverse indirect impacts on topography of areas adjacent to terrace construction from increased sedimentation may occur. CPRA would implement the measures described in Section 4.27 Mitigation Summary to minimize runoff and sedimentation during construction.

As compared with the Applicant's Preferred Alternative, the geometry and size of the intake channel and conveyance channel would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes. Even though construction would occur within a similar construction footprint for all alternatives, the volume of material excavated and emplaced for construction of the conveyance channel berms, guide levees, and outfall transition feature would be greater for alternatives with 150,000 cfs flow volumes and smaller for alternatives with 50,000 cfs flow volumes. Alternatives with higher-flow volumes would have construction times several months longer, and those with lower-flow volumes would have construction times several months shorter. As such, the duration of potential short-term impacts from construction, such as the erosion of exposed soils, would endure for longer or shorter timeframes. See Section 4.2.5 Soils and Prime Farmland for additional details about construction impacts on soils and Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for measures that CPRA would undertake to minimize soil erosion during and after construction.

4.2.3.2 Operational Impacts

4.2.3.2.1 No Action Alternative

Under the No Action Alternative, geology in the Project area, which includes the Barataria Basin and the birdfoot delta as described in Chapter 3, Section 3.1.1 Project Area, would not be affected by operation of the Applicant's Preferred Alternative or any of the action alternatives. The general character of the geomorphology and sediments in the Project area would exist, subject to ongoing future land loss processes, as described in Chapter 3, Section 3.2 Geology and Soils, and the impacts on these resources from operation of the action alternatives would not occur.

The Delft3D Basinwide Model developed by the Water Institute was used to assess potential impacts on sediment transport, land change[53], and other processes from implementation of the Project alternatives, including the No Action Alternative. Although the Delft3D Basinwide Model projects changes in the Project area over the 50-year analysis period, the model setup for most alternatives intentionally did not include other projects that may or are likely to be developed over that period (for example, projects planned as part of the Louisiana Coastal Master Plan [CPRA 2017a]) (see Section 4.1.3 in Approach to Evaluation of Environmental Consequences). Reasonably foreseeable projects, such as the Pass A Loutre Wildlife Management Area Crevasse Access Project, are included in Section 4.25 Cumulative Impacts. In certain instances (for example, where the birdfoot delta is discussed), other planned restoration projects are mentioned in this analysis. Observed processes such as subsidence and sea-level rise were factored into the model setup (see Section 4.1.3 Overview of DelftD

[53] Land area model results are calculated with a precision of approximately 3.8 acres close to the diversion outfall and 35 acres elsewhere in the model domain, based on computation mesh dimensions. Land area results are estimated by the Water Institute to be accurate within ±200 acres. The calculated uncertainties are reported with the results in tabulated and text presentations of the results. See Appendix E for a more complete explanation of model uncertainties.

Basinwide Model for Impact Analysis and Appendix E for additional information about the Delft3D Basinwide Model).

Based on Delft3D Basinwide Modeling results for the No Action Alternative, the trend of increasing land loss in the Barataria Basin would continue, resulting in the conversion of up to nearly 274,000 acres of emergent wetlands and other subaerial (above the water surface) landforms to subaqueous (below the water surface) shallow water by year 2070 (see Table 4.2-3). This represents a major, permanent, adverse impact on wetlands in the basin. In the birdfoot delta, major, permanent land loss impacts would also occur, with a net loss of about 56,200 acres of emergent wetlands by 2070. Land area in the birdfoot delta would be reduced from 62,800 acres in 2020 to 6,640 acres in 2070. Figure 4.2-1 below depicts the approximate extent of the Delft3D Basinwide Model domain for the Barataria Basin and Mississippi River birdfoot delta. The model-assessed area is outside (on the flood side) of major levee systems that surround the Barataria Basin, for example the NOV-NFL, LGM, and WBV levees (see Appendix E for more information about the Delft3D Basinwide Model). See Section 4.6 Wetland Resources and Waters of the U.S. for additional information about proposed Project impacts on wetlands.

Table 4.2-3
Model-projected Total Land Area[a] under the No Action Alternative

Year	Subtotal Land Area (ac) Barataria Basin Only	Subtotal Land Area (ac) Birdfoot Delta Only	Project Area Total Land Area (Barataria Basin + Birdfoot Delta) (ac)
2020	326,000	62,800	389,000
2030	298,000	43,400	342,000
2040	249,000	26,600	276,000
2050	186,000	17,900	204,000
2060	116,000	10,800	127,000
2070	52,100	6,640	58,700

[a] Modeled land areas and changes have been rounded to three significant digits. Land areas are considered accurate to within ±200 acres.

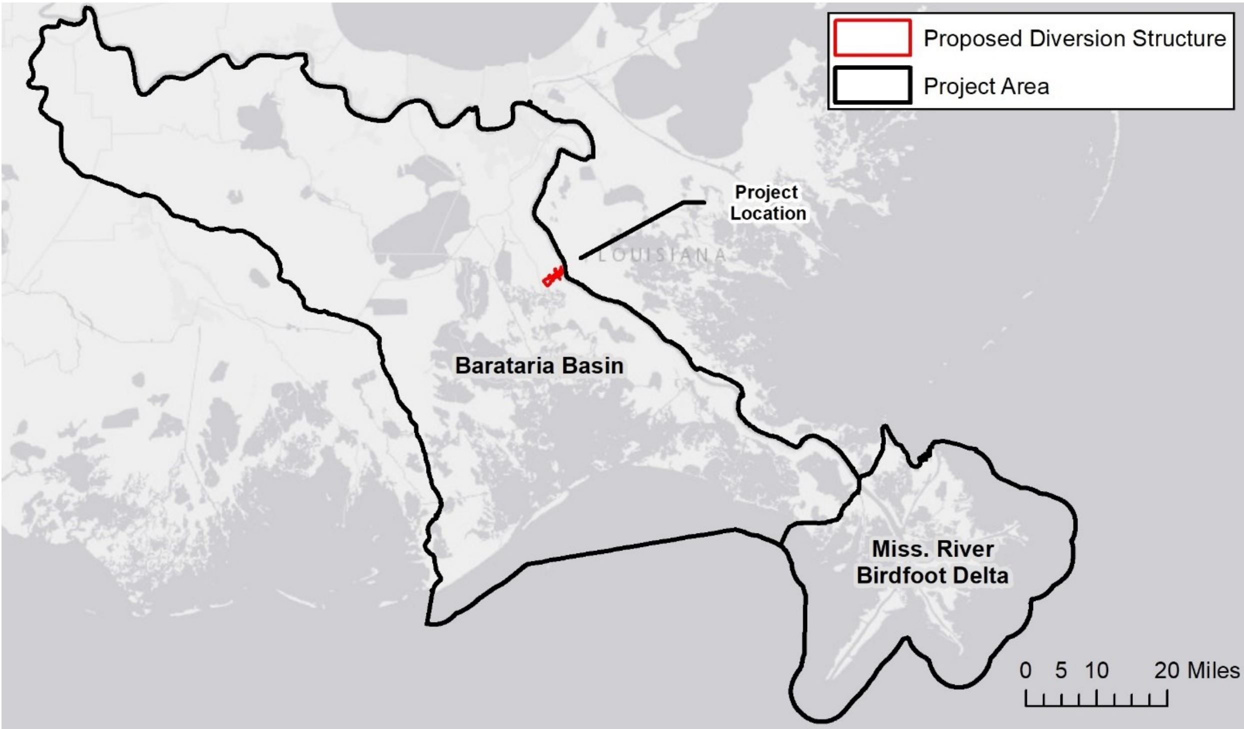


Figure 4.2-1. Approximate Extent of Delft3D Basinwide Model Domain for the Barataria Basin and Mississippi River Birdfoot Delta.

4.2.3.2.2 Applicant's Preferred Alternative

4.2.3.2.2.1 Geology

Operations under the Applicant's Preferred Alternative would directly impact the geology, topography, and geomorphology of the Barataria Basin via the introduction of 5 to 7 million tons of sediment transported through the proposed diversion and deposited in the Barataria Basin annually. This alternative would have permanent, major (readily apparent, widespread), beneficial direct and indirect impacts on land building in the Barataria Basin. However, this sediment deposition and land building would occur against a backdrop of significant land loss across the region due to subsidence and sea-level rise, so that even as diversion operations are increasing sediment deposition and land creation in the outfall area, under the Applicant's Preferred Alternative there is still projected to be a net loss of land across the Barataria Basin and the birdfoot delta between 2030 and 2070. Also, some of the land built by the diversion would be lost over time due to these ongoing processes.

Delft3D Basinwide Modeling for the Barataria Basin yielded estimates of the net change in the volume of sediment retained in the Project area and the resulting change in land over the 50-year analysis period (years 2020 to 2070) of the Applicant's Preferred Alternative relative to the No Action Alternative. Table 4.2-4 summarizes these modeling results, including net changes in sediment volume, total land area, and land area for the Barataria Basin and the birdfoot delta. The percent change values describe percent change in both of these areas as compared with the No Action

Alternative. The proposed Project would introduce significant volumes of sediment into the Barataria Basin, and much of that sediment is expected to be retained, with an expected net addition of 53 mcy of sediment retained in the Project area (Barataria Basin and birdfoot delta) by 2030 and 310 mcy by 2070. In the Project area (Barataria Basin and birdfoot delta), these additions are projected to result in the net creation of 4,980 acres (7.8 square miles) of land by 2030, and 17,300 acres (27.0 square miles) by 2050. In the Barataria Basin portion of the Project area (in other words, not including the birdfoot delta), the diversion is projected to create 6,260 acres of land in the Barataria Basin in its first 10 years and 17,300 acres by year 30 (2050) as compared to the No Action Alternative.

Figures 4.2-2 through 4.2-5 depict maps of the model-projected impacts on land loss and gain in the Project area under the Applicant's Preferred Alternative relative to the No Action Alternative. In the Barataria Basin, the rate of overall land loss is projected to slowly increase until about 2050. The projected rate of land built in just the Barataria Basin (not birdfoot delta) relative to the No Action Alternative peaks around 2050 after which sea-level rise and subsidence would increasingly counter the land building effects of diversion operations, resulting in a net creation of land of 13,400 acres (20.9 square miles) in 2070. Note that while the absolute difference in land area in the Barataria Basin between the Applicant's Preferred Alternative and the No Action Alternative peaks in 2050, the proportion of the projected area remaining as a result of the proposed Project would steadily increase in time. As land loss accelerates, more of the remaining wetland area is attributed to diversion operations (see Figure 4.2-6). See Section 4.1.3.2 Sea-level Rise for more information about sea-level rise projections factored into the Delft3D Basinwide Model for assessment of the Project alternatives.

Table 4.2-4
Delft3D Basinwide Model-projected Cumulative Net Changes in Retained Sediment Volume and Land Area[a] under Action Alternatives Relative to No Action Alternative (NAA)

Year	Project Area Change in Sediment Volume (million cy) Relative to NAA	Project Area Total Land Area (ac) under NAA	Project Area Total Land Area (ac) under Alternative	Project Area Change in Land Area (ac) Relative to NAA	Difference in Land Area (ac and % Change Relative to NAA) – Barataria Basin Only		Difference in Land Area (ac and % Change Relative to NAA) – Birdfoot Delta Only	
75,000 cfs (Applicant's Preferred Alternative)								
2030	53	342,000	347,000	4,980	6,260	2%	-1,280	-3%
2040	103	276,000	288,000	11,900	12,800	5%	-922	-3%
2050	185	204,000	221,000	17,300	17,300	9%	6	0%
2060	261	127,000	142,000	15,800	16,400	14%	-628	-6%
2070	310	58,700	69,100	10,400	13,400	26%	-3,000	-45%
75,000 cfs + Terraces Alternative								
2030	54	342,000	347,000	5,010	6,310	2%	-1,300	-3%
2040	106	276,000	288,000	12,000	12,800	5%	-843	-3%
2050	187	204,000	221,000	17,400	17,200	9%	151	1%
2060	263	127,000	142,000	15,700	16,300	14%	-576	-5%
2070	314	58,700	69,500	10,900	13,800	26%	-2,950	-44%
50,000 cfs Alternative								
2030	40	342,000	345,000	3,630	4,660	2%	-1,030	-2%
2040	78	276,000	285,000	9,440	9,980	4%	-540	-2%
2050	136	204,000	217,000	12,200	12,600	7%	-418	-2%
2060	188	127,000	138,000	10,600	11,600	10%	-979	-9%
2070	219	58,700	65,500	6,840	9,660	19%	-2,820	-42%
50,000 cfs + Terraces Alternative								
2030	41	342,000	345,000	3,900	4,880	2%	-977	-2%
2040	78	276,000	285,000	9,190	9,960	4%	-774	-3%
2050	137	204,000	217,000	12,500	12,900	7%	-392	-2%
2060	186	127,000	138,000	10,900	12,000	10%	-1,070	-10%
2070	217	58,700	65,800	7,070	9,860	19%	-2,790	-42%
150,000 cfs Alternative								
2030	91	342,000	350,000	8,670	11,200	4%	-2,530	-6%
2040	185	276,000	295,000	19,900	22,100	9%	-2,190	-8%
2050	311	204,000	235,000	30,400	31,400	17%	-1,000	-6%
2060	444	127,000	157,000	30,700	32,400	28%	-1,670	-15%
2070	564	58,700	85,100	26,400	29,200	56%	-2,820	-42%
150,000 cfs + Terraces Alternative								
2030	93	342,000	350,000	8,550	11,100	4%	-2,550	-6%
2040	187	276,000	295,000	19,700	22,000	9%	-2,280	-9%
2050	312	204,000	234,000	30,400	31,400	17%	-979	-5%
2060	445	127,000	157,000	31,100	32,600	28%	-1,500	-14%
2070	569	58,700	85,300	26,600	29,100	56%	-2,500	-38%

Table 4.2-4
Delft3D Basinwide Model-projected Cumulative Net Changes in Retained Sediment Volume and Land Area[a] under Action Alternatives Relative to No Action Alternative (NAA)

Year	Project Area Change in Sediment Volume (million cy) Relative to NAA	Project Area Total Land Area (ac) under NAA	Project Area Total Land Area (ac) under Alternative	Project Area Change in Land Area (ac) Relative to NAA	Difference in Land Area (ac and % Change Relative to NAA) – Barataria Basin Only	Difference in Land Area (ac and % Change Relative to NAA) – Birdfoot Delta Only
a	Modeled land areas and changes have been rounded to three significant digits. Land areas are considered accurate to within ±200 acres. That produces an estimated error of ±300 acres in the land change difference values and an average ±3 percent in percent land change values.					

The direct and indirect impacts on land building in the birdfoot delta are more nuanced. As mentioned above, under the No Action Alternative, the birdfoot delta would experience permanent, major, adverse land loss due to subsidence and sea-level rise, decreasing from 62,800 acres in 2020 to 6,640 acres in 2070. Under the Applicant's Preferred Alternative, sediment diverted into the Barataria Basin would not be available for potential land building in the birdfoot delta. Because of this, the proposed Project would increase the rate of this loss in the birdfoot delta. The diversion is also projected to change the water flow downriver. This change in flow is projected to further increase the land loss in the birdfoot delta, as illustrated in Figure 4.2-7. Under the Applicant's Preferred Alternative, land area in the birdfoot delta would be reduced by an additional 3,000 acres to 3,640 acres in 2070. The changes in land area in the birdfoot delta between the Applicant's Preferred Alternative and the No Action Alternative would be relatively minor for (3 to 6 percent) during the first 40 years (4 decades) of operations and by 45 percent in the fifth decade of operations; see Table 4.2-4 and Figure 4.2-7). Indeed, in 2050, there would be no difference in land loss between the Applicant's Preferred and No Action Alternative. The greatest difference between the Applicant's Preferred Alternative and the No Action Alternative is projected to occur in operational year 2070 (see Figure 4.2-7, right panel). These changes represent permanent, minor, and adverse impacts for the first four decades of operation – rising to permanent, moderate, and adverse impacts by 2070.

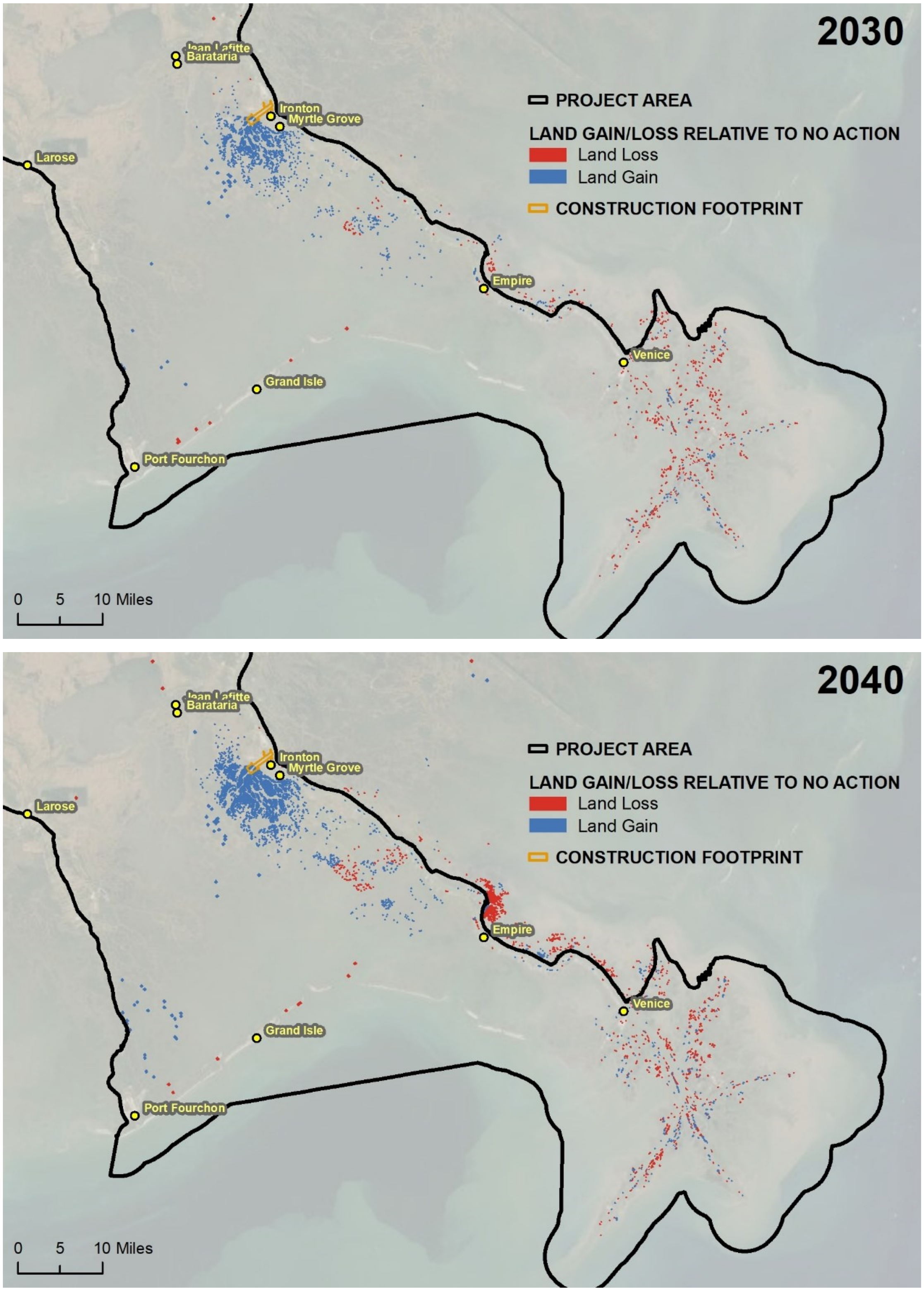
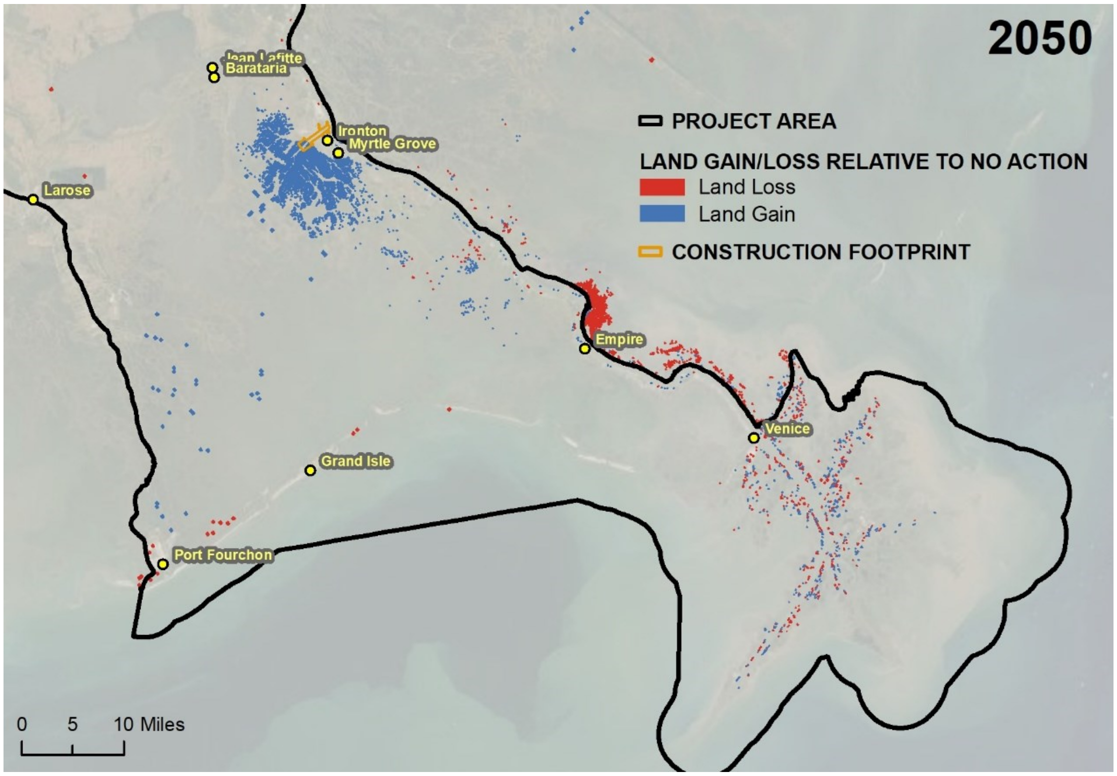


Figure 4.2-2. Model-projected Land Loss and Gain in the Project Area Relative to the No Action Alternative in 2030 and 2040 under the Applicant's Preferred Alternative. Map depicts all model results but results in Table 4.2-4 only tabulated within the Project area, depicted above.



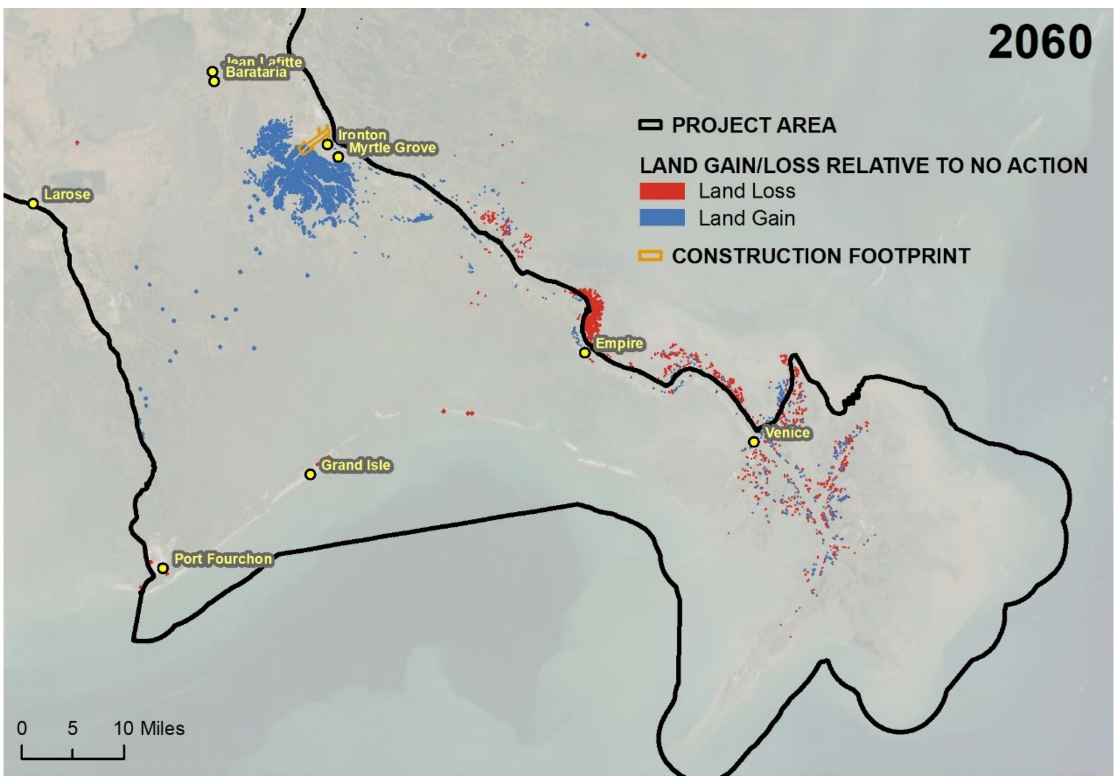


Figure 4.2-3. Model-projected Land Loss and Gain in the Project Area Relative to the No Action Alternative in 2050 and 2060 under the Applicant's Preferred Alternative. Map depicts all model results but results in Table 4.2-4 only tabulated within the Project area, depicted above.

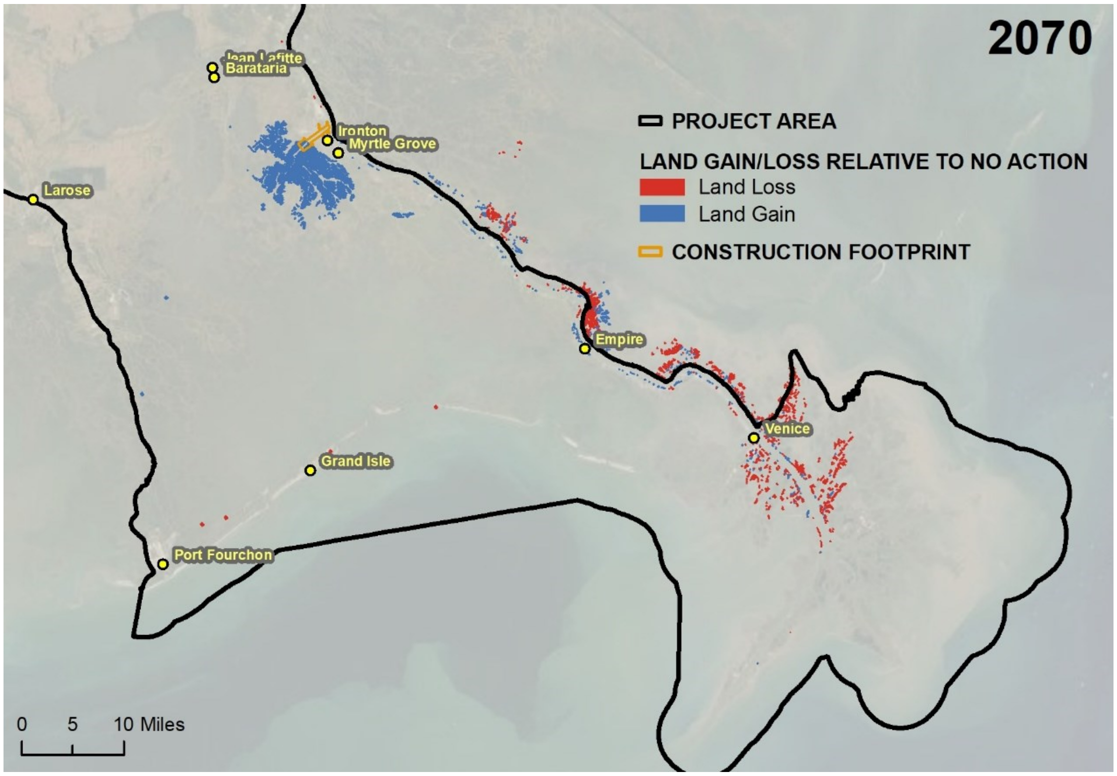


Figure 4.2-4. Model-projected Land Loss and Gain in the Project Area Relative to the No Action Alternative in 2070 under the Applicant's Preferred Alternative. Map depicts all model results but results in Table 4.2-4 only tabulated within the Project area, depicted above.

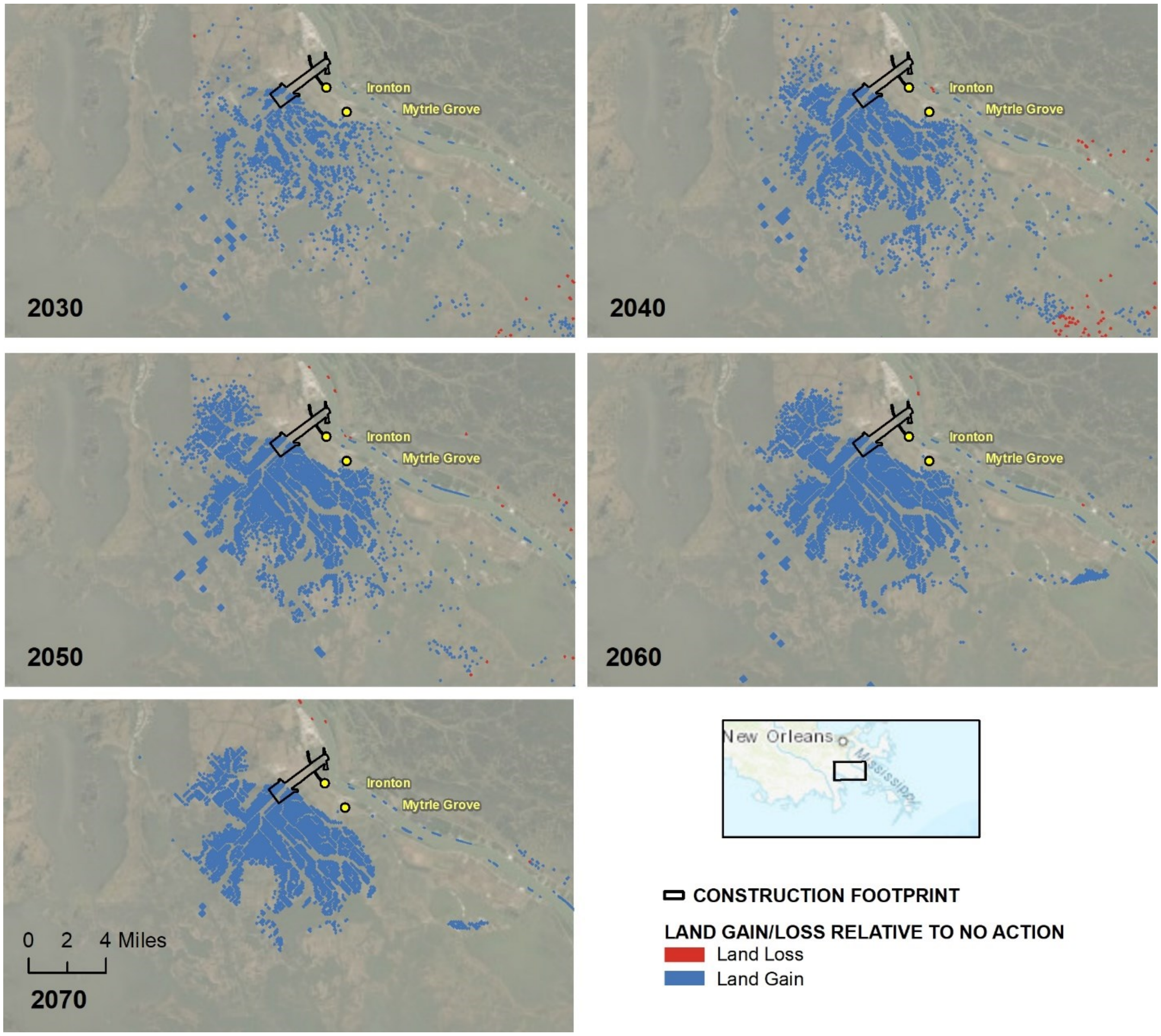


Figure 4.2-5. Model-projected Land Loss and Gain in the Immediate Vicinity (within 0.5-mile) of the Outfall Area Relative to the No Action Alternative in 2030, 2040, 2050, 2060, and 2070 under the Applicant's Preferred Alternative.

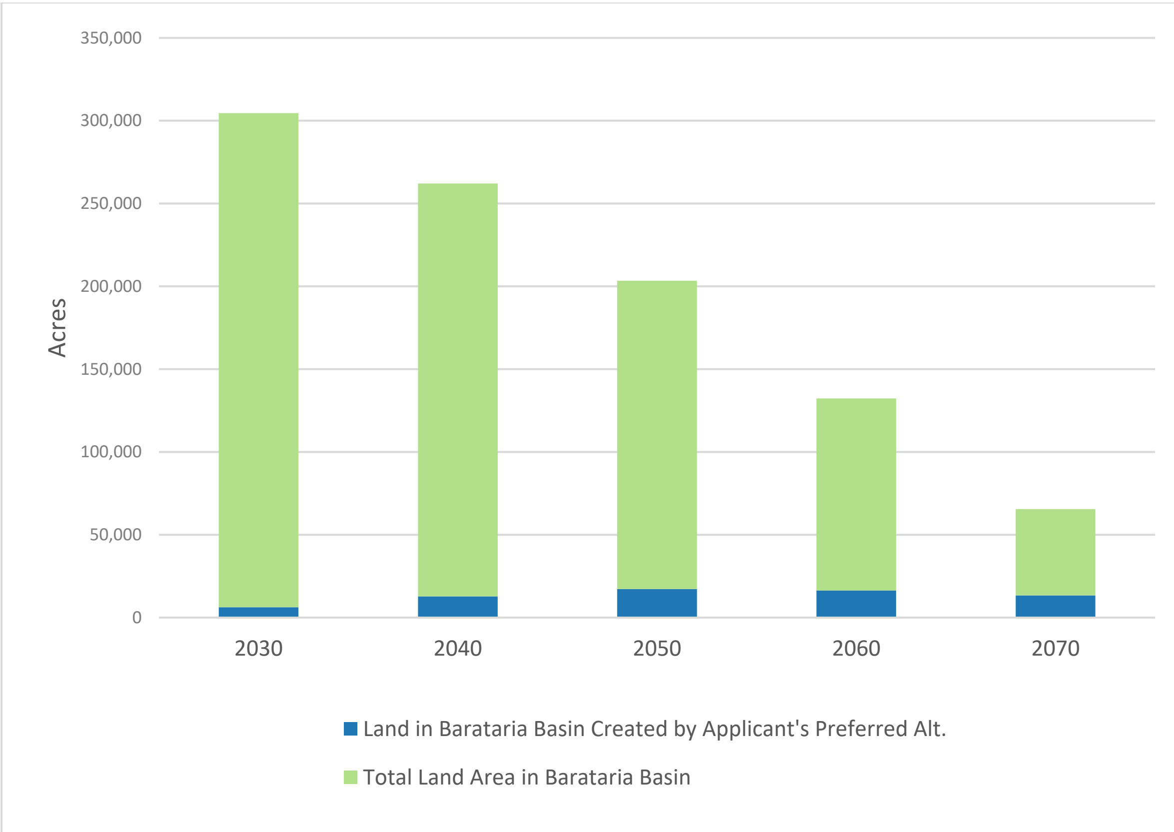


Figure 4.2-6. Model-projected Land Area in the Project Area in the Barataria Basin under the Applicant's Preferred Alternative, and Fraction of the Remaining Area due to the Proposed Project.

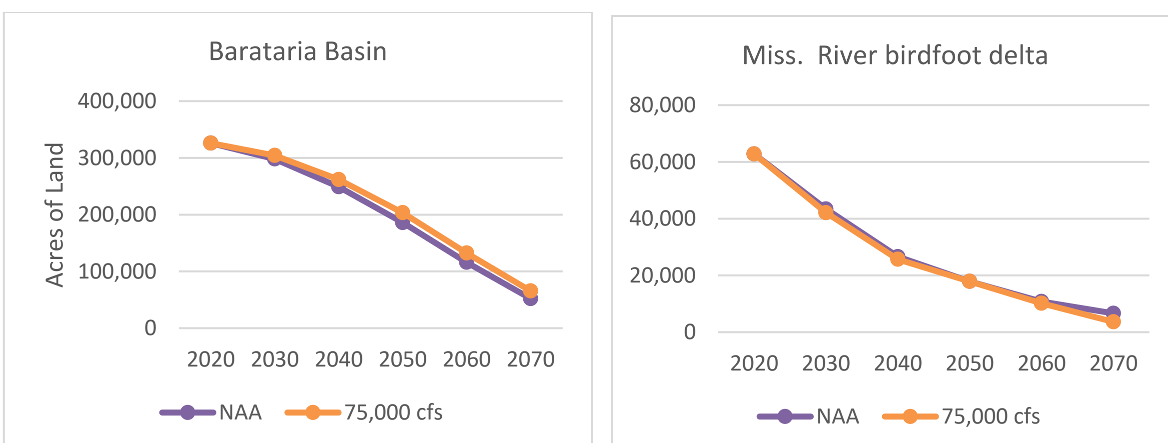


Figure 4.2-7. Model-projected Change in Land Area in the Project Area in the Barataria Basin (left) and Mississippi River Birdfoot Delta (right) under the No Action Alternative and the Applicant's Preferred Alternative.

These impacts in the birdfoot delta may potentially be minimized by improving the capture of sediment that is lost to the Gulf through targeted restoration projects, such as the ongoing Delta-wide Crevasse Program under CWPPRA. By 2070, the impacts of the Applicant's Preferred Alternative in the birdfoot delta appear relatively large because the impacts of sea-level rise and subsidence become predominant and even small changes in wetland acreage represent a large portion of what remains. Loss of sediment from the river via the diversion into the Barataria Basin would not alter the long-term trend of continuing land loss in the birdfoot delta, but it would increase the rate of loss during the last decade of the Project analysis period (2060 to 2070; see Figure 4.2-7). These impacts may be minimized by the foreseeable continuation of other ongoing restoration projects. For more information about reasonably foreseeable projects in the Project area, see Section 4.25 Cumulative Impacts. Please refer to Section 4.4 Surface Water and Coastal Processes for additional discussion about bathymetry impacts in the Project area. Refer to Section 4.17 Public Lands for discussion about land building impacts in the Delta National Wildlife Refuge, which is located in the birdfoot delta.

The Applicant's Preferred Alternative would have indirect impacts on land change in Breton Sound (to the east of the Project area) that would be permanent, minor to moderate, and adverse (see Figures 4.2-2 through 4.2-4). In year 2030, the proposed Project would cause a net loss of 148 acres of land within Breton Sound due to available sediment being diverted from the river to the proposed diversion (see Appendix E), representing a decrease in land of 0.1 percent of total land in Breton Sound compared to the No Action Alternative. By year 2070, the proposed Project would result in a reduction in land of 2,130 acres, representing a 17.6 percent decrease in total land in Breton Sound compared to the No Action Alternative. Restoration projects planned for Breton Sound would help to counteract land loss in this area. See Section 4.25 Cumulative Impacts for information about reasonably foreseeable projects in the area.

The sediment transported into the Barataria Basin by diverted flow would differ in character from existing surficial sediments in the outfall area, resulting in short-term to permanent, moderate, direct and indirect impacts that may be adverse or beneficial due to this change in sediment type. Core data reveal that marsh substrates in the mid-basin generally consist of organic-rich marsh soils to about 5 feet below the marsh surface (Meselhe et al. 2015). At greater depths, more consolidated material predominates, with generally increased sediment bulk density and decreased organic content. These deeper soils vary, but generally consist of approximately 15 percent sand, 55 percent silts, and 30 percent clays, and are generally finer, with a smaller sand and higher clay content, than typical surficial and down-core grain size distributions farther gulfward in the Barataria Basin (Xu et al. 2016). Modeling carried out by the Water Institute in 2019 indicates that sediments transported into and retained in the outfall area under the Applicant's Preferred Alternative are projected to consist of between 14 and 20 percent sand and between 86 to 80 percent fines. Sand-rich sediment loads are preferred for land building from diversions (Brown et al. 2013). While both of these relative grain size fractions are within the bounds of typical grain sizes observed in Louisiana bays and estuaries (Xu et al. 2016), the sediments retained and deposited within the outfall area by the proposed Project would initially be coarser and less consolidated than existing surface sediments, with a larger sand fraction, greater bulk density, and lower organic content. It is expected that, over time, this newly deposited sediment would compact, increase in organic content due to marsh vegetation growth, and decrease in bulk density (Wheelock 2003), representing permanent, moderate, beneficial impacts.

Preliminary modeling (Meselhe et al. 2014) efforts indicate that upon Project initiation, sand and coarser-grained sediments would be deposited in the outfall area within 0.5-mile of the diversion, and finer-grained sediment would be deposited farther gulfward in the basin. These newly introduced sediments would be deposited in shallow bays and ponds and contribute to marsh creation and land building. Sediments would also be deposited on the surface of existing emergent marsh platforms in the outfall area and would likely contribute to grain size changes, with higher sand content and increased bulk densities (Carpenter et al. 2007). There is evidence from other projects involving the placement of mineral sediments atop existing organic marsh soils that such deposition may have beneficial impacts for existing marsh vegetation (see, for example, Ford et al. 1999, Mendelssohn and Kuhn 2003). However, whether impacts on existing marsh are beneficial or adverse would depend upon careful control of the thickness of newly deposited sediments and the rate at which they are deposited (Ray 2007), particularly on freshwater marsh communities (Jurik et al. 1994). Because the thickness and rate at which sediment would be deposited on existing marsh soils during proposed Project operations would not be controlled, the nature of these impacts on marsh soils in the Project area may be either beneficial or adverse. Finer-grained silts and clays introduced into the Barataria Basin would also play an important role in nourishing and sustaining existing wetlands further removed from the immediate outfall area even if they are less likely to contribute directly to land building. See Section 4.6 Wetland Resources and Waters of the U.S. for additional discussion about Project impacts on existing wetlands, and Section 4.2.5 for additional details about impacts of Project operation on soils and soil profiles.

As described in more detail in Appendix E, a different sea-level rise rate assumption would change modeled land building impacts in the basin and birdfoot delta under the Applicant's Preferred Alternative such that a higher rate of sea-level rise would result in reduced land building and a lower rate of sea-level rise would result in increased land building.

4.2.3.2.2.2 Topography

In general, diversion operations would result in substantial increases in the sediment bed elevations in the vicinity of the outfall area – primarily within 5.0 to 10.0 miles from the mouth of the diversion channel. Figures 4.2-3 through 4.2-6 depict these land building changes across the entire Project area. Please refer to Section 4.4 Surface Water and Coastal Processes for details about bathymetry increases due to the proposed Project. In addition, during the first decade of operation, and throughout the 50-year analysis period, preliminary Project plans include maintenance dredging in the diversion complex and basin adjacent to the mouth of the diversion channel to manage sedimentation in the channel and tailwater elevations in order to achieve target flows. Specific areas for dredging in the basin have not been identified but would likely occur within a mile of the outfall transition feature and would result in short-term, minor, adverse direct impacts on the specific areas dredged, but permanent, moderate, beneficial direct impacts on land building in the larger outfall area.

4.2.3.2.2.3 Geomorphology

The existing surficial geomorphology of the outfall area consists of a network of Holocene-era abandoned distributaries and their associated natural levees separated by swamps, interdistributary marshes, lakes, bays, and ponds. The present landforms in the outfall area are deltaic in origin, formed originally as part of the historic St. Bernard and Plaquemines-Balize delta lobes, but they have been modified by relatively long periods with no exposure to the significant hydrodynamic forces present during active delta building. They have also been modified by substantial subsidence and land loss and have been dissected by man-made oil and gas canals. Further, access dredging and other construction activities conducted in the Barataria Basin outfall area during construction of the proposed Project would likely modify the area immediately adjacent (within 0.5-mile) to the outfall transition feature as well, resulting in further conversion of emergent marsh to shallow-bay bottom prior to commencement of operations. As such, new deltaic landforms and marsh surfaces created during Project operations would likely have substantially different characteristics from existing relict delta lobe marshes and shallow bays in the outfall area (Reed 2002). In general, diversion operations would result in permanent, major, beneficial direct and indirect impacts on the geomorphology of the area, in that new deltaic landforms and marsh platforms would be the result of the reconnection of the river to its receiving basin. Diversion operations would necessarily result in permanent, minor, adverse direct impacts on the existing but less desirable landforms (primarily shallow-bay bottom), in that these landforms would be permanently modified or altered.

Modeling results by Meselhe et al. (2014) estimate development of a bifurcating channel network characteristic of deltaic splay deposits within 5 years of the start of diversion operations, assuming sufficient river flows during those years for operation of the diversion. These preliminary modeling efforts indicate that, upon Project initiation, sediments would form a subaqueous delta just below the low tide water level. Over time, the delta would expand to form a delta above the low tide water level, expanding the subaqueous delta farther gulfward into the basin. Fine-grained sediments transported by the diversion would travel farther from the sediment deposition area and be dispersed throughout the Project area.

Studies of other diversions in south Louisiana (including the Wax Lake Outlet; the Caernarvon Freshwater, Davis Pond Freshwater, and West Bay Diversions; the Bohemia and Bonnet Carré Spillways; and Mardi Gras Pass) are instructive in estimating likely geomorphic impacts from diversion operations. All of these examples have both similarities and differences with the proposed MBSD Project, but can help inform the analysis and evaluation of the proposed Project alternatives' impacts on geomorphology.

These examples indicate that diversion operations often yield development of landforms similar to natural deltaic crevasse splay systems (Lopez et al. 2014, Shaw and Mohrig 2014, Yuill et al. 2016, Amer et al. 2017). However, these processes do not occur instantaneously (Paola et al. 2011). Figures 4.2-8 through 4.2-10 depict the evolution of bifurcating crevasse splay and other deltaic depositional landforms for the Wax Lake Outlet and the Caernarvon and West Bay Diversions after initiation of flow, as visualized by historical and current aerial imagery.

The West Bay Diversion was constructed specifically for land building and, although the West Bay Diversion has been supplemented with beneficial use of dredged material, is a reasonable analogue for geomorphologic impacts that may be expected as a result of MBSD Project diversion operations. At the West Bay Diversion, there was significant natural morphologic evolution during the first decade of operation, with initial dominance of erosional processes within the channel and receiving basin that eventually gave way to depositional processes as mouth bars and above- and below-water distributary networks (Yuill et al. 2016). Similar experience at other diversions indicates that it may take 5 to 10 years for stable deltaic landforms to develop. The West Bay Diversion, however, is uncontrolled, supplemented with beneficial use of dredged material, and discharges to a smaller receiving basin with different bathymetry, geometry, and hydrology than the Project receiving area and with different Mississippi River sediment dynamics than the Project location. As such, Project diversion operations may result in a more rapid, or different land building and morphologic evolution than this example.

Meselhe et al. (2015) identified the Caernarvon Diversion as the best physical analogue for the proposed Project due to similarities in receiving basin soils, vegetation, and hydrology for purposes of model development and calibration. The Caernarvon Diversion, however, is substantially smaller than the volume under the Applicant’s Preferred Alternative (maximum capacity is approximately 8,000 cfs) and captures a relatively small fraction of the river sediment load because the diversion inlet is located in the outer bank of a meander bend. Other diversion analogues also differ notably from the proposed Project in that they are either uncontrolled, involve smaller volumes of water higher in the water column, are operated for purposes other than land building (flood or salinity control), or have significantly different inflow or receiving area geometry, morphology, and bathymetry (see Appendix U Summary of Select Natural and Man-made Diversions in Southeastern Louisiana). For these reasons, delta formation in the proposed Project outfall area predicted by the model may occur faster or slower than observed in the analogue projects once Project operation begins.

Figure 4.2-8. Google Earth Imagery Depicting Progression of Landform Development in the Wax Lake Outlet Delta between 1972 (left) and 2017 (right). Outlet opened in 1942. Red arrow indicates outlet mouth. Note extensive development of bifurcating channels, deltaic crevasse splay systems, and emergent marshes between 1972 and 2017, as identified within the red hatching on the right panel.

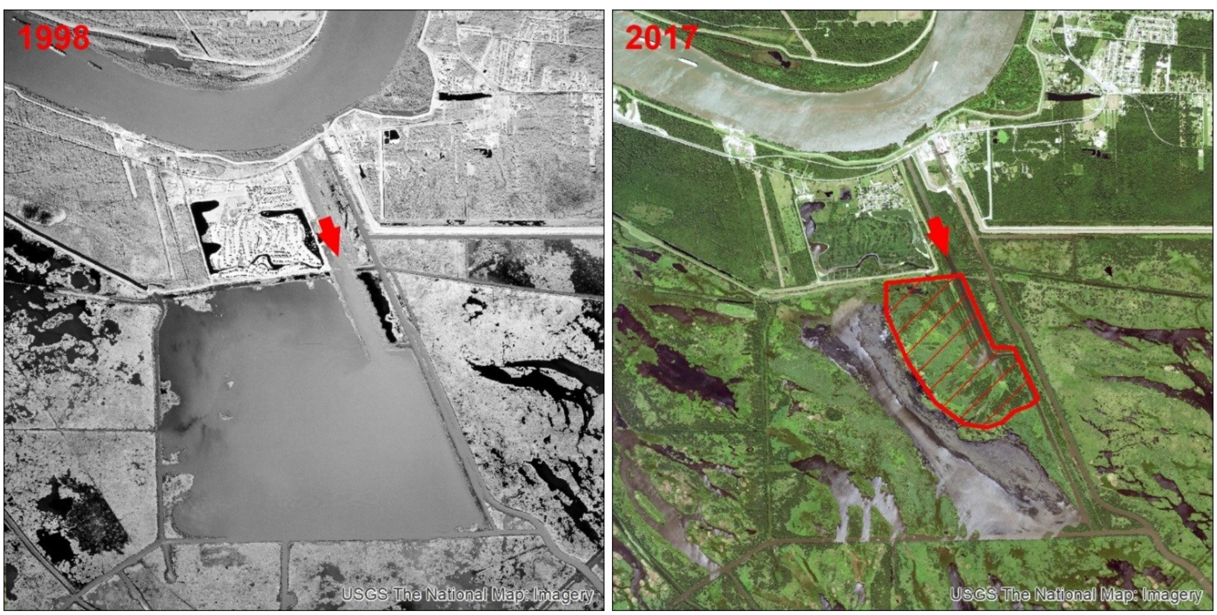


Figure 4.2-9. Google Earth Imagery Depicting Progression of Landform Development in the Vicinity of Caernarvon Diversion, in the Big Mar Receiving Basin between 1998 (left) and 2017 (right). Diversion opened in 1991. Red arrow indicates diversion mouth. Note development of small deltaic system as identified within the red hatching on right. Some material to the southwest in Big Mar was deposited as a result of Hurricane Katrina in 2005, and not by diversion operations.

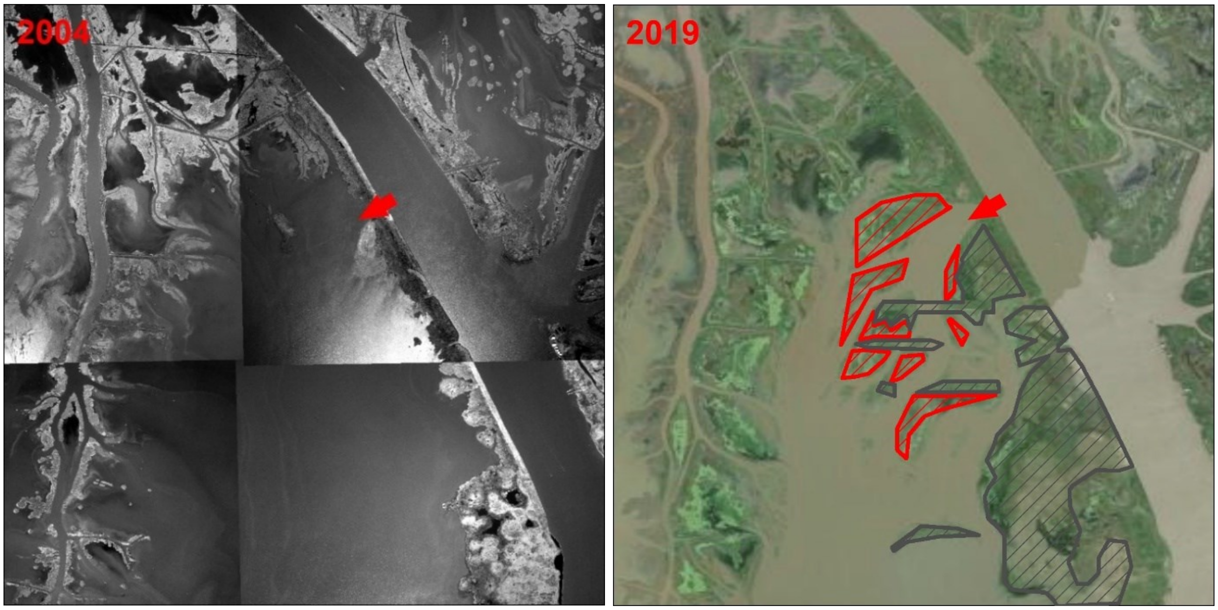
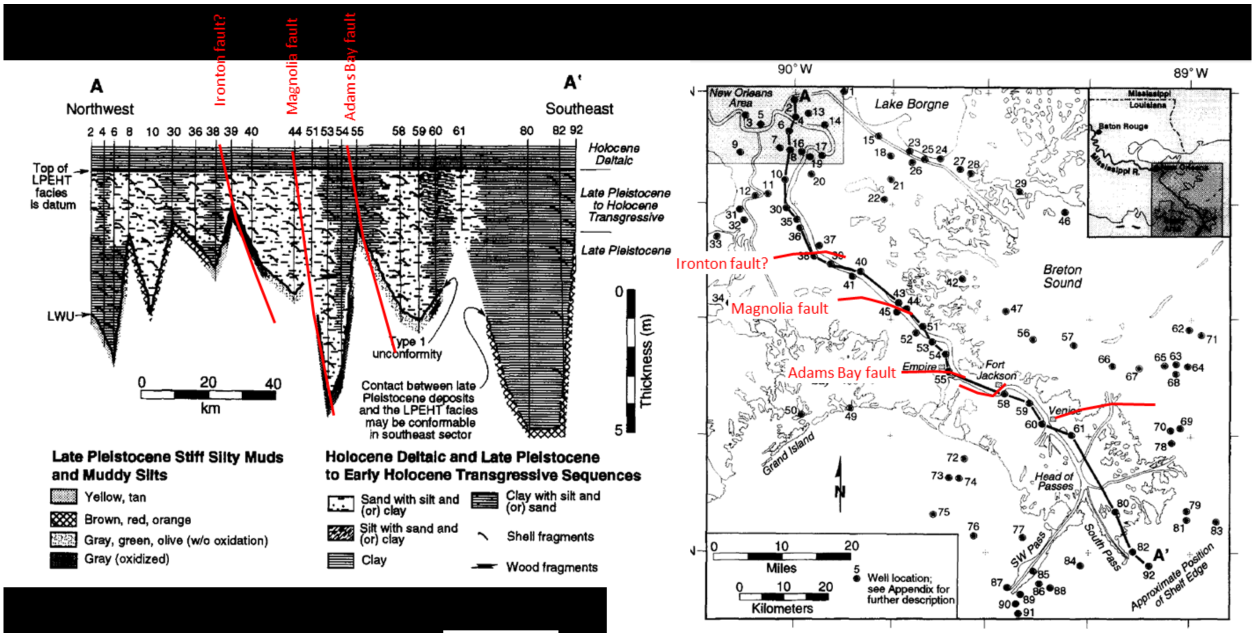


Figure 4.2-10. Google Earth Imagery Depicting Progression of Landform Development in the Vicinity of the West Bay Diversion between 2004 (left) and 2019 (right). Diversion opened in 2003. Red arrow indicates diversion mouth. Note development of small deltaic crevasse splay systems as identified within the red hatching on right. Some material visible in 2019 identified by gray hatching was deposited as beneficial use placement from dredging and not by processes associated with diversion (Google Earth Imagery 2004 and 2019) (Plitsch 2017).

4.2.3.2.2.4 Faulting

As described in Chapter 3, Section 3.2 Geology and Soils, subsurface faults have been identified through seismic surveys in the Barataria Basin, with one estimated to be north of Port Sulphur and two near Empire (see Figure 4.2-11). Concerns were raised in public scoping comments about the potential presence of an additional fault near the proposed Project construction footprint, called the Ironton fault, which was identified by McLindon et al. (2017) (see Figure 4.2-11). Figure 4.2-11 includes the cross-section of the shallow (25 feet below the surface) sediments as determined from sediment cores taken along the west bank of the Mississippi River (Stanley et al. 1996). The red lines are where McLindon et al. (2017) added the Adams Bay and Magnolia faults and a potentially active new fault, the Ironton fault, in the vicinity of the location proposed for the Project diversion channel. Although no surficial fault lines indicating recent episodic activity have been identified in the Project area, McLindon et al. (2017) suggest that these unidentified faults could affect future subsidence rates in the Project area.



Source: Stanley et al. (1996), McLindon et al. (2017)

Figure 4.2-11. Potential Locations of Unidentified Faults in the Barataria Basin. (Left) Cross-section of the shallow sediments (to 25 feet below the surface) from sediment cores taken on the west bank of the Mississippi River. (Right) Location of the sediment core transect. Red lines were added by McLindon et al. (2017) to show the location of known and potential active faults.

There are two concerns about how faulting could affect the proposed Project: (1) through episodic movement along a fault that would lower the land surface by inches to feet over the 50-year analysis period, and (2) fault movement that could be induced by the weight of the proposed diversion structure and the added sediment load diverted into the Barataria Basin during Project operations. The concern is that natural or induced subsidence could increase the rate of wetland loss in the basin if bed elevations fall below the elevation needed to support wetland survival. Subsidence could also lower the proposed diversion guide levees, thereby increasing flooding risks.

Regarding the potential for fault movement in the Project area, there is an increasing awareness that geologic faulting can be a significant contributor to land loss in Louisiana (Gagliano 2005c, Gagliano et al. 2003a, b, Dokka 2006). McLindon et al. (2017) suggest that the high historical rates of wetland loss in the Project area indicate the possible surface expression of the Ironton fault. However, there is insufficient information on which to evaluate the impact of faulting on the proposed Project or the impact of the proposed Project on future fault movement.

Regarding fault movement and sediment compaction induced by the additional weight of the proposed Project diversion structure and/or sediment load from the proposed Project, data are only available for sediment compaction. Törnqvist et al. (2008) found a linear relationship between overburden thickness and compaction rates in Holocene peat deposits, with compaction rates of approximately 0.04 inches/year (1.0 millimeter/year) for overburden thicknesses of 6.5 feet. The Delft3D Basinwide

Modeling results for the Project alternatives indicate net increases in bed elevation after 50 years of operation that range from more than 10 feet closest to the outfall to 0.2 through 0.5 foot over larger areas (Sadid et al. 2018).

If episodic faulting and consequent surface displacement that resulted in lowering of the marsh surface in the Project area occurred, such lowering would be considered permanent, major, adverse impacts due to diversion operations over the 50-year analysis period as a result of the potential for increased wetland loss and flooding risks. McLindon et al. (2017) present a framework for probabilistic estimates of the likelihood of fault slip events of the Ironton fault during the 50 years over which the Project impacts are evaluated. The authors conclude that there is a small possibility that a slip event may occur, and smaller possibility that an event with a magnitude of 1 foot of vertical offset would occur during this period. However, it remains unclear if any of the action alternatives would necessarily contribute to increased fault slip probability. Although additional seismic data and sediment cores could be collected to map historical subsurface faults and to document recurrence intervals of past subsurface fault movements, this information would not necessarily enable improved predictions of the occurrence, location, magnitude, or timing of future fault movements in the Project area. This uncertainty is due to the following factors: (1) there are no surficial fault lines indicating recent episodic activity in the Project area, and (2) there is insufficient understanding of the factors that could trigger elevation changes at the surface if a fault were present, with or without the proposed Project. Furthermore, the potential consequences of faulting would be similar among all alternatives; therefore, gathering additional information on these potential impacts is not essential to a reasoned choice among alternatives.

4.2.3.2.3 Other Alternatives

Ongoing diversion operations under the five other action alternatives would cause similar direct and indirect impacts, beneficial and adverse, on the geology, topography, and geomorphology of the Barataria Basin and birdfoot delta. As compared with the No Action Alternative, diversion operations under these other action alternatives would similarly have permanent, major, beneficial impacts in the Barataria Basin via land building, and permanent, moderate, adverse impacts in the birdfoot delta by exacerbating land loss. The other action alternatives differ from the Applicant's Preferred Alternative in either flow volume and/or the presence of constructed marsh terraces, and these two factors would both modify the impacts on the receiving basin in some way. While these resulting impacts would be moderate under all of the action alternatives, they would differ somewhat from the Applicant's Preferred Alternative in scale and extent. Table 4.2-5 summarizes model-projected net changes in land area for each action alternative relative to the No Action Alternative in each decade. Figures 4.2-12 through 4.2-14 depict model-projected impacts on land loss and gain in the Project area relative to the No Action Alternative in 2070 for each evaluated alternative. Differences are summarized for each action alternative below.

Table 4.2-5
Model-projected Total Land Area Under No Action Alternative (NAA) and Net Changes in Land Area (ac) Relative to NAA under All Alternatives

Year	Total Land Under NAA	Net Changes in Land Area (ac) Relative to No Action Alternative					
		75,000 cfs	75,000 cfs + Terraces	50,000 cfs	50,000 cfs + Terraces	150,000 cfs	150,000 cfs + Terraces
2030	470,000	4,980	5,010	3,630	3,900	8,670	8,550
2040	371,000	11,900	12,000	9,440	9,190	19,900	19,700
2050	263,000	17,300	17,400	12,200	12,500	30,400	30,400
2060	158,000	15,800	15,700	10,600	10,900	30,700	31,100
2070	76,400	10,400	10,900	6,840	7,070	26,400	26,600

4.2.3.2.3.1 50,000 cfs Alternative

The 50,000 cfs Alternative would have permanent, major, beneficial impacts on the geology, topography, and geomorphology of the Barataria Basin via land building, and permanent, moderate, adverse impacts in the birdfoot delta by exacerbating land loss. The impacts from operation and maintenance of the 50,000 cfs Alternative would result in an increase of about 9,660 acres of land area within the Barataria Basin, or a 19 percent increase over the No Action Alternative in year 2070 (see Table 4.2-4). Conversely, because sediments transported by the alternative would be diverted away from the birdfoot delta, that area would experience an additional projected land loss of 2,820 acres of land area, a 42 percent decrease by 2070 as compared with the No Action Alternative (see Table 4.2-4), representing moderate, permanent, adverse impacts. The nature of the impacts in the birdfoot delta under this alternative is qualitatively similar to those under the Applicant's Preferred Alternative. See the description of these impacts above for more information.

As might be expected, the Delft3D Basinwide Modeling results indicate that the reduced maximum flow volume of the 50,000 cfs Alternative would result in less sediment delivered to the outfall area and fewer acres of land built as compared with the Applicant's Preferred Alternative (see Tables 4.2-4 and 4.2-5). The 50,000 cfs Alternative yields roughly 68 percent of the land building of the Applicant's Preferred Alternative (see Figure 4.2-12).

The 50,000 cfs Alternative would have indirect impacts on land loss in Breton Sound (to the east of the Project area) that would be permanent, minor, and beneficial in year 2030, when the proposed Project is projected to result in a net gain of 100 acres of land in Breton Sound (see Figures 4.2-3 through 4.2-5). By year 2070, the proposed Project would result in a reduction in land of 1,221 acres, representing a 10.1 percent decrease in total land in Breton Sound compared to the No Action Alternative, subject to the caveats stated above.

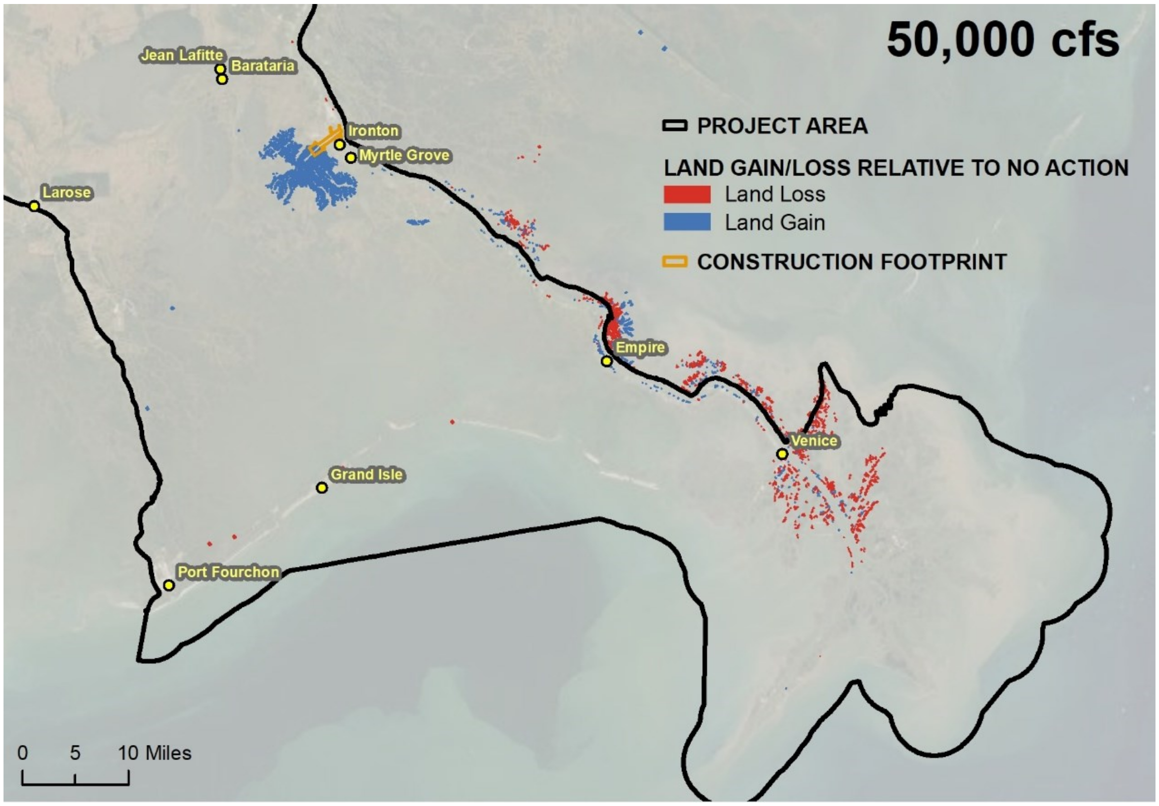


Figure 4.2-12. Model-projected Land Loss and Gain in the Project Area Relative to the No Action Alternative in 2070 under the 50,000 cfs Option. Map depicts all model results but results in Table 4.2-4 only tabulated within the Project area, depicted above.

4.2.3.2.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative would have permanent, major, beneficial impacts on the geology, topography, and geomorphology of the Barataria Basin via land building, and permanent, moderate, adverse impacts in the birdfoot delta by exacerbating land loss. The impacts from operation and maintenance of the 150,000 cfs Alternative would result in an increase of about 29,200 acres of land area within the Barataria Basin, or a 56 percent increase over the No Action Alternative in year 2070 (see Table 4.2-4). Conversely, because sediments transported by the alternative would be diverted away from the birdfoot delta, that area would experience an additional projected land loss of 2,820 acres of land area, a 42 percent decrease by 2070 as compared with the No Action Alternative. Impacts would be less than the Applicant's Preferred Alternative in the birdfoot delta[54] (see Table 4.2-4), representing moderate, permanent, adverse impacts. The nature of the impacts in the birdfoot delta under this alternative is

[54] Under each action alternative scenario, the Delft3D Basinwide Model predicts a levee breach along the Mississippi River and the subsequent emergence of a crevasse splay in the southern part of Breton Sound, which would change the availability of sediment for land building in the birdfoot delta. The timing of this development is projected to vary among alternatives and is the reason that impacts on the birdfoot delta would be less in 2070 under the 150,000 cfs and 150,000 cfs + Terraces Alternatives than the Applicant's Preferred Alternative.

qualitatively similar to those under the Applicant's Preferred Alternative. See the description of these impacts above for more information.

The magnitude of these impacts is generally similar in the birdfoot delta but differ significantly from the Applicant's Preferred Alternative in the Barataria Basin. As might be expected, the Delft3D Basinwide Modeling results indicate that the increased maximum flow volume of the 150,000 cfs Alternative would result in more sediment delivered to the outfall area and more acres of land building as compared with the Applicant's Preferred Alternative (see Tables 4.2-4 and 4.2-5). The 150,000 cfs Alternative yields an increase of roughly 273 percent in land building as compared with the Applicant's Preferred Alternative (see Figure 4.2-13).

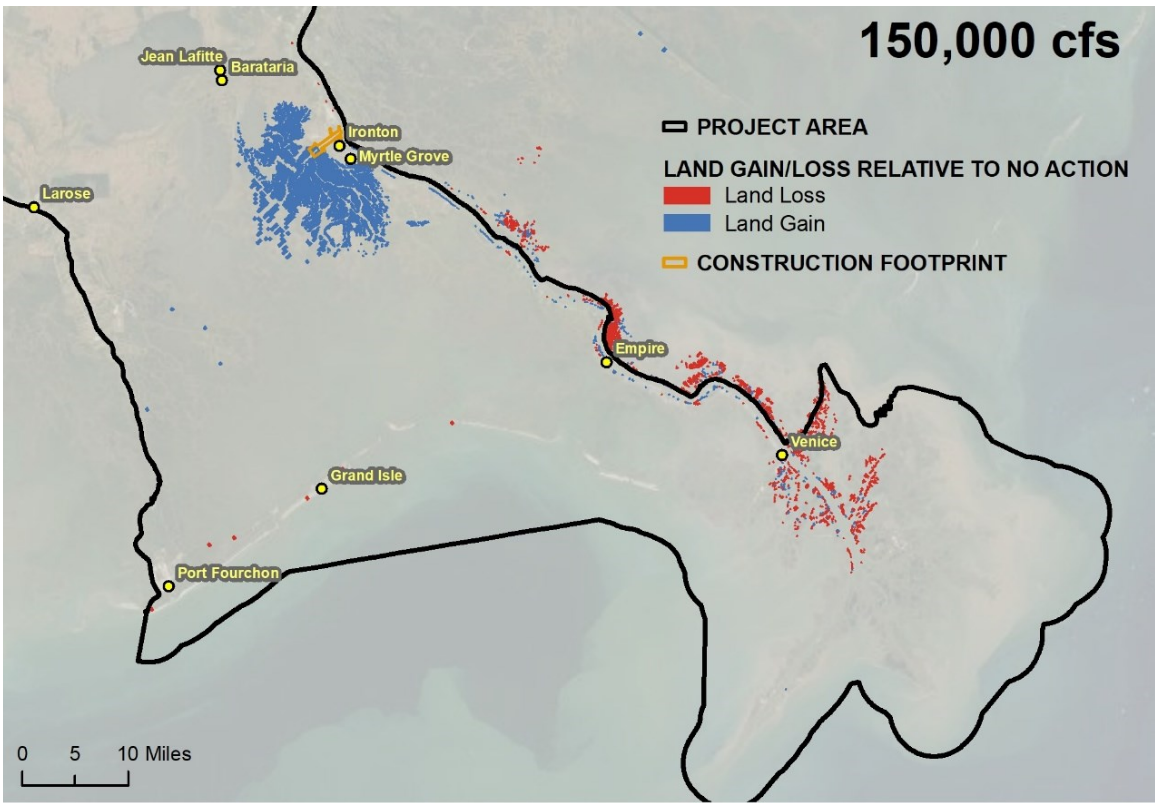


Figure 4.2-13. Model-projected Land Loss and Gain in the Project Area Relative to the No Action Alternative in 2070 under the 150,000 cfs Option. Map depicts all model results but results in Table 4.2-4 only tabulated within the Project area, depicted above.

The 150,000 cfs Alternative would have indirect impacts on land loss in Breton Sound (to the east of the Project area) that would be permanent, minor to moderate, and adverse (see Figures 4.2-3 through 4.2-5). In year 2030, the proposed Project would cause a net loss of 157 acres of land within Breton Sound due to available sediment in the Mississippi River being diverted from the river to the proposed diversion, representing a decrease in land of 0.1 percent of total land in Breton Sound compared to the No Action Alternative. By year 2070, the proposed Project would result in a reduction in land of 3,589 acres, representing a 29.6 percent decrease in total land in Breton Sound compared to the No Action Alternative, subject to the caveats stated above.

4.2.3.2.3.3 Terraces Alternatives

The 75,000 cfs + Terraces Alternative would have permanent, major, beneficial impacts on the geology, topography, and geomorphology of the Barataria Basin via land building, and permanent, moderate, adverse impacts in the birdfoot delta by exacerbating land loss. The impacts from operation and maintenance of the 75,000 cfs + Terracing Alternative would result in an increase of about 13,800 acres of land area within the Barataria Basin, or a 26 percent increase over the No Action Alternative in year 2070 (see Table 4.2-4). Conversely, because sediments transported by the alternative would be diverted away from the birdfoot delta, that area would experience an additional projected land loss of 2,950 acres of land area, a 45 percent decrease by 2070 as compared with the No Action Alternative (see Table 4.2-4), representing moderate, permanent, adverse impacts. The nature of the impacts in the birdfoot delta under this alternative is qualitatively similar to those under the Applicant's Preferred Alternative. See the description of these impacts above for more information.

The magnitude of these impacts differs only slightly from the Applicant's Preferred Alternative. The Delft3D Basinwide Model indicates that the construction of terraces for this alternative would generally result in a small net increase in land building in the Barataria Basin, though this effect would be relatively minor (from a projected difference of about 50 acres in 2030 to about 400 acres in 2070; see Table 4.2-4). The magnitude of this difference is within the confidence intervals of model output and may only reflect model uncertainty. Construction of terraces generally results in deflection of flow farther to the west and southwest across the outfall area, with less sediment accretion and land building in the vicinity of the terraces, and greater sediment accretion and land building to the northwest and west (see Figures 4.2-14 and 4.2-15).

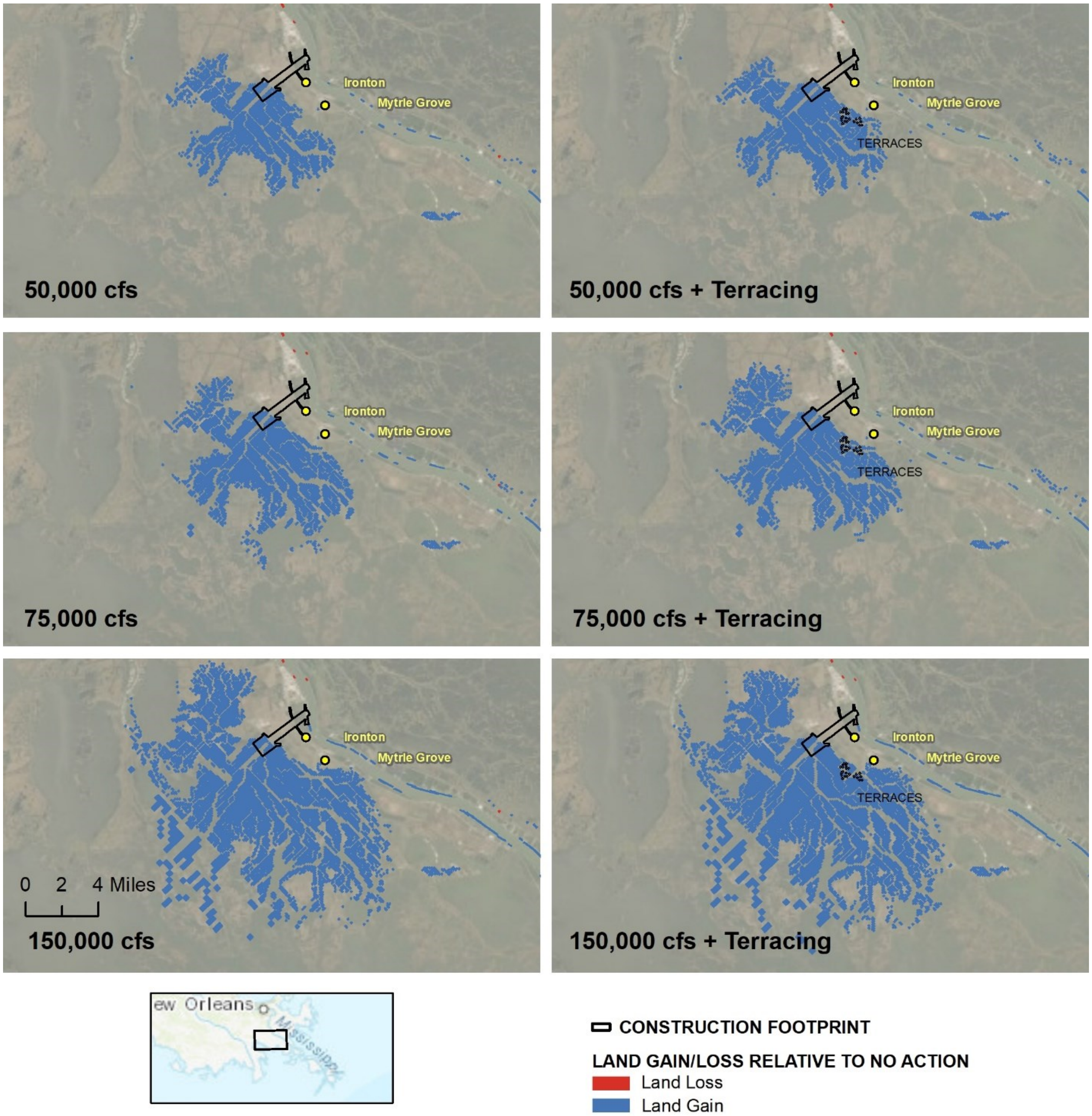


Figure 4.2-14. Model-projected Land Loss and Gain in the Immediate Vicinity (within 0.5-mile) of the Outfall Area Relative to the No Action Alternative in 2070 under the Applicant's Preferred Alternative and Other Action Alternatives.

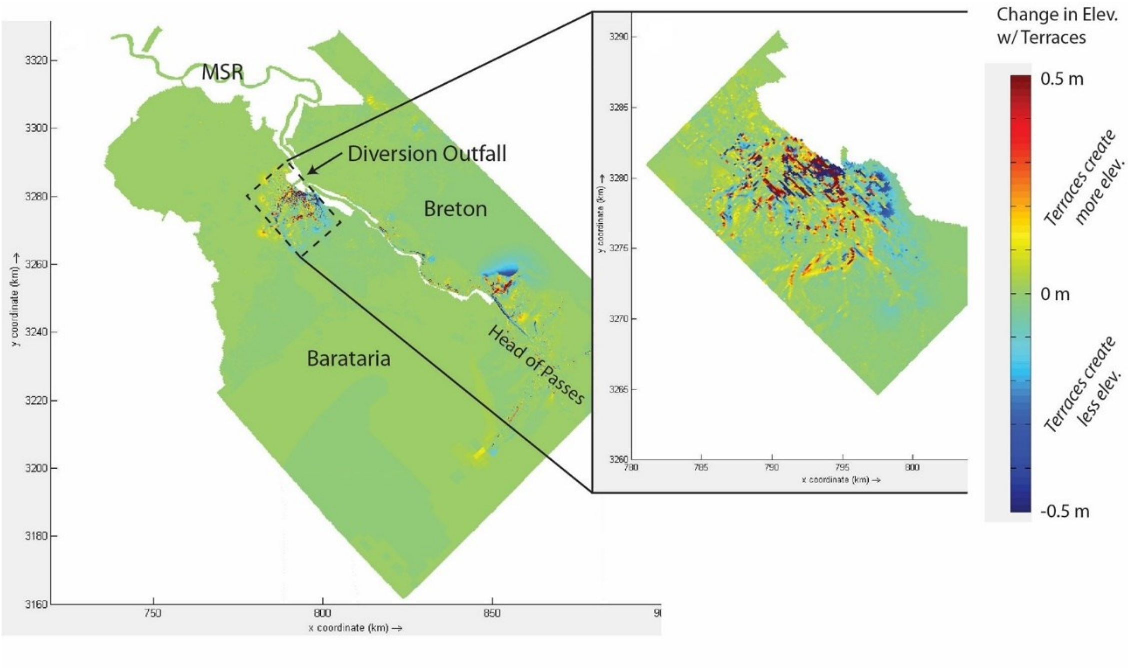


Figure 4.2-15. Model-projected Difference in Bed Elevation With vs. Without-Terrace Field in the Project Area in 2060 under the 150,000 cfs Maximum Flow Volume Alternatives. Inset depicts detail in the vicinity (within 0.5-mile) of immediate outfall area.

The 75,000 cfs + Terraces Alternative would have indirect impacts on land loss in Breton Sound (to the east of the Project area) that would be permanent, minor to moderate, and adverse (see Figures 4.2-3 through 4.2-5). In year 2030, the proposed Project would cause a net loss of 86 acres of land within Breton Sound due to available sediment in the Mississippi River being diverted from the river to the proposed diversion, representing a decrease in land of 0.1 percent of total land in Breton Sound compared to the No Action Alternative. By year 2070, the proposed Project would result in a reduction in land of 2,115 acres, representing a 17.4 percent decrease in total land in Breton Sound compared to the No Action Alternative. As noted above, these Delft3D Basinwide Model projections include the unlikely assumption that the existing Bohemia Spillway levees remain intact over the 50-year analysis period, so actual land loss in Breton Sound due to diversion operations under the Applicant's Preferred Alternative is likely to be less than these projections, particularly in the vicinity of Bayou Lamoque. Restoration projects planned for Breton Sound would help to counteract land loss in this area. See Section 4.25 Cumulative Impacts for information about reasonably foreseeable projects in the area.

The 50,000 cfs + Terraces Alternative would have major, permanent, beneficial impacts on geology, topography, and geomorphology in the Barataria Basin that would be sustained or created by the diversion of sediment and fresh water; the alternative would have minor, permanent, adverse impacts on geology, topography, and geomorphology in the birdfoot delta. The impacts from operation and maintenance of the 50,000 cfs + Terraces Alternative would result in an increase of about 9,860 acres of land area within the Barataria Basin, or a 19 percent increase over the No Action

Alternative in year 2070 (see Table 4.2-4). Conversely, because sediments transported by the alternative would be diverted away from the birdfoot delta, that area would experience an additional projected land loss of 2,790 acres of land area, a 42 percent decrease by 2070 as compared with the No Action Alternative (see Table 4.2-4), representing major, permanent, adverse impacts. The nature of the impacts in the birdfoot delta under this alternative is qualitatively similar to those under the Applicant's Preferred Alternative. See the description of these impacts above for more information.

Similar to the 50,000 cfs Alternative described above, the Delft3D Basinwide Modeling results indicate that the reduced maximum flow volume of the 50,000 cfs + Terraces Alternative would result in less sediment delivered to the outfall area, less change in sediment volume, and smaller amounts of land building as compared with the Applicant's Preferred Alternative (see Tables 4.2-4 and 4.2-5). The 50,000 cfs + Terraces Alternative yields roughly 74 percent of the land building of the Applicant's Preferred Alternative (see Figure 4.2-14). As with other alternatives, the inclusion of terraces would have a relatively minor effect, yielding projected differences of between zero and 200 acres from 2030 to 2070 (see Table 4.2-4) as compared with the 50,000 cfs Alternative alone. However, the Delft3D Basinwide Model projects that these differences would vary from positive to negative from decade to decade, and vary in magnitude, both in the Barataria Basin and in the birdfoot delta (see Table 4.2-4). As per other alternatives, construction of terraces generally results in deflection of flow farther to the west and southwest across the outfall area, with less sediment accretion and land building in the vicinity of the terraces, and greater sediment accretion and land building to the northwest and west (see Figures 4.2-14 and 4.2-15).

The 50,000 cfs + Terraces Alternative would have indirect impacts on land loss in Breton Sound (to the east of the Project area) that would be permanent, minor, and beneficial in year 2030, when the proposed Project is projected to result in a net gain of 133 acres of land in Breton Sound (see Figures 4.2-3 through 4.2-5). By year 2070, the proposed Project would result in a reduction in land of 1,260 acres, representing a 10.4 percent decrease in total land in Breton Sound compared to the No Action Alternative, subject to the caveats stated above.

The 150,000 cfs + Terraces Alternative would have permanent, major beneficial impacts on the geology, topography, and geomorphology of the Barataria Basin via land building, and permanent, moderate, adverse impacts in the birdfoot delta by exacerbating land loss. The impacts from operation and maintenance of the 150,000 cfs + Terraces Alternative would result in an increase of about 29,100 acres of land area within the Barataria Basin, or a 56 percent increase over the No Action Alternative in year 2070 (see Table 4.2-4). Conversely, because sediments transported by the alternative would be diverted away from the birdfoot delta, that area would experience an additional projected land loss of 2,500 acres of land area, a 38 percent decrease by 2070 as compared with the No Action Alternative (see Table 4.2-4), representing moderate, permanent, adverse impacts. The nature of the impacts in the birdfoot delta under this alternative is qualitatively similar to those under the Applicant's Preferred Alternative. See the description of these impacts above for more information.

As with the 150,000 cfs Alternative above, the magnitude of these impacts differs significantly from the Applicant's Preferred Alternative in the Barataria Basin but are generally similar in the birdfoot delta. The Delft3D Basinwide Modeling results indicate that the increased maximum flow volume of the 150,000 cfs + Terraces Alternative would result in more sediment delivered to the outfall area, greater change in sediment volume and larger amounts of land building as compared with the Applicant's Preferred Alternative (see Tables 4.2-4 and 4.2-5). The 150,000 cfs + Terraces Alternative yields an increase of roughly 173 percent in the land building of the Applicant's Preferred Alternative (see Figure 4.2-14). As with other alternatives, the inclusion of terraces would have a relatively minor effect, yielding projected differences of between zero and 200 acres from 2030 to 2070 (see Table 4.2-4) as compared with the 150,000 cfs Alternative alone. However, the Delft3D Basinwide Model projects that these differences would vary from positive to negative from decade to decade, and vary in magnitude, both in the Barataria Basin, and in the birdfoot delta (see Table 4.2-4). As per other alternatives, construction of terraces generally results in deflection of flow farther to the west and southwest across the outfall area, with less sediment accretion and land building in the vicinity of the terraces, and greater sediment accretion and land building to the northwest and west (see Figures 4.2-14 and 4.2-15). Figure 4.2-15 depicts model-projected differences in bed elevation with vs. without terraces in the Project area in 2060 under the 150,000 cfs Alternative.

The 150,000 cfs + Terraces Alternative would have indirect impacts on land loss in Breton Sound (to the east of the Project area) that would be permanent, minor, and beneficial in year 2030, when the proposed Project is projected to result in a net gain of 67 acres of land in Breton Sound (see Figures 4.2-3 through 4.2-5). However, by year 2070, the proposed Project would cause a net loss of 4,053 acres of land within Breton Sound due to available sediment in the Mississippi River being diverted from the river to the proposed diversion, representing a decrease in land of 33.4 percent of total land in Breton Sound compared to the No Action Alternative, subject to the caveats stated above.

4.2.4 Mineral Resources

4.2.4.1 Construction Impacts

4.2.4.1.1 No Action Alternative

Under the No Action Alternative, mineral resources in the proposed Project construction footprint would not be affected by construction of any of the action alternatives. The mineral resources in the Mississippi River, Barataria Basin, and birdfoot delta would continue as described in Chapter 3, Section 3.2 Geology and Soils. Ongoing trends of sea-level rise and subsidence would continue, but only limited changes to mineral resources are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse effect on mineral resources. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25 Cumulative Impacts for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal environmental standards.

4.2.4.1.2 Applicant's Preferred Alternative

Non-fuel mineral resources in the Project area include construction sand excavated from upland mines and borrow pits, borrow pit locations used for supplying clay for the Greater New Orleans HSDRRS projects, and sand borrowed from channel bars in the Lower Mississippi River. Salt/halite, sulfur, and phosphates are produced in coastal Louisiana outside of the Project area (see Chapter 3, Section 3.2.3 in Geology and Soils for more information about mineral resources in the Project area). Construction of the Applicant's Preferred Alternative would have negligible direct impacts on these non-fuel mineral resources. CPRA is proposing to use the existing Phillips 66/Alliance and Midway Cattle Ranch borrow pits (if mutually agreeable to landowner), both of which are located near the proposed MBSD Project channel between the Mississippi River Levee and the Barataria Basin, for disposal of excavated material during construction. Temporary, minor, adverse indirect impacts may occur on the transport of construction sand, salt/halite, sulfur, and phosphates due to minor traffic delays resulting from Project-induced increases in construction traffic using LA 23 in vicinity of the proposed Project construction site (see Section 4.22 Land-Based Transportation for information about transportation impacts). Similarly, temporary, minor, adverse indirect impacts on the transport of materials from the Phillips 66/Alliance and the Midway Cattle Ranch borrow pits may occur due to LA 23 modifications. Any future use of channel bars in the Lower Mississippi River as borrow areas for coastal restoration projects in the vicinity of the intake channel, cofferdam, or gated control structure would be precluded during construction and operation of the Applicant's Preferred Alternative. However, because users could potentially use other borrow sources in the area, this would represent a temporary, minor, adverse impact.

Construction of the Applicant's Preferred Alternative would cause temporary, minor, adverse direct impacts on oil and gas production and transmission infrastructure. The Shell Delta Crude Nairn-Norco 20-inch crude oil pipeline transits the proposed Project conveyance structure outfall area footprint (USDOT 2017) at absolute elevations of between -1.9 to -4.7 feet (NAVD88[55]), buried beneath 5 to 9 feet of sediment. CPRA proposes in-place lowering of an approximately 5,000-foot-long section of the pipeline below the proposed Project conveyance channel via horizontal directional drill (HDD) relocation to an elevation of approximately -120 feet. This would result in temporary, minor, adverse impacts on the transmission of petroleum products via this pipeline. Other natural gas pipelines may transit the construction area and would be subject to similar impacts. No known active oil and gas wells are in the construction footprint, so

[55] All vertical elevations referenced to NAVD88.

no impacts on oil and gas production in the region are expected during the construction phase beyond those related to disruption of transmission via pipeline discussed above.

4.2.4.1.3 Other Alternatives

Under the five other action alternatives, impacts on mineral resources in the Project area due to construction would be similar to those described under the Applicant’s Preferred Alternative, with temporary, minor, adverse indirect impacts on the extraction of mineral resources due to temporary delays during transport or the relocation of infrastructure. As described under impacts on geology, topography, and geomorphology in Section 4.2.3.1.3, the intake and conveyance channel widths would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes, and construction would take place within a similar footprint for all alternatives. Channel width differences are also expected to have negligible differences in impacts because the overall construction footprint of all action alternatives would be similar. Similarly, the 150,000 cfs Alternatives would have construction times several months longer, and the 50,000 cfs Alternatives would have shorter construction timeframes. As such, the resulting temporary impacts on the extraction of mineral resources by construction under these alternatives would last longer or shorter but would not be substantially different than the Applicant’s Preferred Alternative.

4.2.4.2 Operational Impacts

4.2.4.2.1 No Action Alternative

Under the No Action Alternative, the trend of increasing land loss in the Barataria Basin would continue (see Section 4.2.3.2.1) resulting in the conversion of up to nearly 274,000 acres of emergent wetlands and other subaerial (above-water) landforms to subaqueous shallow water by year 2070 (see Table 4.2-3). This land loss could result in increasing wave and storm energy exposure to oil and gas pipelines and wells in the outfall area and the wider Barataria Basin via the removal of sediments currently adjacent to and overlying this infrastructure. This increased exposure, in turn, may result in greater stress on these pipelines and wells, failure of these pipelines and wells, and unintentional spills of hydrocarbon products into the environment.

4.2.4.2.2 Applicant’s Preferred Alternative

Ongoing operations under the Applicant’s Preferred Alternative are expected to have long-term to permanent, minor, beneficial and adverse impacts on mineral resources. Increased deposition of sediment in the Barataria Basin under diversion operations may cause sedimentation of existing access canals, which would result in the need to maintain these channels when access to wells or flowlines for maintenance is required. In the case of active wells, burial may be adverse in that it would prevent access to or maintenance of these wells. Burial of pipelines may be beneficial in that it would reduce the exposure of these pipelines to wave energy or collision damage and resulting risk of petroleum spills. There are 33 active production and injection wells located in the Lafitte oil field between 3.5 and 6.5 miles west and southwest of the planned Project outfall transition feature (LDNR 2017a). The Delft3D Basinwide Modeling results indicate that these may be in areas with between 0 and 4.9 feet of newly deposited sediment by 2070.

Any future use of channel bars in the Lower Mississippi River as borrow areas for coastal restoration projects in the immediate vicinity (within 0.5-mile) of the intake channel, cofferdam, or gated control structure would be precluded during operation of the Applicant's Preferred Alternative. However, because users could potentially use other borrow sources in the area, this would represent a permanent, minor, adverse impact.

4.2.4.2.3 Other Alternatives

Ongoing operations under any of the other proposed alternatives are expected to have indirect impacts on mineral resources similar to those described under the Applicant's Preferred Alternative. As described under impacts on geology, topography, and geomorphology in Section 4.2.3.2.3, diversion operations for alternatives with higher-flow volumes would have similar impacts as the Applicant's Preferred Alternative, but impacts would occur over an area approximately twice as large and may result in burial of oil and gas infrastructure under thicker sediment deposits (see Figure 4.2-14). Diversion operations for alternatives with lower-flow volumes would also have similar impacts, but these would occur over an area roughly 60 to 70 percent as large and would likely result in thinner deposits of new sediment (see Figure 4.2-14).

4.2.5 Soils and Prime Farmland

4.2.5.1 Construction Impacts

4.2.5.1.1 No Action Alternative

Under the No Action Alternative, soils and prime farmland in the Project area would not be affected by construction of the Applicant's Preferred Alternative or any of the action alternatives. The general character of the geomorphology and soils, including prime farmland, in the Project area would exist as described in Chapter 3, Section 3.2.4 Soils. Ongoing trends of sea-level rise and subsidence would continue, but only limited changes to geomorphology and soils are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse effect on soils and prime farmland. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25 Cumulative Impacts for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal environmental standards.

4.2.5.1.2 Applicant's Preferred Alternative

Construction of the Applicant's Preferred Alternative would result in short-term and permanent, minor to moderate, adverse direct and indirect impacts on soils in and adjacent to the construction footprint. Analysis of the SSURGO database (USDA 2017) as provided by the USDA-NRCS indicates that there are 768 acres of Harahan clays and Cancienne clays and silty clay loams, 42 acres of Carville, Cancienne, and Schriever soils, and 55 acres of Westwego clays within the construction footprint of the proposed Project. These native soils would be completely removed by excavation within the footprint of the intake system and conveyance channels. Modifications or removal of these native soil profiles would occur due to compaction and grading activities, associated erosion, and the introduction of nonnative fill within the footprints of highway and railroad alterations, guide levees, stability berms, Project structures, contractor yards, haul roads, and other ancillary site features. Clearing would remove protective vegetation cover and result in short-term exposure of soils to the effects of wind and rain, which would increase the potential for soil erosion and sedimentation until the end of the construction phase, at which time CPRA would seed or mulch exposed soils to minimize erosion. Grading, dredged material storage, and equipment traffic can compact soil, reducing porosity and increasing runoff potential. Removal of native soil profiles would represent a permanent direct impact, while soil erosion impacts are expected to be short-term, significantly reduced once vegetation is established after construction. Minor, short-term, adverse indirect impacts on soils could occur on adjacent lands during construction due to increased runoff and sedimentation and the relocation of existing infrastructure within the Project area. See Section 4.2.6 for additional information about practices that CPRA would implement to minimize adverse impacts on soils.

Beneficial use areas or areas dredged for construction of the outfall transition feature would likely impact an additional large area of Lafitte and Clovelly mucks. These native soils would be completely removed by excavation within the footprint of the outfall transition feature and associated construction and access dredging, or subject to compaction and burial as part of the placement of fill or dredged material within the beneficial use areas. These are the most common soil series in the Barataria Basin.

Construction activities would result in the conversion of designated prime farmland to non-agricultural purposes, representing a permanent, moderate, adverse direct impact. Analysis of available SSURGO data (USDA 2017) indicates that 768 acres of designated prime farmland located within the construction footprint of the greater than-277,000 acres of prime farmland within the Project area would be converted to a non-agricultural use under the Applicant's Preferred Alternative. These soils are from the Harahan clays, Cancienne clays, and silty clay loams and located generally between the MR&T and NOV-NFL Levees. The Farmland Protection Policy Act of 1981 specifies that federal agencies must evaluate the effects of any activities that could result in the conversion of designated prime farmland before taking any action. Documented coordination with USDA-NRCS regarding potential impacts on prime farmland is provided in Chapter 5.

4.2.5.1.3 Other Alternatives

Under the five other action alternatives, the types of impacts on soils and prime farmland in the Project area due to construction would be similar to those described under the Applicant's Preferred Alternative. As compared to the Applicant's Preferred Alternative, the 150,000 cfs Alternatives (with and without terraces) would have wider intake and conveyance channels and construction time frames would be several months longer, whereas the 50,000 cfs Alternatives (with and without terraces) would have narrower intake and conveyance channels and construction times would be several months shorter. As such, the resulting impacts on soils would not substantially differ from those of the Applicant's Preferred Alternative, with permanent, moderate, adverse direct and indirect impacts on soils, including prime farmland soils, present in, and adjacent to, the construction footprint due to excavation and removal. Longer construction timeframes associated with the 150,000 cfs Alternatives would result in a longer duration of short-term impacts on soils, including soil erosion. See Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for a list of measures that CPRA would undertake to minimize impacts on soils during construction.

The construction of marsh terraces would also involve permanent, moderate, adverse impacts on soils. As described in Section 4.2.3.1, under the three marsh terrace alternatives, dredged material excavated from adjacent shallow-bay bottom would be used to create approximately 18 chevron features oriented into the diversion discharge current. This would require the excavation and emplacement of approximately 450,000 cubic yards of native wetland soils. These soils would be subject to compaction and burial as part of the construction of these features.

4.2.5.2 Operational Impacts

4.2.5.2.1 No Action Alternative

The ongoing processes of subsidence and sea-level rise under the No Action Alternative would have major, permanent, adverse impacts on soils and prime farmland in the Barataria Basin. The trend of increasing land loss in the Barataria Basin would continue (see Section 4.2.3.2), resulting in the conversion of up to nearly 274,000 acres of emergent wetlands and other subaerial landforms to subaqueous shallow water by year 2070 (see Table 4.2-3). The soils in these areas would be comprised nearly entirely of Lafitte and Clovelly mucks, and the loss of these soils would constitute a permanent, major, adverse impact of ongoing land loss. Existing agricultural, industrial, and commercial land use trends would continue in the vicinity of the proposed diversion complex, and it is expected that land developed for industrial or commercial purposes may result in conversion of prime farmland to other uses.

4.2.5.2.2 Applicant's Preferred Alternative

Most of the soils in the outfall area are from the Lafitte-Clovelly association (USDA 2017). Short-term to permanent, moderate, adverse and beneficial direct and indirect impacts on these wetland soils are expected due to changes in depth and duration of flooding as a result of diversion operations. Diversion operations would likely result in the transport and removal of some soils close to the outfall transition feature due to scouring and other hydraulic processes. Further, sediment deposited in the outfall area by diversion operations would likely be deposited on top of some existing soils due to elevated water levels in the vicinity of the outfall area. The grain size distribution and other physical characteristics of sediments that would be diverted and retained in the outfall area would differ from sediments found there at present. These differing parent material characteristics may lead to the development of wetland soil profiles that differ from the Lafitte-Clovelly association, at least initially. Lastly, impacts on vegetation community composition may occur as a result of altered flooding and salinity regimes. Impacts on vegetation can impact the rate of surficial deposition, as well as the quantity and quality of the soil profiles that develop. All these impacts can be considered both adverse and beneficial, in that existing soils and associated ecological communities would be disrupted, and new soils and ecological communities would be established. While these new soils would likely be similar to existing soils in the Lafitte-Clovelly association in the long-term, they may differ substantially in the short-term. See Section 4.6 Wetland Resources and Waters of the U.S. for more discussion of impacts related to vegetation community change. Ongoing operations under the Applicant's Preferred Alternative are expected to have no impact on prime farmland after the construction phase is complete.

4.2.5.2.3 Other Alternatives

Under the five other action alternatives, impacts on soils and prime farmland in the Project area during operations would be like those described under the Applicant's Preferred Alternative, with short-term to permanent, moderate, adverse and beneficial direct and indirect impacts on soils in the Barataria Basin and no impacts on prime farmland after the construction phase is complete. The differences would be in terms of scale. Diversion operations for the 150,000 cfs Alternatives (with and without terraces) would impact an area approximately twice as large as that of the Applicant's Preferred Alternative due to the increased rate of flow associated with these alternatives. Diversion operations for the 50,000 cfs Alternatives (with and without terraces) would also have similar impacts, but the impacted area would be about 60 to 70 percent as large as that of the Applicant's Preferred Alternative. See Figure 4.2-14.

4.2.6 Summary of Potential Impacts

Table 4.2-6 summarizes the potential impacts on geology and soils for each alternative. Details are provided in Sections 4.2.2 through 4.2.4 above.

Table 4.2-6
Summary of Potential Impacts on Geology and Soils from Each Alternative[a]

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on geology and soils from construction of the proposed Project would occur. • Future development in the Project vicinity could result in adverse impacts on existing geology and soils. Any future impacts would be required to comply with applicable environmental laws and regulations.
Operational Impacts	• Major, permanent, adverse impacts from continued land loss in the Barataria Basin and birdfoot delta due to subsidence and sea-level rise.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Moderate, permanent, adverse impacts on the existing topography, geology, and geomorphology of the construction footprint from excavation, dredging, compaction, grading, or filling. • Moderate, permanent, beneficial and adverse impacts on the geology and geomorphology of the open water, shallow-bay bottom, and emergent marshes in the Project outfall area from the emplacement of dredged material for beneficial use and from access dredging, respectively. • Minor, temporary, adverse impacts on the extraction of mineral resources due to the relocation of infrastructure or temporary, minor delays during transport. • Moderate, permanent, adverse impacts on soils present in the construction footprint, including prime farmland soils, due to excavation, removal, compaction, and erosion.
Operational Impacts	• Major, permanent, beneficial impacts on land building in the Barataria Basin due to the diversion of flow and sediment load into the Barataria Basin. The 75,000 cfs Alternative would create and sustain 13,400 acres of wetlands in the Barataria Basin by 2070. • Moderate, permanent, adverse impacts on land building in the birdfoot delta due to the diversion of flow and sediment load into the Barataria Basin that would otherwise be transported downstream. The 75,000 cfs Alternative would reduce wetlands in the birdfoot delta by 3,000 acres by 2070. • Moderate, short-term to permanent, adverse and beneficial impacts on existing wetland soils in the outfall area due to existing soils and associated ecological communities being buried (adverse impact), and new soils and ecological communities being established (beneficial impact). • Minor, long-term to permanent, adverse and beneficial impacts on mineral resources due to deposition of sediment that may prevent access to oil and gas extraction infrastructure (adverse impact) and protect pipelines from wave and collision exposure (beneficial impact).
50,000 cfs Alternative	
Construction Impacts	• Moderate, permanent, adverse impacts on the existing topography, geology, and geomorphology of the construction footprint from excavation, dredging, compaction, grading, or filling. • Moderate, permanent, beneficial and adverse impacts on the geology and geomorphology of the open water, shallow-bay bottom, and emergent marshes in the Project outfall area from the emplacement of dredged material for beneficial use and from access dredging, respectively. • Minor, temporary, adverse impacts on the extraction of mineral resources due to the relocation of infrastructure or temporary, minor delays during transport. • Moderate, permanent, adverse impacts on soils present in the construction footprint, including prime farmland soils, due to excavation, removal, compaction, and erosion.

Table 4.2-6 Summary of Potential Impacts on Geology and Soils from Each Alternative[a]	
Impact Type	**Impact Description (as Compared to No Action Alternative unless Otherwise Stated)**
Operational Impacts	• Major, permanent, beneficial impacts on land building in the Barataria Basin due to the diversion of flow and sediment load into the Barataria Basin. The 50,000 cfs Alternative would create and sustain 9,660 acres of wetland in the Barataria Basin by 2070. • Moderate, permanent, adverse impacts on land building in the birdfoot delta due to the diversion of flow and sediment load into the Barataria Basin that would otherwise be transported downstream. The 50,000 cfs Alternative would reduce wetlands in the birdfoot delta by 2,820 acres by 2070. • Moderate, short-term to permanent, adverse and beneficial impacts on existing wetland soils in the outfall area due to existing soils and associated ecological communities being buried (adverse impact), and new soils and ecological communities being established (beneficial impact). • Minor, long-term to permanent, adverse and beneficial impacts on mineral resources due to deposition of sediment that may prevent access to oil and gas extraction infrastructure (adverse impact) and protect pipelines from wave and collision exposure (beneficial impact).
150,000 cfs Alternative	
Construction Impacts	• Moderate, permanent, adverse impacts on the existing topography, geology, and geomorphology of the construction footprint from excavation, dredging, compaction, grading, or filling. • Moderate, permanent, beneficial and adverse impacts on the geology and geomorphology of the open water, shallow-bay bottom, and emergent marshes in the Project outfall area from the emplacement of dredged material for beneficial use and from access dredging, respectively. • Minor, temporary, adverse impacts on the extraction of mineral resources due to the relocation of infrastructure or temporary, minor delays during transport. • Moderate, permanent, adverse impacts on soils present in the construction footprint, including prime farmland soils, due to excavation, removal, compaction, and erosion.
Operational Impacts	• Major, permanent, beneficial impacts on land building in the Barataria Basin due to the diversion of flow and sediment load into the Barataria Basin. The 150,000 cfs Alternative would create and sustain 29,200 acres of wetlands in the Barataria Basin by 2070. • Moderate, permanent, adverse impacts on land building in the birdfoot delta due to the diversion of flow and sediment load into the Barataria Basin that would otherwise be transported downstream. The 150,000 cfs Alternative would reduce wetlands in the birdfoot delta by 2,820 acres by 2070. • Moderate, short-term to permanent, adverse and beneficial impacts on existing wetland soils in the outfall area due to existing soils and associated ecological communities being buried (adverse impact), and new soils and ecological communities being established (beneficial impact). • Minor, long-term to permanent, adverse and beneficial impacts on mineral resources due to deposition of sediment that may prevent access to oil and gas extraction infrastructure (adverse impact) and protect pipelines from wave and collision exposure (beneficial impact).

Table 4.2-6
Summary of Potential Impacts on Geology and Soils from Each Alternative[a]

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Terrace Alternatives	
75,000 cfs + Terraces Alternative	
Construction Impacts	• As compared to the No Action Alternative, this alternative would cause additional construction impacts, both adverse and beneficial, as listed above for the 75,000 cfs Alternative (Applicant's Preferred). Terraces would modify the existing natural topography (adverse) but result in emergent uplands with higher ecological value (beneficial). Otherwise, impacts from the terrace alternatives would be substantially similar to those of the corresponding flow alternatives without terraces.
Operational Impacts	• As compared to the No Action Alternative, this alternative would cause substantially similar operational impacts as listed above for the 75,000 cfs Alternative (Applicant's Preferred). • The presence of terraces would yield only slight increases in land building in the Barataria Basin and slight decreases in land loss in the birdfoot delta as compared with the 75,000 cfs Alternative (Applicant's Preferred). These differences would vary from decade to decade. • The 75,000 cfs + Terraces Alternative would create and sustain 13,800 acres of wetlands in the Barataria Basin by 2070 as compared with 13,400 acres for the 75,000 cfs Alternative. • The 75,000 cfs + Terraces Alternative would reduce wetlands in the birdfoot delta by 2,950 acres by 2070, as compared with 3,000 acres for the 75,000 cfs Alternative.
50,000 cfs + Terraces Alternative	
Construction Impacts	• As compared to the No Action Alternative, this alternative would cause additional construction impacts, both adverse and beneficial, as listed above for the 50,000 cfs Alternative. Terraces would modify the existing natural topography (adverse) but result in emergent uplands with higher ecological value (beneficial). Otherwise, impacts from the terrace alternatives would be substantially similar to those of the corresponding flow alternatives without terraces.
Operational Impacts	• As compared to the No Action Alternative, this alternative would cause the same operational impacts as listed above for the 50,000 cfs Alternative . • The presence of terraces would yield only slight increases in land building in the Barataria Basin and slight decreases in land loss in the birdfoot delta as compared with the 50,000 cfs Alternative. These differences would vary from decade to decade. • The 50,000 cfs + Terraces Alternative would create and sustain 9,860 acres of wetlands in the Barataria Basin by 2070 as compared with 9,660 acres for the 50,000 cfs Alternative. • The 50,000 cfs + Terraces Alternative would reduce wetlands in the birdfoot delta by 2,790 acres by 2070, as compared with 2,820 acres for the 50,000 cfs Alternative.
150,000 cfs + Terraces Alternative	
Construction Impacts	• As compared to the No Action Alternative, this alternative would cause the additional construction impacts, both adverse and beneficial, as listed above for the 150,000 cfs Alternative . Terraces would modify the existing natural topography (adverse) but result in emergent uplands with higher ecological value (beneficial). Otherwise, impacts from the terrace alternatives would be substantially similar to those of the corresponding flow alternatives without terraces.

Table 4.2-6
Summary of Potential Impacts on Geology and Soils from Each Alternative[a]

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• As compared to the No Action Alternative, this alternative would cause the same operational impacts as listed above for the 150,000 cfs Alternative. • The presence of terraces would yield only slight decreases in land building in the Barataria Basin and slight decreases in land loss in the birdfoot delta as compared with the 150,000 cfs Alternative. These differences would vary from decade to decade. • The 150,000 cfs + Terraces Alternative would create and sustain 29,100 acres of wetlands in the Barataria Basin by 2070 as compared with 29,200 acres for the 150,000 cfs Alternative. • The 150,000 cfs + Terraces Alternative would reduce wetlands in the birdfoot delta by 2,500 acres by 2070, as compared with 2,820 acres for the 150,000 cfs Alternative.

[a] Modeled land areas and changes presented in this table and throughout Section 4.2 Geology and Soils have been rounded to three significant digits. Land areas are considered accurate to within ±200 acres.

4.3 GROUNDWATER RESOURCES

4.3.1 Area of Potential Impacts

The area of potential construction impacts on groundwater resources is within the immediate vicinity (within 0.5-mile) of all active construction areas. During operations, the proposed Project has the potential to impact groundwater resources in the vicinity of the proposed diversion complex as well as the outfall area.

4.3.2 Guidelines for Groundwater Resources Impact Determinations

Impact intensities for groundwater are based on the definitions provided in Section 4.1 and the following groundwater-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on groundwater would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: the impact on shallow groundwater elevation would be measurable, but it would be small and localized. The impact would only temporarily alter the area’s shallow groundwater flows. Impacts could result in a detectable change to groundwater quality, but the change could be expected to be small and localized. Impacts could quickly become undetectable;
- moderate: the impact on shallow groundwater elevation would be measurable, but small and limited to local and adjacent areas. The effect could permanently alter the area’s shallow groundwater flows. Impacts on groundwater quality would be observable over a relatively large area.

Impacts would result in a change to water quality that would be readily detectable and limited to local and adjacent areas. Impact on water quality could persist; and

- major: the impact on shallow groundwater elevation would be measurable and widespread. The impact could permanently alter shallow groundwater flows. Impacts would likely result in a change to water quality that would be readily detectable and widespread.

4.3.3 Construction Impacts

4.3.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. Groundwater in the Project area would not be impacted by the Applicant's Preferred Alternative or any of the action alternatives. During the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project), existing agricultural, industrial, and commercial land use trends would continue in the location of the proposed diversion complex, where shallow groundwater flow and depths have historically been and would continue to be altered through the operation of drainage canals and pumping to reduce flooding. Saltwater intrusion would continue into the deeper aquifers underlying the Project area. Because of their depth and distance from recharge areas, current groundwater quality trends in the deeper aquifers would likely continue. Use of the groundwater from the deeper aquifer systems underlying the Project area for irrigation or other purposes would remain unrestricted.

In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have some adverse effect on local water and/or sediment quality. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal water quality standards.

4.3.3.2 Applicant's Preferred Alternative

4.3.3.2.1 Aquifers

Shallow groundwater in surficial aquifers underlying the proposed Project structures could sustain temporary, minor, adverse impacts. The majority of the construction activities associated with the proposed Project would involve temporary and localized excavation. Alterations to overland water flow and recharge would be caused by clearing and grading of the work areas. In addition, dewatering, drainage control, and near-surface soil compaction caused by heavy construction vehicles could alter shallow groundwater flow direction and local water table elevations in the vicinity of construction activities. Because the elevation and flow of surficial aquifers underlying the Project area between the NOV-NFL and Mississippi River Levees have already been considerably modified by drainage canals and forced drainage pumping, the additional Project-induced adverse impacts on shallow groundwater would be minor, unless they cause adverse flood conditions (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for further information about flooding). Piezometer wells would likely be installed within the construction right-of-way to monitor groundwater levels during construction.

With depths of more than 200 feet, the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System would not be impacted by construction activities. Following construction, the portion of the construction footprint that is not paved or occupied by the aboveground facilities would be revegetated or graveled to eliminate exposed soils and to ensure restoration of overland flow and recharge patterns.

4.3.3.2.2 Groundwater Use

Groundwater use would not be impacted by Project construction activities. No public drinking water wells are located in the Project area, and the closest well identified in the vicinity of the proposed diversion complex is a 450-foot-deep irrigation well approximately 0.5-mile southeast. Wells in the Project area are screened in the Mississippi River Alluvial Aquifer with an average well depth of 248 feet and in the Chicot Equivalent Aquifer System with an average well depth of 295 feet. Shallower wells do not occur in the Project area because of the high salinity of shallow groundwater.

4.3.3.2.3 Groundwater Quality

Potential adverse impacts on shallow groundwater during construction could range from temporary and negligible to long-term and moderate depending on the severity of potential spills and leaks of hazardous materials and the effectiveness of the spill response action. Shallow groundwater areas could be directly impacted by contamination caused by inadvertent surface spills of hazardous materials used during construction such as fuels, oil, lubricants, and coolants. Accidental spills and leaks of these materials associated with the refueling or maintenance of vehicles and the storage of fluids pose the greatest risk to groundwater quality.

If not cleaned up, contaminated soils could leach and indirectly add pollutants to groundwater long after a spill has occurred. Impacts from an undetected or unaddressed release could be long-term as contaminants may leach from soils over many years, causing a moderate impact on shallow groundwater quality. Implementation of the Applicant’s Project-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan would minimize the potential for short- and long-term groundwater quality impacts associated with an inadvertent spill of hazardous materials during construction. Therefore, potential impacts on groundwater quality would be negligible.

4.3.3.3 Other Action Alternatives

Impacts on groundwater due to construction of the other alternatives would be the same as those described under the Applicant's Preferred Alternative, with temporary, minor, adverse impacts on surficial aquifers during construction, including alterations to overland water flow and recharge due to clearing and grading, dewatering, drainage control, and near-surface soil compaction in work areas. Similar to the Applicant's Preferred Alternative, this alternative would not impact deep aquifers or groundwater use. Potential impacts on groundwater quality would be negligible with the implementation of a Project SPCC Plan.

The addition of terrace construction in the immediate outfall area under the three action alternatives that include terraces would not impact groundwater resources.

4.3.4 Operational Impacts

4.3.4.1 No Action Alternative

Under the No Action Alternative, groundwater resources would not be impacted by operation of the Applicant's Preferred Alternative or any of the action alternatives. Saltwater intrusion from the Gulf of Mexico would continue to impact the water quality of the Mississippi Alluvial and Chicot Equivalent Aquifers. Groundwater use would continue to be primarily used for industrial and power-generation uses by industries along the Mississippi River corridor (see Chapter 3, Section 3.3 Groundwater Resources).

It is predictable to expect that during the 2020 to 2070 operational period of the proposed MBSD Project, Project-area groundwater resources may be modified through other projects. It is predictable that any future man-made development would be required to comply with applicable local, state, and federal environmental regulations.

4.3.4.2 Applicant's Preferred Alternative

4.3.4.2.1 Aquifers

During operation of the proposed Project, permanent, minor impacts on shallow groundwater elevations and flow direction in surficial aquifers may occur due to the presence of Project structures and modifications to existing drainage channels and forced drainage pumping. The Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System are deeper than 200 feet and regional in extent such that impacts on these aquifers from the Project structures, operations, and the introduction of Mississippi River water into the outfall area would be negligible.

4.3.4.2.2 Groundwater Use

Project operations would have negligible impacts on groundwater use. As described above, wells in the Project area are screened in the Mississippi River Alluvial Aquifer and in the Chicot Equivalent Aquifer System, which have average well depths of

248 feet and 295 feet, respectively. Because the aquifers are deeper than 200 feet and regional in extent, Project infrastructure, operations, and the introduction of Mississippi River water into the outfall area would have negligible impacts on the use of groundwater in these aquifers. The inability to place new water wells within the proposed footprint of the diversion complex and auxiliary structures would be an adverse minor, permanent, indirect impact of the proposed Project.

4.3.4.2.3 Groundwater Quality

Minor short- and long-term impacts on shallow groundwater quality could occur due to the introduction of fresh water in the outfall area during operations. These impacts may be either beneficial or adverse depending on the nature of the chemical changes and their indirect impacts on vegetation and aquatic life. Although saltwater intrusion would continue to impact groundwater in the Project area, the freshwater inputs may temporarily reduce shallow groundwater salinity and specific conductance in the outfall area. Other groundwater quality parameters, including nitrogen, phosphorus, chloride, and sulfate, may be indirectly impacted by causing an increase or decrease in concentrations in shallow groundwater with respect to existing groundwater depending upon soil property differences. The duration of these minor impacts on shallow groundwater quality would vary with the amount and duration of freshwater input, which would be determined by the Project's operation plan. Salinity and specific conductance would be reduced, and oxidized forms of nutrients and other water quality parameters would be increased during higher flows through the diversion channel. The spatial extent of impacts on shallow groundwater would vary with flow volume; the extent would increase with increasing flow through the diversion channel.

Because the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System are deeper than 200 feet and regional in extent, impacts on groundwater quality in these deep aquifers from the introduction of Mississippi River water into the outfall area would be negligible.

4.3.4.3 Other Alternatives

4.3.4.3.1 50,000 cfs Alternative

Impacts on groundwater due to construction of the 50,000 cfs Alternative would be the same as those described under the Applicant's Preferred Alternative. As compared to the No Action Alternative, the 50,000 cfs Alternative would have permanent, minor impacts on shallow groundwater elevations and flow direction in surficial aquifers, and negligible impacts on the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System. Similar to the Applicant's Preferred Alternative, the 50,000 cfs Alternative would have minor impacts on shallow groundwater quality due to the introduction of fresh water in the outfall area during operations; freshwater inputs may temporarily reduce shallow groundwater salinity and specific conductance in the outfall area.

4.3.4.3.2 150,000 cfs Alternatives

Impacts on groundwater due to construction of the 150,000 cfs Alternative would be the same as those described under the Applicant's Preferred Alternative. As compared to the No Action Alternative, the 150,000 cfs Alternative would have permanent, minor impacts on shallow groundwater elevations and flow direction in surficial aquifers, and negligible impacts on the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System. Similar to the Applicant's Preferred Alternative, the 150,000 cfs Alternative would have minor impacts on shallow groundwater quality due to the introduction of fresh water in the outfall area during operations; freshwater inputs may temporarily reduce shallow groundwater salinity and specific conductance in the outfall area.

4.3.4.3.3 Terrace Alternatives

The three terrace alternatives would have the same impacts on groundwater as the three action alternatives described above. The addition of terrace construction in the immediate outfall area under the three action alternatives that include terraces would not impact groundwater resources.

4.3.5 Summary of Potential Impacts

Table 4.3-1 summarizes the potential impacts on groundwater resources for each alternative. Details are provided in Sections 4.3.1 through 4.3.4 above.

Table 4.3-1
Summary of Potential Impacts on Groundwater from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• Existing agricultural, industrial, and commercial land use trends would continue in the location of the proposed diversion complex, where shallow groundwater flow and depths have historically been and would continue to be altered through the operation of drainage canals and pumping to reduce flooding.
Operational Impacts	• Current trends in saltwater intrusion and water well use would continue.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Temporary, minor, adverse impacts on overland water flow, groundwater flow direction, and local water table elevations of shallow aquifers would be caused by clearing, grading, dewatering, and near-surface soil compaction of the work areas. • Negligible impacts on the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System. • Temporary and negligible to long-term and moderate adverse impacts on groundwater quality depending on the severity of potential spills and leaks of hazardous materials and the effectiveness of the spill response action. Impacts would be negligible with the implementation of an effective Project SPCC Plan.

Table 4.3-1
Summary of Potential Impacts on Groundwater from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Permanent, minor, adverse impacts on shallow groundwater elevations and flow direction in surficial aquifers due to the presence of Project structures and modifications to existing drainage channels and forced drainage pumping. • Negligible impacts on groundwater use. • Minor short- and long-term impacts on shallow groundwater quality due to the introduction of fresh water in the outfall area during operations. These impacts may be either beneficial or adverse depending on the nature of the chemical changes and their indirect impacts on vegetation and aquatic life. Although saltwater intrusion would continue to impact groundwater in the Project area, the freshwater inputs may temporarily reduce shallow groundwater salinity and specific conductance in the outfall area.
50,000 cfs Alternative	
Construction Impacts	• Temporary, minor, adverse impacts on overland water flow, groundwater flow direction, and local water table elevations of shallow aquifers would be caused by clearing, grading, dewatering, and near-surface soil compaction of the work areas. • Negligible impacts on the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System. • Temporary and negligible to long-term and moderate adverse impacts on groundwater quality depending on the severity of potential spills and leaks of hazardous materials and the effectiveness of the spill response action. Impacts would be negligible with the implementation of an effective Project SPCC Plan.
Operational Impacts	• Permanent, minor, adverse impacts on shallow groundwater elevations and flow direction in surficial aquifers due to Project structures and modifications to existing drainage channels and forced drainage pumping. • Negligible impacts on groundwater use. • Minor short- and long-term impacts on shallow groundwater quality due to the introduction of fresh water in the outfall area during operations. These impacts may be either beneficial or adverse depending on the nature of the chemical changes and their indirect impacts on vegetation and aquatic life. Although saltwater intrusion would continue to impact groundwater in the Project area, the freshwater inputs may temporarily reduce shallow groundwater salinity and specific conductance in the outfall area.
150,000 cfs Alternative	
Construction Impacts	• Temporary, minor, adverse impacts on overland water flow, groundwater flow direction, and local water table elevations of shallow aquifers would be caused by clearing, grading, dewatering, and near-surface soil compaction of the work areas. • Negligible impacts on the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System. • Temporary and negligible to long-term and moderate adverse impacts on groundwater quality depending on the severity of potential spills and leaks of hazardous materials and the effectiveness of the spill response action. Impacts would be negligible with the implementation of an effective Project SPCC Plan.

Table 4.3-1
Summary of Potential Impacts on Groundwater from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Permanent, minor, adverse impacts on shallow groundwater elevations and flow direction in surficial aquifers due to the presence of Project structures and modifications to existing drainage channels and forced drainage pumping. • Negligible impacts on groundwater use. • Minor short- and long-term impacts on shallow groundwater quality due to the introduction of fresh water in the outfall area during operations. These impacts may be either beneficial or adverse depending on the nature of the chemical changes and their indirect impacts on vegetation and aquatic life. Although saltwater intrusion would continue to impact groundwater in the Project area, the freshwater inputs may temporarily reduce shallow groundwater salinity and specific conductance in the outfall area.
Terraces Alternatives	
Construction and Operational Impacts	• As compared to the No Action Alternative, the three action alternatives would have substantially similar construction and operational impacts as that of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives (see above). • As compared to the Applicant's Preferred Alternative, the construction and presence of marsh terrace features in the basin in the immediate outfall area would have negligible additional impacts on groundwater resources.

4.4 SURFACE WATER AND COASTAL PROCESSES

4.4.1 Area of Potential Impacts

The area of potential direct and indirect construction impacts on hydrology and hydrodynamics is within the immediate vicinity (approximately 0.5 mile) of the construction footprint (see Chapter 2, Figure 2.8-1). The area of potential construction direct and indirect impacts on stormwater management and drainage would be the portion of the construction footprint in the forced drainage area between the MR&T Levee and the NOV-NFL Levee.

The area of potential operational direct and indirect impacts on hydrology and hydrodynamics is within the Lower Mississippi River and throughout the Barataria Basin and the birdfoot delta. The area of potential operational direct and indirect impacts on stormwater management and drainage is the area between the MR&T and the NOV-NFL Levees as well as the Barataria Basin.

4.4.2 Guidelines for Surface Water/Coastal Processes Impact Determinations

Impact intensities for surface water/coastal processes are based on the definitions provided in Section 4.1 and the following resource-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on surface water/coastal processes would be at the lowest levels of detection, barely measurable, with no perceptible consequences;

- minor: the impact on surface water/coastal processes would be barely measurable, small, and localized;
- moderate: the impact on surface water/coastal processes would result in a clearly detectable change, with measurable and quantifiable consequences; and
- major: the impact on surface water/coastal processes would be measurable, readily apparent, and would warrant heightened attention and examination.

4.4.3 Overview of Modeling for Impact Analysis

As described in Section 4.1, the two-dimensional Delft3D Basinwide Model developed by the Water Institute was used to project potential impacts on hydrodynamics, sediment transport, and water quality in the Barataria Basin and the birdfoot delta from implementation of the Project alternatives, including the No Action Alternative. The hydrodynamic model results were extracted at 15 stations across the Barataria Basin and birdfoot delta (shown in Figure 4.4-1 and described in Table 4.4-1). To capture Project operational impacts on hydrology and hydrodynamics across the Barataria Basin and the birdfoot delta, the impact analysis focuses on seven of these stations: the northern/mid-basin station in the Barataria Basin (CRMS 3985), the station near Lafitte (USACE 82875), the station nearest the proposed diversion (CRMS 0276), the station in central Barataria Basin (CRMS 0224), the most western station (Little Lake near Cutoff [Little L. Cutoff]; USGS 07380335), the station in the southwestern portion of the basin (Barataria [B.] Pass at Grand Isle [GI]; USGS 073802516), and the station in the birdfoot delta (CRMS 0163). These stations are discussed to compare modeling results with trends of decreasing impacts with increasing distance from the diversion structure. The station closest to Lafitte (USACE 82875) is discussed with regard to impacts on water levels (see Section 4.4.4.2.2). As shown in Figure 4.4-1, these stations are well distributed in both the north-south and east-west directions from the proposed diversion structure outfall to capture modeling projections of impacts. Model results for all stations are included in Appendix E.

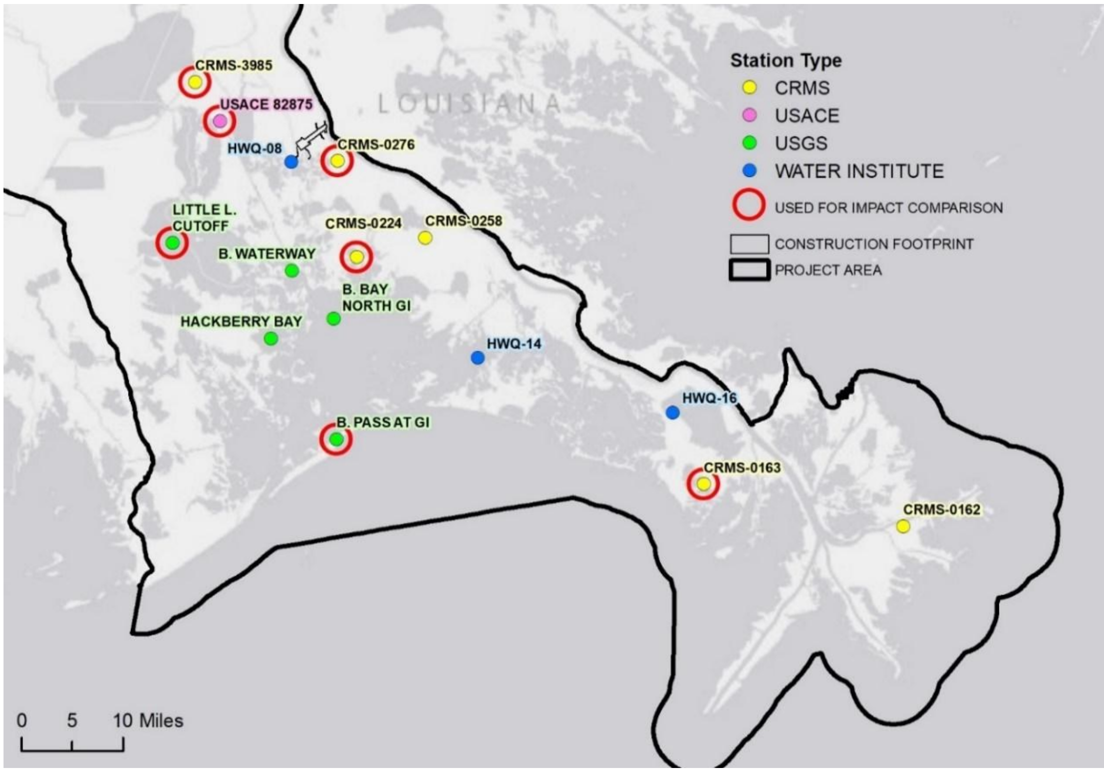


Figure 4.4-1. Station Locations in the Barataria Basin and Birdfoot Delta (Stations discussed in this section for comparison of projected impacts are shown in red circles.)

Table 4.4-1
Stations for Comparison of Project Impacts

Station ID	Description
CRMS 3985	Northern/Mid-Basin
USACE 82875	Near Lafitte
CRMS 0276	Station Nearest Diversion
CRMS 0224	Central Station
Little L. Cutoff	Western Station
B. Pass at GI	Southwestern Station, near Grand Isle
CRMS 0163	Birdfoot delta

4.4.4 Hydrology and Hydrodynamics

Hydrology and hydrodynamics in the Barataria Basin are complex, as described in Chapter 3, Section 3.4.2 in Surface Water and Coastal Processes. Representative locations in the basin have been selected to show typical results. As described above in Section 4.4.3, a more complete set of locations can be found in Appendix E.

4.4.4.1 Construction Impacts

4.4.4.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. In the proposed Project construction footprint during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project), surface water would continue to be confined between the MR&T and NOV-NFL Levees and managed through forced drainage pumping and interconnected drainage channels and swales. The MR&T Levee would continue to confine water and sediment within the Mississippi River channel and existing outlets. In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that may have some impact on hydrology and hydrodynamics. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal standards.

4.4.4.1.2 Applicant's Preferred Alternative

4.4.4.1.2.1 Bed Elevations

As described in Chapter 3, Section 3.4 Surface Water and Coastal Processes, elevation data for land below the water surface is termed bed elevation (referenced to the NAVD88 vertical datum, not to water level or depth[56]). Construction impacts on bed elevations in the immediate Project outfall area would overall be short-term, moderate, and adverse, but would be beneficial over the long-term. Adverse impacts include the disruption of existing bed features and water bottom substrates by the proposed dredging for construction of the outfall transition feature, dredging a 50-foot wide access channel from Bayou Dupont to the outfall transition feature for vessel deliveries of construction materials, and placing dredged or excavated material into three beneficial use areas (see Chapter 2, Figure 2.8-1). The placement of large volumes of excavated and dredged material for use in the beneficial use areas would be considered adverse in the short-term because it would modify existing bed elevations.

4.4.4.1.2.2 Water Levels

Construction impacts on water levels in the basin would be negligible. Any impacts from construction would be limited to areas immediately adjacent to the construction footprint. Dredging access channels in the immediate outfall area for

[56] Changes in bed elevation are not measured in relation to the amount of water on top of the bed. They are based on a vertical datum that is relative to an ellipsoid height rather than to the water surface.

marine vessel access during construction would cause negligible changes in water levels.

In the Mississippi River, construction impacts on water levels would be negligible. Cofferdams built in the river for the construction phase of the proposed Project would cause minor constrictions in river flow, which would cause negligible, localized increases in water surface elevations. This impact would cease when the cofferdams are removed at the end of the construction phase.

4.4.4.1.2.3 Tides, Currents, Flow, and Sediment Transport

Construction impacts on sediment transport in the Barataria Basin would be negligible. Minor increases in vessel traffic for the delivery of construction materials could cause negligible increases in the resuspension of sediments within navigation and access channels, and vessel wakes from the increased traffic could cause negligible increases in channel bank erosion. This resuspended sediment could travel short distances under the influence of tides and currents but is unlikely to leave the general area. Construction impacts on tides, currents, and flows would also be negligible and limited to changing patterns immediately adjacent to the construction footprint.

Construction impacts on currents, water flow, and sediment transport in the Mississippi River at RM 60.7 would be minor (measurable, localized), temporary, and adverse during construction. Project construction would have no impacts on tides. A cofferdam would be built into the Mississippi River outside of the authorized limits of the navigation channel during construction of the intake system (see Chapter 2, Figure 2.8-1). These cofferdams would confine river flows, potentially leading to increased water velocity and changes in sediment movement, including scouring near the cofferdam and deposition downstream of the cofferdam where water velocities would normalize. These impacts would be considered adverse because they could disrupt typical river flows and currents at this location, potentially require temporary changes to existing dredging regimes, and create safety concerns for shallow-draft (shallower than 14 feet) marine vessels, including line-haul tows and barges transiting past the site (see Section 4.21 Navigation for additional information about impacts on navigation and dredging). After the construction phase, the cofferdams would be removed to allow the gated control structure to connect to the river. For impacts of the proposed diversion intake system on the hydrology of the Mississippi River during Project operations, see Section 4.4.4.2.3 Tides, Currents, and Flow below.

In the portion of the construction footprint between the Mississippi River and the Barataria Basin where hydrology is controlled by a system of pumps and drainage canals, direct and indirect impacts on existing drainage patterns would be temporary, minor, and adverse. These impacts are discussed in Section 4.4.5 below. In general, the existing level of drainage in this area would be maintained.

4.4.4.1.3 Other Alternatives

The direct and indirect impacts from construction of the other action alternatives on hydrology and hydrodynamics would be similar to those caused by the Applicant's Preferred Alternative with respect to the following impacts:

- minor, temporary, adverse impacts on tides, currents, flow, and sediment transport in the Mississippi River from the proposed cofferdam placed in the river during construction;
- negligible impacts on tides, currents, flows, and sediment transport in the Barataria Basin;
- permanent, minor, adverse impacts on existing hydrology between the levees. Existing level of drainage would be maintained; and
- short-term, moderate, adverse impacts on existing bed elevations in the immediate outfall area due to dredging of the outfall transition feature, access channels, and placement of material for beneficial use sites.

As compared with the Applicant's Preferred Alternative, the size of the intake channel and conveyance channel would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes. As such, the duration of above-mentioned temporary and short-term impacts on hydrology in the Mississippi River and the Barataria Basin would be concomitantly longer or shorter from construction of the 150,000 cfs and 50,000 cfs Alternatives, respectively, as compared with the Applicant's Preferred Alternative.

Additional short-term and permanent, minor, adverse construction impacts could occur on local hydrology and bed elevations in the immediate outfall area for the construction of the terraces associated with three of the action alternatives. To construct the terraces, approximately 450,000 cy of material would be excavated from adjacent water bottom soils to create approximately 18 chevron features oriented into the diversion discharge current. These features would have a higher elevation (about 5 feet higher than initial conditions) than typical surrounding water levels and would have a footprint of approximately 80 to 90 acres. Construction of these terraces would generally result in the deflection of existing flow farther to the south and west across the outfall area. These impacts could cause minor, localized, permanent alterations to existing water flow within the immediate vicinity (less than 0.5 mile) of the terraces.

4.4.4.2 Operational Impacts

4.4.4.2.1 Bed Elevation

4.4.4.2.1.1 <u>No Action Alternative</u>

Under the No Action Alternative, bed elevations (referenced to the NAVD88 vertical datum) in the Barataria Basin are projected to decrease due to land subsidence, representing major, permanent, adverse impacts. Other causes of bed elevation decreases include wind- and wave-induced erosion, which may be exacerbated by sea-level rise. Figure 4.4-2 shows the difference in bed elevations between modeled years 2020 and 2070 under the No Action Alternative. As shown, the general trend of subsidence (shown in yellow, orange, and red) would impact the entire basin, with the exception of bed elevation increases (shown in blue) in the northern portion of the basin and in portions of the birdfoot delta. There are additional model-projected bed elevation increases on the eastern side of the Mississippi River due to periodic flooding from the river.

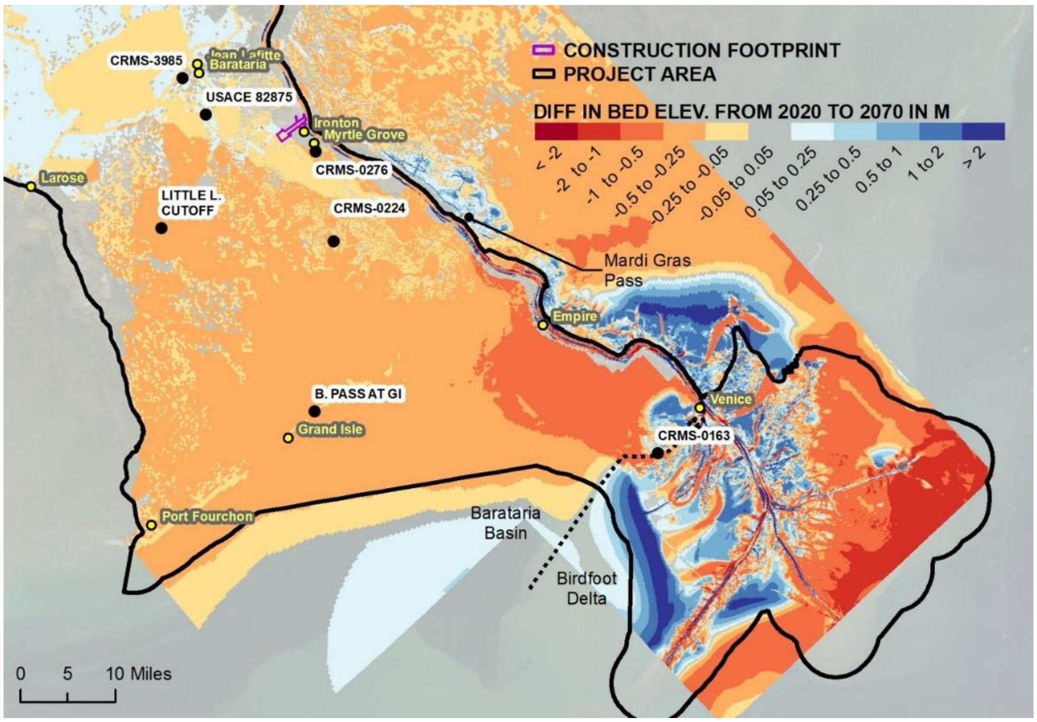


Figure 4.4-2. No Action Alternative Bed Elevation Change from 2020 to 2070. Positive values indicate bed elevation increase; negative values indicate bed elevation decrease, showing the basin-wide subsidence trend. Note the continued bed elevation increases on the eastern side of the Mississippi River north of Venice and at the birdfoot delta under the No Action Alternative.

Under the No Action Alternative, bed elevation changes between modeled years 2020 and 2070 would range from a decrease of approximately 1.3 foot (0.33 meter) at the station nearest the proposed diversion (CRMS 0276) to an increase of 0.3 foot (0.08 meter) in the birdfoot delta (CRMS 0163) (see Table 4.4-2). Spatially varying subsidence and existing sediment transport patterns account for varying bed elevation changes across the basin, as discussed in the Delft3D Basinwide Modeling appendix (see Appendix E).

Table 4.4-2
Progression of Changes in Bed Elevation for No Action Alternative at Six Locations in the Barataria Basin for the Modeled Period 2020 to 2070

Year	Northern/ Mid-Basin (CRMS 3985) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station, near (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163) (ft (m))
2020	0.7 (0.20)	-1.4 (-0.43)	0.3 (0.10)	-6.0 (-1.83)	-14.0 (-4.27)	-2.7 (-0.83)
2030	0.8 (0.23)	-1.6 (-0.50)	0.4 (0.11)	-6.2 (-1.89)	-14.2 (-4.33)	-3.2 (-0.98)
2040	0.9 (0.27)	-1.8 (-0.56)	0.2 (0.05)	-6.4 (-1.96)	-14.4 (-4.39)	-3.7 (-1.14)
2050	1.0 (0.31)	-2.1 (-0.63)	0.0 (-0.01)	-6.6 (-2.02)	-14.6 (-4.46)	-4.2 (-1.29)
2060	0.9 (0.28)	-2.3 (-0.70)	-0.2 (-0.07)	-6.8 (-2.08)	-14.8 (-4.52)	-4.4 (-1.33)
2070	0.8 (0.24)	-2.5 (-0.76)	-0.4 (-0.13)	-7.1 (-2.15)	-15.0 (-4.58)	-2.5 (-0.75)
Bed elevation change between 2020-2070[a]	0.1 (0.04)	-1.3 (-0.33)	-0.8 (-0.23)	-1.0 (-0.32)	-1.0 (-0.31)	0.3 (0.08)

[a] Rounding may produce apparent discrepancies in change values.

Bed elevations are projected to decrease for the No Action Alternative throughout most of the birdfoot delta. This elevation loss is due to land subsidence and a reduction of sediment transported by the Mississippi River in comparison to historic loads. Model results show various areas of aggradation and degradation in the birdfoot delta, with increases in bed elevation within the delta generally occurring upstream of Head of Passes and significant bed elevation loss downstream. Overall, this aligns with Maloney et al. (2018), which discusses the loss of historic sediment loads and retrogradation (retreating) of the Mississippi River subaqueous delta near the end of several river passes. Under the No Action Alternative, bed elevation projections for modeled year 2070 show some spatially varying bed elevation increases near Head of Passes, with the majority of bed elevation increases on the western side of the basin and north of Venice (see Figure 4.4-2), where sediment deposition naturally occurs because these areas are outside of the Mississippi River Levee system. Maloney et al. (2018) shows continued growth of the Southwest Pass. As can be seen by reviewing the land loss projected for the birdfoot delta under the No Action Alternative in Section 4.2 Geology and Soils, Figures 4.2-4 through 4.2-6, bed elevation increases in the birdfoot delta are not projected to result in new land due to continual sea-level rise; the increased bed elevations are projected to occur under water. Although not included in the Delft3D Basinwide Modeling setup or shown in Figure 4.4-2, additional bed elevation increases in the birdfoot delta may be expected to occur in the future from the beneficial use of dredged material occurring as part of CEMVN maintenance dredging in the Mississippi River Passes and other restoration projects, such as those proposed in the Louisiana Coastal Master Plan. For more information about reasonably foreseeable projects in the Project area, see Section 4.25 Cumulative Impacts.

Under the No Action Alternative, ongoing trends of flow and dredging (and the associated impacts on bed elevations) are expected to continue in the Mississippi River. Additional modeling conducted by the USACE (Thomas et al. 2018) discusses the projected continued need for dredging along the Mississippi River from Baton Rouge to the Gulf under the No Action Alternative (see Section 4.21 Navigation for further discussion about navigation and maintenance dredging in the Mississippi River).

4.4.4.2.1.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative would have permanent, major (measurable and widespread) to minor, beneficial impacts on land building through raised bed elevations in the Barataria Basin (see Figure 4.4-3 and Table 4.4-3), with impacts decreasing with distance from the immediate outfall area. Although ongoing trends of subsidence and local erosion would continue to impact the basin, sediments introduced through the proposed diversion would help to offset land loss and sustain or increase bed elevations, primarily within roughly 100-square-miles of the diversion. The most significant impacts on bed elevations would occur within approximately 10 miles of the diversion outlet, with moderate and minor impacts extending farther, primarily southward, including filling any access channels dredged during construction. For example, by year 2070, projected bed elevations would have a major increase of 3.7 feet (1.12 meter) at the station nearest the diversion (CRMS 0276), but approximately 10 miles south of this station at the central station (CRMS 0224) (see Figure 4.4-4), bed elevations are projected to increase by only 0.3 foot (0.10 meter), representing permanent, minor, beneficial impacts. Bed elevation impacts would be negligible at the northern/mid-basin station (CRMS 3985), the western station (Little L. Cutoff), and the southwestern station near Grand Isle (B. Pass at GI) (see Table 4.4-3).

Significant scour potential exists in the immediate outfall area as the diverted flow enters the marsh. Modeling performed as part of the Applicant's engineering and design effort indicated that a scour hole as deep as 75 feet below the existing marsh bottom may occur (elevation of -80 feet NAVD88) during the first year of operation. As a result of this engineering modeling, the Applicant incorporated an engineered outfall transition feature armored with riprap into the Project design. With this engineered outfall transition feature, the Applicant's Preferred Alternative is predicted to produce a scour hole no more than approximately 10 feet below the existing marsh bottom.

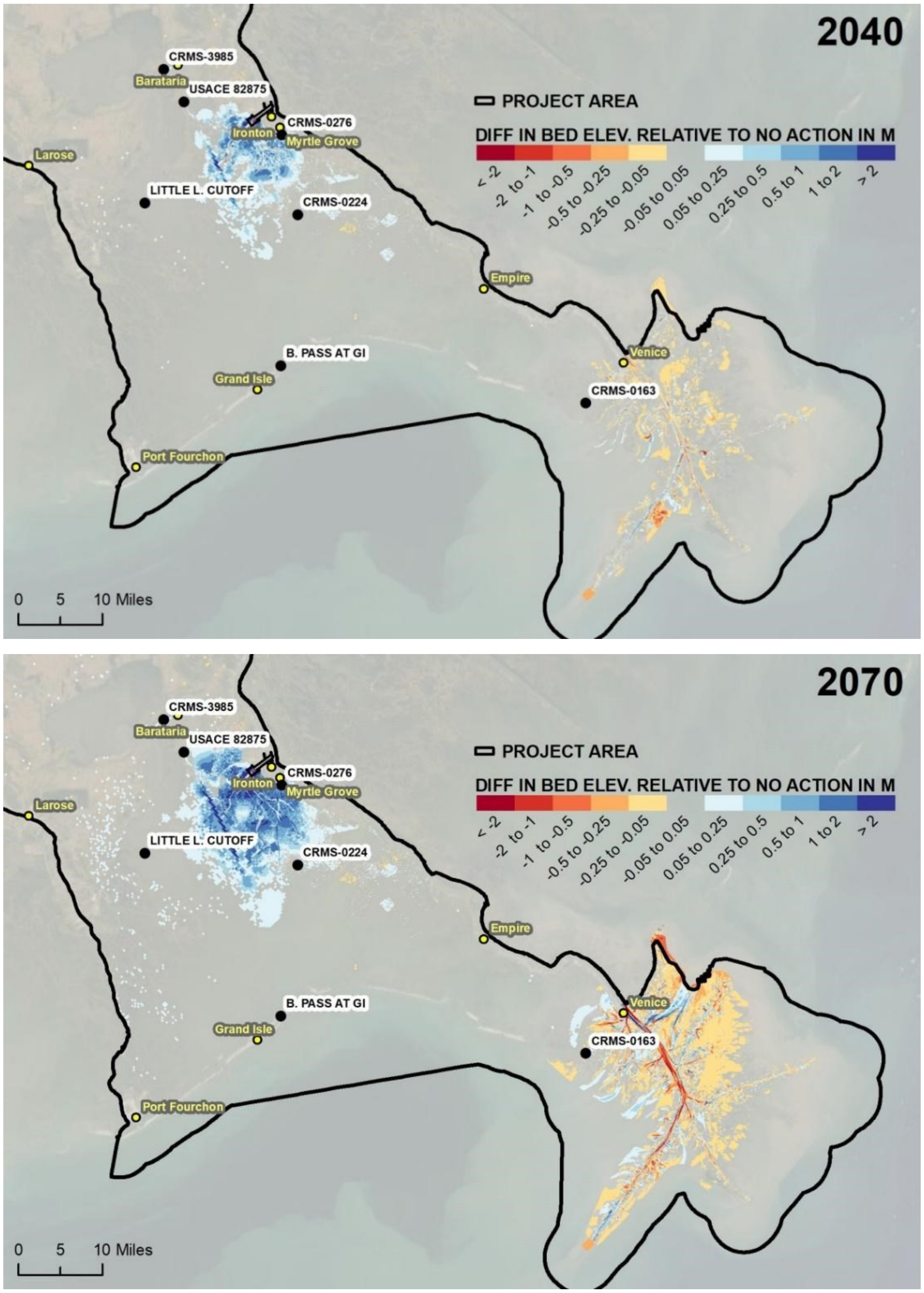


Figure 4.4-3. Projected Bed Elevations Changes in 2040 and 2070 for the Applicant's Preferred Alternative Compared to the No Action Alternative. Positive values indicate upward movement of bed elevations compared to the No Action Alternative. Note the reduction in bed elevation in the birdfoot delta from the diversion of river sediments into the Barataria Basin. Areas in the map not showing blue or orange/red colors indicate no change between the Applicant's Preferred Alternative and the No Action Alternative.

Table 4.4-3
Changes in Bed Elevation for Project Alternatives at Six Locations in the Barataria Basin and Birdfoot Delta for the Modeled Period 2020 to 2070 Relative to No Action Alternative

Year	Northern/ Mid-Basin (CRMS 3985) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163 [a]) (ft (m))
75,000 cfs (Applicant's Preferred Alternative)						
2020	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2030	0.0 (0.00)	1.2 (0.36)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2040	0.0 (0.00)	2.5 (0.76)	0.3 (0.08)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2050	0.0 (0.00)	2.8 (0.86)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	0.0 (0.00)
2060	0.0 (0.00)	3.5 (1.06)	0.3 (0.09)	0.0 (0.01)	0.0 (0.00)	0.0 (-0.01)
2070	0.0 (0.01)	3.7 (1.12)	0.3 (0.10)	0.1 (0.02)	0.0 (0.00)	-0.1 (-0.02)
75,000 cfs + Terraces Alternative						
2020	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2030	0.0 (0.00)	0.7 (0.22)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2040	0.0 (0.00)	2.0 (0.60)	0.3 (0.08)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2050	0.0 (0.00)	1.9 (0.58)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	0.0 (0.00)
2060	0.0 (0.00)	2.7 (0.82)	0.3 (0.09)	0.0 (0.01)	0.0 (0.00)	0.0 (-0.01)
2070	0.0 (0.01)	3.0 (0.91)	0.3 (0.09)	0.1 (0.02)	0.0 (0.00)	-0.1 (-0.04)
50,000 cfs Alternative						
2020	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2030	0.0 (0.00)	0.9 (0.28)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2040	0.0 (0.00)	2.1 (0.65)	0.3 (0.08)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2050	0.0 (0.00)	2.2 (0.67)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	0.0 (0.00)
2060	0.0 (0.00)	2.7 (0.83)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	-0.1 (-0.02)
2070	0.0 (0.01)	2.9 (0.89)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	-0.2 (-0.05)
50,000 cfs + Terraces Alternative						
2020	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2030	0.0 (0.00)	0.2 (0.07)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2040	0.0 (0.00)	1.2 (0.38)	0.3 (0.08)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2050	0.0 (0.00)	2.0 (0.62)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	0.0 (0.00)
2060	0.0 (0.00)	2.6 (0.79)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	-0.1 (-0.03)
2070	0.0 (0.01)	2.7 (0.82)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	-0.2 (-0.07)
150,000 cfs Alternative						
2020	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2030	0.0 (0.00)	1.1 (0.34)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2040	0.0 (0.00)	3.6 (1.10)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	0.0 (0.00)
2050	0.0 (0.00)	4.8 (1.46)	0.3 (0.09)	0.1 (0.02)	0.0 (0.00)	0.0 (0.00)
2060	0.0 (0.00)	5.4 (1.64)	0.4 (0.12)	0.1 (0.02)	0.0 (0.00)	-0.1 (-0.03)
2070	0.0 (0.01)	5.9 (1.81)	0.7 (0.21)	0.1 (0.03)	0.0 (0.00)	-0.6 (-0.17)
150,000 cfs + Terraces Alternative						
2020	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2030	0.0 (0.00)	1.0 (0.32)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
2040	0.0 (0.00)	3.4 (1.04)	0.3 (0.08)	0.0 (0.01)	0.0 (0.00)	0.0 (0.00)

Table 4.4-3
Changes in Bed Elevation for Project Alternatives at Six Locations in the Barataria Basin and Birdfoot Delta for the Modeled Period 2020 to 2070 Relative to No Action Alternative

Year	Northern/ Mid-Basin (CRMS 3985) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163 [a]) (ft (m))
2050	0.0 (0.00)	3.9 (1.18)	0.3 (0.09)	0.1 (0.02)	0.0 (0.00)	0.0 (0.00)
2060	0.0 (0.00)	5.3 (1.62)	0.4 (0.12)	0.1 (0.02)	0.0 (0.00)	-0.2 (-0.05)
2070	0.0 (0.01)	6.0 (1.83)	0.8 (0.25)	0.1 (0.03)	0.0 (0.00)	-0.6 (-0.18)

[a] Note that this station data is from one distinct Delft3D Basinwide Model cell located in the western edge of the birdfoot delta and does not represent the scope of land loss projected by the model for the overall birdfoot delta as described in Section 4.2 Geology and Soils and illustrated in Figure 4.4-3.

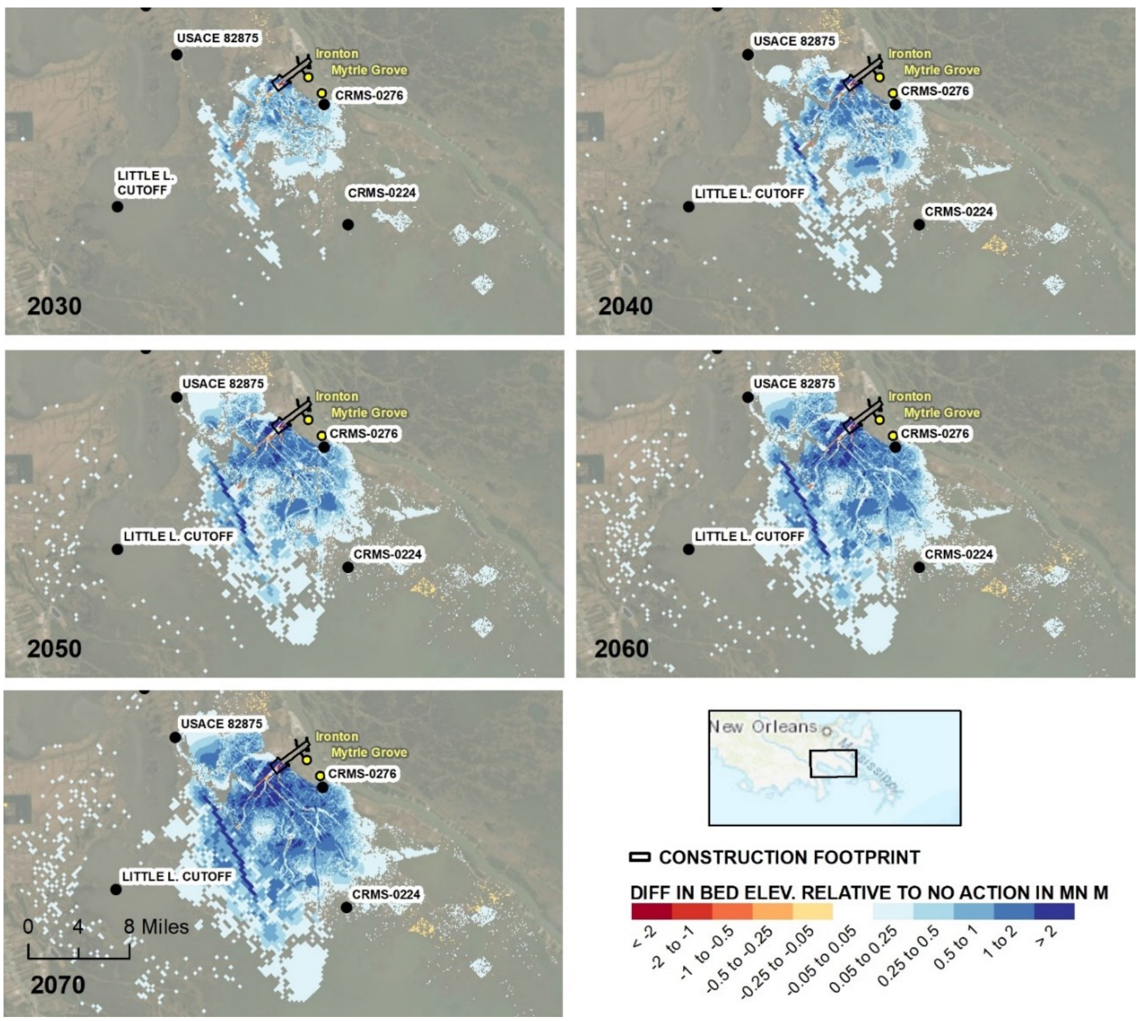


Figure 4.4-4. Model-projected Changes to Bed Elevation in Meters in the Project Area Relative to the No Action Alternative in 2030, 2040, 2050, 2060, and 2070 under the Applicant's Preferred Alternative.

The Applicant's Preferred Alternative would have permanent, moderate, adverse impacts on bed elevations in the birdfoot delta due to the reduced sediment load reaching the delta during the 50-year analysis period of the proposed diversion (see Figure 4.4-3). Delft3D Basinwide Modeling projects that the Applicant's Preferred Alternative would result in more steadily and rapidly decreasing bed elevations than the No Action Alternative. Bed elevation increases beyond the scope of the Delft3D Basinwide Model in the birdfoot delta may be expected to occur in the future from restoration projects as well as from the beneficial use of dredged material occurring as part of CEMVN maintenance dredging in the Mississippi River Passes. See Section 4.25 Cumulative Impacts for details about cumulative impacts from other projects in the Project area.

At the station near the birdfoot delta (CRMS 0163), the Applicant's Preferred Alternative would have similar impacts in 2070 compared to the No Action Alternative (see Table 4.4-3). Other areas in the birdfoot delta are projected to have greater decreases in bed elevation (0.3 to 1.6 feet [0.10 to 0.50 meter]) as compared with the No Action Alternative, as shown in Figure 4.4-5. Areas downstream of the proposed Project, such as on the eastern side of the Mississippi River across from Venice, are projected to have decreasing elevations compared to the No Action Alternative, because the diversion would capture some of the high river volume and sediment load that would passively flood these areas under the No Action Alternative. Indirect impacts from projected bed elevation impacts would include, but not be limited to, changes in wetland habitats and the aquatic species that depend on these habitats, and impacts on flooding. See Section 4.6 Wetland Resources and Waters of the U.S., Section 4.10 Aquatic Resources, and Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, respectively, for further discussion about impacts on these resources.

As projected by the Delft3D Basinwide Model, in the Mississippi River, the Applicant's Preferred Alternative would have permanent, moderate, and adverse impacts, with general trends of increased erosion immediately upstream of the diversion and increased deposition immediately downstream of the diversion, with the exception of the birdfoot delta, as explained above and shown in Figure 4.4-5. These Delft3D Basinwide Model projections are supported by a study by Allison et al. (2013) and Meselhe et al. (2016a) indicating that deposition generally occurs downstream of a diversion. The driving force for these changes is the reduced flow and consequently slower water velocity downstream of diversions from the rerouting of the water through the diversion. Immediately upstream of diversions, erosion is expected to increase due to the increased water surface slope induced when the diversion is open (flowing greater than the 5,000 cfs up to a maximum of 75,000 cfs depending on flows in the river). These model results are also generally supported by a recent USACE one-dimensional modeling study (Thomas et al. 2018), which projects a general increase in deposition within the Mississippi River after the proposed Project begins operating, with more deposition occurring immediately downstream of the diversion than upstream. Project impacts on navigation and dredging due to the projected alteration of existing deposition patterns are discussed in Section 4.21 Navigation.

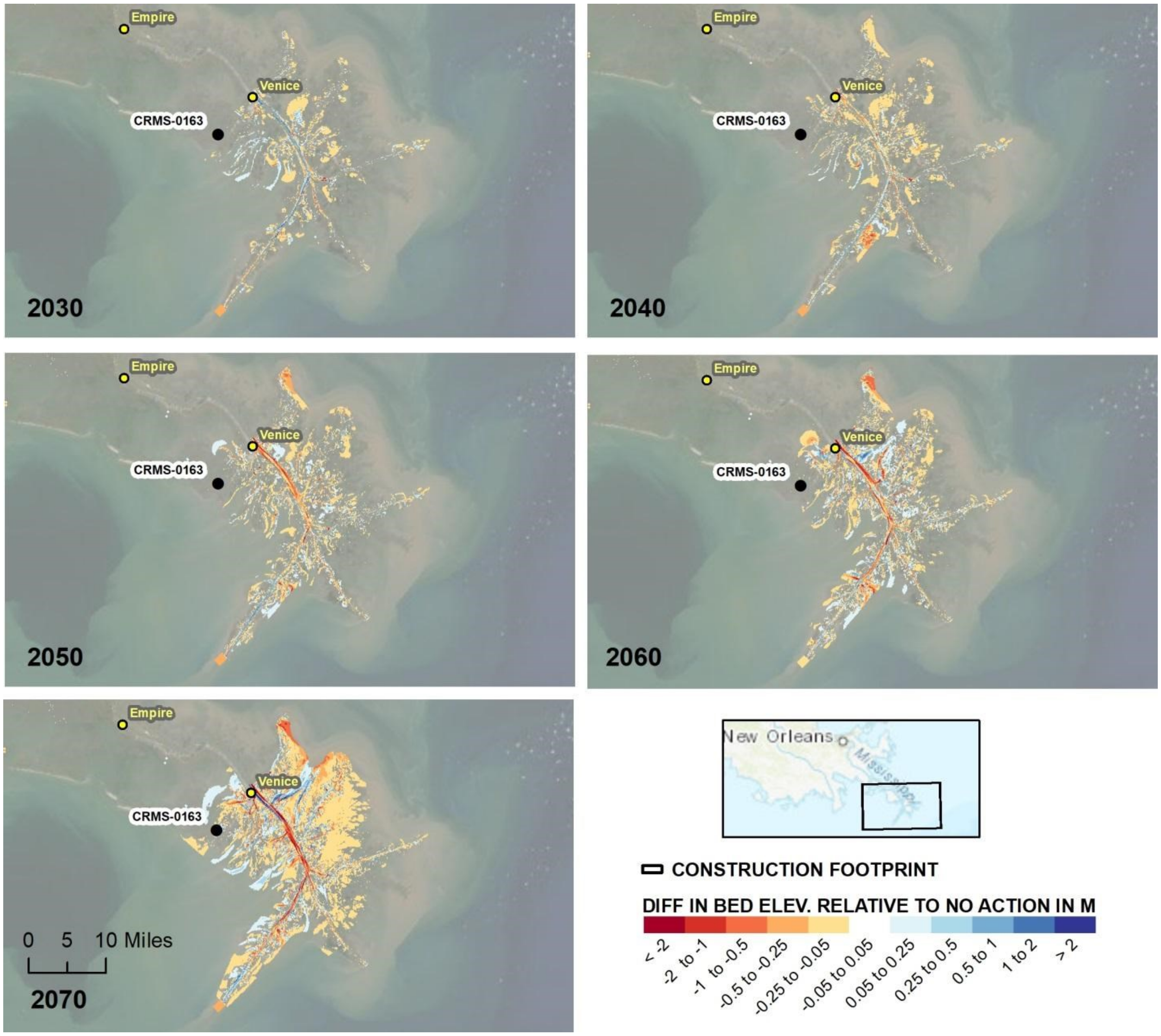


Figure 4.4-5. Model-projected Changes to Bed Elevation in Meters in the Birdfoot Delta Relative to the No Action Alternative in 2030, 2040, 2050, 2060, and 2070 under the Applicant's Preferred Alternative.

4.4.4.2.1.3 Other Alternatives

4.4.4.2.1.3.1 50,000 cfs Alternative

The 50,000 cfs Alternative would have impacts on bed elevations similar to those under the Applicant's Preferred Alternative. Within the Barataria Basin, bed elevation increases would be slightly less than the Applicant's Preferred Alternative due to smaller diversion size and concurrent smaller amount of diverted sediment (see Figure 4.4-6 and Table 4.4-3). At the station nearest the diversion, bed elevations are projected to increase by 2.9 feet (0.89 meter) compared to 3.7 feet (1.12 meters) for the Applicant's Preferred Alternative. At the central station (CRMS 0224) bed elevations are projected to be nearly the same as those under the Applicant's Preferred Alternative.

Operational impacts on the Mississippi River and birdfoot delta would be slightly less than the Applicant's Preferred Alternative, but remain permanent, moderate, and adverse. Within the birdfoot delta, general bed elevations are projected to decrease, as shown in Figure 4.4-6.

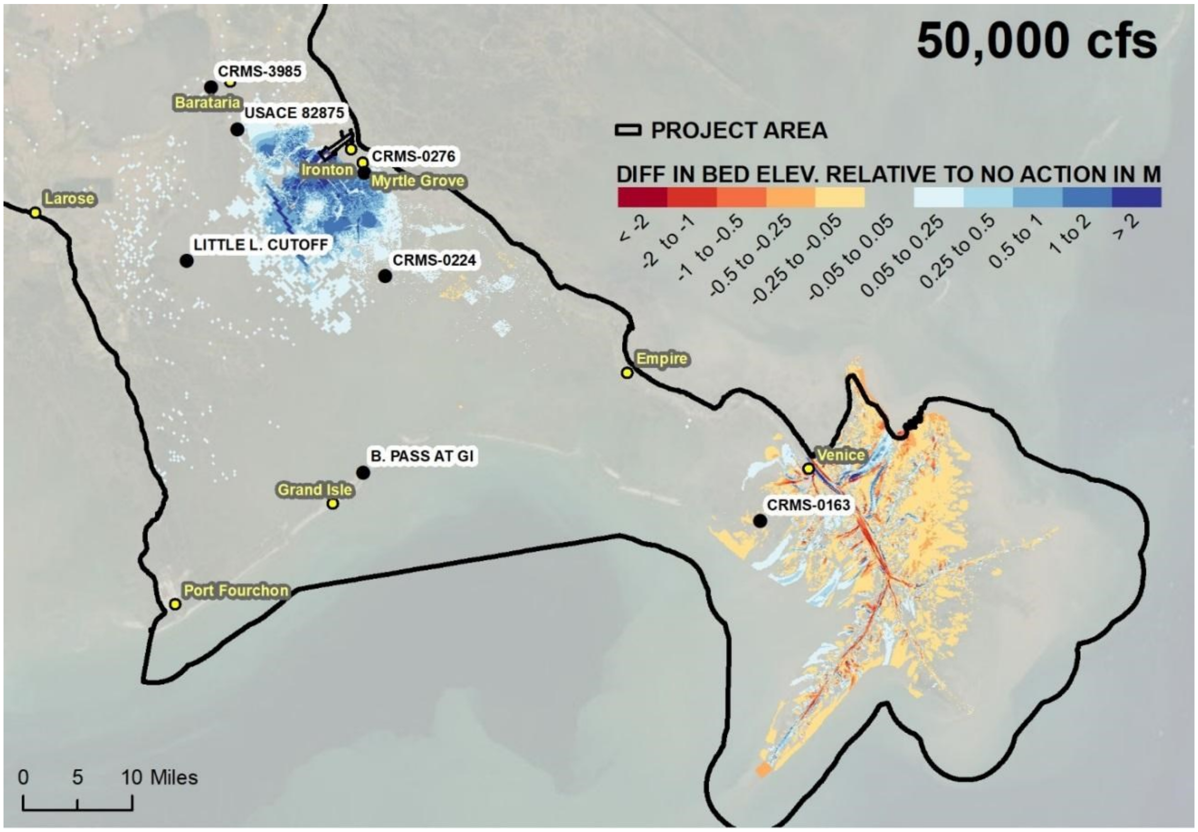


Figure 4.4-6. Model-projected Bed Elevation Changes in 2070 for the 50,000 cfs Alternative Compared to the No Action Alternative.

4.4.4.2.1.3.2 150,000 cfs Alternative

Within the Barataria Basin, the magnitude of bed elevation increases under the 150,000 cfs Alternative would be greater than bed elevation increases under the Applicant's Preferred Alternative due to the larger diversion size of the 150,000 cfs Alternative and concurrent greater amount of diverted sediment (see Figures 4.4-6 and 4.4-7 and Table 4.4-3). Nearest the diversion at CRMS 0276, projected bed elevation increases for the 150,000 cfs Alternative and the Applicant's Preferred Alternative are 5.9 feet (1.81 meters) and 3.7 feet (1.12 meters), respectively. In the center of the basin at the central station (CRMS 0224), projected bed elevation increases for the 150,000 cfs Alternative and the Applicant's Preferred Alternative are 0.7 foot (0.21 meter) and 0.3 foot (0.10 meter), respectively.

Under the 150,000 cfs Alternative, operational impacts on bed elevations in the Mississippi River and birdfoot delta would be permanent, moderate, and adverse. As compared to the No Action Alternative, bed elevations at the birdfoot delta (CRMS

0163) are projected to decrease by 0.6 foot (0.17 meter). Figure 4.4-7 shows the general trend of decreasing bed elevations in the birdfoot delta, with greater magnitudes than the lower capacity alternatives.

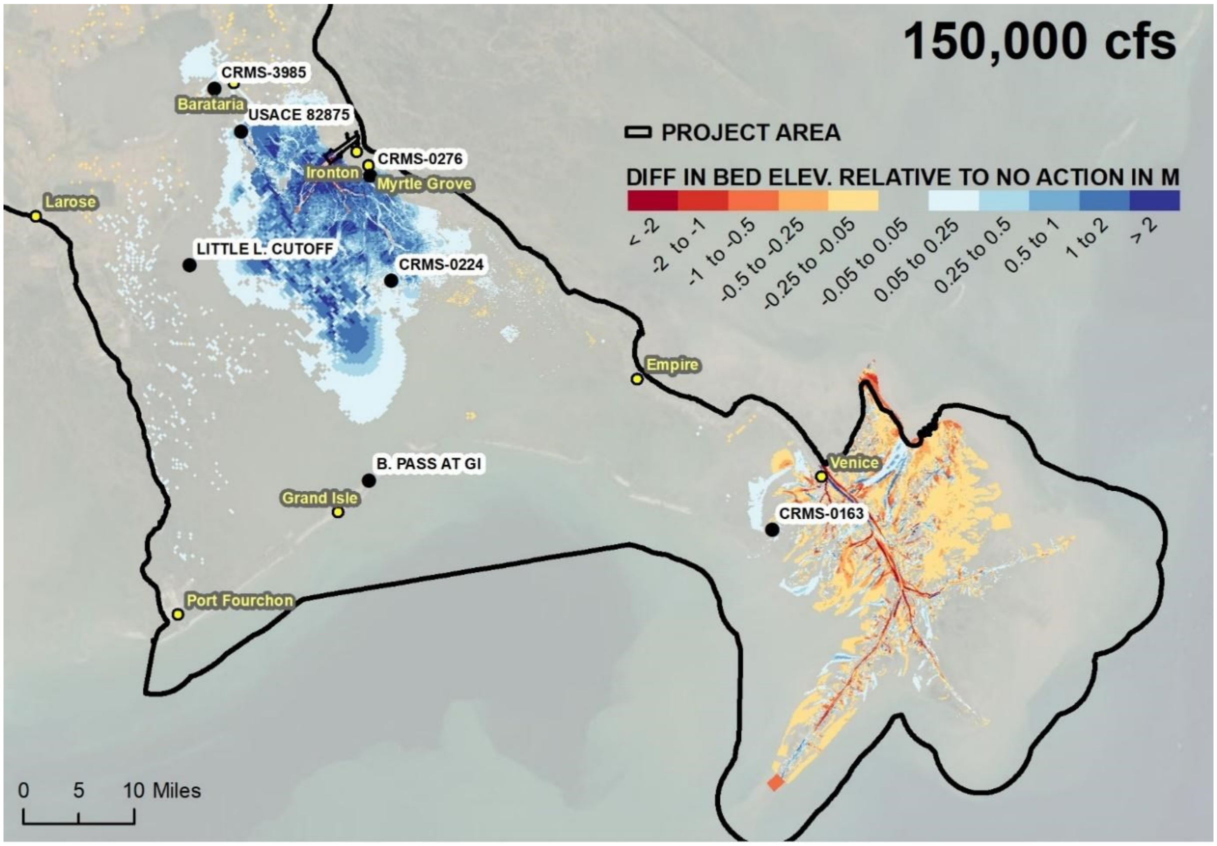


Figure 4.4-7. Model-projected Bed Elevation Changes in 2070 for the 150,000 cfs Alternative Compared to the No Action Alternative.

4.4.4.2.1.3.3 Terrace Alternatives

The 75,000 cfs, 50,000 cfs, and 150,000 cfs Terraces alternatives would have nearly identical operational impacts on bed elevations as compared to the Applicant's Preferred Alternative. In the Barataria Basin, each terrace alternative would have major, permanent, beneficial impacts as compared to the No Action Alternative. The addition of the terrace features within the Barataria Basin would slightly change the deposition patterns (see Figures 4.4-8 and 4.4-9 and Table 4.4-3), but the general pattern, location, and magnitude of the bed elevation changes would be consistent with the Applicant's Preferred Alternative.

Operational impacts on the Mississippi River and birdfoot delta would be nearly identical to the Applicant's Preferred Alternative: permanent, moderate, and adverse. General bed elevations in the birdfoot delta are projected to decrease, particularly on the eastern side of the delta (see Figure 4.4-8). A lower sea-level rise rate would reduce the decreasing rate of the bed elevations in the birdfoot delta due to lower water levels.

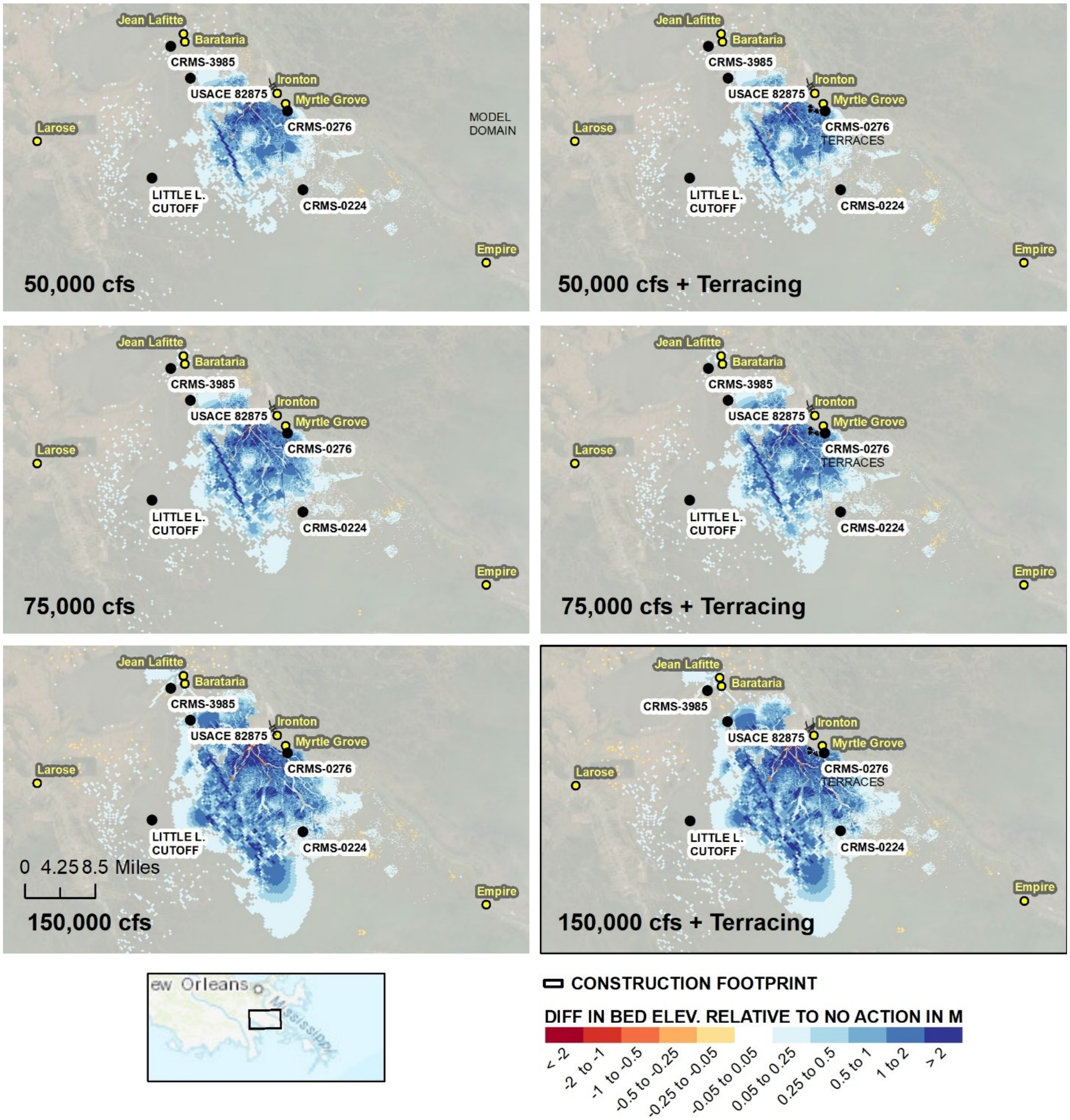


Figure 4.4-8. Model-projected Changes in Bed Elevation in Meters in the Project Area Relative to the No Action Alternative in 2070 under the Applicant's Preferred Alternative and Other Action Alternatives. Insets depict detail in the east/central portion of the Barataria Basin.

Figure 4.4-9. Marsh Terrace Features Proposed for the Three Terrace Alternatives (shown in yellow). CRMS station 0276 marked by red circle.

4.4.4.2.2 Water Levels

In this section, monthly averages were used to characterize seasonal trends in water levels for each alternative, including the No Action Alternative. Monthly averages give a more detailed picture of data than do seasonal averages, but also show trends in the data better than daily averages do. To display five discontinuous decades of model-projected results over the 50-year analysis period, the representative hydrograph for each decadal cycle was used (see Section 4.1 for more information about Delft3D Basinwide Model hydrographs). This was done to better mimic river flows and changes and to show how different annual hydrographs impact the model response, as opposed to using the same hydrograph for the entire analysis period. The graphs in this section show the monthly water levels for one year within each decade to show the impacts of sea-level rise on the overall water surface elevations combined with any impacts (for example, changes in bed elevation, vegetation, and wetland formation) from the diversion over the life of the proposed Project (see Section 4.1.3.2 for more information about sea-level rise). Points on the lines are the average monthly water levels at the station.

4.4.4.2.2.1 No Action Alternative

Water levels within the Barataria Basin are primarily impacted by tides and sea-level rise (see Chapter 3, Section 3.4 Surface Water and Coastal Processes). Figure 4.4-10 shows the projected monthly water levels for the No Action Alternative at the seven selected stations over the 50-year analysis period. As seen in the figure, monthly water levels under the No Action Alternative would continue to trend upwards over the simulation period due to sea-level rise. This would increase impacts at all station locations. Increased water levels would decrease land area, increase the extent of open water areas, and increase the probability of flooding events throughout the basin under the No Action Alternative.

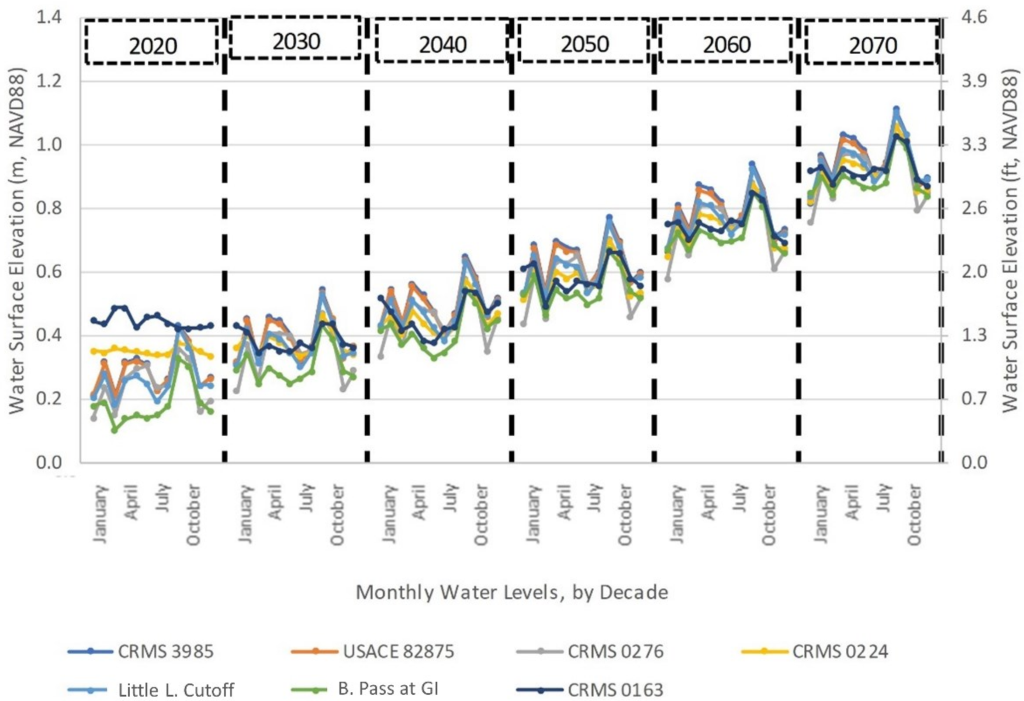


Figure 4.4-10. Water Level Trends for Selected Stations for the No Action Alternative. Note that all stations are impacted by the increasing sea level over the 50-year analysis period.

Under the No Action Alternative, in the Mississippi River, water levels would be impacted by increasing sea level as well, which would increase water surface elevations at locations upriver. If the water level in the Gulf of Mexico increases by 2 feet (0.60 meter), water levels upstream would also increase by following a nonlinear function of river flow and distance upstream from the Gulf, but the incremental difference in water levels would eventually diminish to zero at a certain location upstream. Increases in river water levels would reduce the degree of protection afforded by the MR&T Levee.

4.4.4.2.2.2 Applicant's Preferred Alternative

Operational impacts on water levels in the Barataria Basin under the Applicant's Preferred Alternative would be permanent, major to minor (depending on the location in the basin), and adverse. These impacts, seen as higher water levels, would primarily occur when the diversion is flowing above base flow (up to 75,000 cfs depending on flows in the river). The proposed 5,000 cfs base flow would continue to impact water levels near the proposed diversion structure outlet when head differential allows. Impacts on water levels in the basin would decrease with increasing distance from the diversion structure, with negligible (inconsequential and barely measurable) impacts on water levels occurring near the western and southern ends of the Project area.

Figure 4.4-11 illustrates water level differences between the No Action Alternative and the Applicant's Preferred Alternative based on the historical representative hydrograph in modeled year 2040 (top panel, 1985 historical representative hydrograph) and 2070 (bottom panel, 2008 historical representative hydrograph) during the third week of May when the diversion would be operating at maximum capacity (75,000 cfs). Using a threshold of 0.3 foot (0.1 meter, consistent with the minimal water level increases portrayed in Figures 4.4-11 and 4.4-12), the Delft3D Basinwide Model projects that in 2040 water levels under the Applicant's Preferred Alternative would increase in some areas outside of levee protection—mainly within approximately 10 miles north and 20 miles south (along the NOV and NOV-NFL levees) of the immediate outfall area, with additional smaller, isolated areas of water level increases occurring up to approximately 35 miles to the northwest (to Des Allemands). These distances are projected to decrease to 5.2 miles to the northwest and 9.4 miles to the south by operational year 2070. See Section 4.20.4 Storm Surge and Flooding for more details about Project-induced tidal flooding in communities outside of levee protection.

Model results in 2040 at the Barataria Bay Waterway near Lafitte (USACE 82875) project that monthly average water levels would increase a maximum of 0.5 foot (0.14 meter) during diversion operations as compared to the No Action Alternative (see Table 4.4-4). Model results in 2070 at the Barataria Bay Waterway near Lafitte (USACE 82875) project that monthly average water levels would increase a maximum of 0.2 foot (0.05 meter) during diversion operations as compared to the No Action Alternative (see Table 4.4-4). See Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for additional information about storm surge and flooding impacts on communities in the Project area. Figure 4.4-12 shows water level impacts during operation of the Applicant's Preferred Alternative (as compared with the No Action Alternative) for the 3rd Week of May in 2030, 2040, 2050, 2060, and 2070. The maps show progressively decreasing differences in the spatial extent of projected water level impacts between the Applicant's Preferred Alternative and the No Action Alternative due to increasing sea-level rise over the 50-year analysis period. Water level increases for the Applicant's Preferred Alternative compared to the No Action Alternative in 2070 impact a much smaller area than in earlier decades of operations.

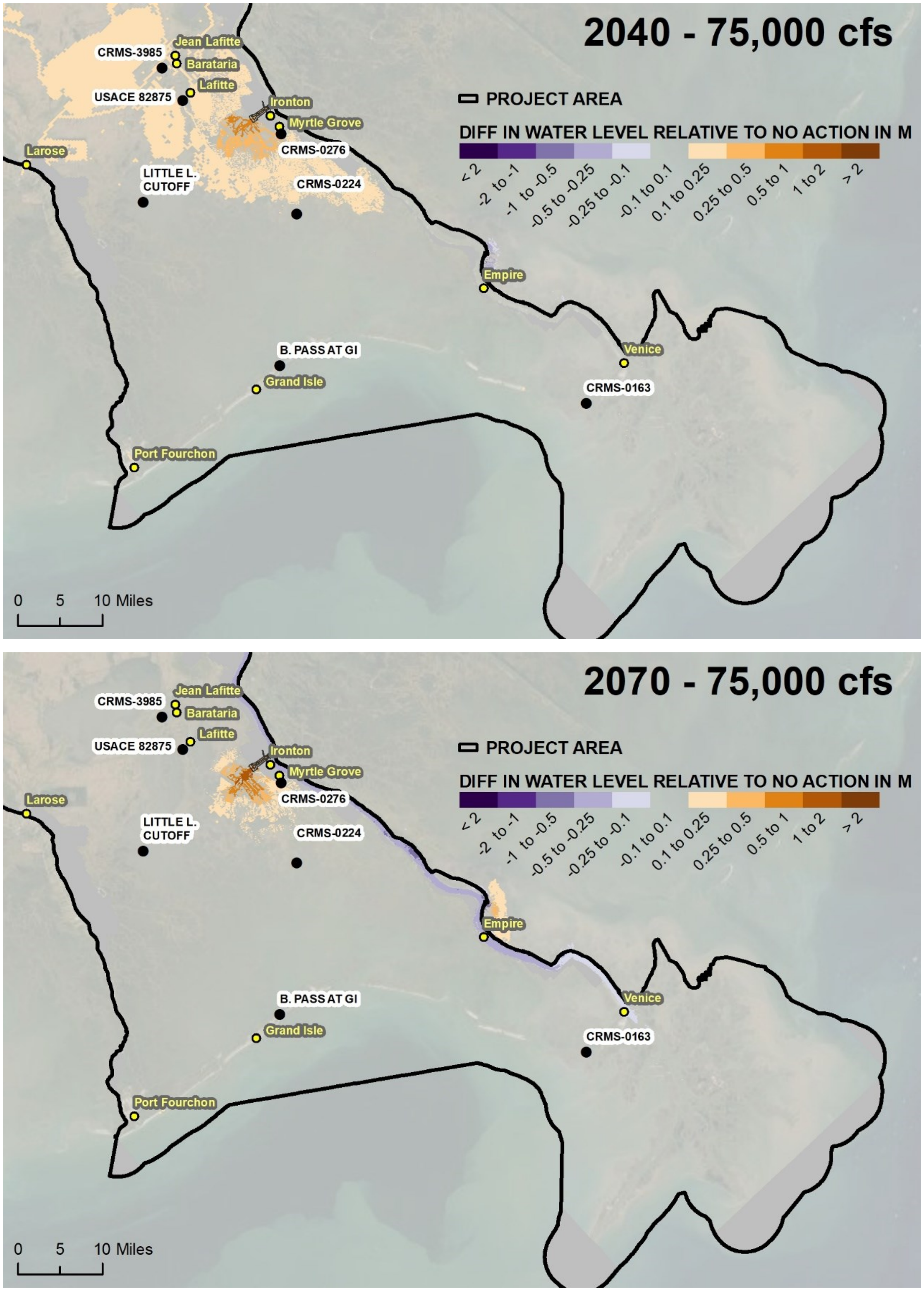


Figure 4.4-11. Map of Water Level Increase for the Applicant's Preferred Alternative for the 3rd Week of May under 2040 Conditions (Top Panel) and 2070 Conditions (Bottom Panel) using historical representative hydrograph (1985 for 2040, and 2008 for 2070). Note increased water levels in the Barataria Basin near the diversion and decreased water levels in the Mississippi River.

Table 4.4-4
Maximum Monthly Average Water Level Differences for Project Alternatives at Seven Locations in the Barataria Basin for the Modeled Period 2020 to 2070 relative to No Action Alternative[a] (Representative Hydrograph)

Year	Northern/ Mid-Basin (CRMS 3985) (ft (m))	Near Lafitte (USACE 82875) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163)[b] (ft (m))
75,000 cfs (Applicant's Preferred Alternative)							
2020	0.3 (0.10)	0.4 (0.11)	1.1 (0.33)	0.1 (0.02)	0.3 (0.09)	0.1 (0.03)	- (-)
2030	0.4 (0.11)	0.4 (0.12)	1.1 (0.33)	0.1 (0.04)	0.3 (0.08)	0.1 (0.03)	0.0 (0.01)
2040	0.4 (0.11)	0.5 (0.14)	1.1 (0.33)	0.1 (0.04)	0.3 (0.08)	0.1 (0.03)	0.0 (0.01)
2050	0.3 (0.08)	0.3 (0.09)	0.9 (0.28)	0.1 (0.04)	0.2 (0.06)	0.1 (0.03)	0.0 (0.01)
2060	0.2 (0.07)	0.3 (0.08)	0.7 (0.21)	0.1 (0.03)	0.2 (0.05)	0.1 (0.02)	0.0 (0.01)
2070	0.1 (0.04)	0.2 (0.05)	0.4 (0.13)	0.0 (0.01)	0.1 (0.03)	0.0 (0.01)	-0.1 (-0.02)
75,000 cfs + Terraces Alternative							
2020	0.3 (0.10)	0.4 (0.11)	1.0 (0.31)	0.1 (0.02)	0.3 (0.08)	0.1 (0.03)	0.1 (0.03)
2030	0.4 (0.11)	0.4 (0.12)	1.0 (0.31)	0.1 (0.04)	0.3 (0.08)	0.1 (0.03)	0.0 (-0.01)
2040	0.4 (0.12)	0.5 (0.14)	1.0 (0.3)	0.2 (0.05)	0.3 (0.08)	0.1 (0.03)	0.0 (0.01)
2050	0.3 (0.08)	0.3 (0.09)	0.7 (0.22)	0.1 (0.04)	0.2 (0.06)	0.1 (0.03)	0.0 (0.01)
2060	0.2 (0.07)	0.3 (0.08)	0.6 (0.19)	0.1 (0.03)	0.2 (0.05)	0.1 (0.03)	0.1 (0.02)
2070	0.2 (0.05)	0.2 (0.06)	0.4 (0.13)	-0.1 (-0.02)	0.1 (0.04)	0.1 (0.02)	-0.1 (-0.03)
50,000 cfs Alternative							
2020	0.2 (0.07)	0.3 (0.08)	0.8 (0.25)	0.0 (0.01)	0.2 (0.06)	0.1 (0.02)	0.1 (0.03)
2030	0.2 (0.07)	0.3 (0.08)	0.8 (0.24)	0.1 (0.03)	0.2 (0.06)	0.1 (0.02)	0.0 (-0.01)
2040	0.3 (0.08)	0.3 (0.10)	0.7 (0.21)	0.1 (0.03)	0.2 (0.06)	0.1 (0.03)	0.0 (0.01)
2050	0.2 (0.05)	0.2 (0.07)	0.4 (0.13)	0.1 (0.02)	0.1 (0.04)	0.1 (0.02)	0.0 (0.01)
2060	0.1 (0.04)	0.2 (0.05)	0.3 (0.10)	0.1 (0.02)	0.1 (0.03)	0.0 (0.01)	0.0 (0)
2070	0.1 (0.03)	0.1 (0.03)	0.2 (0.05)	0.0 (-0.01)	0.1 (0.02)	0.0 (-0.01)	-0.1 (-0.02)
50,000 cfs + Terraces Alternative							
2020	0.2 (0.07)	0.2 (0.07)	0.8 (0.24)	0.1 (0.02)	0.2 (0.06)	0.1 (0.03)	0.1 (0.03)
2030	0.2 (0.07)	0.3 (0.08)	0.7 (0.22)	0.1 (0.03)	0.2 (0.06)	0.1 (0.02)	0.0 (0.01)
2040	0.3 (0.08)	0.3 (0.09)	0.6 (0.18)	0.1 (0.03)	0.2 (0.06)	0.1 (0.02)	0.0 (0.01)
2050	0.2 (0.06)	0.2 (0.06)	0.4 (0.12)	0.1 (0.02)	0.1 (0.04)	0.1 (0.02)	0.0 (0.01)
2060	0.2 (0.05)	0.2 (0.06)	0.3 (0.10)	0.1 (0.02)	0.1 (0.03)	0.0 (0.01)	0.0 (0.01)
2070	0.1 (0.02)	0.1 (0.03)	0.4 (0.12)	-0.1 (-0.02)	0.1 (0.02)	0.1 (0.02)	-0.1 (-0.03)
150,000 cfs Alternative							
2020	0.7 (0.21)	0.8 (0.25)	1.7 (0.51)	0.1 (0.04)	0.6 (0.17)	0.2 (0.05)	-0.1 (-0.03)
2030	0.7 (0.22)	0.9 (0.26)	1.9 (0.57)	0.2 (0.07)	0.5 (0.16)	0.1 (0.04)	0.0 (0.01)
2040	0.7 (0.21)	0.9 (0.26)	1.9 (0.59)	0.2 (0.07)	0.5 (0.15)	0.2 (0.05)	0.0 (0.01)
2050	0.5 (0.16)	0.6 (0.19)	1.7 (0.51)	0.2 (0.06)	0.4 (0.12)	0.2 (0.05)	0.0 (0.01)
2060	0.5 (0.14)	0.6 (0.17)	1.3 (0.41)	0.2 (0.05)	0.4 (0.11)	0.1 (0.04)	0.0 (0.01)
2070	0.4 (0.11)	0.4 (0.12)	1.6 (0.48)	0.1 (0.03)	0.3 (0.09)	0.1 (0.03)	-0.1 (-0.02)
150,000 cfs + Terraces Alternative							
2020	0.7 (0.21)	0.8 (0.25)	1.6 (0.49)	0.1 (0.04)	0.6 (0.17)	0.2 (0.05)	0.0 (0.01)
2030	0.7 (0.22)	0.9 (0.26)	1.7 (0.53)	0.2 (0.07)	0.5 (0.16)	0.1 (0.04)	0.0 (-0.01)

Table 4.4-4
Maximum Monthly Average Water Level Differences for Project Alternatives at Seven Locations in the Barataria Basin for the Modeled Period 2020 to 2070 relative to No Action Alternative[a] (Representative Hydrograph)

Year	Northern/ Mid-Basin (CRMS 3985) (ft (m))	Near Lafitte (USACE 82875) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163)[b] (ft (m))
2040	0.7 (0.21)	0.9 (0.27)	1.9 (0.57)	0.2 (0.07)	0.5 (0.16)	0.2 (0.05)	0.0 (0.01)
2050	0.5 (0.15)	0.6 (0.18)	1.5 (0.47)	0.2 (0.06)	0.4 (0.12)	0.1 (0.04)	0.0 (0.01)
2060	0.5 (0.14)	0.6 (0.17)	1.3 (0.4)	0.2 (0.05)	0.4 (0.11)	0.1 (0.04)	0.0 (0.01)
2070	0.3 (0.10)	0.4 (0.11)	1.4 (0.44)	0.1 (0.03)	0.3 (0.08)	0.1 (0.03)	-0.1 (-0.02)

[a] Values in the table were obtained by subtracting the projected monthly average water levels for the No Action Alternative from the corresponding monthly average water level of each project alternative. The maximum change for any given month is extracted and displayed in the table. The values do not indicate an annual change, only the maximum change for a single month of the year. Negative values indicate that the largest magnitude of change is a reduction in water levels compared to the No Action Alternative. See Appendix E for the complete set of water level tables.

[b] The Delft3D Basinwide Model cell for the birdfoot delta station (CRMS 0163) in the birdfoot delta is projected to be partially dry marsh in modeled year 2020 transitioning to open water in year 2030. For this reason, results before 2030 are not included for the CRMS 0163 station in the analysis

Figure 4.4-12 displays water level and bed elevation trends for the No Action Alternative and the Applicant’s Preferred Alternative from 2020 to 2070 at the station nearest the proposed diversion (CRMS 0276). A comparison of the bed elevation trends (shown in orange and yellow) alongside modeled water level trends (shown in blue and gray in Figure 4.4-16) demonstrates the increase in overall water depth over the simulation period because of both land subsidence and sea-level rise under the No Action Alternative.

As shown in Figure 4.4-13, water levels and bed elevations would increase under the Applicant’s Preferred Alternative near the diversion, but the overall water depth would decrease as Project-induced bed elevation increases outpace sea-level rise. As described above, water level differences between the No Action Alternative and the Applicant’s Preferred Alternative decrease with increasing distance from the diversion. Water level differences between the Applicant’s Preferred Alternative and the No Action Alternative also decrease over time due to the influence of sea-level rise increasing the overall water levels. In general, an increased rate of sea-level rise over time would increase the rate of water level increases such that the difference in impacts between the Applicant’s Preferred Alternative and the No Action Alternative would be less.

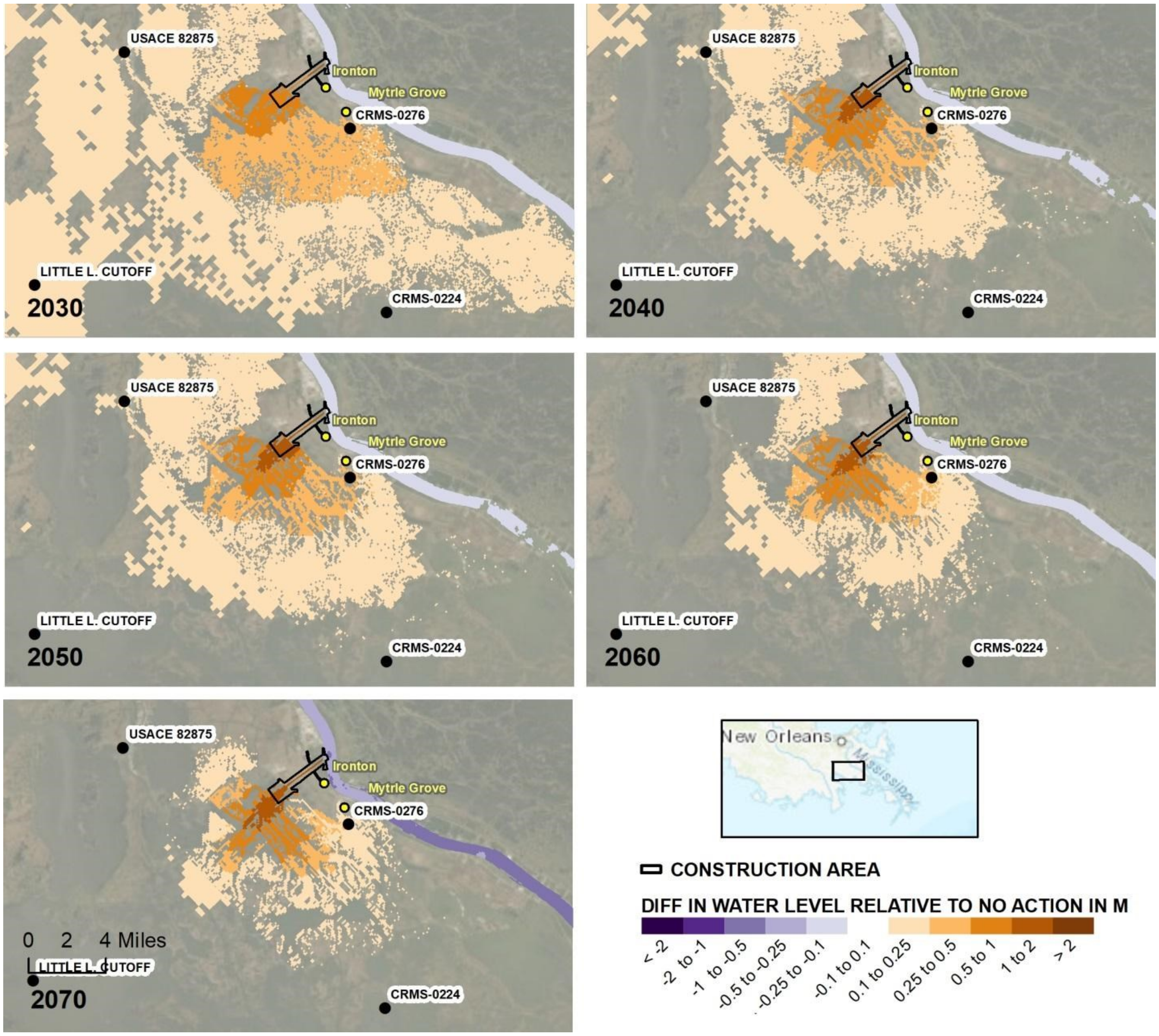


Figure 4.4-12. Model-projected Water Level Impacts in the Immediate Outfall Area Relative to the No Action Alternative for the 3rd Week of May in 2030, 2040, 2050, 2060, and 2070 under the Applicant's Preferred Alternative (using the historical representative hydrograph for each decade).

Moving from the northern portion of the basin to the birdfoot delta, the Applicant's Preferred Alternative is projected to have minor impacts on water levels at the northern/ mid-basin station (CRMS 3985) and near Lafitte (USACE 82875) (see Figures 4.4-14 and 4.4-15). It can be concluded that Upper Barataria Basin would experience negligible impacts from the diversion. At the station nearest the proposed diversion (CRMS 0276), the Applicant's Preferred Alternative would have major water level increases over the 50-year analysis period (see Figure 4.4-16 and Table 4.4-4.) Water level impacts are projected to be larger here due to its proximity to the diversion channel. Impacts are expected to be minor at the central station (CRMS 0224, see Figure 4.4-17), western station (Little L. Cutoff, see Figure 4.4-18), and southwestern station near Grand Isle (B. Pass at GI, see Figure 4.4-19). Figure 4.4-20 shows water levels for all alternatives near the birdfoot delta (CRMS 0163) and displays the minor water level increases for the Applicant's Preferred Alternative over the 50-year analysis period. Some minor differences are shown in the first two decades, which is likely due to model limitations (see Appendix E), as this station is located in a marsh-type area that is not fully inundated in the beginning of the simulations. See Table 4.4-4 for a summary of maximum average water level increases.

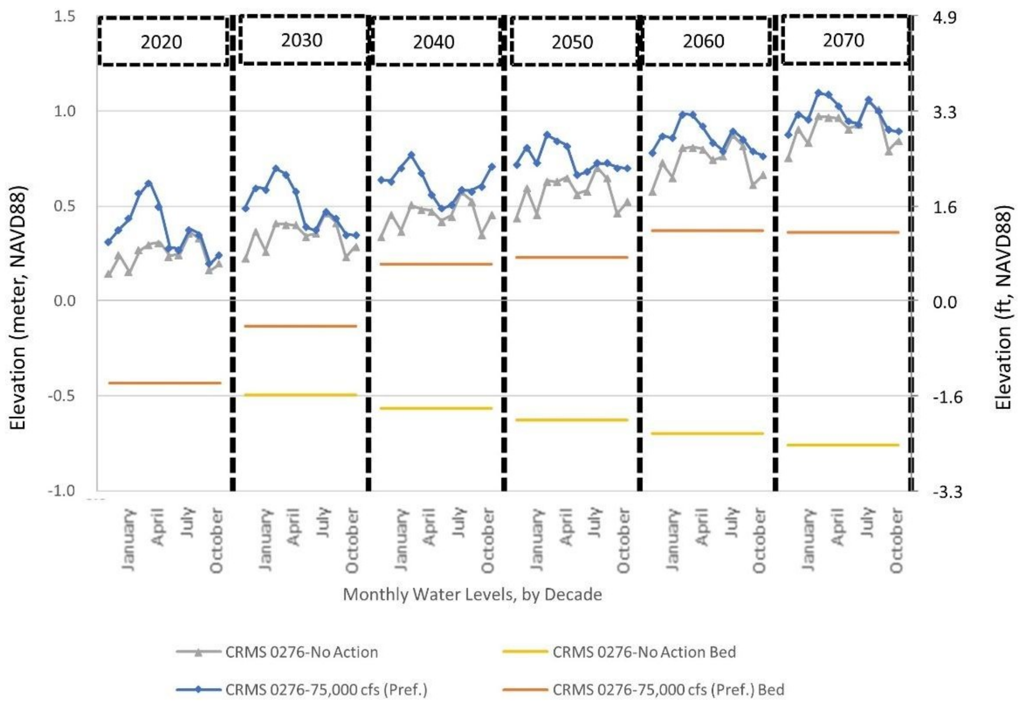


Figure 4.4-13. Model-projected Water Surface and Bed Elevations for the No Action Alternative and Applicant's Preferred Alternative at the Station Nearest the Diversion (CRMS 0276).

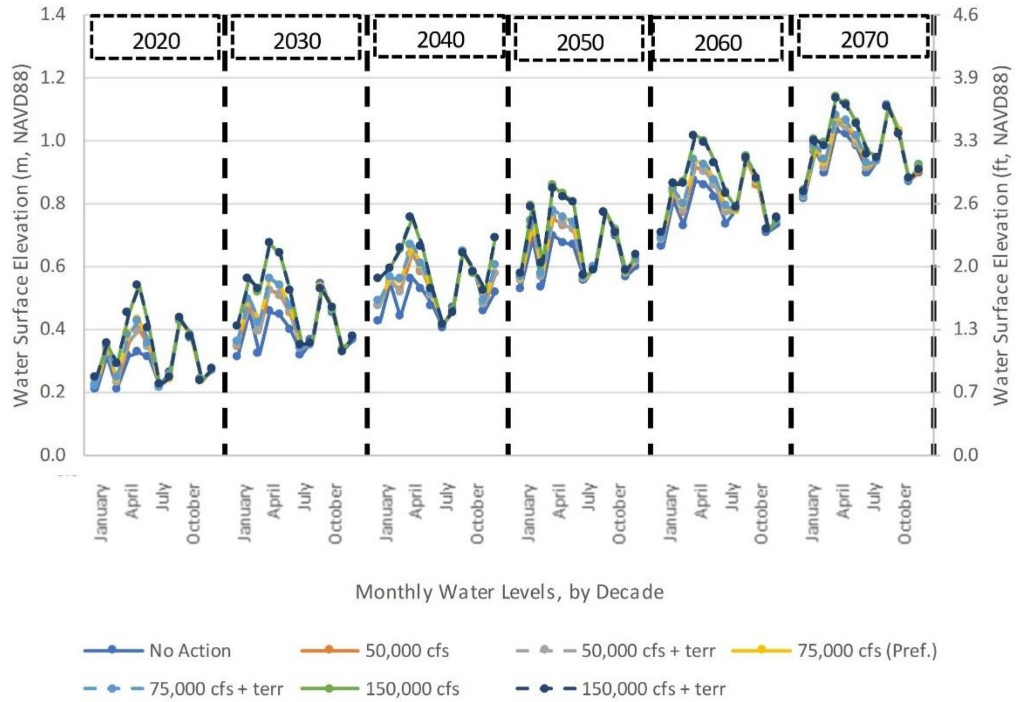


Figure 4.4-14. Water Levels for All Alternatives at the Northern/Mid-Basin Station (CRMS 3985).

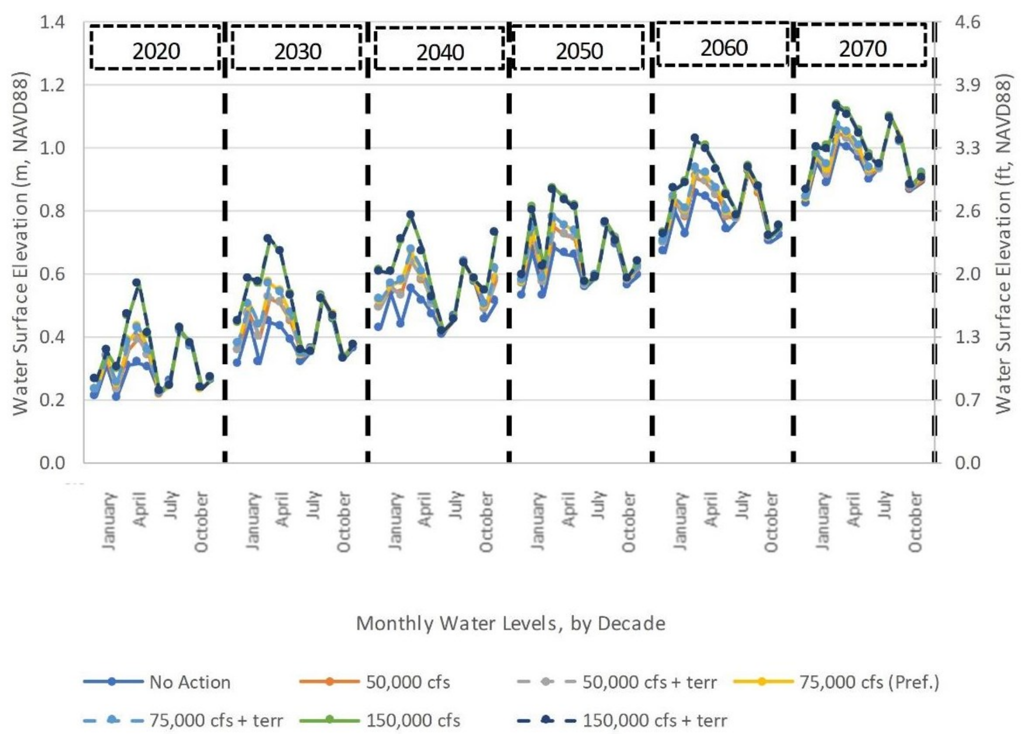


Figure 4.4-15. Water Levels for All Alternatives near Lafitte (USACE 82875).

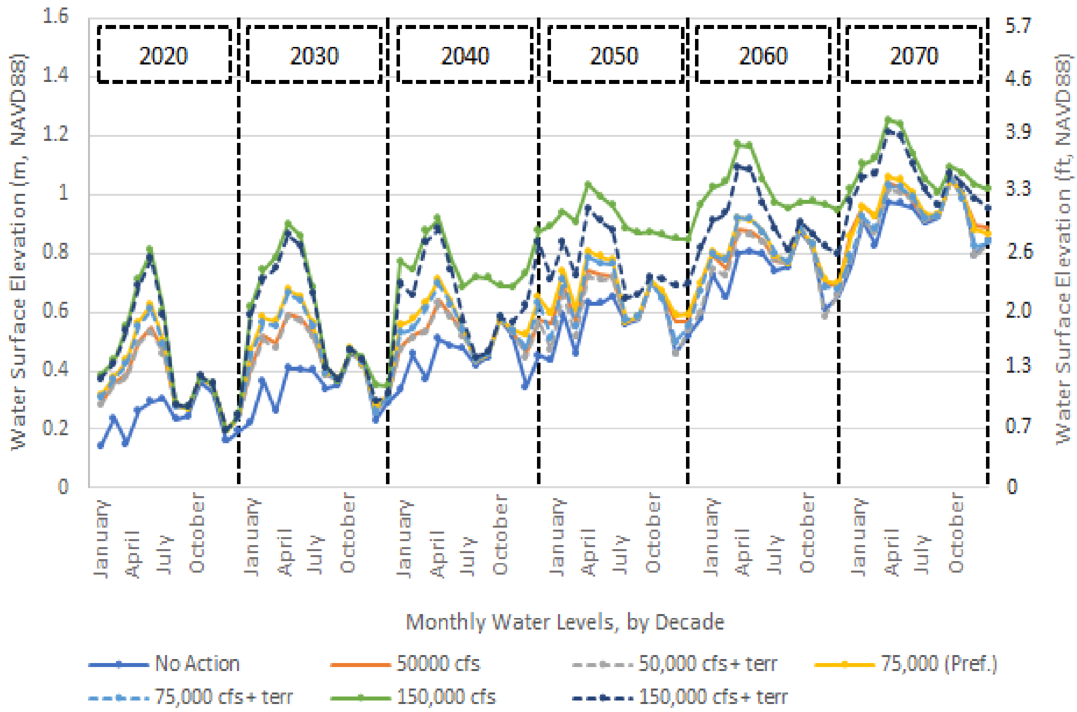


Figure 4.4-16. Water Levels for All Alternatives at the Station Nearest the Diversion (CRMS 0276).

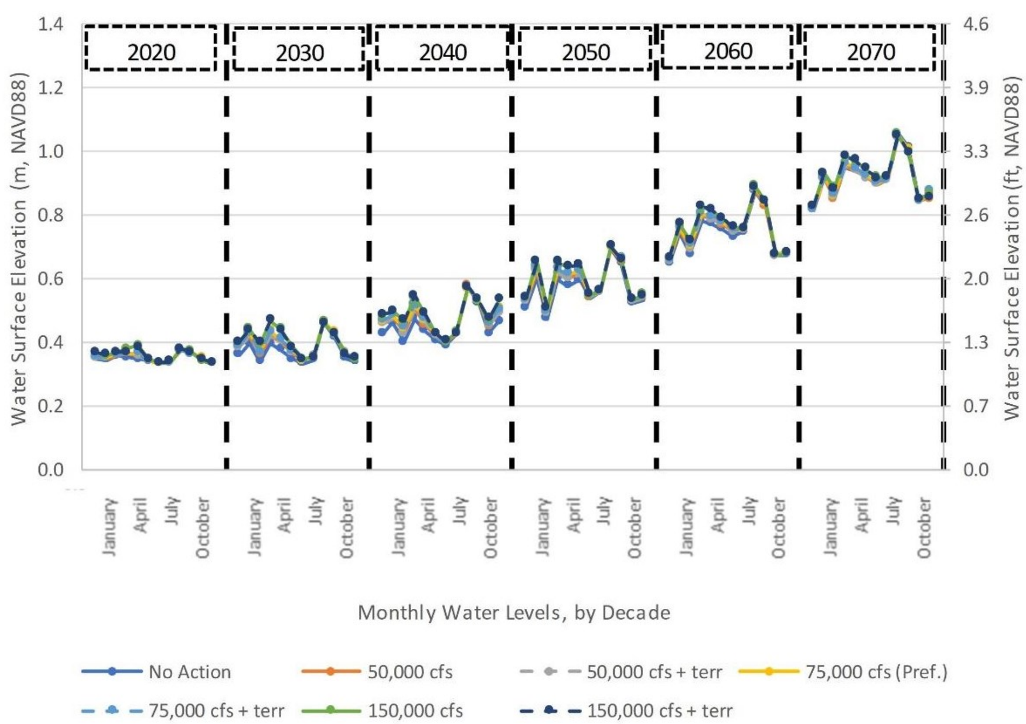


Figure 4.4-17. Water Levels for All Alternatives at the Central Station (CRMS 0224).

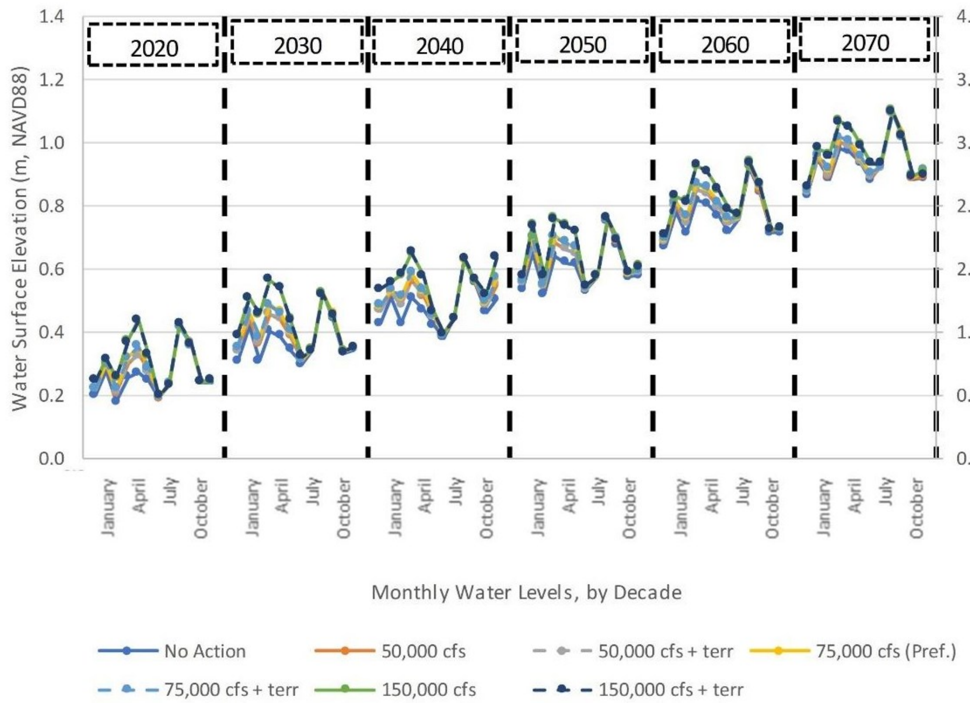


Figure 4.4-18. Water Levels for All Alternatives at the Western Station (Little L. Cutoff).

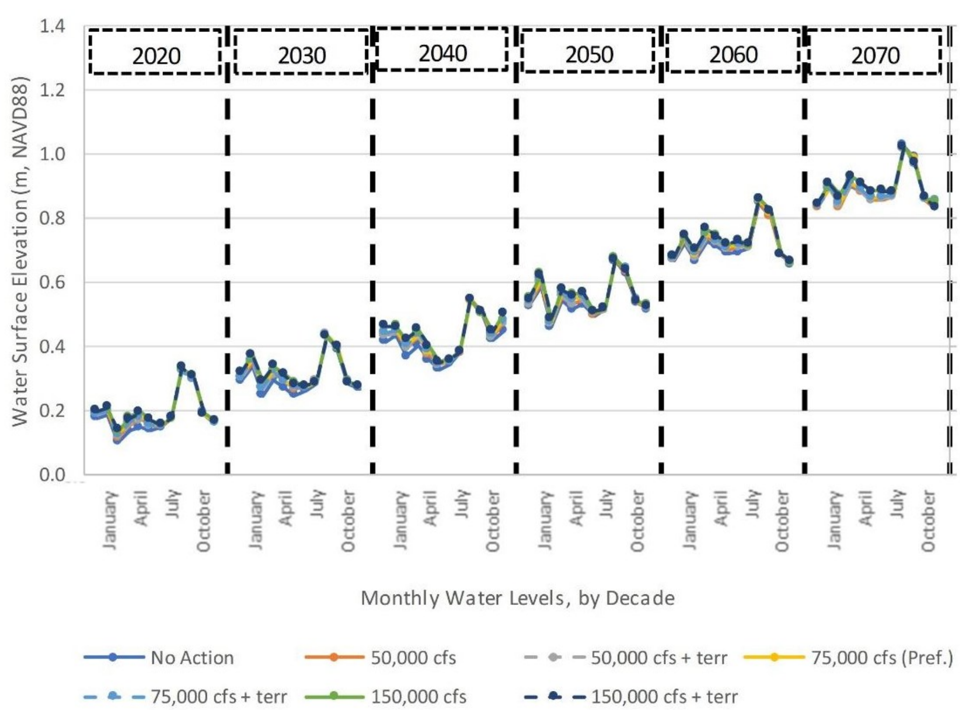


Figure 4.4-19. Water Levels at the Southwestern Station near Grand Isle (B. Pass at GI).

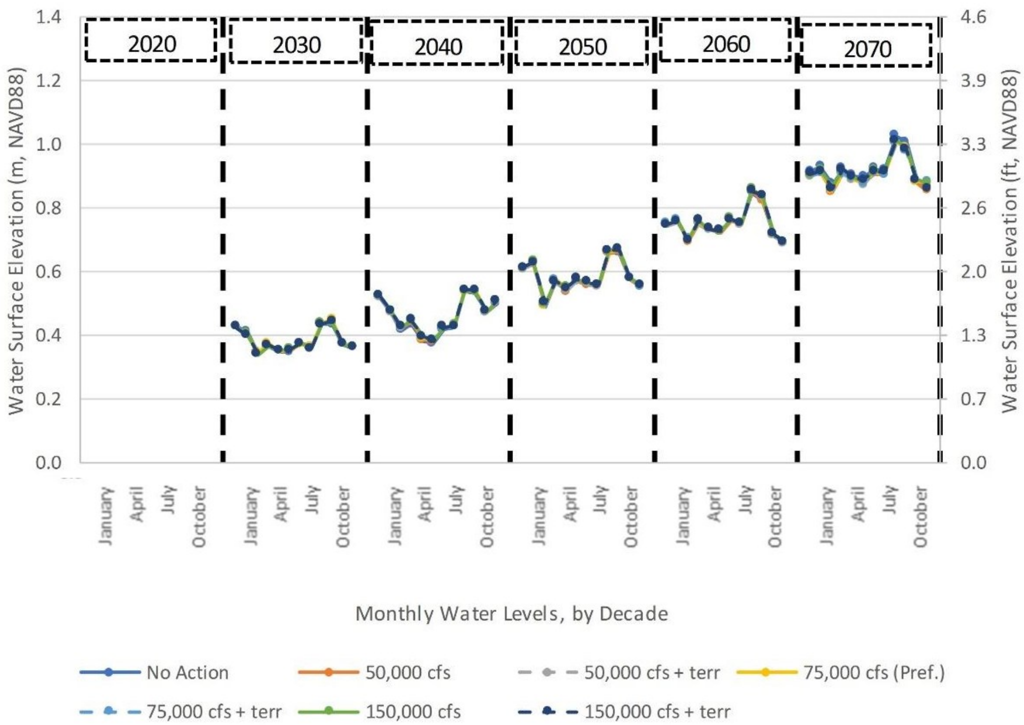


Figure 4.4-20. Water Levels for All Alternatives at the Birdfoot Delta Station (CRMS 0163).

At the northern/mid-basin station (CRMS 3985) and the station near Lafitte (USACE 82875), projected maximum monthly average increases in water levels compared with the No Action Alternative are on the order of 0.4 foot (approximately 0.11 meter) and 0.5 foot (0.14 meter), respectively, in the 2040 decade (see Table 4.4-4). This is the largest projected water level difference over the No Action Alternative over the 50-year analysis period at this site. Initial water level increases of 0.3 foot (approximately 0.10 meter) are projected at both the northern/mid-basin (CRMS 3985) and near Lafitte (USACE 82875) when the diversion begins operating. At the end of the model simulation in 2070, projected maximum monthly average water level increases for these two stations would be less than 0.2 foot (approximately 0.05 meter) as compared to the No Action Alternative. With both the proposed MBSD diversion and the Davis Pond Freshwater Diversion operating concurrently, there may be a slight increase in water levels in the upper basin, but this increase is not expected to adversely impact the upper basin marsh (see Section 4.6 Wetlands and Waters of the U.S. for more information about wetland impacts). Table 4.4-4 gives the maximum model-projected monthly water surface change for all alternatives at the seven stations as compared to the No Action Alternative. As can be seen in the figures and tables, water levels nearest the diversion (CRMS 0276) would be highly impacted during operations above base flow (up to 75,000 cfs depending on flows in the river), while stations farther from the diversion would be minimally impacted.

The time it takes for the increased water levels from proposed diversion operations to finish draining and return to average No Action conditions would be within 2 days of the diversion closure.

As projected by the Delft3D Basinwide Model, the Applicant's Preferred Alternative is projected to have intermittent, minor, beneficial impacts on water levels in the Mississippi River during Project operations. Water levels are projected to decrease upriver and downriver of the proposed diversion structure compared to the No Action Alternative due to diverting water from the river into the basin, with a maximum modeled change of 1.0 foot (approximately 0.3 meter) in the river. These projections are based on the 3rd week of May 2008 hydrograph (high, consistent spring flow) when the diversion would be operating at maximum capacity (75,000 cfs), with similar patterns seen for other hydrograph years. See Section 4.21 Navigation for more information about impacts on navigation in the Project area. The average projected water level drop at Belle Chasse caused by operation of the proposed Project would be about 1 foot when the river is flowing at 1 million cfs. A decrease in water levels of 1.0 foot (approximately 0.3 meter) may be beneficial for flood control purposes. See Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for additional discussion. Negligible impacts on water levels in the birdfoot delta are projected. These projections are consistent with recent USACE one-dimensional modeling results (Thomas et al. 2018), which project a lowering of water surface elevation along the river, with water levels returning to No Action Alternative levels around RM 5.0 AHP.

4.4.4.2.2.3 Other Alternatives

4.4.4.2.2.3.1 50,000 cfs Alternative

The 50,000 cfs Alternative would have similar operational impacts as the Applicant's Preferred Alternative. Operational impacts on water levels in the Barataria Basin under this alternative would be permanent, major to minor (depending on the location in the basin), and adverse. As the diversion size is smaller, water level impacts would be slightly smaller, with a maximum monthly average water level difference of 0.8 foot (approximately 0.25 meter) compared to 1.1 foot (approximately 0.33 meter) at the station nearest the diversion (CRMS 0276) in 2020. See Table 4.4-4 and Figures 4.4-21 and 4.4-22. As shown in Figure 4.4-22, water level increases would impact a much smaller area in 2070 than in 2040.

4.4.4.2.2.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative has similar operational impacts as the Applicant's Preferred Alternative. Operational impacts on water levels in the Barataria Basin under this alternative would be permanent, major to minor (depending on the location in the basin), and adverse. As the diversion size is larger, water level impacts would be greater, with a maximum monthly average water level difference of 1.7 feet (0.51 meter) compared to the Applicant's Preferred Alternative at 1.1 foot (0.33 meter) at the station nearest the diversion (CRMS 0276) in 2020 (see Table 4.4-4). Water levels are projected to substantially increase over the Applicant's Preferred Alternative at the northern/mid-basin station (CRMS 3985), station near Lafitte (USACE 82875), station nearest the diversion (CRMS 0276), and the western station (Little L. Cutoff). See Table 4.4-4 and Figures 4.4-22 and 4.4-23. As shown in Figure 4.4-23, water level increases would impact a somewhat smaller area in 2070 as compared to 2040, primarily to the south of the diversion.

4.4.4.2.2.3.3 Terrace Alternatives

The three terrace alternatives would have nearly identical operational impacts on water levels as the corresponding action alternatives without terraces. Operational impacts on water levels in the Barataria Basin under the three terrace alternatives would be permanent, major to minor (depending on the location in the basin), and adverse. The addition of the terrace features is projected to block some of the water from flowing eastward, slightly reducing water levels at the station nearest the diversion (CRMS 0276) in 2050 and near central station (CRMS 0224) compared to the alternatives without terraces. See Table 4.4-4 and Figure 4.4-21.

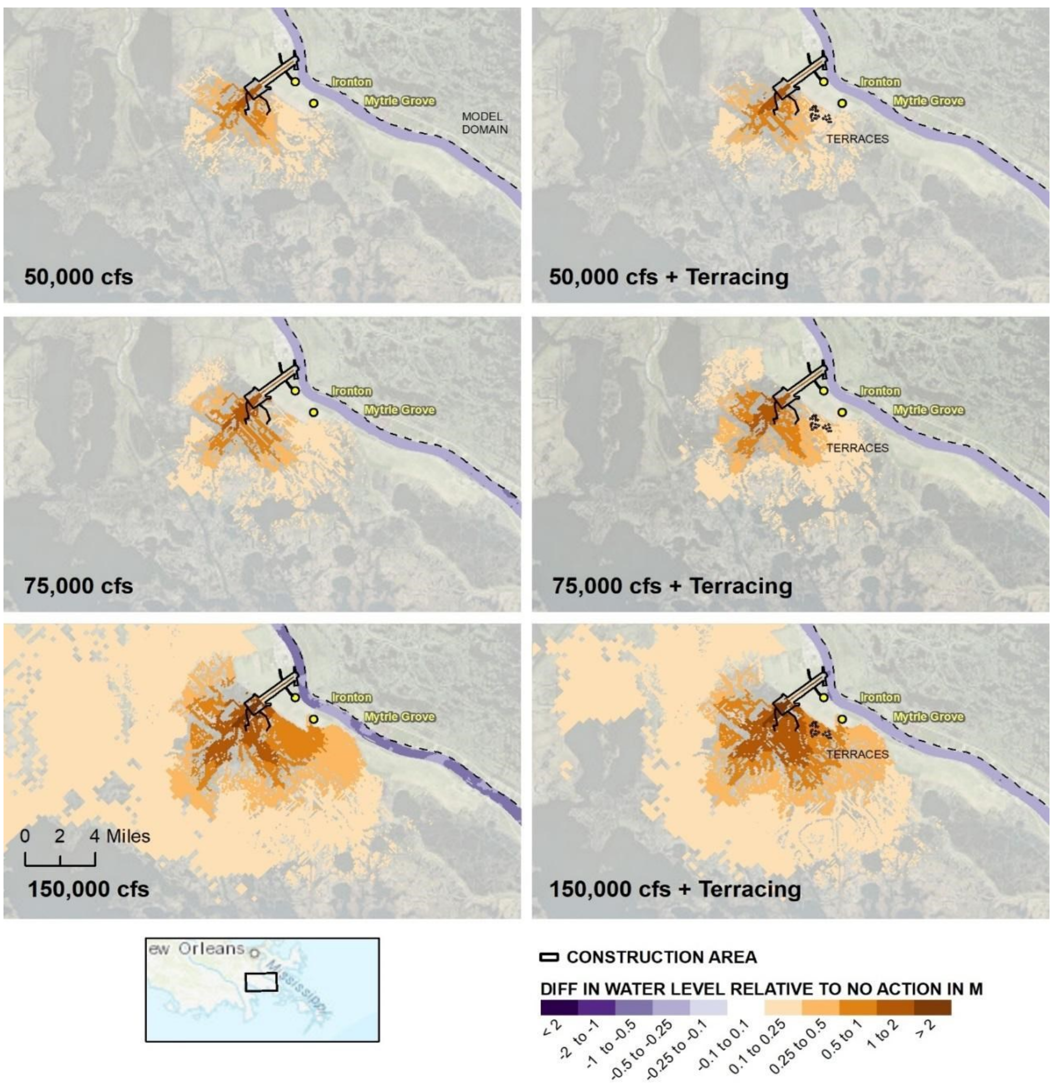


Figure 4.4-21. Water Level Differences for the 3rd Week of May, 2008 Historical Representative Hydrograph, 2070 Conditions, for All Action Alternatives compared to the No Action Alternative.

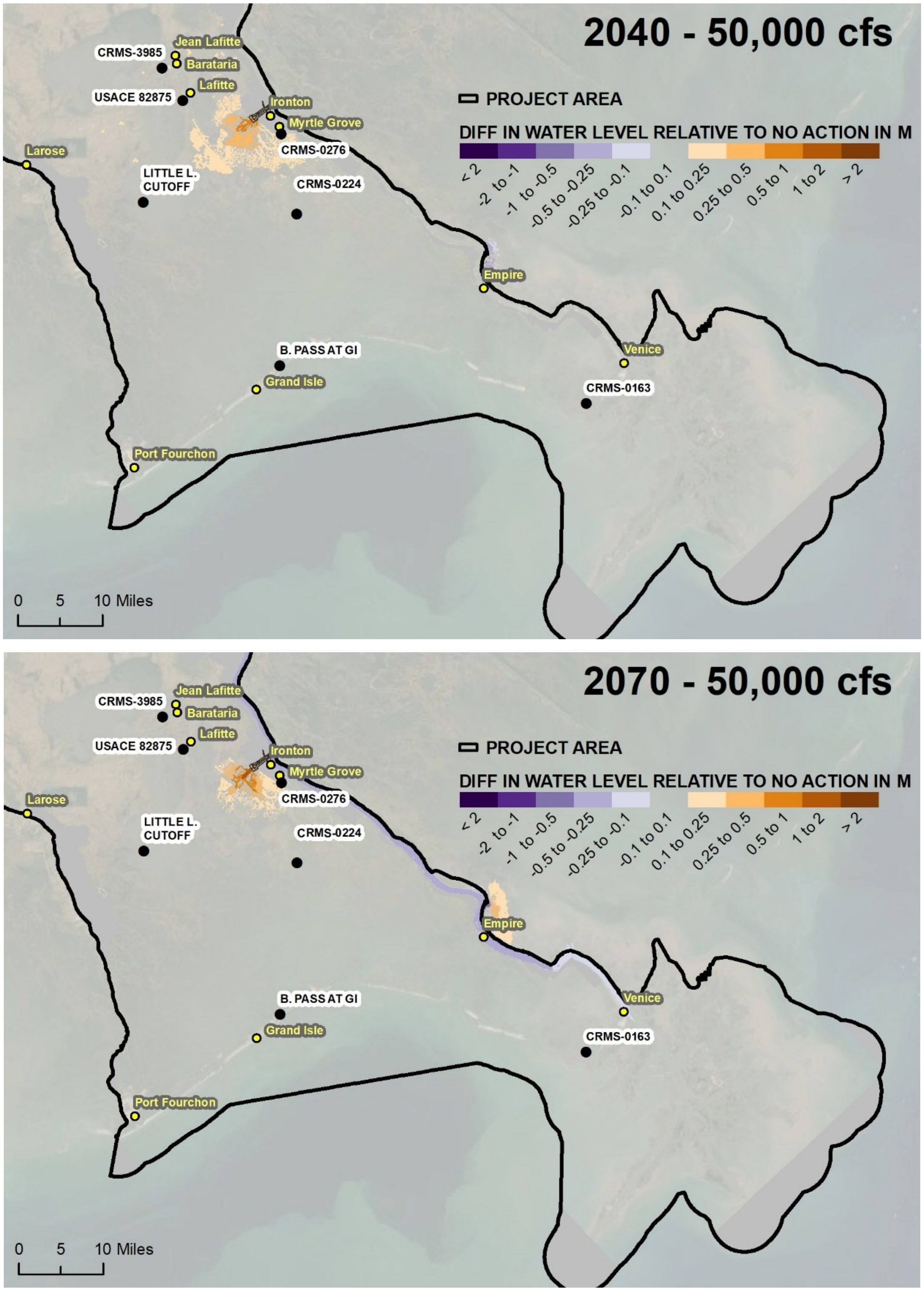


Figure 4.4-22. **Water Level Differences for the 3rd Week of May, Historical Representative Hydrograph, 2040 (1985 hydrograph) (Top Panel) and 2070 (2008 hydrograph) (Bottom Panel) Conditions, for 50,000 cfs Alternative Compared to the No Action Alternative.**

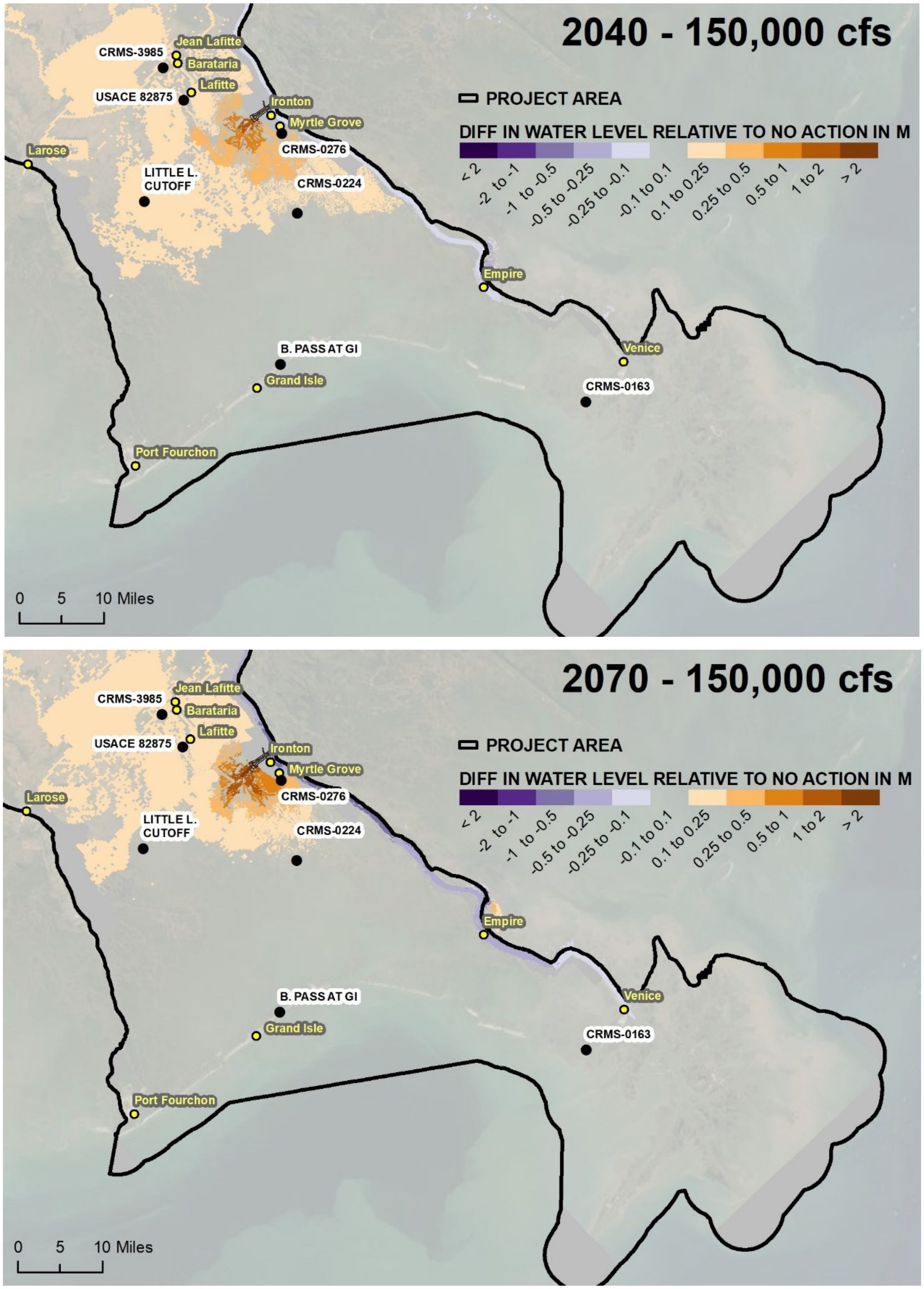


Figure 4.4-23. Water Level Differences for the 3rd Week of May, Historical Representative Hydrograph, 2040 (1985 hydrograph) (Top Panel) and 2070 (2008 hydrograph) (Bottom Panel) Conditions, for 150,000 cfs Alternative Compared to the No Action Alternative.

4.4.4.2.3 Tides, Currents, and Flow

4.4.4.2.3.1 No Action Alternative

Under the No Action Alternative, tides and wind-driven currents would continue to be the principal driver of circulation within the Barataria Basin. Existing circulation patterns would continue as discussed in Chapter 3, Section 3.4 Surface Water and Coastal Processes. As relative sea level continues to increase, the tidal influence would extend farther northward into the basin and circulation patterns would change. Salinities in the lower basin would increase. Land loss would be extensive and open water areas would increase. Flooding events would be more common than previously experienced. These changes represent moderate, permanent, adverse impacts.

Hourly water level data were used to show changes in the tidal signal in the Barataria Basin. Figure 4.4-24 shows an example of hourly water level changes at the northern/mid-basin station (CRMS 3985) for 2020 and 2070 conditions as modeled by the Delft3D Basinwide Model (see Appendix E). This station most clearly demonstrates the impacts of sea-level rise on the tidal signal due to increased depth and reduced friction. As can be seen in the figure, the daily tidal signal is projected to become stronger and the overall tidal range larger in 2070 as compared to 2020. The tidal range for May 3rd of the 1994 hydrograph (high, consistent spring flow) for 2020 conditions is 0.4 foot (0.10 meter) while by 2070 it has increased to 0.6 foot (0.20 meter). Additionally, as seen in the figure on April 30th, after a high-water event, the water drains more quickly (seen as a steeper slope) in 2070 than in 2020. This trend is anticipated partly due to the increased water depths in the basin related to the combined impacts of subsidence and sea-level rise. Daily wetting and drying cycles from the tide would impact vegetation at locations farther north than existing conditions.

Nearest the proposed diversion (CRMS 0276) (see Figure 4.4-25), the tidal range would increase by 0.8 foot (0.20 meter). Lower in the basin, at the southwestern station near Grand Isle (B. Pass at GI), the tidal range over the same period is projected to decrease slightly from 1.3 to 1.1 feet (0.40 meter to 0.30 meter) (see Figure 4.4-26). Similar impacts on the tidal signals are observed for the intermediate decades between 2020 and 2070. Table 4.4-5 shows the maximum daily water level, minimum daily water level, and total monthly tide range for May of the 1994 hydrograph (high, consistent spring flow) for the No Action Alternative 2040 and 2070 conditions compared to the No Action Alternative 2020 conditions. Positive values indicate an increase in tide level. For 2070, at the northern/mid-basin station (CRMS 3985), the high tide in May has increased by 2.5 feet (0.76 meter) and the overall tide range has increased by 1.2 feet (0.38 meter) as compared to 2020. Sea-level rise and increased open water areas would raise the water levels and also increase the tidal range for the majority of the stations.

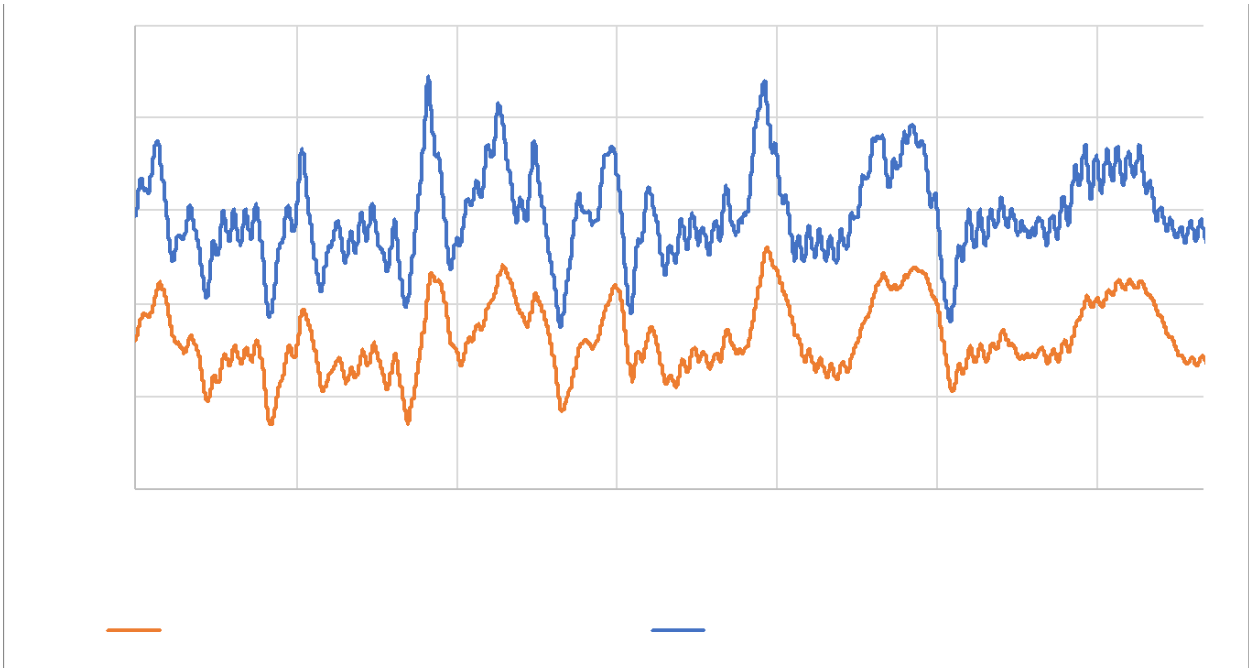


Figure 4.4-24. No Action Alternative Water Level and Tide Signals at the Northern/Mid-Basin Station (CRMS 3985) for 2020 and 2070 Modeled Years.

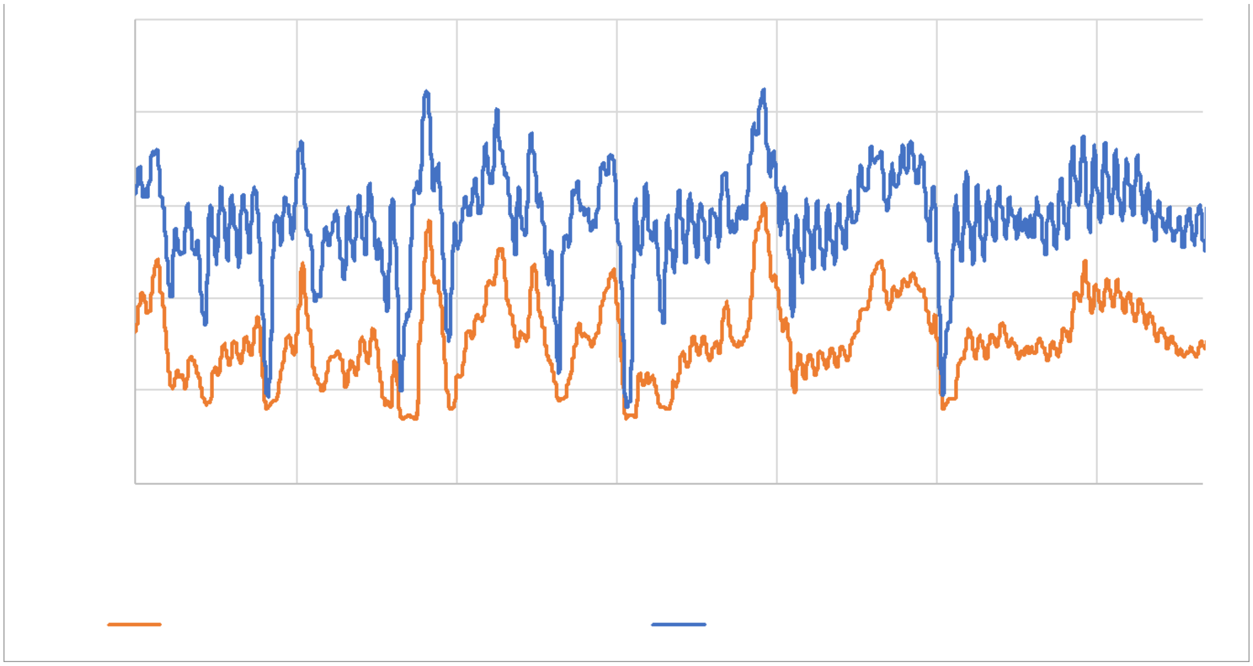


Figure 4.4-25. No Action Alternative Water Level and Tide Signals at the Station Nearest the Diversion (CRMS 0276) for 2020 and 2070 Modeled Years.

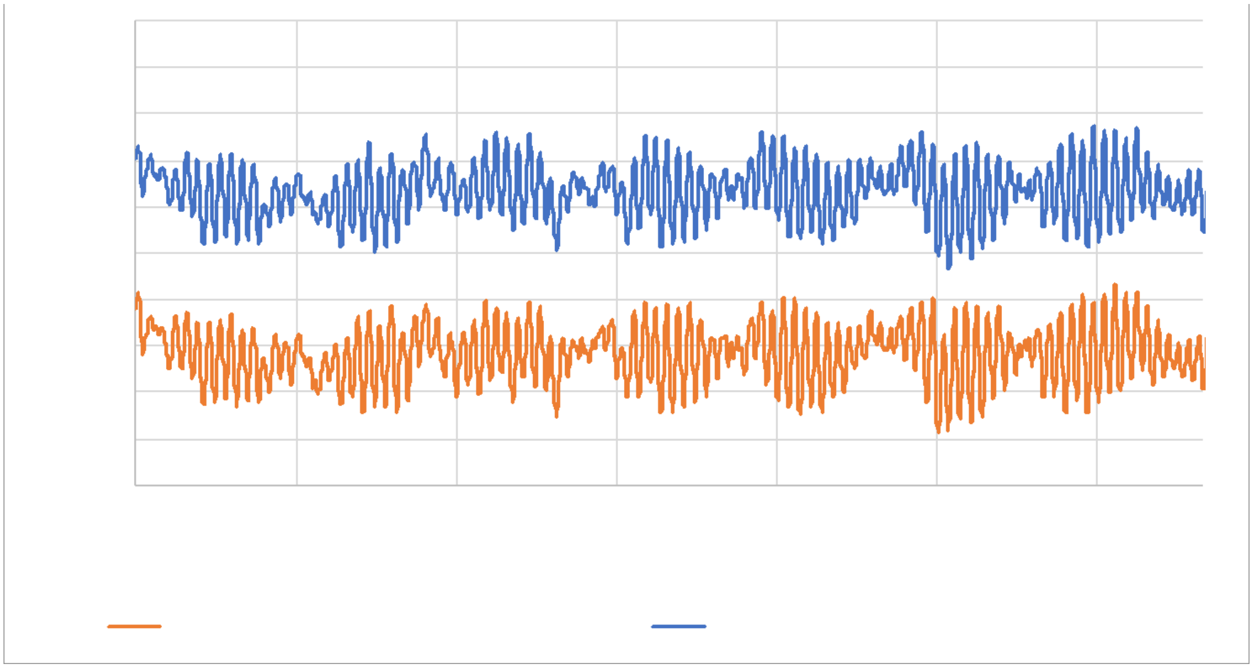


Figure 4.4-26. No Action Alternative Water Level and Tide Signals at the Southwestern Station near Grand Isle (B. Pass at GI) for 2020 and 2070 Modeled Years.

Table 4.4-5
Tidal Changes for No Action 2040 and 2070 Conditions Compared to No Action 2020 Conditions May 1994 Hydrograph – High, Consistent Spring Flow (Diversion Operating above Base Flow)

Tidal Value	Northern/ Mid-Basin Station (CRMS 3985) (ft (m))	Near Lafitte (USACE 82875) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163) (ft (m))
2040 Compared to 2020							
Max	0.8 (0.23)	0.8 (0.23)	0.7 (0.20)	0.6 (0.17)	0.8 (0.23)	0.6 (0.18)	0.9 (0.26)
Min	0.5 (0.15)	0.5 (0.15)	-0.1 (-0.03)	-0.3 (-0.09)	0.5 (0.16)	0.6 (0.19)	-0.7 (-0.21)
Range	0.4 (0.07)	0.3 (0.08)	0.8 (0.24)	0.9 (0.26)	0.2 (0.06)	0.0 (0.00)	1.6 (0.48)
2070 Compared to 2020							
Max	2.5 (0.76)	2.4 (0.74)	2.2 (0.67)	2.1 (0.65)	2.4 (0.72)	2.2 (0.68)	2.3 (0.69)
Min	1.2 (0.38)	1.2 (0.37)	0.2 (0.07)	0.1 (0.02)	1.6 (0.49)	2.3 (0.71)	0.6 (0.18)
Range	1.2 (0.38)	1.2 (0.37)	1.9 (0.59)	2.1 (0.63)	0.8 (0.23)	-0.1 (-0.03)	1.7 (0.51)

Under the No Action Alternative, general flow patterns in the Barataria Basin are expected to continue to be cyclical, with circulation dominated by the tide and wind as described in Chapter 3, Section 3.4 Surface Water and Coastal Processes. Rainfall and local drainage in the basin combined with operation of the Davis Pond Freshwater Diversion would provide the primary sources of freshwater inflow into the basin. In the Mississippi River, no changes in current direction are expected under the No Action Alternative.

4.4.4.2.3.2 Applicant's Preferred Alternative

Under the Applicant's Preferred Alternative, operational direct and indirect impacts on existing currents and flow in the Barataria Basin would be permanent and minor to major (depending on distance from the immediate outfall area) due to widespread and readily apparent impacts on water flow velocity and direction when the proposed Project is operating above base flow (up to 75,000 cfs depending on flows in the river). These current and flow impacts would be beneficial for reestablishing deltaic processes in the basin and adverse on the larval transport and juvenile recruitment of some aquatic species (see Section 4.2 Geology and Soils and Section 4.10 Aquatic Resources for further details about Project impacts on land building and aquatic resources, respectively). Tides would not be impacted, other than from overall impacts of higher water levels. The Applicant's Preferred Alternative is designed to have a maximum flow more than seven times that of the Davis Pond Freshwater Diversion (CPRA 2016a). During operation, this amount of fresh water would create a general north to south flow as the fresh water moves towards the Gulf.

As discussed above, general water levels in the Barataria Basin would increase near the proposed diversion structure, with the magnitude of impacts decreasing with distance from the structure. Analyzing the Delft3D Basinwide Model results from the Mississippi River 1994 hydrograph (high, consistent spring flow) allows for a comparison of alternatives under high-flow conditions. In high, consistent spring flow conditions, the proposed Project diversion would likely operate at maximum capacity (75,000 cfs throughout May).

At the northern/mid-basin station (CRMS 3985), the tidal range for the Applicant's Preferred Alternative on May 3, for the 2040 conditions, is projected to be at most 0.3 foot (0.09 meter) higher than the No Action Alternative. The Applicant's Preferred Alternative is projected to raise the low tide water surface by 0.5 foot (0.14 meter) and also increase the high tide water surface by 0.4 foot (0.11 meter), compared with the No Action Alternative (see Figure 4.4-27, top). The tidal range for the Applicant's Preferred Alternative on May 3, for the 2070 conditions, is projected to be 0.5 foot (0.15 meter) higher than the No Action Alternative. The Applicant's Preferred Alternative is projected to slightly raise the low tide water surface and the high tide water surface, compared with the No Action Alternative (see Figure 4.4-28, bottom).

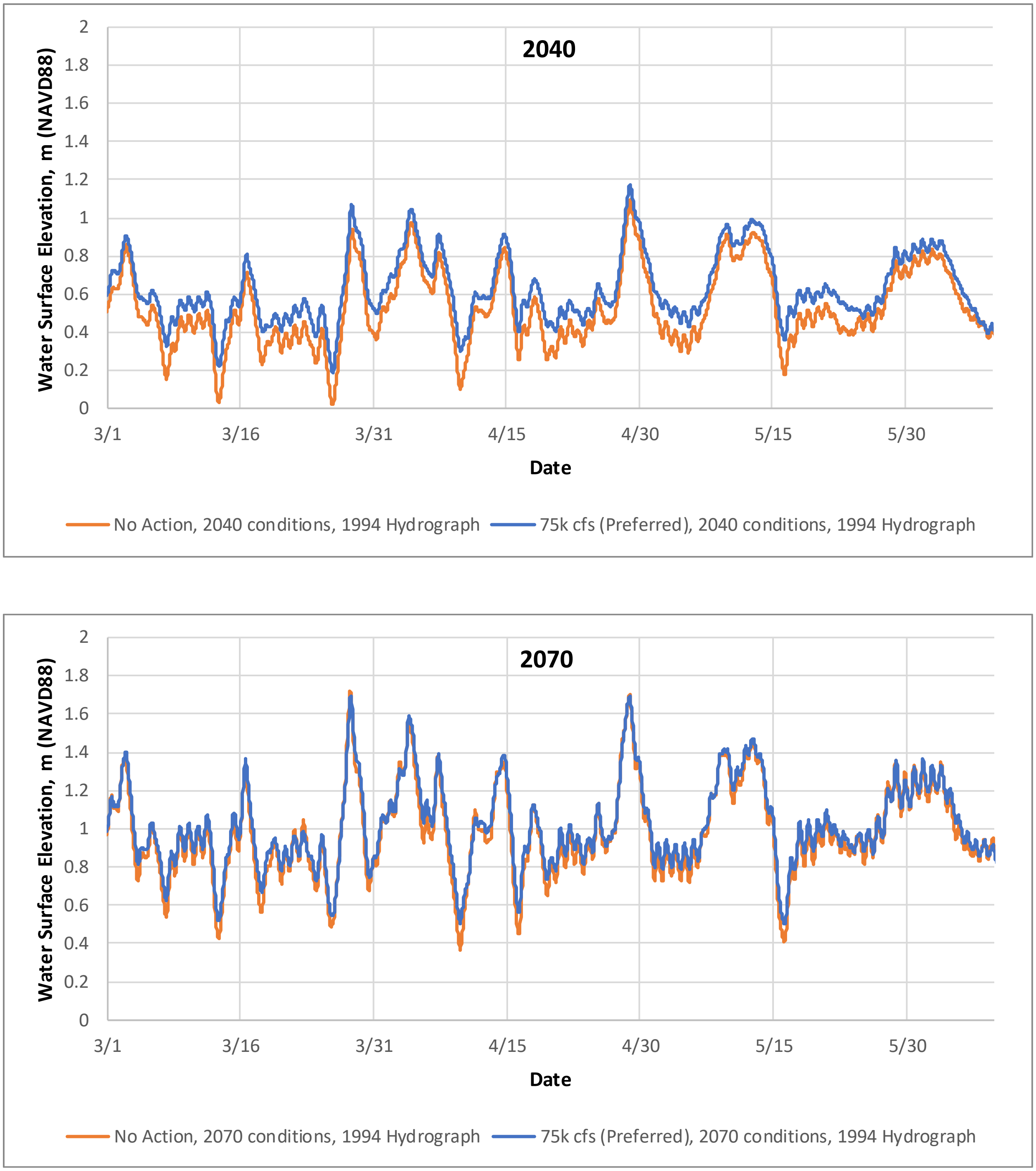
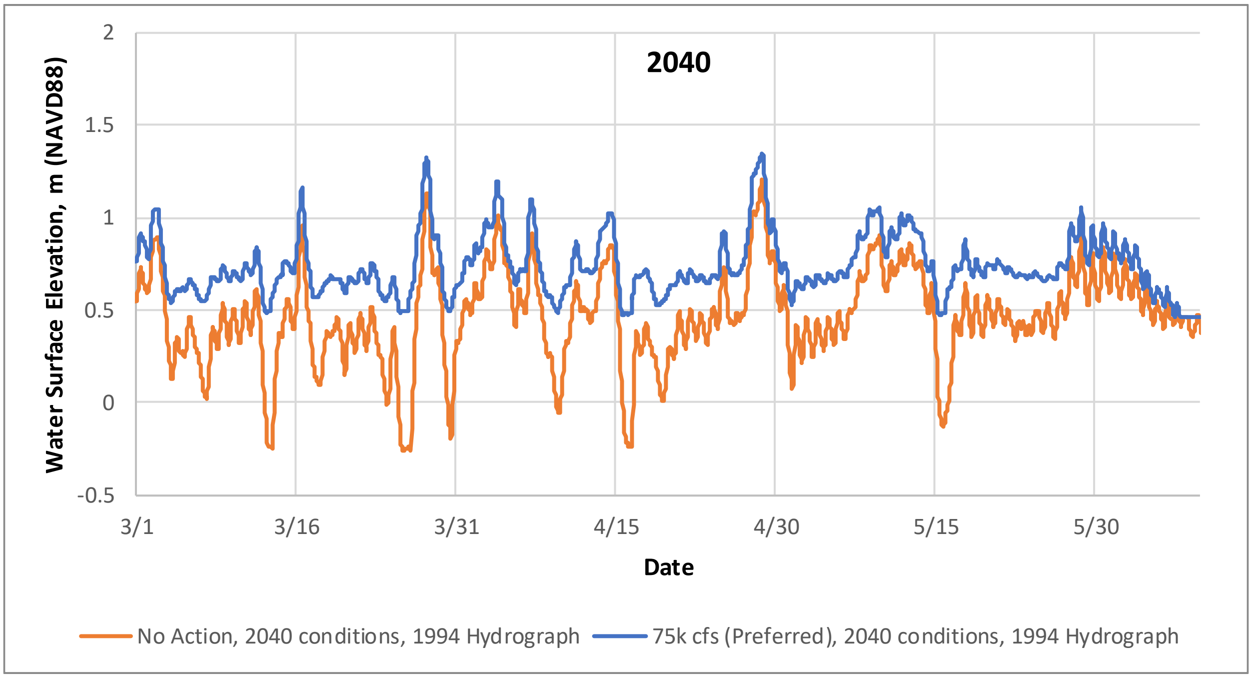


Figure 4.4-27. Water Level and Tide Signals at the Northern/Mid-Basin Station (CRMS 3985). Top Panel: No Action Alternative and Applicant's Preferred Alternative, 2040 Conditions, 1994 High, Consistent Spring Flow Hydrograph. Bottom Panel: No Action Alternative and Applicant's Preferred Alternative, 2070 Conditions, 1994 High, Consistent Spring Flow Hydrograph.



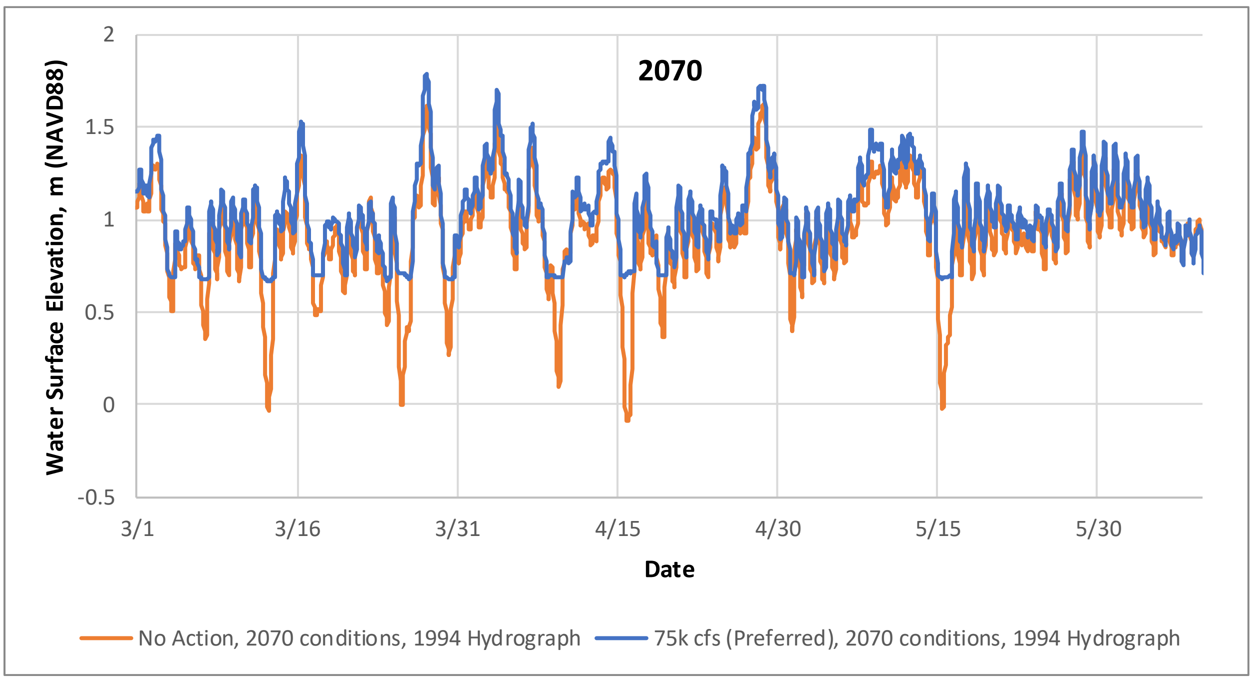
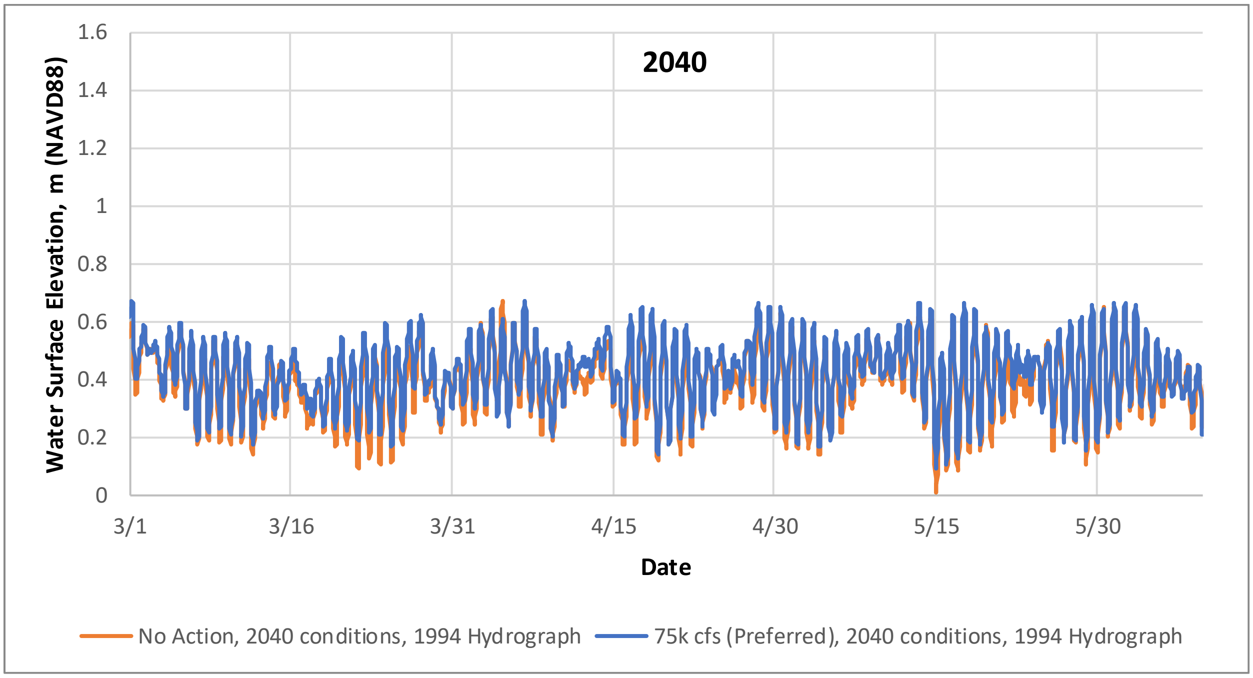


Figure 4.4-28. Water Level and Tide Signals at the Station Nearest the Diversion (CRMS 0276). Top Panel: No Action Alternative and Applicant's Preferred Alternative, 2040 Conditions, 1994 High, Consistent Spring Flow Hydrograph. Bottom Panel: No Action Alternative and Applicant's Preferred Alternative, 2070 Conditions, 1994 High, Consistent Spring Flow Hydrograph.

For May 3 of the 1994 hydrograph (high, consistent spring flow) for the 2040 conditions, at the station nearest the diversion (CRMS 0276), the water level at low tide would be substantially increased over the No Action Alternative (by 1.3 feet [0.38 meter]) with a smaller increase at the high tide (0.8 foot [0.24 meter]), shown in Figure 4.4-28, top panel. For the 2070 conditions, shown in Figure 4.4-28, bottom panel, slight increases in both high tide and low tide are projected as in 2040, although the magnitudes are smaller, likely due to the influence of sea-level rise. Extreme low tides in the figure for the No Action Alternative are likely due to model simulated wetting and drying. In general, the Applicant's Preferred Alternative would keep higher water levels at low tides due to the large influx of freshwater during operations. Because the low tide level would be increased much, the tidal range would be reduced.

At the southwestern station near Grand Isle (B. Pass at GI), the Applicant's Preferred Alternative would have minor impacts on the tidal signal, with a slight daily increase when the diversion is operating at capacity, as seen in Figure 4.4-29, top and bottom panels. Table 4.4-6 lists the changes in maximum daily, minimum daily, and monthly tidal range for May of 1994 hydrographs (high, consistent spring flow) compared to the No Action Alternative for 2020, 2040, and 2070 conditions for all alternatives.

The Delft3D Basinwide Model projected velocity impacts of the proposed Project on water flow during operations. Although modeling results were reported throughout the basin, detailed analysis for three locations in the basin are provided here (see Figure 4.4-30). The proposed diversion would cause major impacts on the speed and direction of currents and flows at the Lafitte Oil and Gas Field to Barataria Waterway station (near the diversion, see Figure 4.4-30) when operating above base flow and minor impacts on currents and flows farther away from the diversion structure at the Harvey Cutoff station (western/mid-basin) and the Grand Bayou to Hackberry Bay station (southern/mid-basin) and when diversion is operating at or below the 5,000 cfs base flow. Velocities and current patterns within the Barataria Basin are projected to sustain minor to major (depending on the flow rate), permanent impacts during diversion operations.



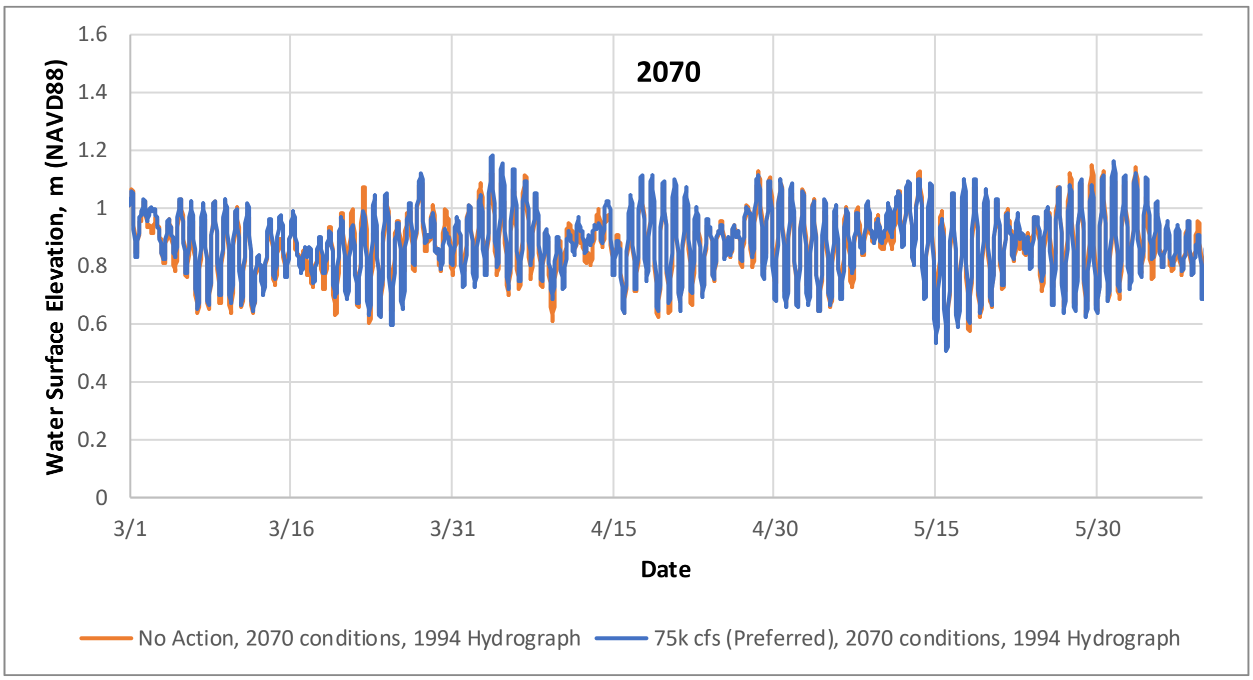


Figure 4.4-29. Water Level and Tide Signals at the Southwestern Station near Grand Isle (B. Pass at GI). Top Panel: No Action Alternative and Applicant's Preferred Alternative, 2040 Conditions, 1994 High, Consistent Spring Flow Hydrograph. Bottom Panel: No Action Alternative and Applicant's Preferred Alternative, 2070 Conditions, 1994 High, Consistent Spring Flow Hydrograph.

Table 4.4-6
Tidal Impacts for Alternatives Compared to the No Action Alternative
Modeled Years 2020, 2040, and 2070, May 1994 Hydrograph (High, Consistent Spring Flow; Diversion Operating Above Base Flow)

Tidal Value	Northern/ Mid-Basin Station (CRMS 3985) (ft (m))	Near Lafitte (USACE 82875) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163) (ft (m))
2020 Conditions							
50,000 cfs							
Diff. in Daily Max comp. to No Action	0.3 (0.09)	0.3 (0.10)	0.4 (0.12)	0.0 (-0.01)	0.3 (0.09)	0.0 (0.01)	0.3 (0.08)
Diff. in Daily Min comp. to No Action	0.4 (0.12)	0.4 (0.12)	1.1 (0.33)	0.0 (0.00)	0.4 (0.11)	0.1 (0.04)	0.0 (0.00)
75,000 cfs (Applicant's Preferred Alternative)							
Diff. in Daily Max comp. to No Action	0.3 (0.09)	0.3 (0.10)	0.7 (0.20)	0.3 (0.08)	0.3 (0.08)	0.1 (0.03)	0.1 (0.02)
Diff. in Daily Min comp. to No Action	0.5 (0.16)	0.6 (0.17)	1.5 (0.47)	0.0 (0.01)	0.5 (0.15)	0.1 (0.02)	0.0 (-0.01)
150,000 cfs							
Diff. in Daily Max comp. to No Action	0.6 (0.18)	0.6 (0.19)	1.0 (0.32)	0.2 (0.05)	0.5 (0.14)	0.1 (0.03)	0.0 (0.01)
Diff. in Daily Min comp. to No Action	1.2 (0.38)	1.4 (0.44)	2.5 (0.77)	0.0 (0.01)	1.1 (0.34)	0.1 (0.03)	0.0 (0.00)
2040 Conditions							
50,000 cfs							
Diff. in Daily Max comp. to No Action	0.2 (0.06)	0.2 (0.06)	0.5 (0.14)	0.2 (0.07)	0.2 (0.05)	0.0 (0.01)	-0.1 (-0.03)

Table 4.4-6
Tidal Impacts for Alternatives Compared to the No Action Alternative
Modeled Years 2020, 2040, and 2070, May 1994 Hydrograph (High, Consistent Spring Flow; Diversion Operating Above Base Flow)

Tidal Value	Northern/ Mid-Basin Station (CRMS 3985) (ft (m))	Near Lafitte (USACE 82875) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163) (ft (m))
Diff. in Daily Min comp. to No Action	0.4 (0.12)	0.5 (0.14)	1.5 (0.47)	0.0 (0.00)	0.3 (0.09)	0.2 (0.05)	0.0 (0.00)
75,000 cfs (Applicant's Preferred Alternative)							
Diff. in Daily Max comp. to No Action	0.2 (0.06)	0.2 (0.07)	0.5 (0.15)	0.1 (0.03)	0.1 (0.04)	0.1 (0.02)	0.1 (0.02)
Diff. in Daily Min comp. to No Action	0.6 (0.18)	0.7 (0.21)	2.0 (0.61)	0.0 (0.00)	0.5 (0.14)	0.3 (0.08)	0.0 (0.00)
150,000 cfs							
Diff. in Daily Max comp. to No Action	0.5 (0.15)	0.5 (0.16)	1.0 (0.32)	0.3 (0.09)	0.4 (0.13)	0.2 (0.05)	0.1 (0.02)
Diff. in Daily Min comp. to No Action	1.1 (0.34)	1.4 (0.42)	3.2 (0.97)	0.0 (0.01)	0.9 (0.28)	0.2 (0.06)	0.0 (0.00)
2070 Conditions							
50,000 cfs							
Diff. in Daily Max comp. to No Action	0.0 (0.00)	0.0 (-0.01)	0.3 (0.09)	0.2 (0.05)	0.0 (-0.01)	0.0 (0.01)	0.0 (0.00)
Diff. in Daily Min comp. to No Action	0.1 (0.04)	0.2 (0.05)	2.3 (0.70)	-0.2 (-0.05)	0.0 (0.01)	0.0 (-0.01)	-0.1 (-0.03)

Table 4.4-6
Tidal Impacts for Alternatives Compared to the No Action Alternative
Modeled Years 2020, 2040, and 2070, May 1994 Hydrograph (High, Consistent Spring Flow; Diversion Operating Above Base Flow)

Tidal Value	Northern/ Mid-Basin Station (CRMS 3985) (ft (m))	Near Lafitte (USACE 82875) (ft (m))	Station Nearest Diversion (CRMS 0276) (ft (m))	Central Station (CRMS 0224) (ft (m))	Western Station (Little L. Cutoff) (ft (m))	Southwestern Station near Grand Isle (B. Pass at GI) (ft (m))	Birdfoot Delta (CRMS 0163) (ft (m))
75,000 cfs (Applicant's Preferred Alternative)							
Diff. in Daily Max comp. to No Action	0.0 (0.01)	0.1 (0.02)	0.4 (0.12)	0.1 (0.03)	0.1 (0.02)	0.1 (0.02)	0.0 (0.00)
Diff. in Daily Min comp. to No Action	0.3 (0.09)	0.4 (0.12)	2.3 (0.70)	-0.3 (-0.08)	0.2 (0.05)	-0.1 (-0.02)	-0.1 (-0.04)
150,000 cfs							
Diff. in Daily Max comp. to No Action	0.2 (0.05)	0.2 (0.06)	1.0 (0.31)	0.2 (0.07)	0.2 (0.05)	0.1 (0.04)	0.1 (0.02)
Diff. in Daily Min comp. to No Action	0.7 (0.20)	0.9 (0.27)	3.6 (1.10)	-0.3 (-0.08)	0.5 (0.16)	0.0 (0.01)	-0.1 (-0.03)

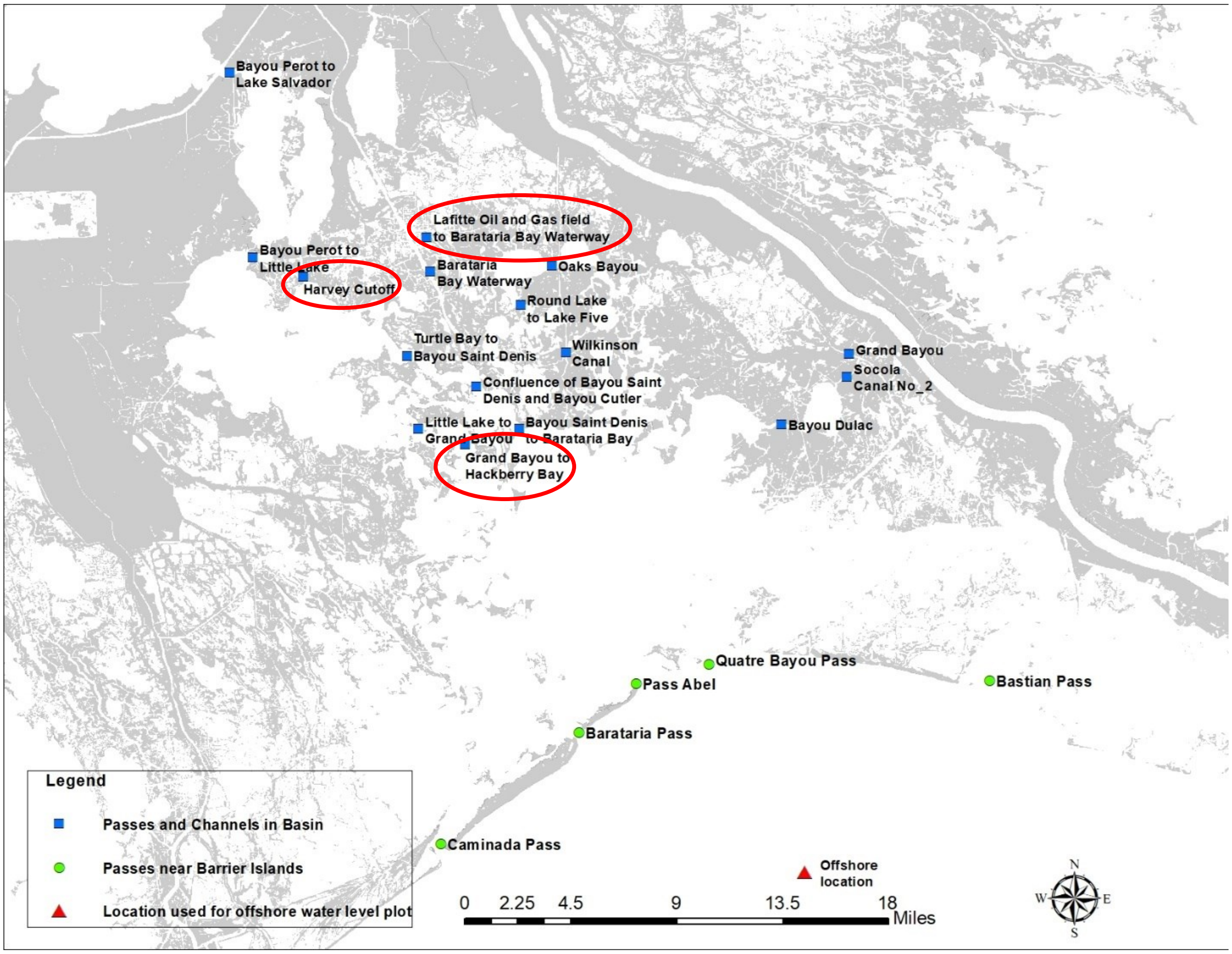


Figure 4.4-30. Locations for Modeled Velocity Output. Stations circled in red are discussed in detail. Blue squares are the actual model locations where output was extracted.

Near the diversion at the Lafitte Oil and Gas Field, the proposed diversion would cause major increases in water velocity and currents when operating above base flow, as compared to the No Action Alternative. For example, in May of 2020 (when the diversion is projected to operate near capacity), at the Lafitte Oil and Gas Field station (near the diversion), average velocity would more than double, from 0.6 foot/second (approximately 0.2 meter/second) under the No Action Alternative to 1.6 feet/second (approximately 0.5 meter/second) under the Applicant's Preferred Alternative (see Figure 4.4-31). Additionally, Project operations would consistently direct flow to the southwest such that water flow would be less driven by tidal cycles as compared to the No Action Alternative. When the diversion would operate at base flow, the proposed Project would cause only minor increases in peak velocity, and flows would continue to be mainly driven by the existing tidal direction pattern. Figures 4.4-32 and 4.4-33 show the months of May (when the diversion is projected to operate near capacity) and October (when the diversion would operate at or below base flow), respectively, when the flow directions are impacted by the diversion flow versus when they are more similar to the No Action Alternative at base flow.

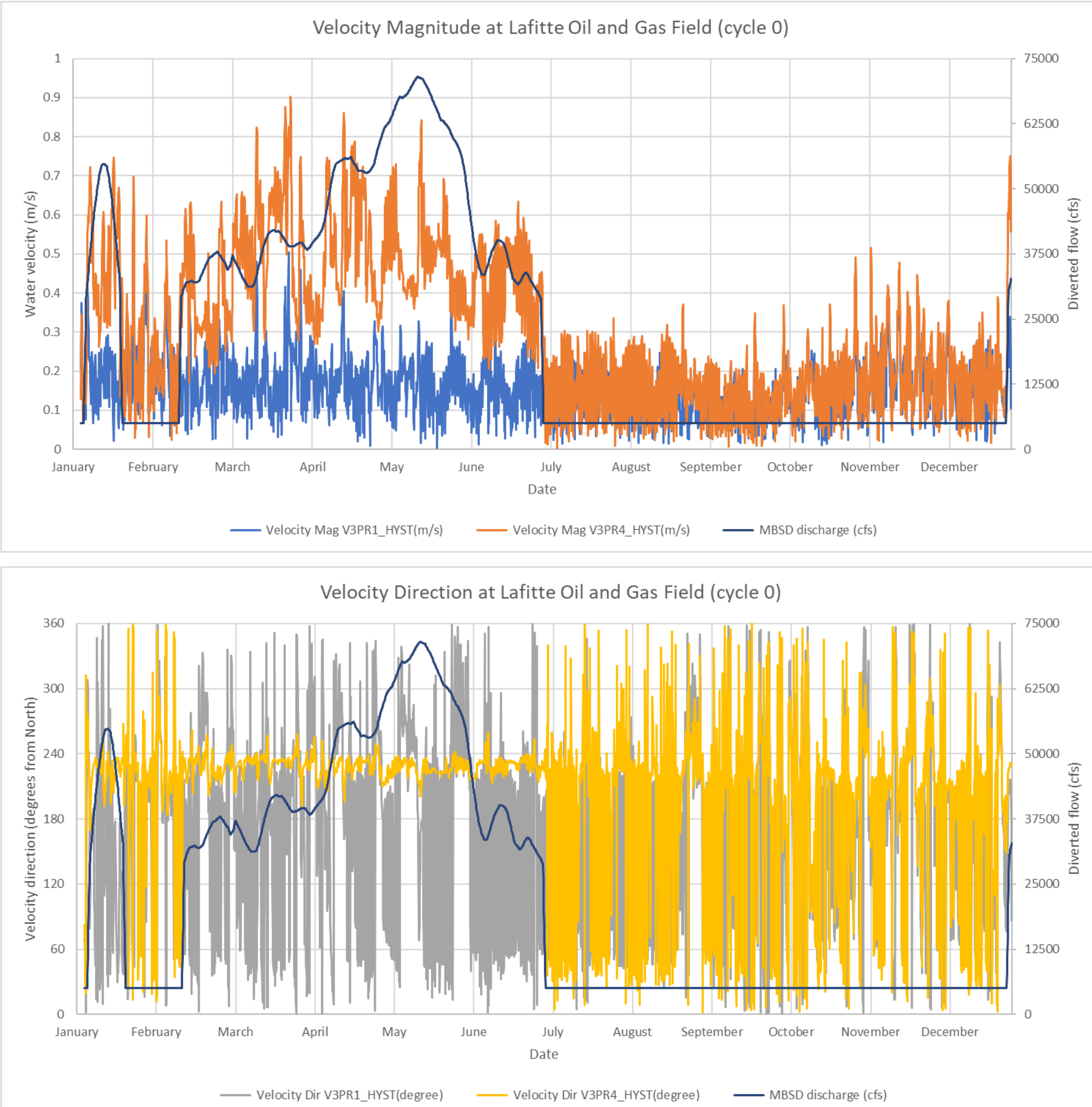
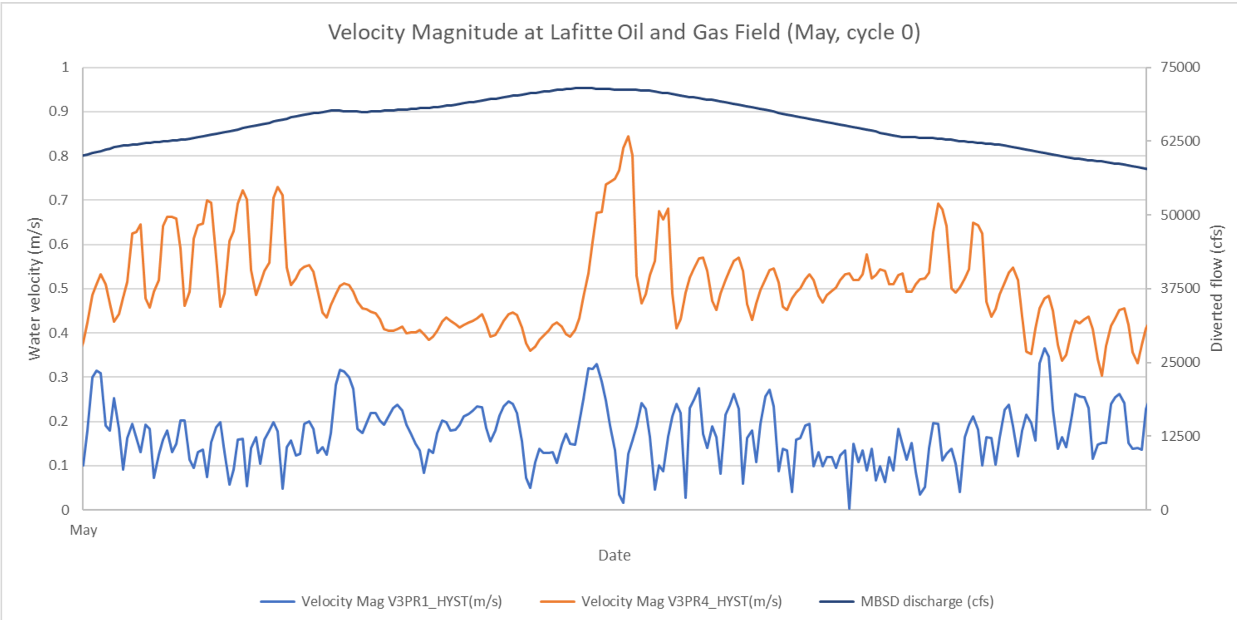


Figure 4.4-31. 2020 (1970) Hydrograph, Velocity Output for Applicant's Preferred Alternative (V3PR4) and No Action Alternative (V3PR1) at Lafitte Oil and Gas Field (Near the Diversion).



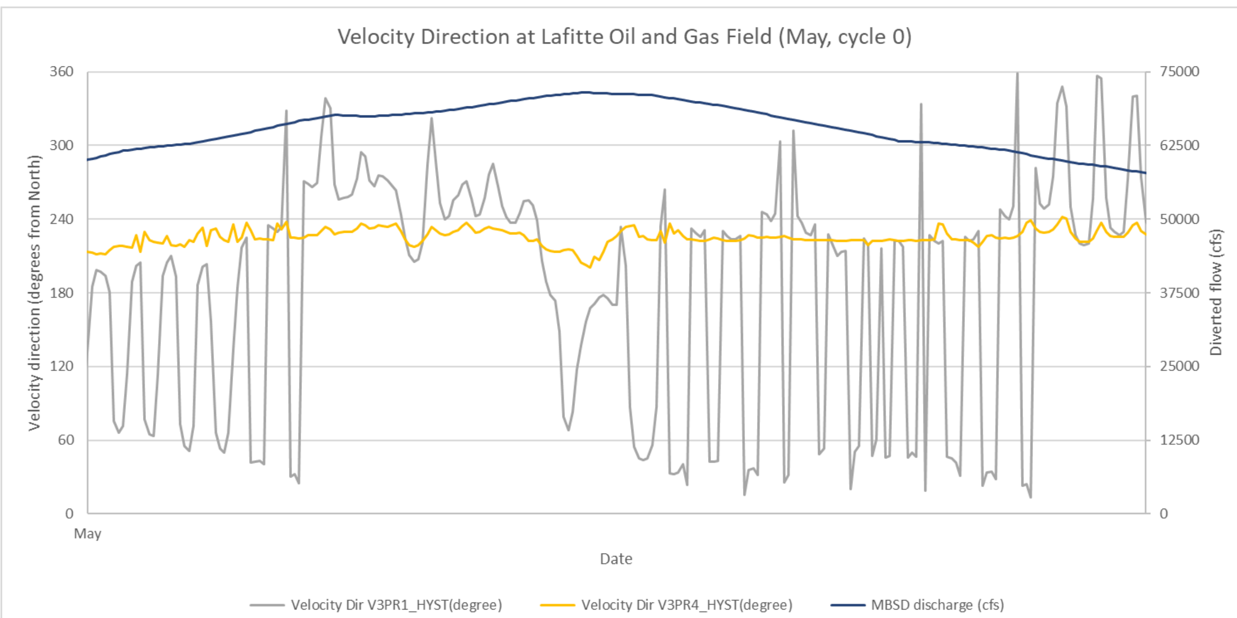
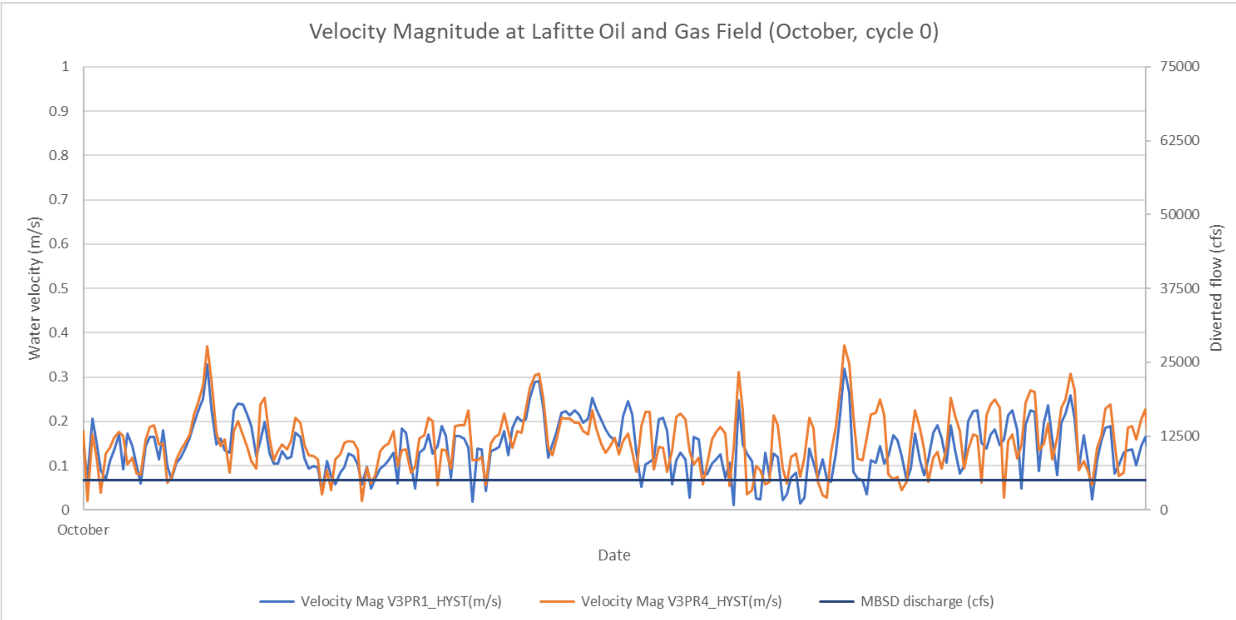


Figure 4.4-32. 2020 (1970) Hydrograph, May, Velocity Output for Applicant's Preferred Alternative (V3PR4) and No Action Alternative (V3PR1) at Lafitte Oil and Gas Field (Near the Diversion).



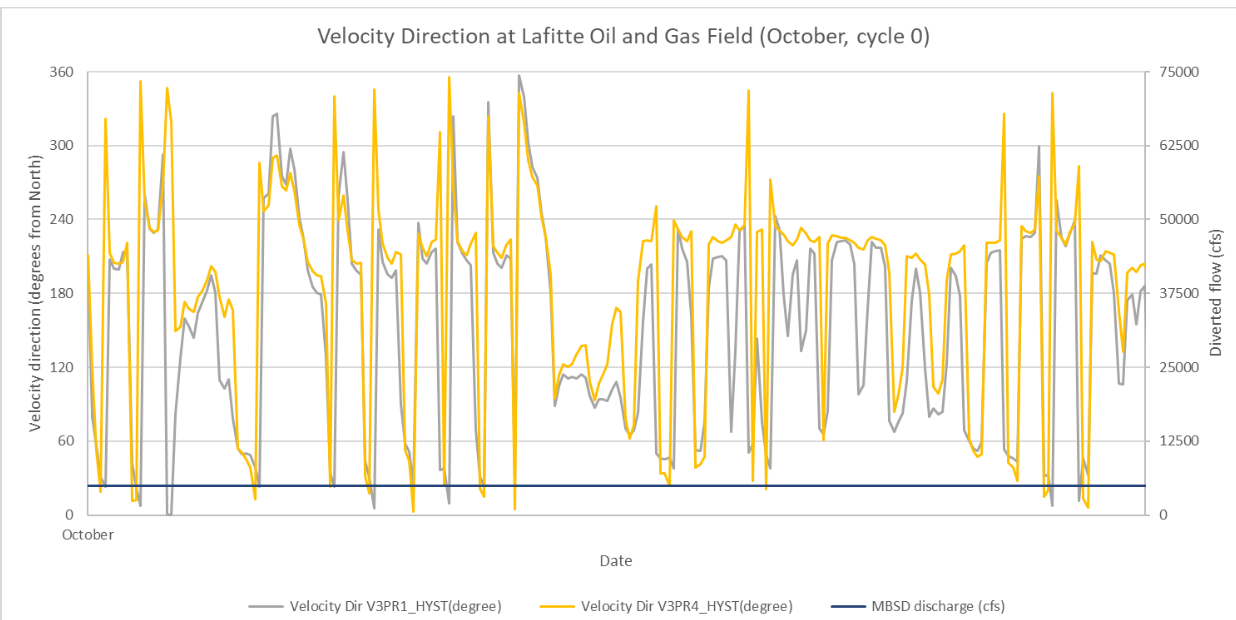


Figure 4.4-33. 2020 (1970) Hydrograph, October, Velocity Output for Applicant's Preferred Alternative (V3PR4) and No Action Alternative (V3PR1) at Lafitte Oil and Gas Field (Near the Diversion).

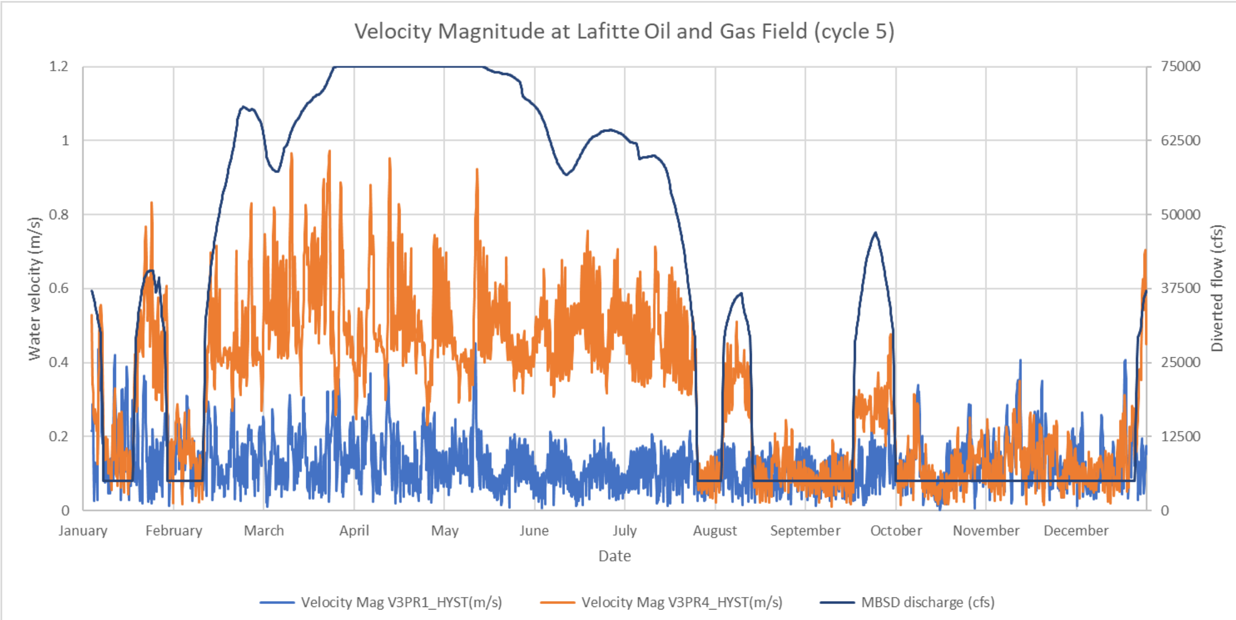
Note that in the velocity direction figures below, the direction values of 0 and 360 degrees from the north both indicate flows would generally be to the north. This means that while the figure may show what looks like opposite directions to the top and bottom, there would only be a small variation in direction. For example, if the velocity changed direction from 358 degrees north to 3 degrees north, that represents only a 5-degree change in direction and would still indicate a northern flow.

In 2070, these patterns would generally be repeated, with average velocities in May during diversion operations near capacity increasing from 0.3 foot/second (0.1 meter/second) for the No Action Alternative to 1.6 feet/second (0.5 meter/second) for the Applicant's Preferred Alternative. Diversion operations would also strongly direct velocities to the southwest with no tidal reversing (see Figure 4.4-34). During October (when the diversion would operate at or below base flow), velocities would be similar in magnitude and direction to the No Action Alternative, representing minor impacts from the proposed Project.

Near the western side of the basin at the Harvey Cutoff station (western/mid-basin), in 2020 and 2070, proposed diversion operations would have minor impacts on water velocity and direction compared to the No Action Alternative, even in May when the diversion would operate at capacity.

In 2020 and 2070, near the southern end of the basin at the Grand Bayou to Hackberry Bay station (southern/mid-basin), diversion operations would have minor impacts on water velocity and direction even when the diversion would operate at capacity in May (see Figure 4.4-35 and 4.4-36) See Section 4.10 Aquatic Resources for a discussion of the impacts of water velocity and direction on aquatic species.

In the Mississippi River, operational impacts under the Applicant's Preferred Alternative on the existing flow of the Mississippi River would be permanent, moderate, and adverse due to the creation of a cross-stream (perpendicular to the existing general downstream flow) velocity component near the proposed diversion site. CPRA used FLOW-3D modeling to assess the performance and design of the proposed diversion structure alternatives. Modeling results indicated that diverting 75,000 cfs of water from the river through the diversion would impact river flow immediately upstream and downstream of the proposed intake structure in the zone of influence (ZOI) shown in Figure 4.4-37. River flow in this ZOI would turn from the existing downstream flow towards the intake channel (see Figure 4.4-37) and create a cross-stream velocity. As shown, a cross-stream directional change in velocity towards the intake channel, both at the structure and immediately downstream of the structure, is projected to be at least 1 foot/second (0.3 meter/second) during maximum diversion flow. River velocities upstream of the diversion would increase by less than 1 foot/second. At lower diversion flows, similar patterns are projected with smaller magnitudes. The maximum flow of 75,000 cfs under this alternative would only be released through the diversion when river flows are 1 million cfs or more, which would occur only a small percentage of the time. Of the 1 million cfs river flow, less than 10 percent would be diverted through the diversion at maximum capacity, which may limit the overall impact of the cross-stream velocities. This change is anticipated to cause adverse impacts on shallow-draft vessels transiting past the site and on the pallid sturgeon. For further discussion of Project impacts on navigation and the pallid sturgeon, see Section 4.21 Navigation and 4.12 Threatened and Endangered Species.



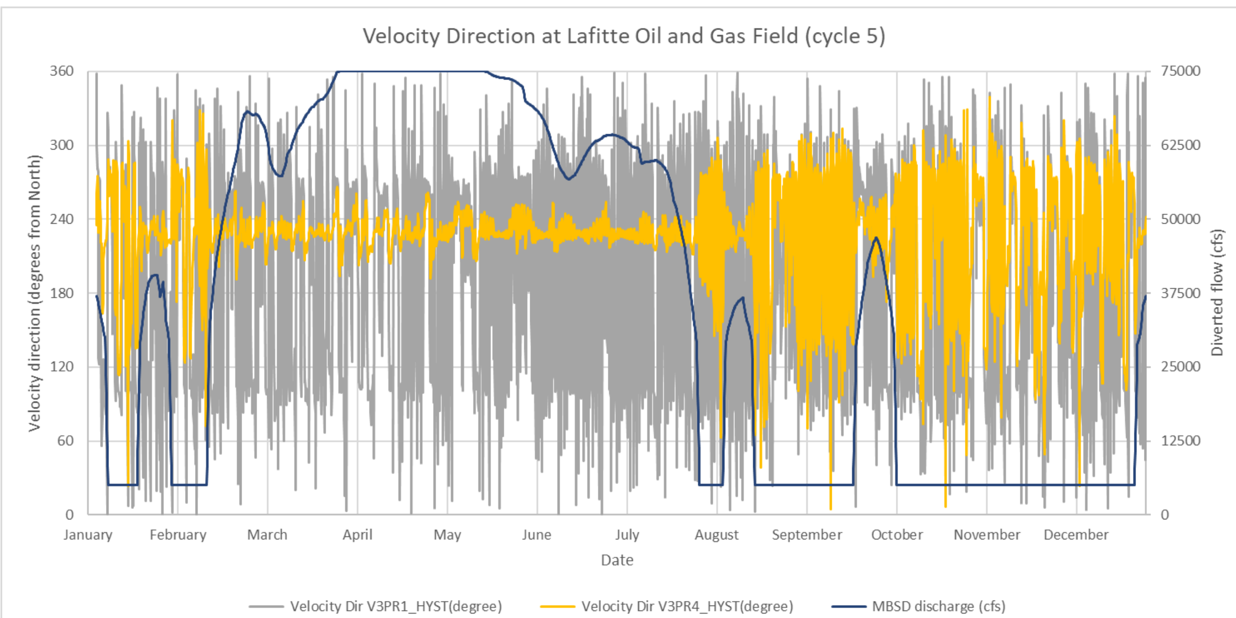


Figure 4.4-34. 2070 (2008) Hydrograph, Velocity Output for Applicant's Preferred Alternative (V3PR4) and No Action Alternative (V3PR1) at Lafitte Oil and Gas Field (Near the Diversion). Diversion operations at capacity would cause major impacts on velocity magnitudes and direction at this location.

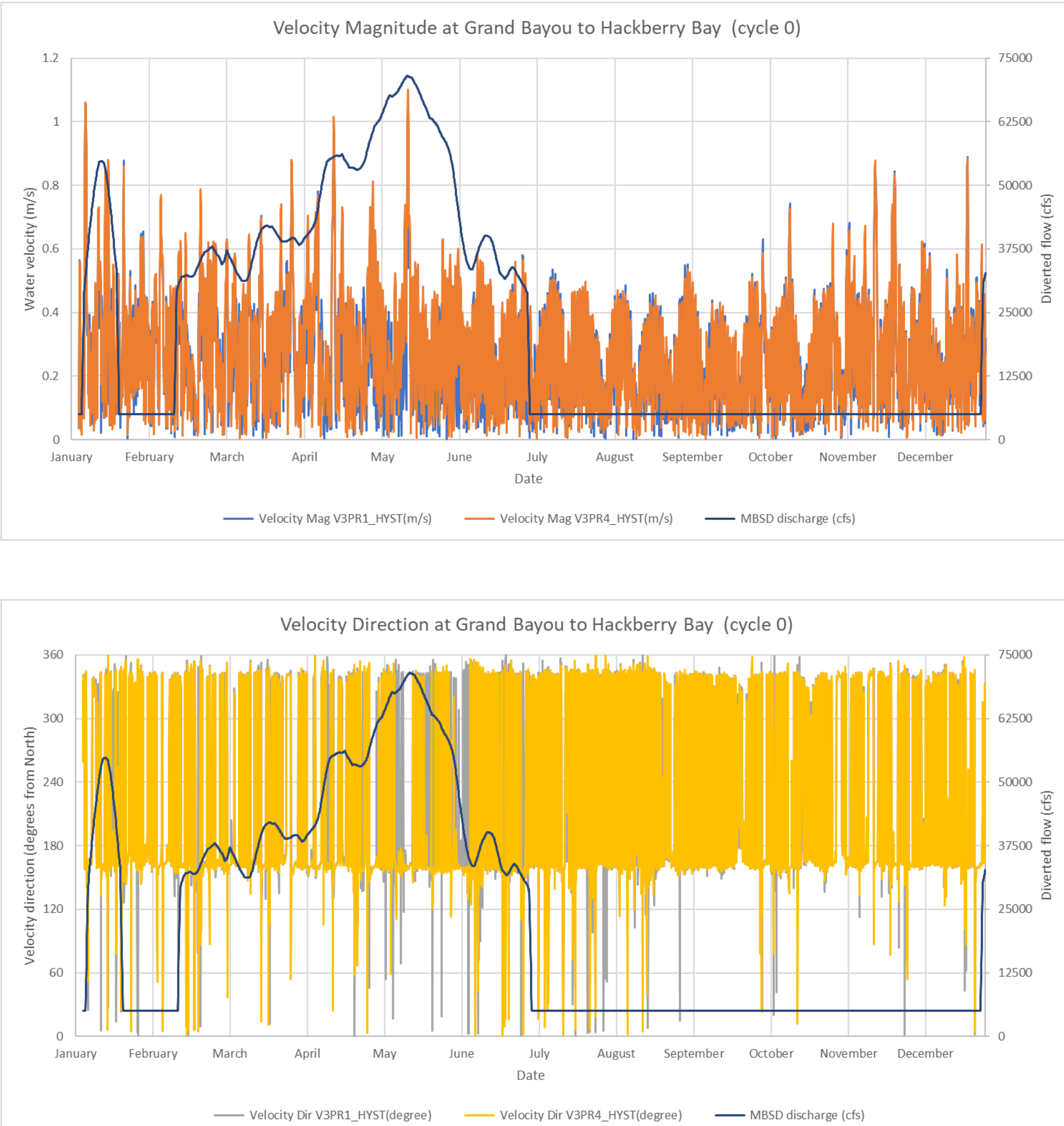
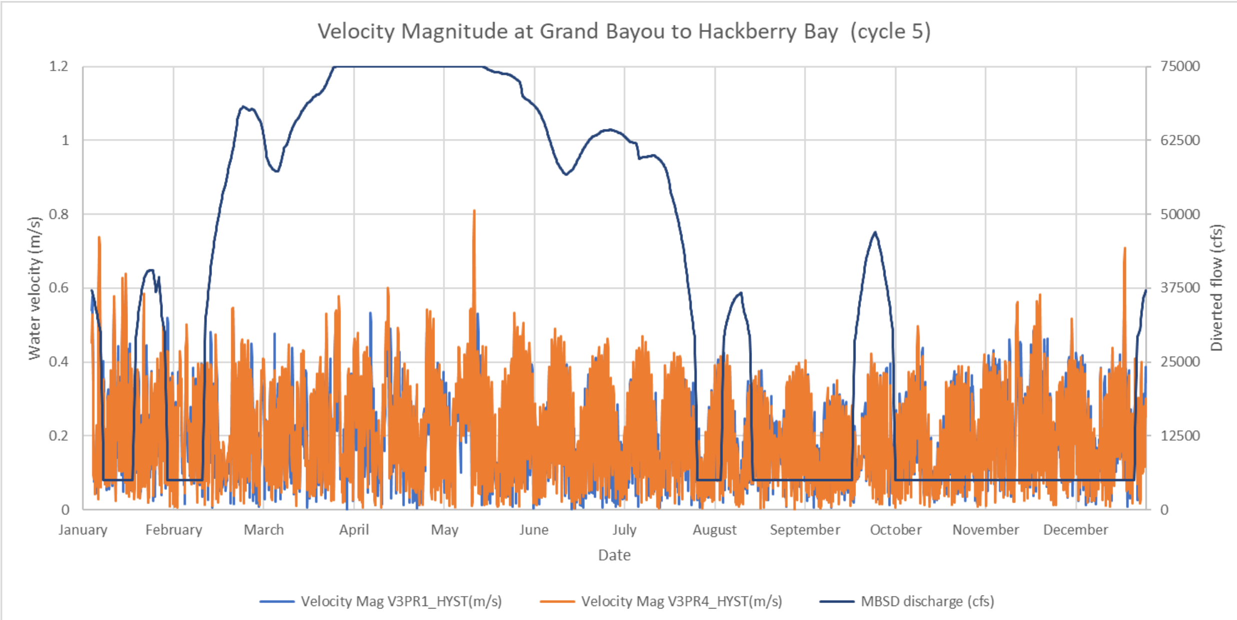


Figure 4.4-35. 2020 (1970) Hydrograph, Velocity Output for Applicant's Preferred Alternative (V3PR4) and No Action Alternative (V3PR1) at Grand Bayou. Diversion operations at base flow or above would cause minor impacts on velocity magnitudes and direction at this location.



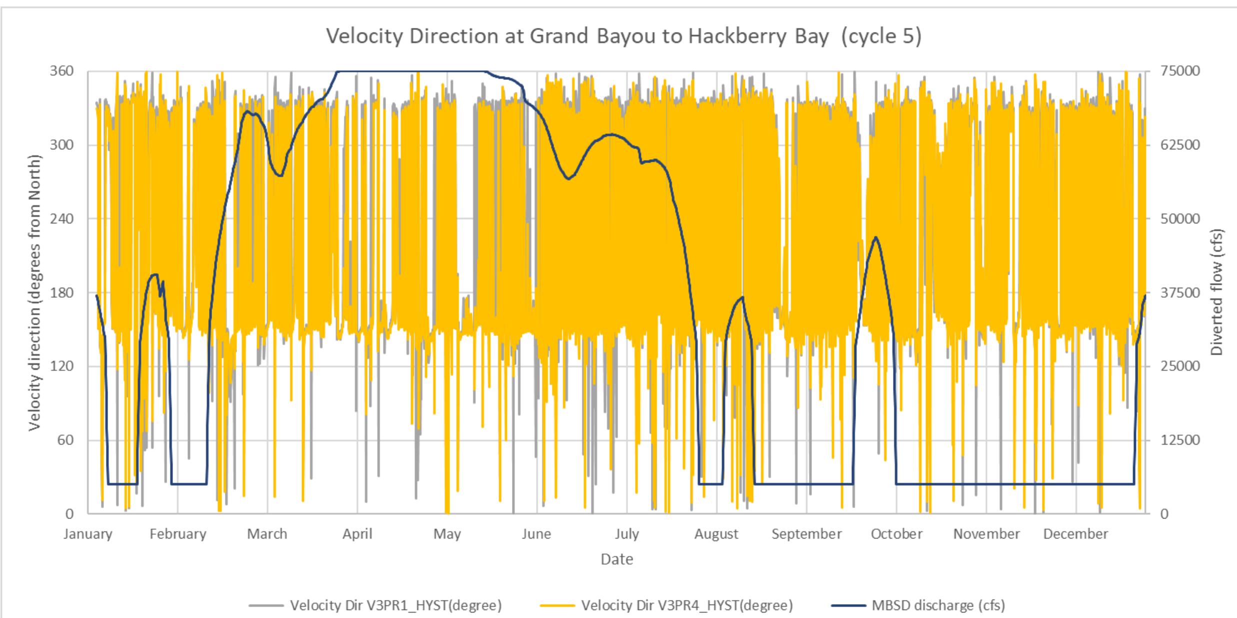
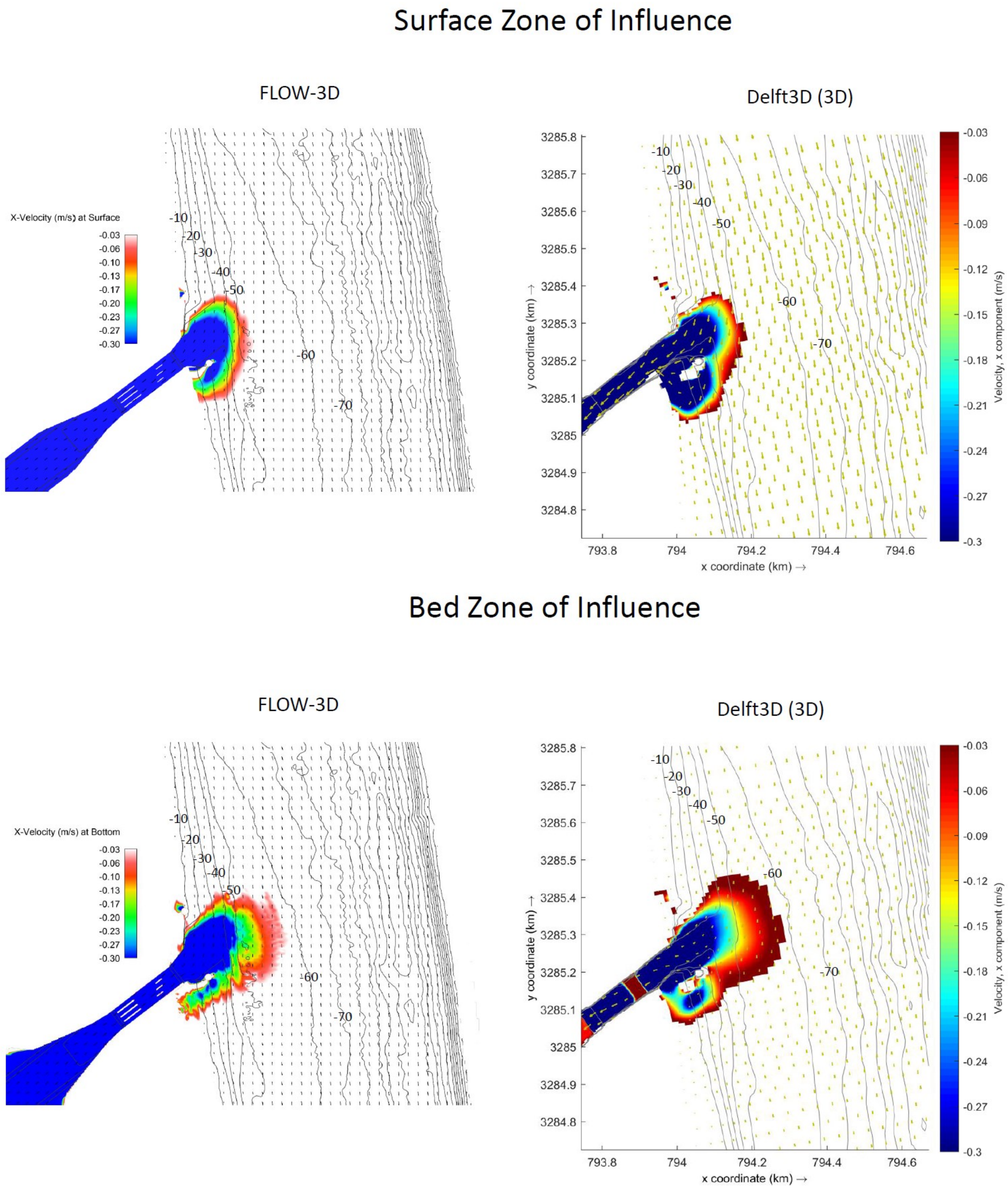


Figure 4.4-36. 2070 (2008) Hydrograph, Velocity Output for Applicant's Preferred Alternative (V3PR4) and No Action Alternative (V3PR1) at Grand Bayou. Diversion operations at base flow or above would cause minor impacts on velocity magnitudes and direction at this location.



Source: CPRA 2018b

Figure 4.4-37. Zone of Influence (changes in cross-stream velocity) on Mississippi River Flow from Diversion Operations at the Surface (top panel) and near Bed (bottom panel). Colors indicate changes in velocity towards the diversion compared to the Existing Conditions (the values are negative as cross-stream velocity is flowing to the left in the figure, in the negative x-direction). Cross-stream velocity changes of greater than 1 foot/second (0.3 meter/second) are considered the ZOI (dark blue in figure). The left panels are cross-stream velocity changes simulated with FLOW-3D, and the right panel is cross-stream velocity changes simulated with the Delft3D Basinwide Model.

4.4.4.2.3.3 Other Action Alternatives

4.4.4.2.3.3.1 50,000 cfs Alternative

Operational impacts on tides, currents, and flows would be similar to the Applicant's Preferred Alternative, with some reduction in the overall currents due to the smaller amount of diverted water. Operational direct and indirect impacts on existing currents and flow in the Barataria Basin would be permanent, minor to major (depending on distance from the immediate outfall area), and adverse due to widespread and readily apparent impacts on water flow velocity and direction when the proposed Project is operating above base flow. The 5,000 cfs base flow would continue to maintain a general north to south flow in the basin, as with the Applicant's Preferred Alternative, with stronger impacts when the diversion is operating at capacity. Projected impacts on the tidal signal are smaller than for the Applicant's Preferred Alternative. At 2020, 2040, and 2070 conditions, for the hydrograph from May 1994 (high, consistent spring flow), high tides are increased nearly the same as the Applicant's Preferred Alternative near Lafitte and the northern/mid-basin station (CRMS 3985). Low tide would be increased at both stations less than the Applicant's Preferred Alternative (differences of less than 0.1 to 0.2 foot [0.1 meter]) with the smaller diversion flow. Near the diversion, projected increases in high and low tide are less than the Applicant's Preferred Alternative, by 0.3 foot (0.09 meter) and 0.5 foot (0.15 meter), respectively.

The 50,000 cfs Alternative would have similar impacts on velocity magnitudes and direction as the Applicant's Preferred Alternative, with major impacts on the speed and direction of currents and flows at the Lafitte Oil and Gas Field station (near the diversion) when the diversion is operating at maximum capacity. Minor impacts on currents and flows would occur farther away from the diversion structure at the Harvey Cutoff station (western/mid-basin) and the Grand Bayou to Hackberry Bay station (southern/mid-basin) even when the diversion is operating at maximum capacity, and also when the diversion is operating at base flow. Velocity magnitudes at the Lafitte Oil and Gas Field station (near the diversion) compared to the No Action Alternative would increase to an average of 1.6 feet/second (0.5 meter/second) in May 2020 (when the diversion is operating near maximum capacity) and to 0.6 foot/second (0.2 meter/second) in October of 2020 (when the diversion is operating at base flow). Directional changes would be similar to the Applicant's Preferred Alternative, with a consistent southwest direction when the diversion is operated at capacity and negligible impacts on direction when the diversion operates at or below base flow. In general, there would be slightly more direction variation compared to the Applicant's Preferred Alternative due to the smaller flows. In 2070, the 50,000 cfs Alternative would increase velocity magnitudes to an average of 1 foot/second (0.3 meter/second) in May (when the diversion is operating near maximum capacity) with a strong southwest direction, and in October (when the diversion is operating at base flow) increase to 0.6 foot/second (0.2 meter/second) with a similar directional pattern to as compared to the No Action Alternative. Farther away from the diversion, at Harvey Cutoff station (western/mid-basin) and Grand Bayou to Hackberry Bay station (southern/mid-basin), velocities would be nearly identical to No Action for 2020 and 2070.

4.4.4.2.3.3.2 150,000 cfs Alternative

Operational impacts on tides, currents, and flows would be similar to the Applicant's Preferred Alternative, with an increase in the overall currents due to the substantially larger amount of diverted water. Operational direct and indirect impacts on existing currents and flow in the Barataria Basin would be permanent, minor to major (depending on distance from the immediate outfall area), and adverse due to widespread and readily apparent impacts on water flow velocity and direction when the proposed Project is operating above base flow. The 5,000 cfs base flow would continue to maintain a general north to south flow in the basin, as with the Applicant's Preferred Alternative, with much stronger impacts when the diversion is operating at capacity (150,000 cfs). Near the diversion for 2020, 2040, and 2070 conditions, high tide would be increased over the Applicant's Preferred Alternative by 0.4 foot (0.10 meter), 0.6 foot (0.20 meter), and 0.6 foot (0.20 meter), respectively, and low tide would be increased by 1.0 foot (approximately 0.3 meter), 1.2 feet (0.40 meter), and 1.3 feet (0.40 meter), respectively, due to the larger 150,000 cfs flow of the diversion. At other stations, tidal impacts would be consistently stronger than the Applicant's Preferred Alternative, especially at low tides.

The 150,000 cfs Alternative would have similar impacts on velocity magnitudes and direction as the Applicant's Preferred Alternative, with major impacts on the speed and direction of currents and flows at the Lafitte Oil and Gas Field station (near the diversion) when the diversion is operating at maximum capacity. Minor impacts on currents and flows would occur farther away from the diversion structure at the Harvey Cutoff station (western/mid-basin) and the Grand Bayou to Hackberry Bay station (southern/mid-basin) even when the diversion is operating at maximum capacity, and also when the diversion is flowing at or below the 5,000 cfs base flow. Under the 150,000 cfs Alternative, velocity magnitudes at the Lafitte Oil and Gas Field station (near the diversion) compared to No Action Alternative would increase to an average of 2.0 feet/second (approximately 0.6 meter/second) in May 2020 (when the Delft3D Basinwide Model projects the diversion to be operating near maximum capacity) and to 0.6 foot/second (approximately 0.2 meter/second) in October (when the diversion is projected to be operating at base flow) of 2020. Directional changes would be similar to the Applicant's Preferred Alternative, with a consistent southwest direction when the diversion is flowing at capacity and similar patterns to No Action Alternative when operating at or below base flow. In general, there would be slightly less direction variation compared to the Applicant's Preferred Alternative, due to the much larger flows. In 2070, velocity magnitudes would increase to an average of 2.6 feet/second (approximately 0.8 meter/second) in May (when the Delft3D Basinwide Model projects the diversion to be operating near maximum capacity) with a strong southwest direction, and in October (when the Delft3D Basinwide Model projects the diversion to be operating at base flow) to 1 foot/second (approximately 0.3 meter/second) with minor impacts on the directional pattern as compared to the Applicant's Preferred Alternative. Farther away from the diversion, at the Harvey Cutoff station (western/mid-basin) and Grand Bayou to Hackberry Bay station (southern/mid-basin), velocity impacts would also be minor as compared to the No Action Alternative in both 2020 and 2070.

4.4.4.2.3.3.3 Terrace Alternatives

Operational impacts of the three terrace alternatives on tides, currents, and flows would be similar to the Applicant's Preferred Alternative. Operational direct and indirect impacts on existing currents and flow in the Barataria Basin would be permanent, minor to major (depending on distance from the immediate outfall area), and adverse due to widespread and readily apparent impacts on water flow velocity and direction when the proposed Project is operating above base flow. The presence of terraces would cause minor impacts on local currents and slightly shift the overall diverted water to the west. The general flow pattern would remain north to south, especially when the diversion is operating at capacity. Impacts from this shift in flow patterns are demonstrated in the slightly changed deposition patterns and water levels, as shown in the bed elevation and water level sections above.

4.4.4.2.4 Sediment Transport

4.4.4.2.4.1 No Action Alternative

Under the No Action Alternative, sediment transport within the Barataria Basin would continue to be driven by storm events along with wind- and wave-induced resuspension (see Chapter 3, Section 3.4 Surface Water and Coastal Processes). Storm surge has been shown to erode vegetation and sediment, altering subsequent sediment transport (Howes et al. 2010). Studies have investigated the impacts of storms and hurricanes on long-term sedimentation rates (Smith et al. 2015, Tweel and Turner 2014) and determined that hurricanes do contribute to sediment accretion in the coastal zone; however, hurricanes are an unpredictable extreme event. As explained in Chapter 3, Section 3.1.4 Overview and History of the Project Area, modifications to the Mississippi River including, but not limited to, the construction of river levees have altered the hydrologic connectivity and reduced sediment input to the basin, ultimately resulting in extensive wetland loss and barrier island erosion.

4.4.4.2.4.2 Applicant's Preferred Alternative

A primary goal of the proposed Project is the introduction of new sediments into the basin from the Mississippi River. The diversion intake system is designed to capture sediment and fresh water from the Mississippi River and deliver it to the basin.

Direct and indirect operational impacts under the Applicant's Preferred Alternative would be permanent, major, and beneficial on land building and sustaining wetlands in the Barataria Basin. Impacts would be permanent, moderate, and adverse in the birdfoot delta, as sediment in the river that would be deposited into the birdfoot delta under the No Action Alternative would be deposited into the Barataria Basin instead. Similar to the No Action Alternative, storm-induced resuspension would continue to have an effect within the basin, but deposition would be dominated by the large influx of sediments through the diversion.

Sediment transported by the Mississippi River is primarily comprised of fine sediments, with higher river flows suspending more coarse-grained sediment that are important in delta building (see Chapter 3, Section 3.4 Surface Water and Coastal Processes). The intake channel was modeled and designed to divert a high SWR while minimizing energy loss (to maintain flow and sediment transport through the diversion complex) and impacts on the river. The amount of sediment carried through the diversion would vary by year, depending on flow rates in the river and the corresponding variation of diversion operations. Fine sediment transport through the diversion would be generally proportional to water flow.

Figure 4.4-38 demonstrates quantitative differences in sediment transport among the action alternatives. The model projects that approximately 275 million metric tons of sediment would be transported into the basin for the Applicant's Preferred Alternative over the 50-year analysis period.

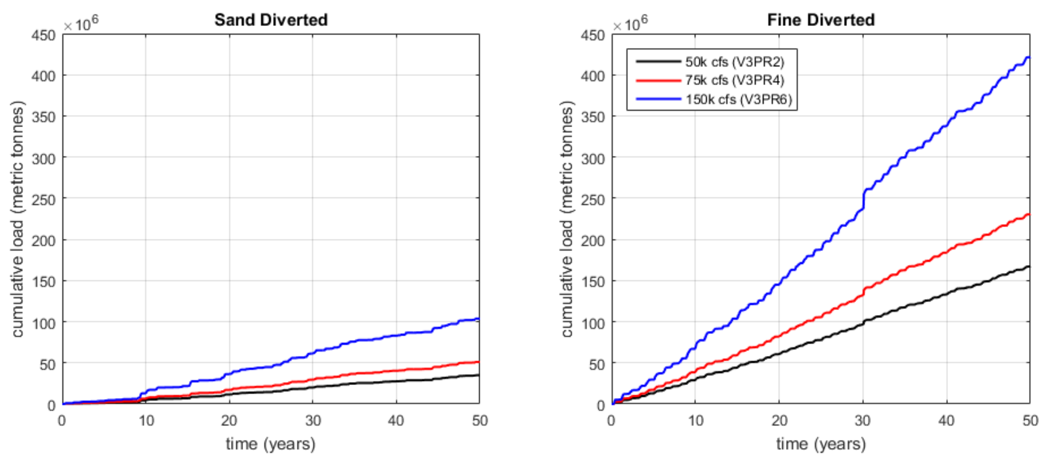
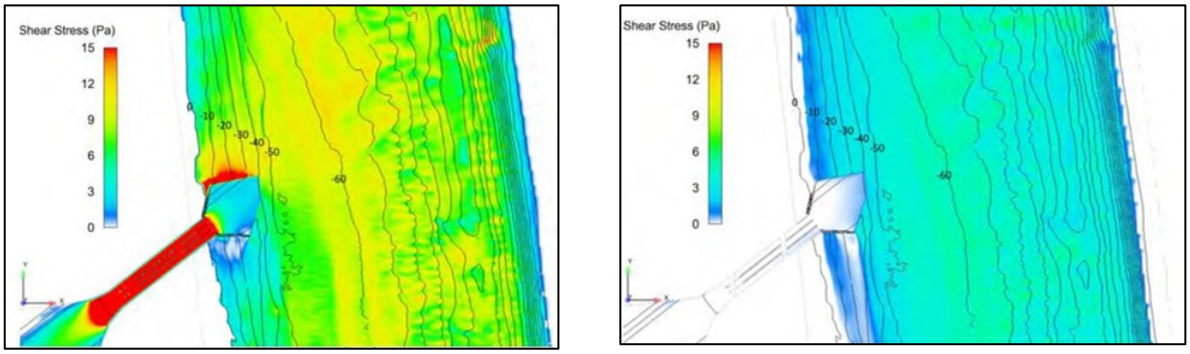


Figure 4.4-38. Model-projected Sand and Fine Sediment Transport Mass for the Three Diversion Sizes (from Water Institute 2019).

In the Mississippi River, the Applicant's Preferred Alternative is projected to reduce bed shear stress on the river bottom immediately downstream of the intake channel, which may produce local deposition, including when the diversion is flowing at or below the 5,000 cfs base flow (see Figure 4.4-39). This would represent negligible impacts. Additional simulations were run to investigate potential impacts of local sediment deposition on the functionality of the diversion intake, and the diversion intake was projected to be rapidly self-clearing when the diversion is flowing greater than the 5,000 cfs base flow, even under scenarios of very large deposition amounts in the vicinity of the intake.



Source: CPRA 2018b

Figure 4.4-39. Shear Stress Plots at High-Flow (left) and at 5,000 cfs Base Flow (right). Areas where operation of the diversion reduces bed shear stress are indicated by white areas.

By diverting sediment from the Mississippi River for diversion operations, less material would be transported to the birdfoot delta and into the Gulf of Mexico. Modeled bed changes at the birdfoot delta under the Applicant's Preferred Alternative compared to the No Action Alternative would be permanent, moderate, and adverse, with areas of both erosion and deposition (see *Bed Elevation* section above) that would cause an overall moderate, adverse impact on wetlands and land change in the birdfoot delta (see Section 4.6 Wetlands and Waters of the U.S. and Section 4.2 Geology and Soils for further details about projected Project impacts on wetlands and land change). The frequency and quantity of dredging in the Mississippi River and the Barataria Basin navigation channels may be impacted by changes in sediment transport and bathymetry in these waterways. Potential impacts on dredging operations in the Mississippi River as a result of the proposed Project are discussed in Section 4.21 Navigation.

4.4.4.2.4.3 Other Action Alternatives

4.4.4.2.4.3.1 50,000 cfs Alternative

The 50,000 cfs Alternative is projected to transport approximately 190 million metric tons of sediment into the basin (approximately 30 percent less than the Applicant's Preferred Alternative), representing permanent, major, and beneficial land building and wetland impacts, as sediment diverted from the river would be deposited into the Barataria Basin. Similar to the No Action Alternative, storm-induced resuspension would continue to have an effect within the basin, but deposition would be dominated by the large influx of sediments through the diversion.

Operational impacts in the birdfoot delta would be permanent, moderate, and adverse with less sediment reaching the birdfoot delta and the Gulf of Mexico. Impacts on sediment transport in the Mississippi River and the impacts on bed elevations are discussed above in the *Bed Elevation* section.

4.4.4.2.4.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative is projected to transport approximately 525 million metric tons of sediment into the basin (approximately 90 percent more than the Applicant's Preferred Alternative), representing permanent, major, and beneficial land building and wetland impacts, as sediment diverted from the river would be deposited into the Barataria Basin. Similar to the No Action Alternative, storm-induced resuspension would continue to have an effect within the basin, but deposition would be dominated by the large influx of sediments through the diversion.

Operational impacts in the birdfoot delta would be permanent, moderate, and adverse with less sediment reaching the Gulf of Mexico. Impacts on the sediment transport in the Mississippi River and the impacts on bed elevations are discussed above in the *Bed Elevation* section.

4.4.4.2.4.3.3 Terrace Alternatives

The three terrace alternatives would have the same overall impacts on sediment transport in the Barataria Basin and birdfoot delta as the other action alternatives. Impacts in the basin would be permanent, major, and beneficial. However, terraces are projected to result in less sediment accretion and land building in the vicinity of the terraces (to the southeast of the diversion) and more sediment accretion to the south and west. See Section 4.2 Geology and Soils for details about impacts of the terrace features on geology and geomorphology. Operational impacts in the birdfoot delta would be permanent, moderate, and adverse.

4.4.5 Stormwater Management and Drainage

4.4.5.1 Construction Impacts

4.4.5.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. As described in Chapter 3, Section 3.4 Surface Water and Coastal Processes, the proposed construction footprint between the MR&T and NOV-NFL Levees is generally low-lying, flat agricultural land. Stormwater management is dependent upon forced drainage pumping to lower the water table for pasture-grazing. Stormwater is conveyed by canals leading to Timber Canal, which drains the stormwater to the Wilkinson Canal Pump Station. These conditions are expected to continue during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse effect on local water and/or sediment quality. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal standards.

4.4.5.1.2 Applicant's Preferred Alternative

Construction impacts on stormwater management and drainage between the levees would be temporary, minor, and adverse. During construction, local drainage may be interrupted or redirected, which may cause local water level increases and minor flooding of low-lying areas. Although these impacts can be considered adverse in that existing drainage patterns would be disrupted, they would be minor because the existing drainage in the areas is already artificially controlled by a system of pumps and canals, and the existing level of drainage would be maintained. New levees would be constructed paralleling the conveyance channel, which would require filling in portions of the existing Timber Canal, which drains stormwater southeast towards the Wilkinson Canal Pump Station (see Chapter 2, Figure 2.8-1). These activities would have the net impact of disconnecting the northern portion of the local watershed from its southern portion as shown in Figure 4.4-40. Watershed drainage would be redirected through a siphon constructed under the proposed conveyance channel. This siphon would carry drainage flow under the conveyance channel to the southeast and then down to the Wilkinson Canal Pump Station. The siphon would be constructed in advance of the conveyance channel construction to maintain water flow during construction of the levees.

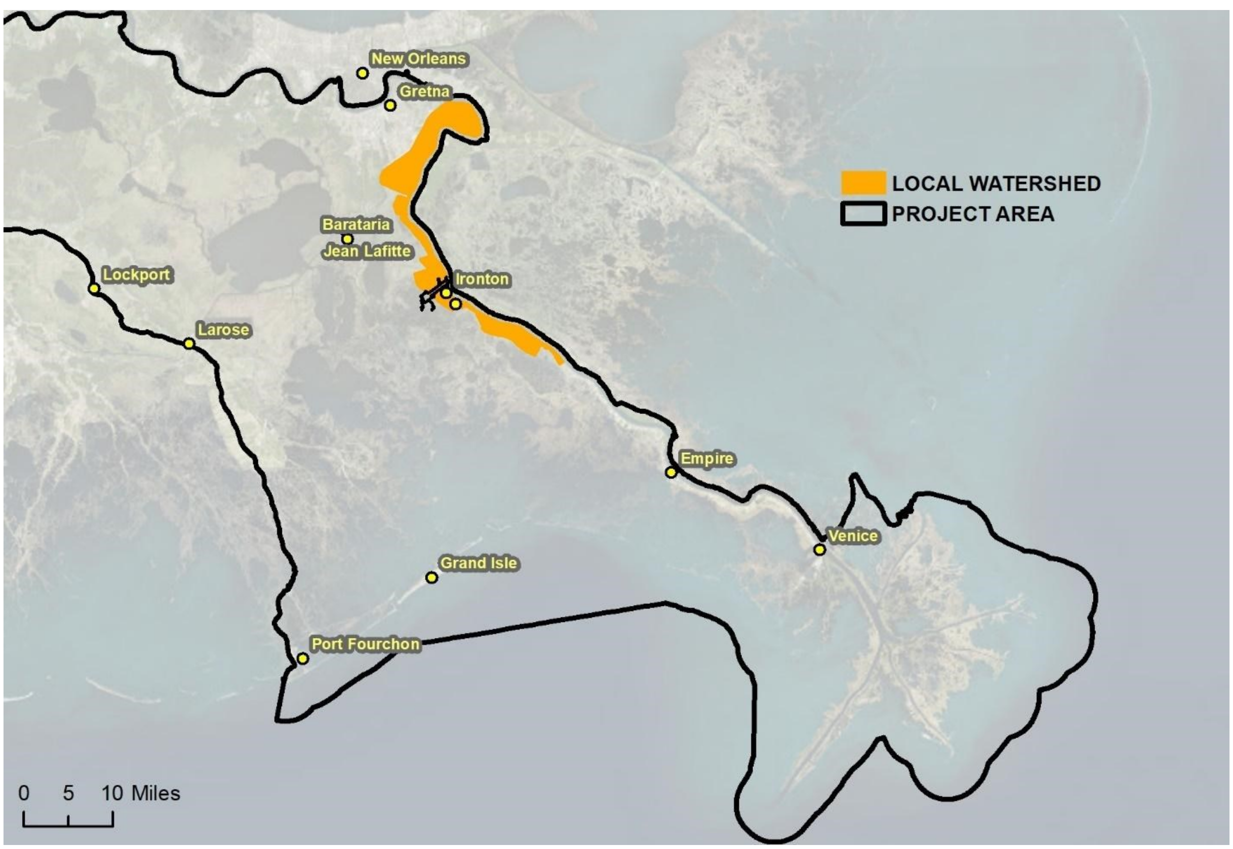


Figure 4.4-40. Local Watershed Division from the Construction of the Diversion Structure.

4.4.5.1.3 Other Alternatives

The impacts from construction of the other action alternatives on stormwater management and drainage in the Project construction footprint between the MR&T and the NOV-NFL Levees would be similar to those caused by the Applicant's Preferred Alternative. There would be negligible differences to impacts on stormwater management and drainage associated with the variations in the width of the intake channel and conveyance channel for the 50,000 cfs and 150,000 cfs Alternatives, as compared to the Applicant's Preferred Alternative. Consistent with the Applicant's Preferred Alternative, redirecting watershed drainage during construction from the Timber Canal through a siphon under the proposed conveyance channel would represent a temporary, minor, adverse impact on stormwater management and drainage with potential minor flooding of low-lying areas. The addition of terrace construction in the immediate outfall area under three of the action alternatives would not impact stormwater management drainage between the MR&T and NOV-NFL Levees. Terrace construction impacts on hydrology are addressed in Section 4.4.2.

4.4.5.2 Operational Impacts

4.4.5.2.1 No Action Alternative

Under the No Action Alternative, stormwater management and drainage would not be impacted by operation of the Applicant's Preferred Alternative or any of the action alternatives. Over time, all of coastal Louisiana would be impacted as sea levels continue to rise and the land continues to subside. These impacts may be felt with increased pumping demands, less efficient water drainage, and increased flooding throughout the region. In consideration of current, ongoing, and planned developments in the Project area, it is predictable that the proposed Project construction footprint may be developed for industrial or commercial purposes. The details of these stormwater management and drainage impacts, including their context and intensity, are not known at this time.

4.4.5.2.2 Applicant's Preferred Alternative

Operational impacts on stormwater management and drainage between the MR&T Levee and NOV-NFL Levee would be negligible. The proposed conveyance channel would bisect the drainage area served by the Wilkinson Canal Pump Station. To address this, the proposed Project would connect the bisected area by inverted siphons (six large-diameter steel pipes) routed beneath the proposed conveyance channel. CPRA estimates that at a 10-year, 24-hour storm level-of-service, the total head loss through the siphon system (including the upstream and downstream bar screens) would be less than one tenth of a foot because the stormwater flow entering the siphon would be mitigated by the 450-acre reduction in the overall basin size (due to the presence of the diversion structure). Therefore, the difference between water levels on the upstream (northwestern) side of the conveyance channel compared to water levels on the downstream (southeastern) side of the conveyance channel would be negligible. These modifications would have negligible impacts on the pumping capacity and operation of the Wilkinson Canal Pump Station as compared to the No Action Alternative. According to the Wilkinson Canal Pump Station's operating procedure, the first pump would be turned on when the stage detected at the Pump Station's intake channel is higher than -4.5 feet NAVD88. Other pumps would be turned on in sequence when the stage at the inflow channel increases. Pumps would be turned off in sequence when the stage at the intake channel decreases. All pumps would be turned off when the stage at the intake channel is lower than -5.5 feet NAVD88. CPRA would be responsible for the operation of the inverted siphons and maintenance gates.

Operational impacts on stormwater management and drainage in the Barataria Basin in the immediate outfall area would be permanent, minor, and adverse. Water levels near the immediate outfall area would be raised during diversion operations, potentially adversely impacting local drainage. As discussed previously, model results under high-flow conditions in modeled years 2040 and 2070 at the Barataria Bay Waterway near Lafitte (USACE 82875, see Figure 4.4-1) project that monthly average water levels would increase a maximum of 0.5 foot (approximately 0.14 meter) and 0.2 foot (approximately 0.05 meter), respectively, during diversion operations. Increased water levels in the basin would cause increased head differential between the basin and protected side of levees, requiring increased pumping. Pump stations, depending on design, may require more frequent pumping, resulting in indirect, minor, adverse impacts on air quality.

Operational impacts on stormwater management farther away from the proposed diversion in the basin would be negligible (see Section 4.4.3). Sea-level rise and land subsidence factored into the Delft3D Basinwide Model for all alternatives would have stronger impacts on stormwater management and drainage throughout the basin away from the diversion than would impacts associated with diversion operations.

4.4.5.2.3 Other Alternatives

The impacts from operation of the other action alternatives on stormwater management and drainage would be similar to those caused by the Applicant's Preferred Alternative, with negligible impacts expected between the MR&T and NOV-NFL Levees; minor, permanent, and adverse impacts in the Barataria Basin near the immediate outfall area; and negligible impacts farther away from the proposed diversion structure in the basin. There would be negligible differences in impacts on stormwater management and drainage associated with the variations in water flows of the 50,000 cfs and 150,000 cfs Alternatives. The addition of terraces in the immediate outfall area under three of the action alternatives would have no impacts on stormwater management and negligible impacts on drainage into the basin.

4.4.6 Summary of Potential Impacts

Table 4.4-7 summarizes the potential impacts on hydrology, hydrodynamics, and stormwater management and drainage for each alternative. Details are provided in Sections 4.4.4 through 4.4.5 above.

Table 4.4-7
Summary of Potential Impacts on Surface Water and Coastal Processes from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on surface water and coastal processes from construction of the proposed Project would occur.
Operational Impacts	• Continued processes of land subsidence and sea-level rise leading to major, permanent, adverse impacts by lowering bed elevations and increasing water levels. This also would contribute to land loss and wetlands, as discussed in Section 4.2 Geology and Soils and Section 4.6 Wetland Resources and Waters of the U.S. • Negligible impacts on sediment transport, which would continue to be driven by wind- and wave-induced currents. • Negligible impacts on flows, which would generally be small, north to south, and driven by tidal exchange and the Davis Pond Freshwater Diversion. • As sea level continues to increase, the tidal influence would extend farther northward into the basin and circulation patterns would change, representing moderate, permanent, adverse impacts.
75,000 cfs Alternative (Applicant's Preferred Alternative)	
Construction Impacts	• Moderate, short-term, adverse impacts on existing bed elevations in the basin due to dredging and the placement of material for beneficial use compared to the No Action Alternative with impacts becoming beneficial over time as wetlands are created and sustained in the beneficial use areas. • Negligible impacts on water levels, water flow, and sediment transport in the basin for dredging activities and increased vessel traffic in the basin. • Minor, temporary, adverse impacts on water flows and sediment transport in the Mississippi River due to the presence of the cofferdam, including localized increases in water velocity, scouring near the cofferdam, and deposition downstream of the cofferdam.

Table 4.4-7
Summary of Potential Impacts on Surface Water and Coastal Processes from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Major to minor, permanent, beneficial impacts in Barataria Basin bed elevations and land building from the influx of sediments (approximately 275 million tons over 50 years) with impacts decreasing with distance from the immediate outfall area. Maximum of 3.6-foot increase over the No Action Alternative in bed elevation at the station nearest the diversion (CRMS 0276) by 2070. • Moderate, permanent, adverse impacts on bed elevations and land building in the birdfoot delta compared to the No Action Alternative due to a reduction in sediment in the Mississippi River from the diversion. • Major to minor, permanent, adverse impacts on water levels in the basin from the input of fresh water, with impacts decreasing with distance from the diversion structure (maximum increase of 1.0 foot [approximately 0.3 meter] compared with the No Action Alternative at the station nearest the diversion [CRMS 0276]). • Minor, intermittent, beneficial impacts on water levels in the Mississippi River, with local reductions of up to 1.0 foot (approximately 0.3 meter) compared with the No Action Alternative during maximum Project operations. • Major to minor, permanent adverse impacts on the speed and direction of currents and flows in the Barataria Basin and moderate, permanent, adverse impacts on flows in the Mississippi River near the intake structure. • Moderate, permanent, and adverse impacts on currents and flow in the Mississippi River due to the creation of a cross-stream (perpendicular to the existing general downstream flow) velocity component near the proposed diversion site. • Negligible impacts on bed shear stress and deposition immediately in the Mississippi River adjacent to the intake channel. • Negligible impacts on stormwater management and drainage in the land between the levees where the diversion structure would be located; minor, permanent, adverse impacts on stormwater management and drainage in the Barataria Basin near the immediate outfall area due to increased water levels and head differential between the basin and protected side of levees, requiring increased pumping.

Table 4.4-7
Summary of Potential Impacts on Surface Water and Coastal Processes from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
50,000 cfs Alternative	
Construction Impacts	• Moderate, short-term, adverse impacts on existing bed elevations in the basin due to dredging and the placement of material for beneficial use compared to the No Action Alternative. • Negligible impacts on water levels, water flow, and sediment transport in the basin for dredging activities and increased vessel traffic in the basin. • Minor, temporary, adverse impacts on water flows and sediment transport in the Mississippi River due to the presence of the cofferdam, including localized increases in water velocity, scouring near the cofferdam, and deposition downstream of the cofferdam.
Operational Impacts	• Major to minor, permanent, beneficial impacts in Barataria Basin bed elevations and land building from the influx of sediments (approximately 190 million tons over 50 years) with impacts decreasing with distance from the immediate outfall area. Maximum of 2.9-foot increase over the No Action Alternative in bed elevation at the station nearest the diversion (CRMS 0276) by 2070. • Moderate, permanent, adverse impacts on bed elevations and land building in the birdfoot delta compared to the No Action Alternative due to a reduction in sediment in the Mississippi River from the diversion. • Major to minor, permanent, adverse impacts on water levels in the basin from the input of fresh water, with impacts decreasing with distance from the diversion structure (maximum increase of 0.7 foot compared with the No Action Alternative at the station nearest the diversion [CRMS 0276]). • Minor, intermittent, beneficial impacts on water levels in the Mississippi River, with local reductions of up to 1.0 foot (approximately 0.3 meter) compared with the No Action Alternative during maximum Project operations. • Major to minor, permanent adverse impacts on the speed and direction of currents and flows in the Barataria Basin and moderate, permanent, adverse impacts on flows in the Mississippi River near the intake structure. • Moderate, permanent, and adverse impacts on currents and flow in the Mississippi River due to the creation of a cross-stream (perpendicular to the existing general downstream flow) velocity component near the proposed diversion site. • Negligible impacts on bed shear stress and deposition immediately in the Mississippi River adjacent to the intake channel. • Negligible impacts on stormwater management and drainage in the land between the levees where the diversion structure would be located; minor, permanent, adverse impacts on stormwater management and drainage in the Barataria Basin near the immediate outfall area due to increased water levels and head differential between the basin and protected side of levees, requiring increased pumping.
150,000 cfs Alternative	
Construction Impacts	• Moderate, short-term, adverse impacts on existing bed elevations in the basin due to dredging and the placement of material for beneficial use compared to the No Action Alternative. • Negligible impacts on water levels, water flow, and sediment transport in the basin for dredging activities and increased vessel traffic in the basin. • Minor, temporary, adverse impacts on water flows and sediment transport in the Mississippi River due to the presence of the cofferdam, including localized increases in water velocity, scouring near the cofferdam, and deposition downstream of the cofferdam.

Table 4.4-7
Summary of Potential Impacts on Surface Water and Coastal Processes from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Major to minor, permanent, beneficial impacts in Barataria Basin bed elevations and land building from the influx of sediments (approximately 525 million tons over 50 years) with impacts decreasing with distance from the immediate outfall area. Maximum of 5.9-foot increase over the No Action Alternative in bed elevation at the station nearest the diversion (CRMS 0276) by 2070. • Moderate, permanent, adverse impacts on bed elevations and land building in the birdfoot delta compared to the No Action Alternative due to a reduction in sediment in the Mississippi River from the diversion. • Major to minor, permanent, adverse impacts on water levels in the basin from the input of fresh water, with impacts decreasing with distance from the diversion structure (maximum increase of 2.0 feet compared with the No Action Alternative at the station nearest the diversion [CRMS 0276]). • Minor, intermittent, beneficial impacts on water levels in the Mississippi River, with local reductions of up to 1.0 foot (approximately 0.3 meter) compared with the No Action Alternative during maximum Project operations. • Major to minor, permanent adverse impacts on the speed and direction of currents and flows in the Barataria Basin and moderate, permanent, adverse impacts on flows in the Mississippi River near the intake structure. • Moderate, permanent, and adverse impacts on currents and flow in the Mississippi River due to the creation of a cross-stream (perpendicular to the existing general downstream flow) velocity component near the proposed diversion site. • Negligible impacts on bed shear stress and deposition immediately in the Mississippi River adjacent to the intake channel. • Negligible impacts on stormwater management and drainage in the land between the levees where the diversion structure would be located; minor, permanent, adverse impacts on stormwater management and drainage in the Barataria Basin near the immediate outfall area due to increased water levels and head differential between the basin and protected side of levees, requiring increased pumping.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, the three terrace alternatives would have substantially similar construction impacts as that of the 75,000 cfs, 50,000 cfs, and 150, 000 cfs Alternatives (see above), plus additional minor, short-term, adverse construction impacts on local hydrology and bed elevations in the basin for the construction of terraces.
Operational Impacts	• As compared to the No Action Alternative, the three terrace alternatives would have substantially similar operational impacts as that of the 75,000 cfs, 50,000 cfs, and 150, 000 cfs Alternatives (see above), plus, the presence of terraces would have minor impacts on diversion-induced deposition patterns resulting in less sediment accretion and land building in the vicinity of the terraces, and greater sediment accretion and land building to the northwest and west of the terraces.

4.5 SURFACE WATER AND SEDIMENT QUALITY

4.5.1 Area of Potential Impacts

Potential construction impacts on surface water and sediment quality would occur within the immediate vicinity (within 0.5-mile) of all active construction areas. Direct impacts would also occur in the area downstream or down gradient of construction in both the Mississippi River and the Barataria Basin, respectively. Indirect impacts would occur in a larger area of the basin or Mississippi River and would vary depending upon the nature of the impact. For example, runoff from the construction area could impact surface water and/or sediment downstream depending on the amount of the release, what countermeasures are in place, the timeliness of the response action, and the weather conditions at the time of the release.

During operations, direct impacts would occur on surface water and sediment quality in the Barataria Basin and the birdfoot delta from the transfer of water and sediment from the Mississippi River to the Barataria Basin. No impacts are anticipated on water or sediment quality in the Mississippi River. Indirect impacts during operations would occur in the same area as direct impacts and may extend beyond the areas directly impacted by a proposed Project alternative. Project operation impacts on surface water and sediment quality may also indirectly impact other natural resources. Indirect impacts on other natural resources as a result of Project impacts on water quality, including salinity, are discussed in Section 4.6 Wetland Resources and Waters of the U.S., Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, Section 4.14 Commercial Fisheries, and Section 4.16 Recreation and Tourism.

4.5.2 Guidelines for Water and Sediment Quality Impact Determinations

Impact intensities for water and sediment quality are based on the definitions provided in Section 4.1 and the following resource-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: the impact would result in a detectable change to water and/or sediment quality, but the change would be expected to be small, localized, and temporary. State water quality standards as required by the Clean Water Act would not be exceeded;
- moderate: impacts on water and/or sediment quality would be observable over a relatively large area. Impacts would result in a change to water and/or sediment quality that would be readily detectable but would be limited to local and adjacent areas. Change in water and/or sediment quality would persist; however, it would likely not exceed state water quality standards as required by the Clean Water Act or federal, state, or local hazardous waste criteria; and
- major:
    - water quality: impacts would likely result in a change to water quality that would be readily detectable and widespread (extending beyond local and adjacent areas). Impacts would likely result in exceedance of state water quality standards and/or would impair designated uses of a waterbody;

- sediment quality: actions would result in (1) sediment contamination at levels exceeding federal, state, or local hazardous waste criteria, including those established by 40 CFR 261; (2) mobilization of contaminants currently in the sediments, resulting in exposure of humans or other sensitive receptors such as plants and wildlife to contaminant levels that would result in health impacts; and (3) the presence of contaminated sediments within the Project area, exposing workers and/or the public to contaminated or hazardous materials at levels exceeding those permitted by the federal Occupational Safety and Health Administration (OSHA) in 29 CFR 1910.

4.5.3 Overview of Modeling for Impact Analysis

Delft3D Basinwide Modeling was conducted by the Water Institute and used to assess Project alternative impacts on seven of the 11 water quality parameters assessed in this section, including salinity, temperature, nitrogen, phosphorus, dissolved oxygen, TSS, and sulfate. Delft3D Basinwide Modeling results were extracted at 15 stations across the Barataria Basin and birdfoot delta (shown in Figure 4.5-1). To capture Project operational impacts on water quality across the Barataria Basin and the birdfoot delta, the impact analysis focuses on six of these stations listed in Table 4.5-1. These stations were chosen for the analysis because they allow comparison of projected Project impacts at varying distances from the proposed diversion structure and within various portions of the Project area. As shown in Figure 4.5-1, these stations are well distributed in both the north-south and east-west directions from the proposed diversion structure outfall.

In the Delft3D Basinwide Model projections for salinity (see Section 4.5.5.1 below), the station nearest the diversion (CRMS 0276) is projected to be in open water during the first modeled decade, transitioning to land in the following cycles under all action alternatives due to Project-induced land building in this area. In subsequent years, when the diversion is operating above base flow, this station is projected to become inundated by the diversion of fresh water. When the diversion is operating at base flow (up to 5,000 cfs), the cell is projected to be dry, making it impossible to analyze water quality because there would be no water; therefore, Delft3D Basinwide Model water quality data projected for the station nearest the diversion (CRMS 0276) has been replaced with data from an adjacent model cell that is not projected to become dry. Additionally, in the Delft3D Basinwide Model results for salinity, the CRMS 0163 station in the birdfoot delta is projected to be partially dry marsh in modeled year 2020, transitioning to open water in year 2030. For this reason, model results for 2020 are not included for the birdfoot delta station (CRMS 0163) in the salinity analysis.

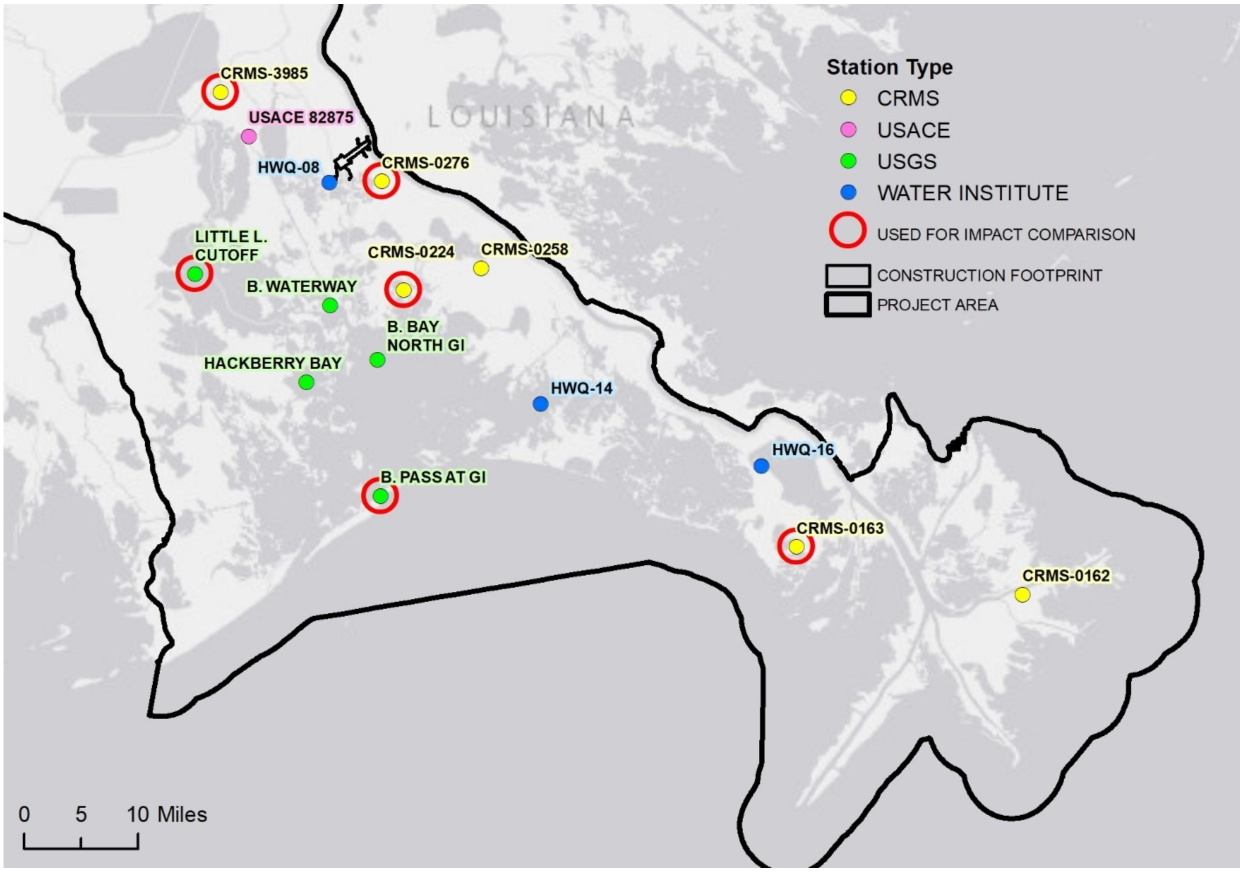


Figure 4.5-1. Six Station Locations in the Barataria Basin and Birdfoot Delta. Stations discussed in this section for comparison of projected impacts are shown in red circles.

Table 4.5-1
Stations for Comparison of Project Impacts

Station ID	Description
CRMS 3985	Northern/Mid-Basin
CRMS 0276	Station Nearest Diversion
CRMS 0224	Central Station
Little L. Cutoff	Western Station
B. Pass at GI	Southwestern Station, near Grande Isle
CRMS 0163	Birdfoot delta

In the following sections, monthly averages were used to characterize seasonal trends in water quality impacts from the proposed Project alternatives. Monthly averages present a more detailed picture than do seasonal averages, but more clearly show trends in the data than do daily averages. Impacts on water quality discussed in the following sections are based on the historical representative hydrograph for each decade, unless otherwise noted. The Water Institute identified four historical hydrographs that showed various high- and low-flow conditions. The four hydrographs chosen to represent various Mississippi River flow scenarios are 1994 (high, consistent spring flow), 2006 (low, multiple peak spring flow), 2010 (high, multiple peak spring flow), and 2011 (high, late spring flood flow) (see Section 4.1.3, Figure 4.1-1 and Table 4.1-1). Table 4.1-2 in Section 4.4 Surface Water and Coastal Processes lists peak annual flow, annual average flow, and number of days with flow greater than 450,000 cfs, which is the flow rate in the Mississippi River at which CPRA proposes to initiate diversion operations above base flow. The Water Institute provided model outputs based on each of these four hydrographs for each of the five decades of the model run. See Section 4.1.3 and Appendix E for an overview of the Delft3D Basinwide Model including hydrographs, the model domain, methodology, and key processes for the hydrodynamics, sediment transport, water quality, vegetation, and land building components of the model framework. Model results for water quality impacts for all hydrographs at all 15 stations, including both periods when the diversion is projected to operate above base flow, and when it is operating at base flow, are included in Appendix L.

4.5.4 Construction Impacts

The discussion of construction impacts includes an evaluation of all water and sediment quality parameters.

4.5.4.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The ambient water quality and sediment quality conditions in the Mississippi River, Barataria Basin, and birdfoot delta would continue as described in Chapter 3, Sections 3.5.2 and 3.5.3 in Surface Water and Sediment Quality. Ongoing trends of sea-level rise and increasing salinities would continue, but only limited changes to water quality are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse effect on surface water and/or sediment quality. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal water quality standards.

4.5.4.2 Applicant's Preferred Alternative

Impacts on surface water and sediment quality during Project construction would range from temporary, minor (detectable, localized) to moderate (observable over a large area; readily detectable in local areas), adverse impacts from the resuspension of fine sediments into the water column from in-water activities or runoff of sediment from the Project construction footprint, resulting in increased turbidity and suspended sediment. Construction impacts would be avoided and minimized by the implementation of Best Management Practices (BMPs) that would be documented in a Project SWPPP and a SPCC Plan. Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) to surface water in both the Mississippi River and the Barataria Basin. Contaminant loads may ultimately settle in river or basin sediments. The impact intensity of inadvertent releases of contaminants would depend upon the nature of the release. Accidental spills during routine construction activities such as fueling construction vehicles would likely be temporary, minor, and adverse. These types of spills would be controlled and mitigated with the implementation of a Project SPCC Plan.

Construction of the intake system would require the placement of a temporary cofferdam on the west side of the Mississippi River, which would divert water around the construction work area. Excavation and dewatering, along with scouring river flows around the cofferdam, would likely re-suspend fine sediment into the water. Increased suspended sediment and turbidity would be localized and temporary; suspended sediment would settle out downstream through mixing and return to ambient area conditions.

The use of the cofferdam would help minimize impacts on water quality by allowing the intake system to be constructed in a dry area to the maximum extent feasible, thus minimizing any potential for leaching of uncured concrete into the water column. However, there would potentially be some water within the cofferdam from seepage under the cofferdam. CPRA would discharge any water seepage in the cofferdam back into the river. There is some risk of the cofferdam being overtopped during high flows, which could wash turbid or higher-pH water into the river due to contact with uncured concrete within the cofferdam. However, the risk would be addressed and mitigated in accordance with the Project SWPPP and the Site Safety and Health, Accident Prevention Plan which would specify emergency procedures during inclement weather (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for details about BMPs and other minimization measures CPRA would implement during construction of the proposed Project).

Access routes and staging or construction-material-stockpiling areas would disturb soils and remove vegetation, increasing the potential for runoff of sediment into the river and the basin. Actions to minimize this potential would include the use of silt fencing and other containment measures documented in the SWPPP to prevent runoff.

As discussed in Section 4.23 Hazardous, Toxic, and Radioactive Waste, there are known abandoned oil and/or gas waste pits in the immediate outfall area in the vicinity of the proposed beneficial use placement areas. Disturbance of potentially contaminated sediments associated with the beneficial use placement area could result in the release of contaminants from these pits into surface or groundwater in the vicinity of the Project area. If contaminated soil or groundwater with concentrations exceeding regulatory limits is unearthed or discovered during construction, CPRA would handle the material in accordance with applicable regulations and ensure the appropriate disposal of contaminants offsite. The placement of material in proposed beneficial use sites in the immediate outfall area would adversely impact water quality through localized increases in turbidity and suspended solids concentrations. These impacts are anticipated to be minor and temporary. The use of containment dikes, if implemented, would minimize these impacts.

For all alternatives, actions would be taken to avoid, minimize, or contain potential contaminants during construction, including adhering to a Project SPCC Plan, SWPPP, and an Accident Prevention Plan (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for further discussion about BMPs and actions to minimize Project impacts on water and sediment quality). Implementation of these required plans was assumed in this impact analysis for all action alternatives.

4.5.4.3 Other Alternatives

Impacts on water and sediment quality due to the construction of the other action alternatives would be similar to those described above for the Applicant's Preferred Alternative because each would have the same proposed features and similar overall construction footprint. Impacts would be temporary, minor or moderate, and adverse and related to increases in turbidity and suspended sediments. Preventative plans (for example, the Project SWPPP, SPCC, and Accident Prevention Plan) would be in place to minimize and mitigate inadvertent substantial releases of contaminants.

As compared with the Applicant's Preferred Alternative, the size of the proposed intake channel and conveyance channel would be wider for the two alternatives with 150,000 cfs flow volumes, and narrower for the two alternatives with 50,000 cfs flow volumes. Even though construction would occur within a similar construction footprint for all alternatives, the volume of material excavated and placed for construction of the conveyance channel berms, guide levees, and outfall transition feature would be greater for alternatives with 150,000 cfs flow volumes and smaller for alternatives with 50,000 cfs flow volumes. Additionally, alternatives with higher-flow volumes would have construction times several months longer, and those with lower-flow volumes would have construction times several months shorter. As such, the duration of potential temporary impacts from construction, such as increases in turbidity and suspended sediments, would endure for longer or shorter timeframes as compared to the Applicant's Preferred Alternative.

Three of the action alternatives propose the construction of terraces in the immediate outfall area, which would cause additional temporary, moderate (observable over a large area, readily detectable in local areas), adverse impacts on water quality. The terraces would be constructed from sediments from adjacent water bottoms using a marsh excavator or a barge-mounted dragline. Impacts would include potential temporary increases in turbidity and suspended sediments in the water column. These impacts would subside once terrace construction is complete. Other natural resources, such as aquatic vegetation, may be indirectly impacted by increased turbidity and suspended sediments in the water column. See Section 4.10 Aquatic Resources for more information about construction impacts on aquatic resources in the Project area.

4.5.5 Operational Impacts

4.5.5.1 Salinity

4.5.5.1.1 No Action Alternative

As described in Section 4.5.3, the Delft3D Basinwide Model was used to project ambient water quality conditions, including salinity, under the No Action Alternative. Under the No Action Alternative, surface water quality in the Project area would not be impacted by the Applicant's Preferred Alternative or any of the action alternatives. Land subsidence and sea-level rise would continue, resulting in permanent elevated salinity throughout the Barataria Basin and birdfoot delta. Figure 4.5-2 depicts the modeled average monthly salinity concentrations for the No Action Alternative over the 50-year analysis period at each of the six representative stations within the Barataria Basin and birdfoot delta (see Figure 4.5-1 for a map of the station locations). These data were based on the historical representative hydrograph, which differs for each decade (see Section 4.1.3 for more information about Delft3D Basinwide modeled hydrographs).

Under the No Action Alternative, Project area salinity during the first decade of modeled conditions (2020 to 2030) is projected to be within the range of the existing monthly average salinity concentrations presented in Chapter 3, Section 3.5.2.2 in Surface Water and Sediment Quality. Average salinity in the Barataria Basin and birdfoot delta would continue to show seasonal variability, with the lowest salinities occurring in the spring and summer, and the highest salinities occurring in the fall and winter (see Figure 4.5-2).

The northern/mid-basin station (CRMS 3985) and western station (Little L. Cutoff) are projected to show a different seasonally variable pattern than the other four representative stations and are projected to have the highest salinities in May and June of the first three modeled decades (see Figure 4.5-2). This is most likely due to the timing and impact of spring floods delaying the onset of higher salinities in the warmer spring/summer months. The model projects that all six stations would reach similar seasonal variability patterns within the last two modeled decades (2050 to 2070) (see Figure 4.5-2).

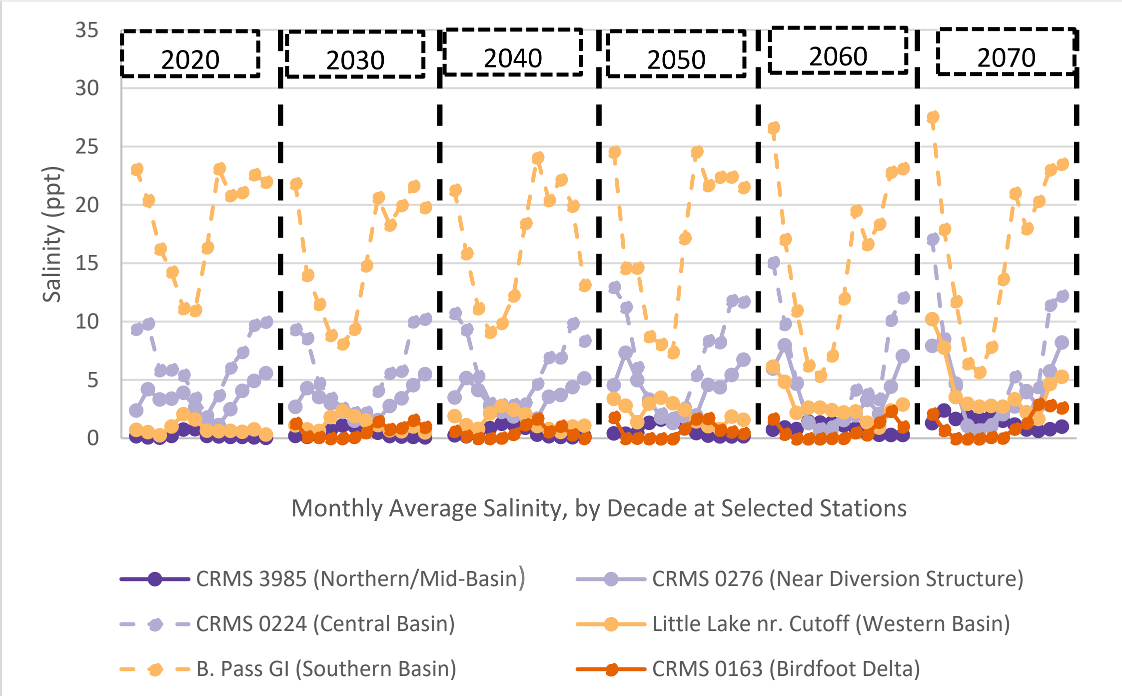


Figure 4.5-2. Modeled Monthly Average Salinity for the No Action Alternative at the Station Nearest the Diversion (CRMS 0276), Central Station (CRMS 0224), Southwestern Station at Barataria Pass near Grand Isle (B. Pass at GI), Western Station (Little L. Cutoff), Northern/Mid-Basin Station (CRMS 3985), and Birdfoot Delta Station (CRMS 0163) under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections. The Delft3D Basinwide Model cell for the birdfoot delta station (CRMS 0163) is projected to be dry marsh in modeled year 2020 transitioning to open water in year 2030. For this reason, results before 2030 are not available for this station.

Also consistent with historical and existing monthly salinities in the basin (see Chapter 3, Section 3.5.2.2 in Surface Water and Sediment Quality), salinities under the No Action Alternative are projected to be lower in the Barataria Basin at and north of the northern/mid-basin station (CRMS 3985) and the station nearest the diversion (CRMS 0276), transitioning to more saline conditions in the southern area of the basin (central station [CRMS 0224] and southwestern station, at Barataria Pass near Grand Isle [B. Pass at GI]) (see Figure 4.5-2). The western station (Little L. Cutoff) and the birdfoot delta station (CRMS 0163) are influenced by freshwater inputs not associated with the proposed Project, and salinities are projected to remain low over the modeled timeframe.

The last two decades (2050 to 2070) are projected to have moderately higher average salinities in the winter at all six stations as compared to modeled years 2020 to 2050 (see Figure 4.5-2). The increase in maximum salinities would range from 1 to 11 ppt. This may be due to sea-level rise, which is factored into the Delft3D Basinwide Model and is projected to increase from 2050 to 2070 (see Section 4.1.3 Overview of Delft3D Basinwide Model). At the central station (CRMS 0224) and southwestern station, at Barataria Pass near Grand Isle (B. Pass at GI), projected salinities are lower April through July in 2060 to 2070 than salinities projected for the previous decades.

These projected differences are due to the use of a different representative hydrograph for each previous decade, and the projected redistribution of fresh water from the Mississippi River Delta.

Figures 4.5-3 and 4.5-4 depict the seasonal variability in salinities spatially within the Project area over the 50-year analysis period. With the exceptions noted at the northern/mid-basin station (CRMS 3985) and western station (Little L. Cutoff) during the first three modeled decades, salinities in the basin would be generally lower in the spring due to freshwater inputs from upstream spring runoff, and salinity would increase in the Project area in the winter months when there would be less influence from freshwater inputs. Under the No Action Alternative, elevated winter salinities are projected to extend farther north into the basin over the 50-year analysis period, most likely due to increased rates of sea-level rise projected by the Delft3D Basinwide Model from 2050 to 2070.

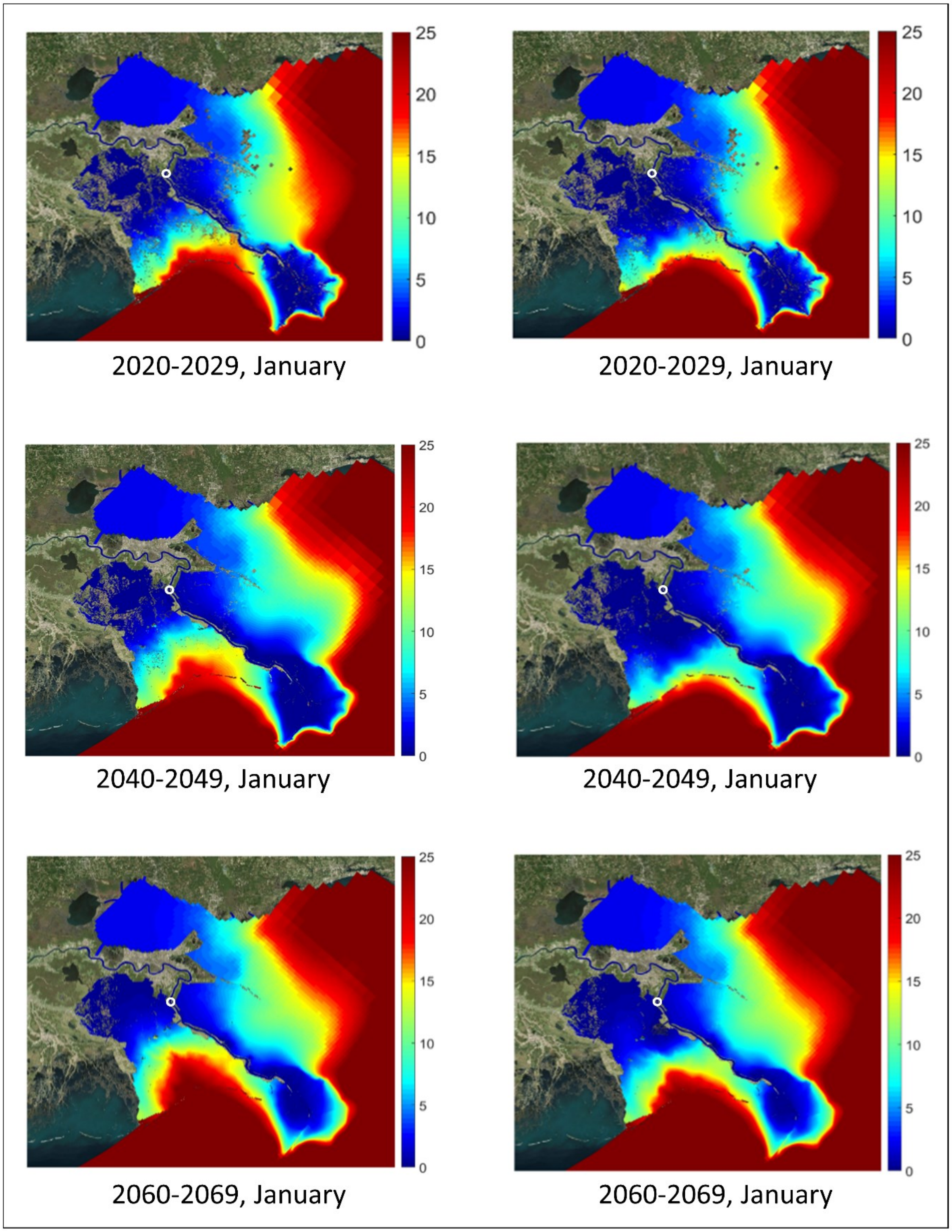


Figure 4.5-3. Maps of No Action Alternative (Left Panels) and Applicant's Preferred Alternative (Right Panels) Salinity Averages (ppt) Modeled under the Historical Representative Hydrograph in Winter (January), Decades 2020 to 2029, 2040 to 2049, and 2060 to 2069.

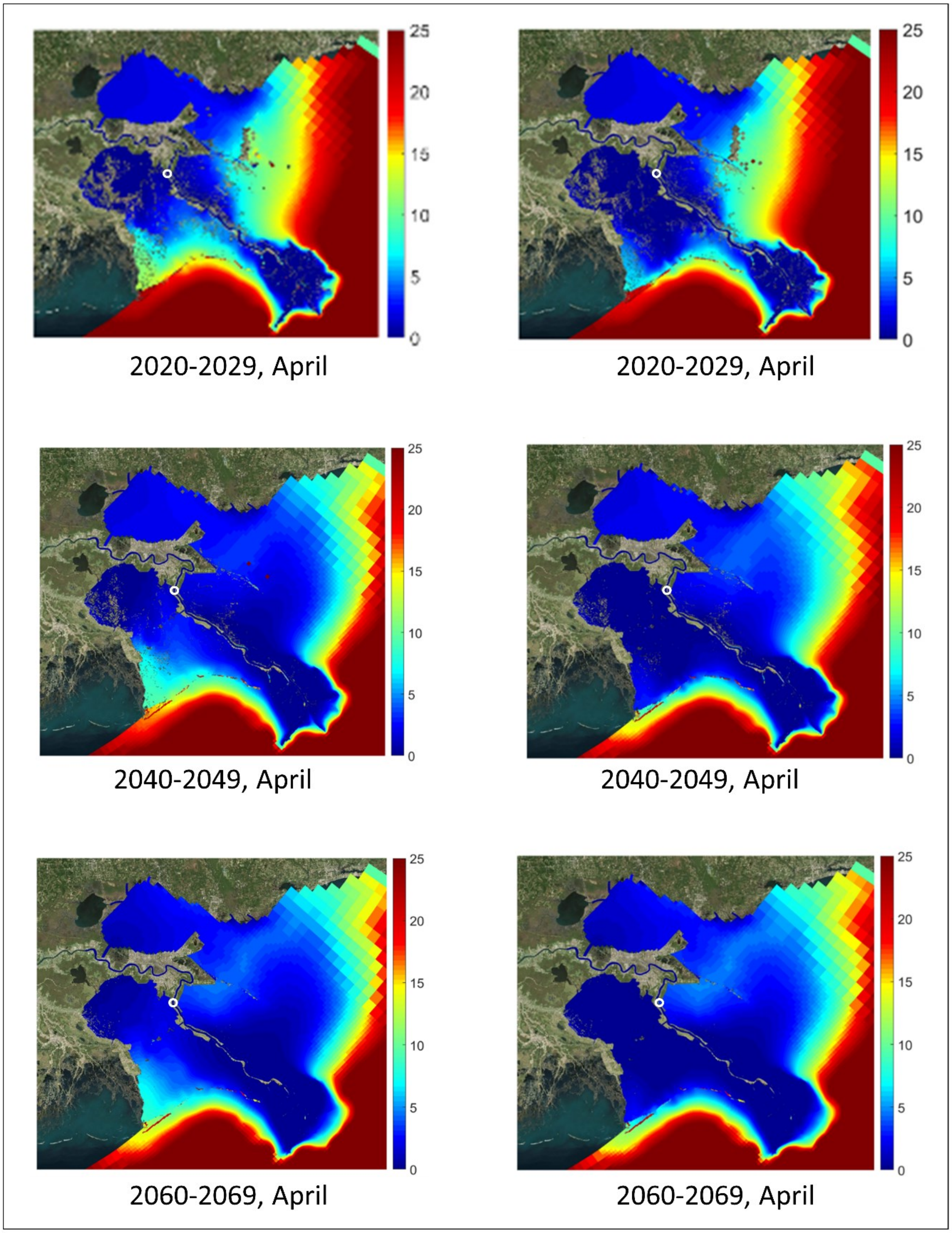


Figure 4.5-4. Maps of No Action Alternative (Left Panels) and Applicant's Preferred Alternative (Right Panels) Salinity Averages (ppt) Modeled under the Historical Representative Hydrograph in Spring (April), Decades 2020 to 2029, 2040 to 2049, and 2060 to 2069.

4.5.5.1.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative would cause permanent, minor (detectable over a small area) to moderate (observable over a large area, readily detectable in local areas) reductions in salinity in the Barataria Basin and permanent, minor increases in salinity in the birdfoot delta during Project operations. These salinity impacts would be beneficial for some wetland types and aquatic species and adverse for others (see Section 4.6 Wetland Resources and Waters of the U.S. and Section 4.10 Aquatic Resources for further details about Project salinity impacts on wetlands and aquatic resources, respectively).

Under the Applicant's Preferred Alternative, using the relevant historical representative hydrograph for each decade, the model projected the frequency at which the diversion would operate above base flow as shown in Table 4.1-2 in Section 4.1.3 Overview of Delft3D Basinwide Model. See Section 4.1.3 for details regarding the various hydrographs used in the MBSD Delft3D Basinwide Modeling. The salinity model results discussed in this section are intended to illustrate the relative difference in impacts projected between alternatives, rather than to predict absolute salinity values. The majority of the Barataria Basin is shallow and not typically prone to stratification (Orlando et al. 1993). The model does not account for potential density stratification and assumes the vertical water column is mixed. Therefore, in limited areas or times when stratification may occur, the model does not include stratification impacts in its outputs. Details regarding Delft3D Basinwide Modeling uncertainty areas are provided in Section 4.1.3 and Appendix E.

Table 4.5-2 shows the average monthly salinity ranges over the 50-year analysis period modeled under the historical representative hydrograph for the No Action Alternative and the action alternatives, including the Applicant's Preferred Alternative. A comparison of the projected minimum and maximum average salinity values between the No Action Alternative and the Applicant's Preferred Alternative over the 50-year analysis period indicates that the Applicant's Preferred Alternative would reduce maximum salinity values by 4 ppt, 5 ppt, and 5 ppt at the station nearest the diversion (CRMS 0276), at the central station (CRMS 0224), and at the western station (Little L. Cutoff), respectively. The Applicant's Preferred Alternative would increase maximum salinities by 5 ppt at the birdfoot delta station (CRMS 0163) as compared to the No Action Alternative (see Table 4.5-2). A trend of progressively lower minimum salinities as compared to the No Action Alternative from years 2030 to 2050 is apparent at all five stations in the basin. By years 2050 to 2070, the model projects slightly reduced differences between the No Action Alternative and the Applicant's Preferred Alternative minimum salinities at the stations that are less influenced by non-diversion freshwater inputs (station nearest the diversion [CRMS 0276], central station [CRMS 0224], and southwestern station, at Barataria Pass near Grande Isle [B. Pass at GI]). Impacts at these stations would be moderate (observable over a large area, readily detectable in local areas) and permanent. This trend may be linked to the increasing rate of sea-level rise assumed in these last two decades of operations, as described above. At the stations more influenced by non-diversion freshwater inputs (northern/mid-basin station [CRMS 3985], western station [Little L. Cutoff], and birdfoot delta station [CRMS 0163]), the differences in maximum projected salinities between the Applicant's Preferred Alternative and the No Action Alternative would be permanent and minor. This is likely due to the timing and intensity of spring flood inputs at each station.

Table 4.5-2
Minimum and Maximum Average Monthly Salinities, All Project Alternatives (2020-2070) (ppt)

Year	Northern/ Mid-Basin (CRMS 3985)	Station Nearest Diversion (CRMS 0276)	Central Station (CRMS 0224)	Western Station (Little L. Cutoff)	Southwestern Station at Barataria Pass, near Grand Isle (B. Pass at GI)	Birdfoot Delta (CRMS 0163)
No Action Alternative						
2020	0 to 1	1 to 6	2 to 10	0 to 2	11 to 23	Data excluded
2030	0 to 1	1 to 5	2 to 10	0 to 2	8 to 22	0 to 2
2040	0 to 1	2 to 5	3 to 11	1 to 3	9 to 24	0 to 2
2050	0 to 2	1 to 7	2 to 13	0 to 3	7 to 25	0 to 2
2060	0 to 1	1 to 8	1 to 15	1 to 6	5 to 27	0 to 2
2070	1 to 2	1 to 8	1 to 17	2 to 10	6 to 28	0 to 3
75,000 cfs (Applicant's Preferred Alternative)						
2020	0	0	0 to 7	0 to 1	3 to 22	Data excluded
2030	0	0 to 1	0 to 8	0 to 1	2 to 21	0 to 1
2040	0	0 to 1	0 to 5	0 to 1	3 to 23	0 to 1
2050	0 to 1	0 to 1	0 to 10	0 to 2	3 to 24	0 to 2
2060	0 to 1	0 to 2	0 to 10	0 to 3	2 to 25	0 to 2
2070	0 to 1	0 to 4	0 to 12	0 to 5	3 to 27	0 to 8
75,000 cfs + Terraces Alternative						
2020	0	0	0 to 7	0 to 1	3 to 23	Data excluded
2030	0	0 to 1	0 to 8	0 to 1	2 to 21	0 to 1
2040	0	0 to 1	0 to 6	0 to 1	3 to 23	0 to 1
2050	0	0 to 2	0 to 10	0 to 1	3 to 24	0 to 2
2060	0 to 1	0 to 2	0 to 10	0 to 3	2 to 25	0 to 2
2070	0 to 1	0 to 4	0 to 12	0 to 5	3 to 27	0 to 8
50,000 cfs Alternative						
2020	0	0	0 to 7	0 to 1	5 to 23	Data excluded
2030	0	0 to 1	0 to 7	0 to 1	4 to 21	0 to 1
2040	0	0 to 2	0 to 6	0 to 1	5 to 24	0 to 2
2050	0	0 to 2	0 to 10	0 to 2	4 to 24	0 to 2
2060	0 to 1	0 to 2	0 to 10	0 to 3	3 to 26	0 to 2
2070	0 to 1	0 to 5	0 to 13	0 to 6	4 to 28	0 to 9
50,000 cfs + Terraces Alternative						
2020	0	0	0 to 7	0 to 1	5 to 23	Data excluded
2030	0	0 to 1	0 to 8	0 to 1	3 to 21	0 to 1
2040	0	0 to 2	0 to 6	0 to 1	5 to 24	0 to 2
2050	0	0 to 2	0 to 10	0 to 2	4 to 24	0 to 2
2060	0 to 1	0 to 2	0 to 10	0 to 3	3 to 26	0 to 2
2070	0 to 1	0 to 2	0 to 12	0 to 6	4 to 28	0 to 8

Table 4.5-2
Minimum and Maximum Average Monthly Salinities, All Project Alternatives (2020-2070) (ppt)

Year	Northern/ Mid-Basin (CRMS 3985)	Station Nearest Diversion (CRMS 0276)	Central Station (CRMS 0224)	Western Station (Little L. Cutoff)	Southwestern Station at Barataria Pass, near Grand Isle (B. Pass at GI)	Birdfoot Delta (CRMS 0163)
150,000 cfs Alternative						
2020	0	0	0 to 7	0 to 1	1 to 22	Data excluded
2030	0	0 to 1	0 to 8	0 to 1	1 to 21	0 to 1
2040	0	0 to 1	0 to 5	0 to 1	1 to 23	0 to 1
2050	0	0 to 3	0 to 10	0 to 1	1 to 24	0 to 2
2060	0 to 1	0 to 3	0 to 10	0 to 2	1 to 23	0 to 2
2070	0 to 1	0 to 5	0 to 11	0 to 3	1 to 26	0 to 5
150,000 cfs + Terraces Alternative						
2020	0	0	0 to 6	0 to 1	1 to 22	Data excluded
2030	0	0 to 1	0 to 8	0 to 1	1 to 21	0 to 1
2040	0	0 to 1	0 to 5	0 to 1	1 to 23	0 to 2
2050	0	0 to 2	0 to 10	0 to 1	1 to 24	0 to 2
2060	0 to 1	0 to 2	0 to 9	0 to 2	1 to 23	0 to 2
2070	0 to 1	0 to 4	0 to 11	0 to 3	1 to 26	0 to 5

Figures 4.5-5 through 4.5-7 depict the modeled average monthly salinity for the Project alternatives under the historical representative hydrograph over the 50-year analysis period at each of the six representative stations across the Project area. In general, average salinity across the basin modeled under the Applicant's Preferred Alternative are projected to be consistently lower than the salinity under the No Action Alternative, with the exception of the birdfoot delta station (CRMS 0163), which would have maximum increases in salinity of 5 ppt above the No Action Alternative by modeled year 2070 (see Figure 4.5-7).

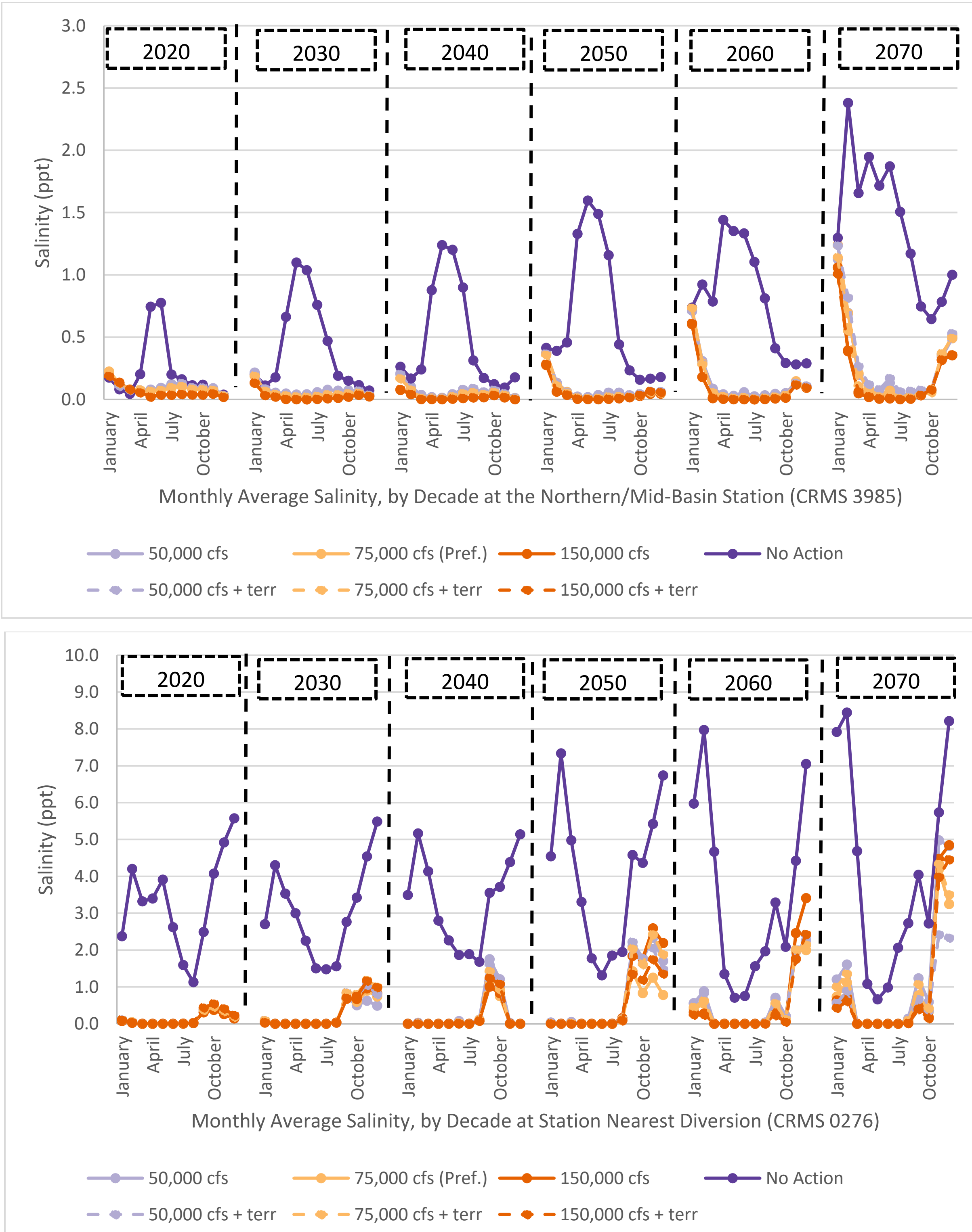


Figure 4.5-5. Average Modeled Salinity at Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections. Note the range of values on the y axis differs between figures.

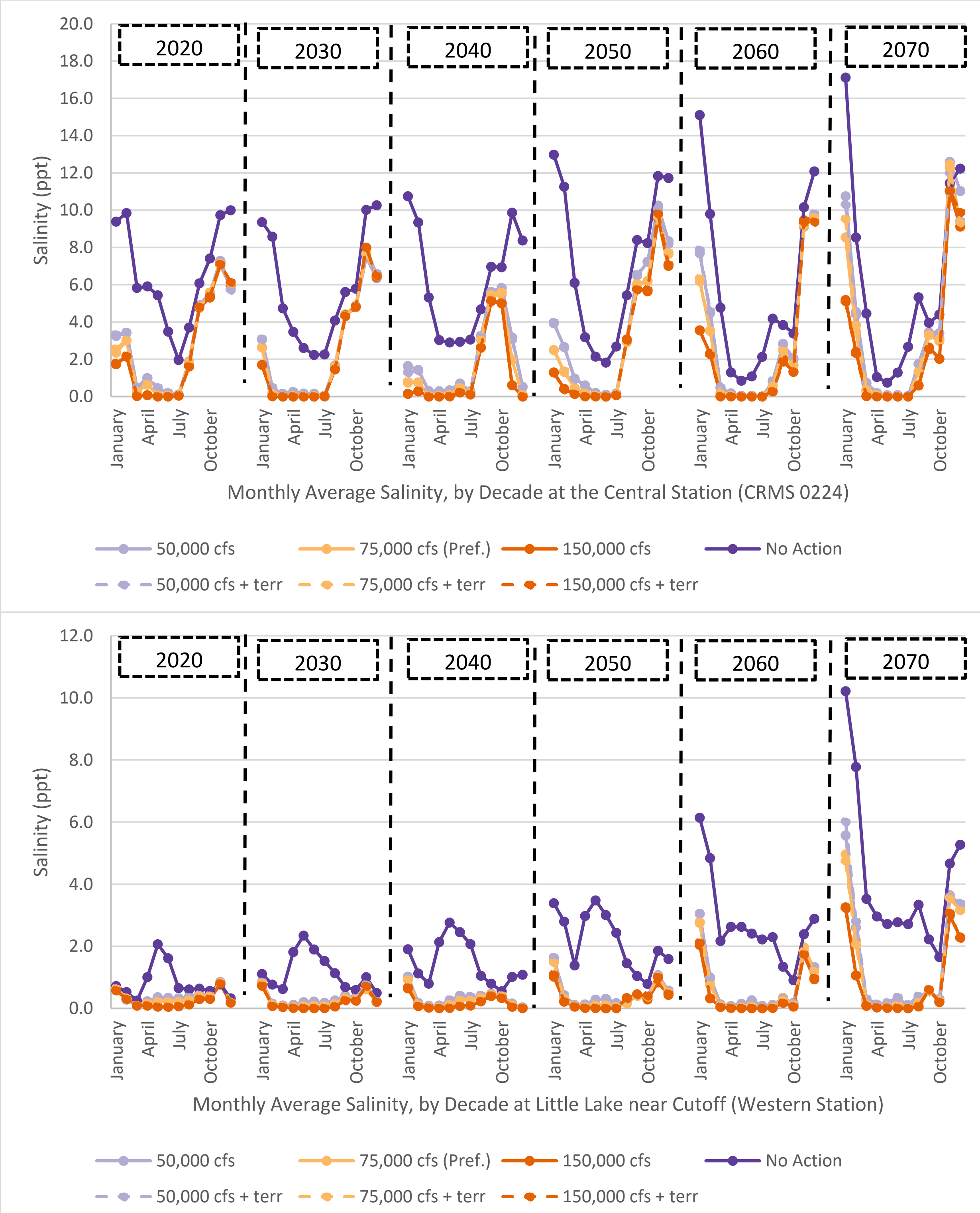
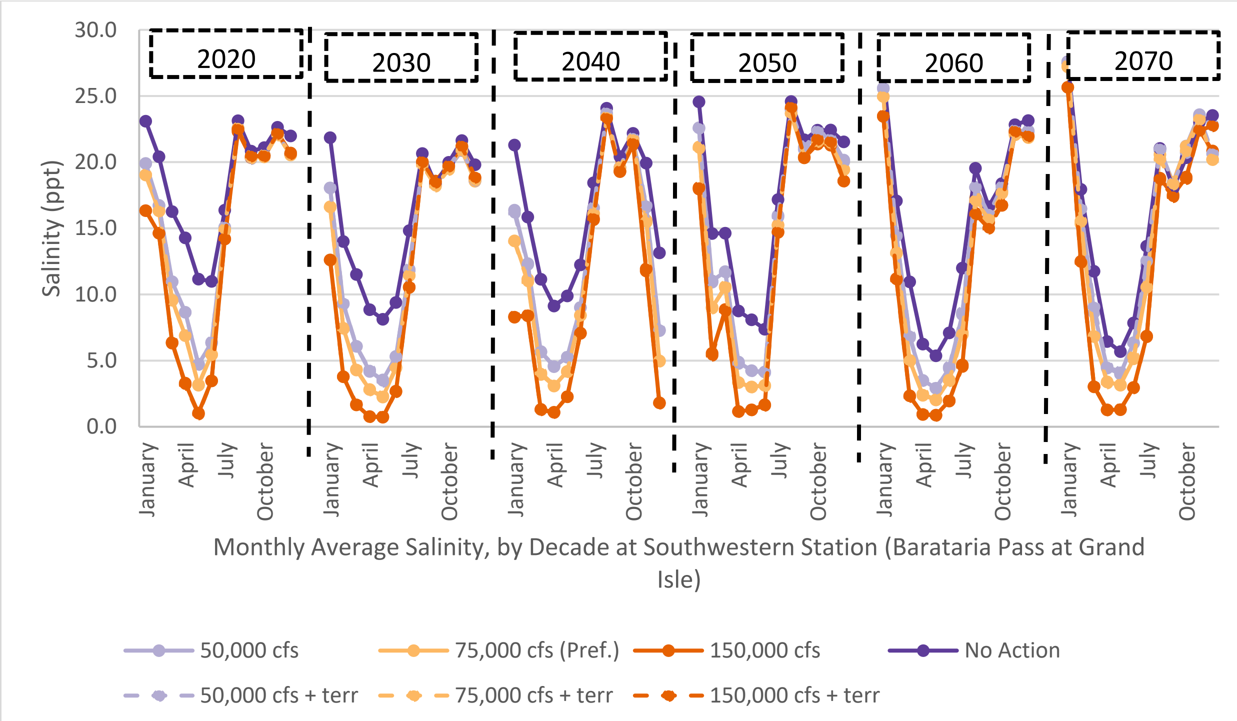


Figure 4.5-6. Average Modeled Salinity at Central Station (CRMS 0224) and Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections. Note the range of values on the y axis differs between figures.



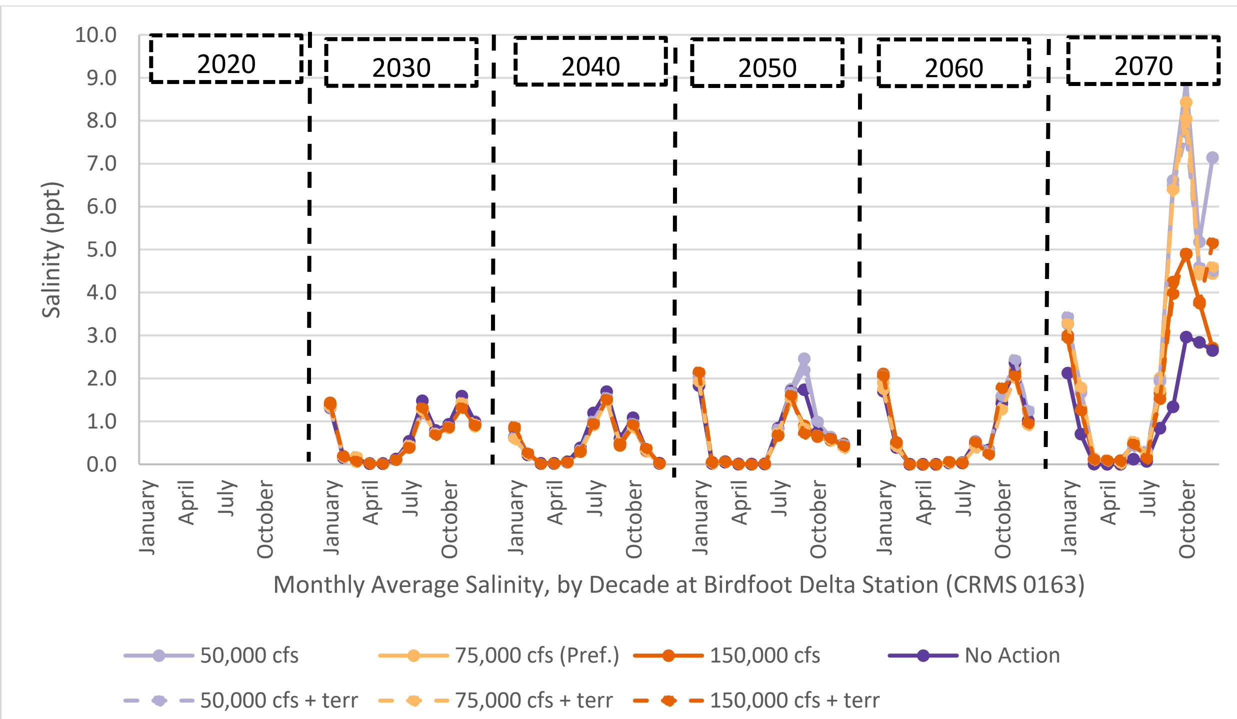


Figure 4.5-7. Average Modeled Salinity at Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and Birdfoot Delta Station (CRMS 0163) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections. Note the range of values on the y axis differs between figures. The Delft3D Basinwide Model cell for birdfoot delta station (CRMS 0163) is projected to be dry marsh in modeled year 2020. For this reason, results for 2020 are not included for this station.

Major (readily apparent and widespread) decreases in salinity are projected to occur in the immediate outfall area as indicated at the station nearest the diversion (CRMS 0276) and central station (CRMS 0224) (see Figures 4.5-5 and 4.5-6). At the station nearest the diversion (CRMS 0276), salinity is not projected to return to No Action Alternative salinity levels during the 50-year analysis period. At the central station (CRMS 0224), in the fall months, salinity is projected to return to within 1 ppt of the No Action Alternative concentrations within approximately 2 months of diversion flows being reduced to the 5,000 cfs base flow between 2020 and 2060 for a period of 1 month, and then fall below the projected No Action Alternative concentrations again. Between 2060 and 2070, salinity is projected to return to No Action Alternative concentrations during the 1 month when diversion flows would be reduced to the 5,000 cfs base flow in November, and remain similar to No Action Alternative concentrations into December.

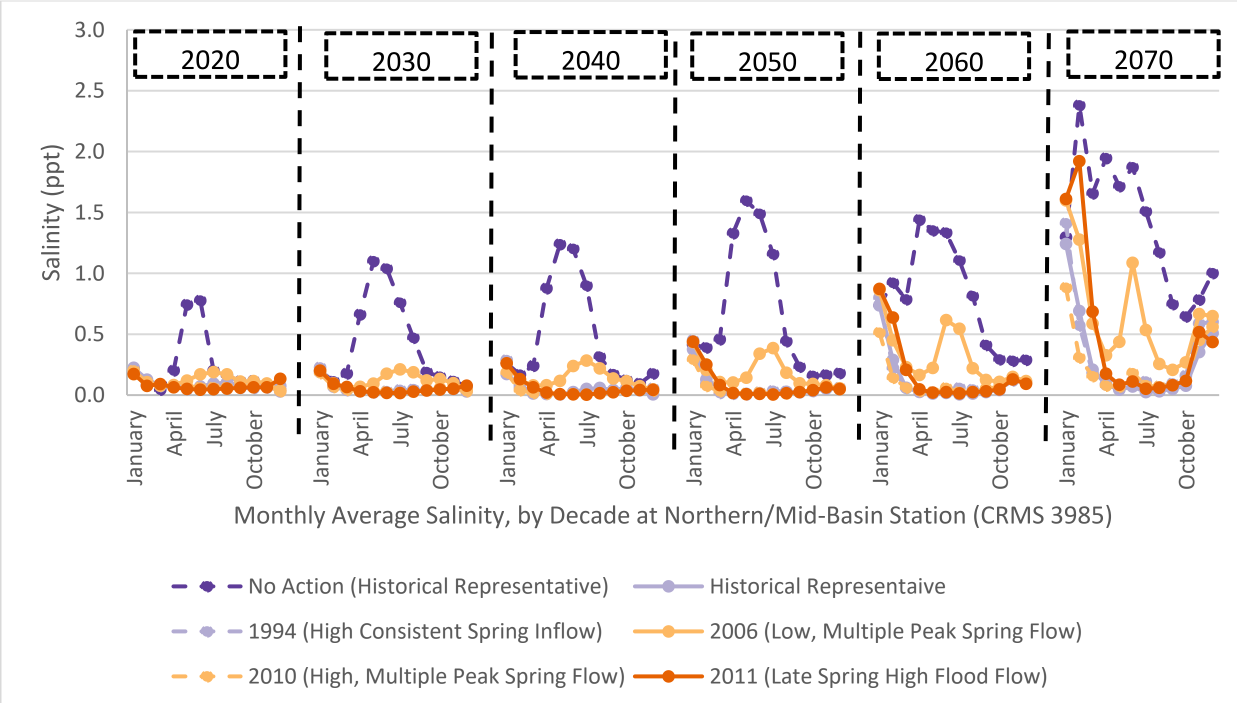
Project-induced reductions in salinity would be more moderate (observable over a large area, readily detectable in local areas) at the northern/mid-basin station (CRMS 3985) and western station (Little L. Cutoff) (see Figures 4.5-5 and 4.5-6), with decreases in average salinities ranging from 0 to 5 ppt as compared to the No Action Alternative. Salinity is projected to be low at the northern/mid-basin station (CRMS 3985) because it would be influenced by freshwater inputs not associated with the proposed Project. Salinity is projected to remain within 1 ppt of the No Action Alternative until 2050 at this northern station. Between 2050 and 2060, projected salinity would return to within 1 ppt of the No Action Alternative concentration within 2 months of diversion flows being reduced to the 5,000 cfs base flow. Between 2060 and 2070, projected salinity concentrations would return to within 1 ppt of the No Action Alternative concentration by September while the diversion is flowing greater than the 5,000 cfs base flow and remain similar to No Action Alternative concentrations through November when diversion flows would be reduced to the 5,000 cfs base flow. At the western station (Little L. Cutoff), salinity concentrations are projected to be within 1 ppt of the No Action Alternative level within 1 month of when diversion flows would be reduced to the 5,000 cfs base flow between 2020 and 2060. Between 2060 and 2070, salinities are projected to return to No Action Alternative concentrations prior to the diversion being operated at base flow (in October) and remain similar to No Action Alternative concentrations into December.

At the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI, see Figure 4.5-7), impacts are projected to be minor (barely detectable and localized) during the winter months and moderate (2 to 8 ppt lower) during the spring months when the diversion gates would flow greater than the 5,000 cfs base flow at variable flow rates. Salinities are projected to be within 1 ppt of the No Action Alternative at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI) within approximately 2 months of when diversion flows would be reduced to the 5,000 cfs base flow between 2020 and 2060. Between 2060 and 2070, salinities are projected to return to No Action Alternative levels prior to when diversion flows would be reduced to the 5,000 cfs base flow and remain similar to No Action Alternative levels into December. At the birdfoot delta station (CRMS 0163), the model projects negligible impacts between the Applicant's Preferred Alternative and the No Action Alternative until modeled decade 2070, when projected salinity increases in the birdfoot delta would increase from 0 to 5 ppt above No Action Alternative salinities. This is likely due to projected sea-level rise increases and subsidence rates, which are incorporated into the Delft3D Basinwide Model setup (see Section 4.1 and Appendix E for more information about the Delft3D Basinwide Model), as well as projected water elevation and bottom elevation changes due to the proposed Project (see Section 3.4 Surface Water and Coastal Processes).

Likewise, average salinities would increase to some degree at all five Barataria Basin stations in modeled years 2050 to 2070 due to sea-level rise and land subsidence rates as factored into the Delft3D Basinwide Model. This permanent impact would occur with or without Project implementation; however, the model projects that Project implementation would result in minor (detectable, localized) to moderate (observable over a large area, readily detectable in local areas) reductions in sea-level-rise-induced increases in salinity with respect to the No Action Alternative at all stations.

Salinity trends modeled for the Applicant's Preferred Alternative would generally follow the same seasonal trends as the No Action Alternative, with minimum salinities occurring in the spring and early summer when the diversion is projected to operate above base flow more often, and maximum salinities generally occurring between early fall and winter months when the diversion is projected to operate only at base flow (5,000 cfs) more often. Figures 4.5-3 and 4.5-4 depict the spatial distribution of the Applicant's Preferred Alternative average winter (January) and spring (April) salinities in the Project area over the 50-year analysis period.

Modeled salinity impacts under the historical representative hydrograph were compared with salinity impacts under the four alternative historical hydrographs for high- and low-flow conditions at the six representative stations (see Figures 4.5-8 through 4.5-10; see Section 4.1.3 and Appendix E for further explanation of the hydrographs used in the Delft3D Basinwide Modeling). All hydrograph scenarios follow seasonal trends similar to the No Action Alternative under the historical representative hydrograph. Minor differences between the variable hydrograph projections as compared to the historical representative hydrograph projection include minor to moderately decreased or elevated maximum projected salinities at all six stations, and minor shifts in seasonal maximums at some of the six stations. In general, higher salinities are projected under the 2006 hydrograph (low, multiple peak spring flow); however, the 1994 (high, consistent spring flow), 2010 (high, multiple peak spring flow), and 2011 (high, late spring flood flow) hydrographs are projected to result in variably higher or lower salinities compared to the historical representative hydrograph. Increases in maximum salinities are projected in all hydrographs in 2060 through 2070, when the previously discussed influence of sea-level rise and land subsidence becomes apparent. In general, salinity trends and ranges are similar to the historical representative hydrograph for all modeled hydrographs (see Figures 4.5-8 through 4.5-10).



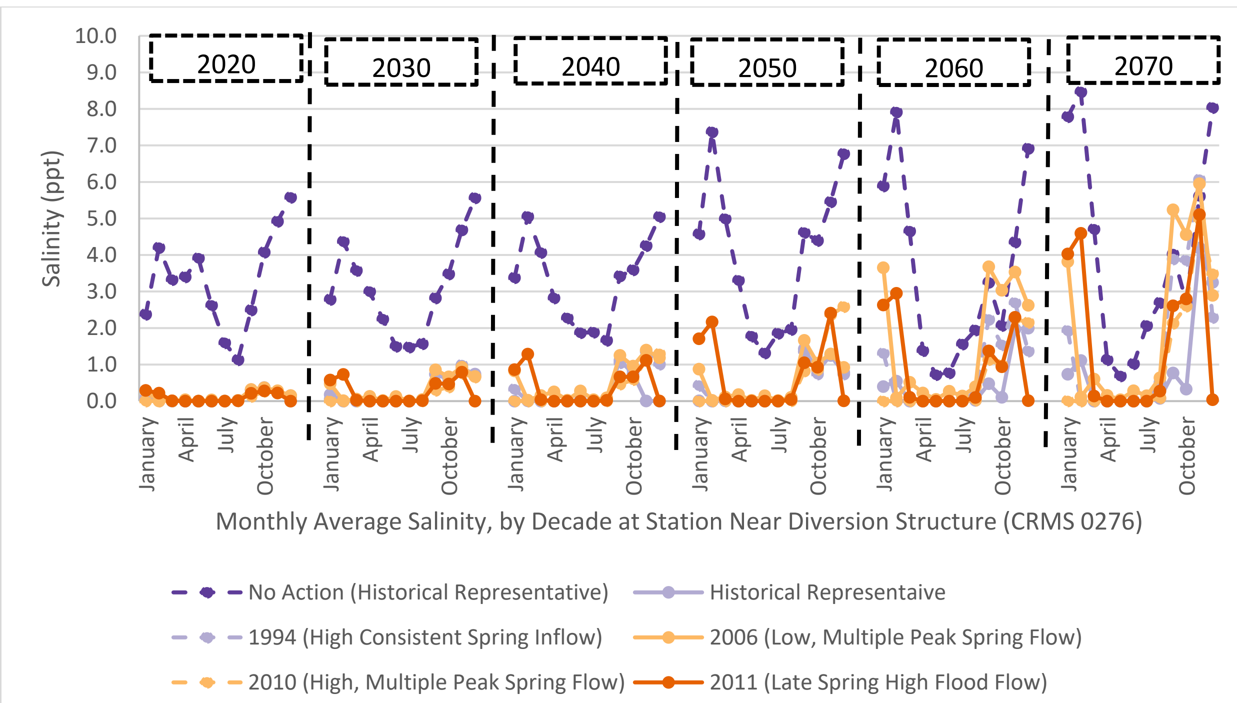


Figure 4.5-8. Comparison of Hydrographs: Average Modeled Monthly Average Salinity at the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for Applicant's Preferred Alternative under Representative Historical, 1994, 2006, 2010, and 2011 Mississippi River Hydrographs. Overlapping graph lines indicate negligible differences in model projections. Note the range of values on the y axis differs between figures.

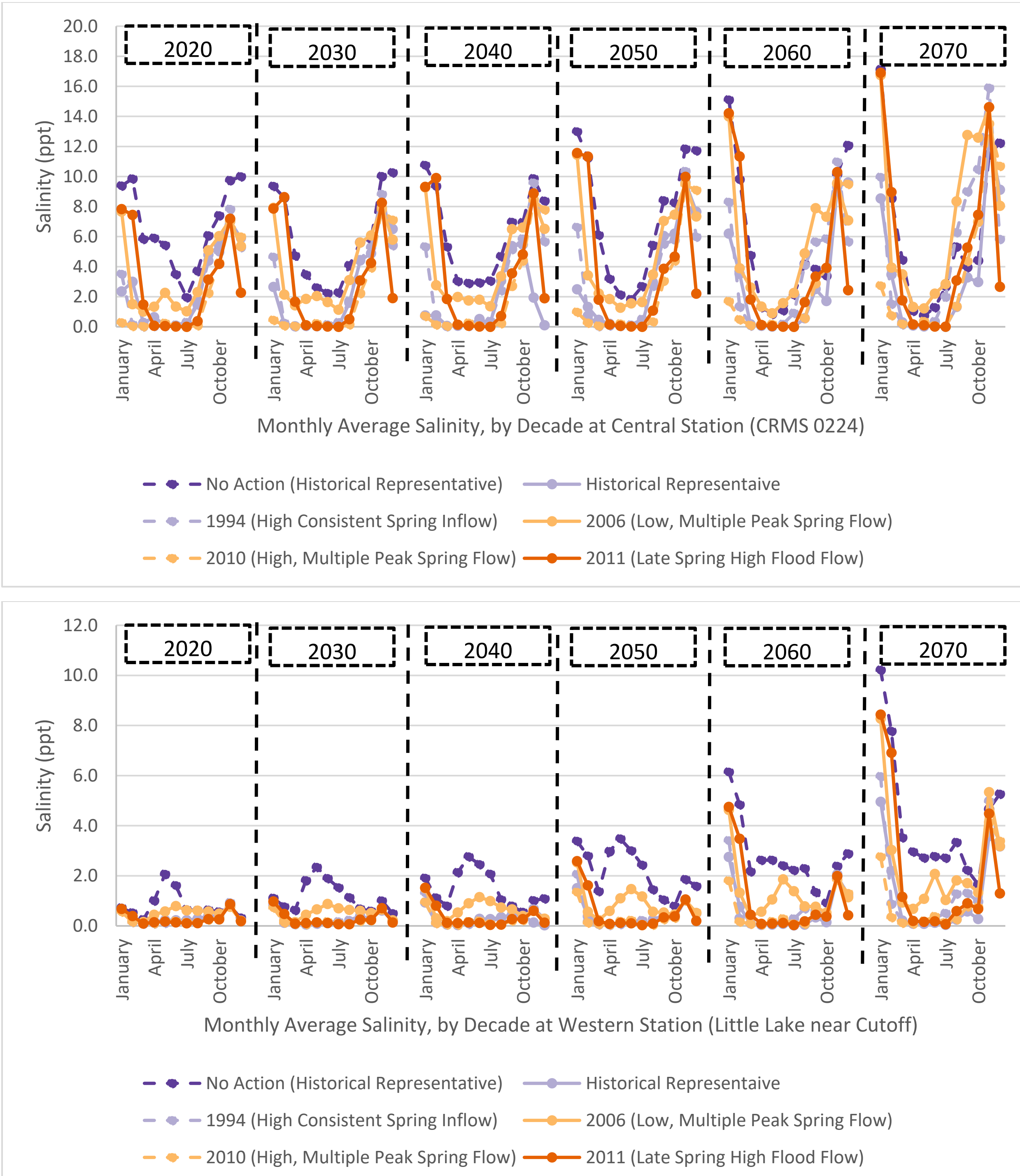
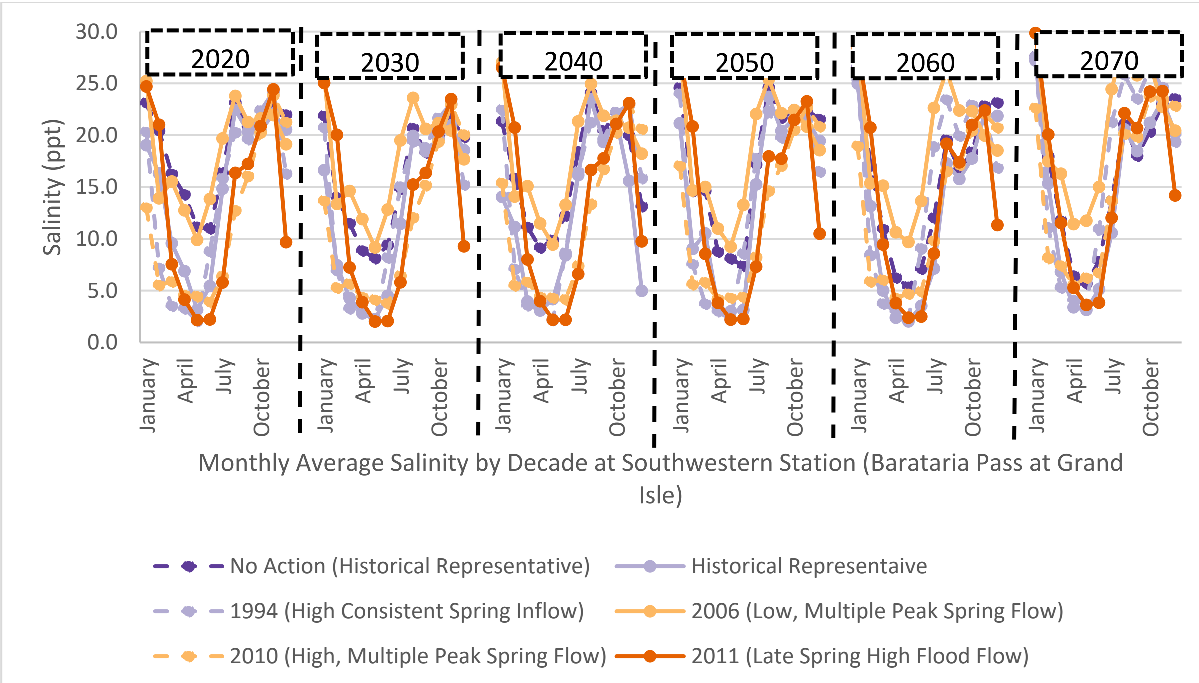


Figure 4.5-9. Comparison of Hydrographs: Average Modeled Monthly Average Salinity at the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for Applicant's Preferred Alternative under Representative Historical, 1994, 2006, 2010, and 2011 Mississippi River Hydrographs. Overlapping graph lines indicate negligible differences in model projections. Note the range of values on the y axis differs between figures.



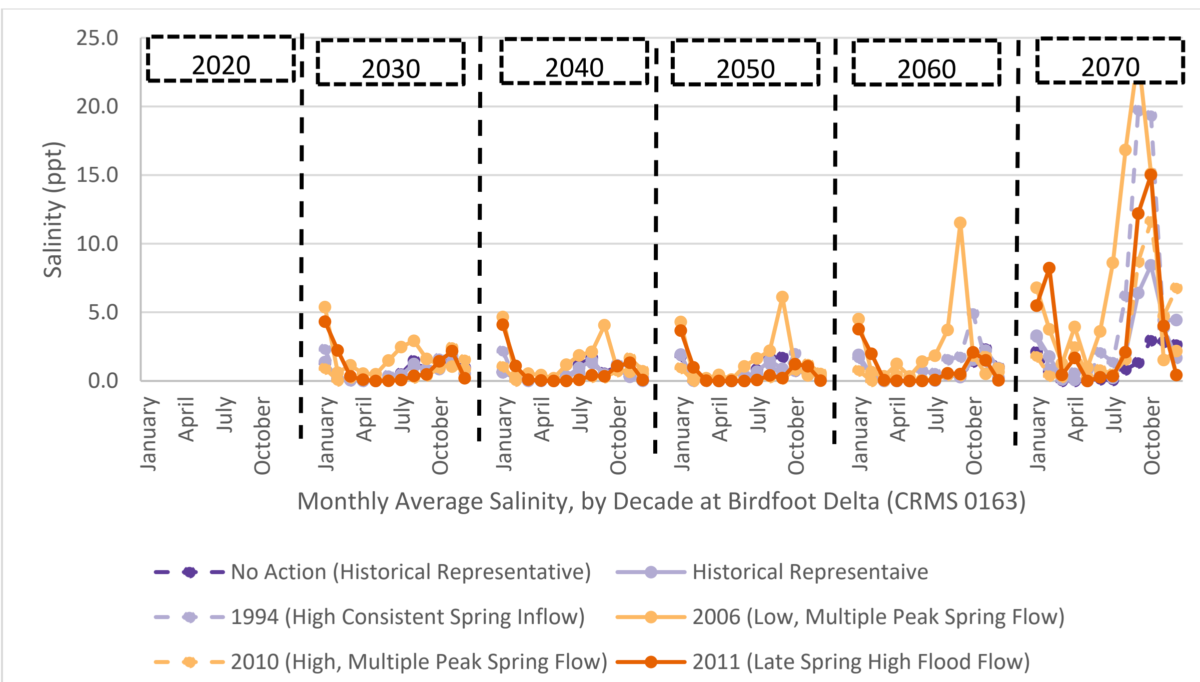


Figure 4.5-10. Comparison of Hydrographs: Average Modeled Monthly Average Salinity at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for Applicant's Preferred Alternative under Representative Historical, 1994, 2006, 2010, and 2011 Mississippi River Hydrographs. Overlapping graph lines indicate negligible differences in model projections. Note: the range of values on the y axis differs between figures. The Delft3D Basinwide Model cell for the birdfoot delta station (CRMS 0163) is projected to be partially dry marsh in modeled year 2020. For this reason, results for 2020 are not included for this station.

The model projects that, under all hydrographs, salinities would generally decrease as compared to the No Action Alternative at the northern/mid-basin station (CRMS 3985), the station nearest the diversion (CRMS 0276, see Figure 4.5-8), the central station (CRMS 0224), and the western station (Little L. Cutoff, see Figure 4.5-9). Farther from immediate outfall area at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI) and the birdfoot delta station (CRMS 0163), results generally approximate the modeled No Action Alternative and historical representative hydrograph salinity projections until the impacts of sea-level rise and land subsidence increases are projected in decades 2060 and 2070 (see Figure 4.5-10). Tabulations for these data are provided in Appendix E.

In summary, the Delft3D Basinwide Model projects that implementation of the Applicant's Preferred Alternative would moderately decrease average monthly salinity at all representative stations in the Project area except at the birdfoot delta station (CRMS 0163) over the 50-year analysis period. Permanent impacts on salinity would be major in the immediate outfall area and in the central basin, and minor at locations farther away from the immediate outfall area and at locations that are influenced by other existing freshwater inputs. Average seasonal salinities are projected to decrease basin-wide over the first 30 years of Project operation. By operational years 2050 to 2070, average seasonal salinities in the basin would continue to remain lower than No Action Alternative conditions, but the differences between the Applicant's Preferred Alternative and the No Action Alternative would decrease, potentially due to land subsidence and sea-level rise, which are factored into the Delft3D Basinwide Model for these decades. At the birdfoot delta station (CRMS 0163) the model projects salinities similar to the No Action Alternative throughout the 50-year analysis period until 2070 (see Figure 4.5-6). In 2070, the model projects moderate (observable over a large area, readily detectable in local areas) increases in salinity as compared to the No Action Alternative that are likely due to projected minor morphological impacts in the basin as well as land subsidence and sea-level rise, which are factored into the Delft3D Basinwide Model for these decades. See Section 4.1 for more information about land subsidence and sea-level rise rates used for the Delft3D Basinwide Model.

Differences in projected salinities and seasonal variability between the historical representative hydrograph and the variable Mississippi River hydrographs (1994 [high consistent spring flow], 2006 [low, multiple peak spring flow], 2010 [high, multiple peak spring flow], and 2011 [high, late spring flood flow]) are minor (detectable, localized) to moderate (observable over a large area, readily detectable in local areas).

4.5.5.1.3 Other Action Alternatives

Salinity impacts resulting from all other alternatives are projected to be similar to the Applicant's Preferred Alternative with respect to seasonal trends (see Figures 4.5-4 through 4.5-6). Neither the variable Project flow rates nor the presence of terraces appear to result in major differences in salinity as compared to the Applicant's Preferred Alternative (see Table 4.5-2 and Figures 4.5-4 through 4.5-6). Impacts specific to each of the other alternatives are described below.

4.5.5.1.3.1 50,000 cfs Alternative

The 50,000 cfs Alternative is projected to have permanent, minor to moderate reductions in salinity in the Barataria Basin and permanent, minor increases in salinity in the birdfoot delta as compared to the No Action Alternative. At the central station (CRMS 0224), the 50,000 cfs Alternative is projected to result in minor increases in maximum salinities with respect to the other action alternatives from 2040 to 2070 (see Figure 4.5-5). This is likely because this alternative would divert less fresh water through the proposed diversion than the other action alternatives.

At the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI), salinities for the 50,000 cfs Alternative are projected to be slightly lower (less than 1 ppt) than the No Action Alternative until 2070, when the increased salinities associated with sea-level rise would overcome the Project-induced decreases in salinity at this southern station. At the birdfoot delta station (CRMS 0163), the 50,000 cfs Alternative is projected to have higher monthly average salinities than all alternatives, including the No Action Alternative, in the last decade of Project operations (see Figure 4.5-6). This projected increase in salinity in the birdfoot delta is likely a result of the combined impacts of sea-level rise and subsidence as well as projected minor morphological impacts in the basin.

4.5.5.1.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative is projected to have permanent, minor to moderate reductions in salinity in the Barataria Basin and permanent, minor increases in salinity in the birdfoot delta, projected salinities would be consistently lower than those projected for the No Action Alternative.

At the northern/mid-basin station (CRMS 3985) and the western station (Little L. Cutoff), the 150,000 cfs Alternative is projected to produce minor decreases in salinities compared with the other action alternatives and the No Action Alternative throughout the 50-year analysis period (see Figures 4.5-4 and 4.5-5).

At the central station (CRMS 0224) and the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI), salinities for this alternative, like the other action alternatives, are projected to be lower than the No Action Alternative until 2070, when differences in projected salinities between the No Action Alternative and the action alternatives would be minor (+/- 1 ppt) (see Figures 4.5-5 and 4.5-6). At the birdfoot delta station (CRMS 0163), projected salinities under this alternative would generally approximate the No Action Alternative except during the last modeled decade, when the 150,000 cfs Alternative is projected to exceed the No Action Alternative salinities (see Figure 4.5-7), but would remain lower than the salinity projected for the Applicant's Preferred Alternative. This projected increase in salinity in the birdfoot delta is likely a result of the combined impacts of sea-level rise and subsidence as well as projected minor morphological impacts in the basin.

4.5.5.1.3.3 Terraces Alternatives

Terrace alternatives are generally projected to have impacts similar to their flow alternatives without terraces as described above. The following differences were noted between terrace alternatives and their associated flow alternative without terraces:

- At the central station (CRMS 0224), the 50,000 cfs + Terraces Alternative is projected to produce minor increases in maximum salinities with respect to the other action alternatives from 2040 to 2070, but would result in decreased salinities as compared to the No Action Alternative until the end of 2070, when increased salinities associated with sea-level rise would override Project-induced decreases in salinity (see Figure 4.5-5). This same trend is apparent at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI); salinities under this alternative are projected to be lower than the No Action Alternative until 2070, when salinities would be nearly equal (see Figure 4.5-6).

- At the birdfoot delta station (CRMS 0163), the 50,000 cfs + Terraces Alternative salinities are projected to exceed No Action Alternative salinities during the last modeled decade. This projected increase in salinity in the birdfoot delta is likely a result of the combined impacts of sea-level rise and land subsidence as well as projected minor morphological impacts in the basin.

- At the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI), salinities for the 75,000 cfs + Terraces Alternative are projected to be lower than the No Action Alternative until 2070, when salinity is projected to be 4 ppt fresher (20 ppt average December salinity in 2070) than the No Action Alternative in the same month and year (24 ppt average December salinity in 2070) (see Appendix E).

4.5.5.2 Water Temperature

4.5.5.2.1 No Action Alternative

Under the No Action Alternative, current temperature trends are expected to continue. As described in Chapter 3, Section 3.5 Surface Water and Sediment Quality, average monthly temperatures in the Mississippi River at Belle Chasse are seasonally variable. Between 1977 through 2017, temperatures ranged from 44ºF (6.6ºC) in January to 86ºF (30ºC) in August. While average monthly temperatures in the Barataria Basin also vary seasonally, the range of variability is smaller in the basin than in the river. Between 2006 and 2018 (the years for which data were available), average monthly basin temperatures ranged from 55ºF (13ºC) in January to 86ºF (30ºC) in August (see Chapter 3, Section 3.5 Surface Water and Sediment Quality for existing and historic water temperature trends in the Project area).

Figures 4.5-11 through 4.5-13 depict the Delft3D Basinwide modeled average monthly temperatures for the Project alternatives, including the No Action Alternative, over the 50-year analysis period at each of the six representative stations across the Barataria Basin. Under the No Action Alternative, as compared with existing and historical temperatures described above and in Chapter 3, Section 3.5 Surface Water and Sediment Quality, the model projects the same seasonal pattern in the basin, with minimum temperatures of about 50ºF (10ºC) in January and maximum temperatures of about 86ºF (30ºC) in August, which are projected to remain the trend throughout the 50-year analysis period. The model projects that over time, average minimum water temperatures may show a minor increase on the order of 2 to 4ºF (1 to 2ºC) in 50 years at all six stations with the exception of the northern/mid-basin station (CRMS 3985), where minimum temperatures are projected to remain constant with existing trends. Maximum temperatures would remain consistent at all six stations with the exception of the birdfoot delta station (CRMS 0163), where maximum temperatures are projected to increase by approximately 5ºF (3ºC) in 50 years as compared with existing trends.

4.5.5.2.2 Applicant's Preferred Alternative

Temperature trends modeled for the Applicant's Preferred Alternative would generally follow the same seasonal trends as the No Action Alternative, with minimum temperatures occurring in January and maximum temperatures occurring in August. However, the Applicant's Preferred Alternative is projected to cause intermittent, permanent, minor decreases in water temperatures compared to the No Action Alternative throughout the basin during Project operations.

As shown in Figures 4.5-11 through 4.5-13, as compared with the No Action Alternative, the Applicant's Preferred Alternative is projected to cause a minor decrease in temperature on the order of less than 2 to 5ºF (less than 1 to 3ºC) during the winter and spring months, which would generally correspond to the diversion flowing greater than the 5,000 cfs base flow, at all stations except at the birdfoot delta station (CRMS 0163). Temperatures are projected to return to No Action Alternative conditions within 1 month of when diversion flows would be reduced to the 5,000 cfs base flow. At the birdfoot delta station (CRMS 0163), temperature differences with respect to the No Action Alternative are projected to be negligible until 2070, when minor increases of less than 0.18 to 0.9ºF (less than 0.1 to 0.5ºC) are projected in the winter months. Delft3D Basinwide Model projections for temperature are consistent with a study in Breton Sound that found that cooler river temperatures entering the estuary through the Caernarvon Diversion tended to equilibrate to estuarine temperatures within several kilometers of the diversion under low flows, and can propagate farther throughout the estuary during larger flow events (Lane 2003).

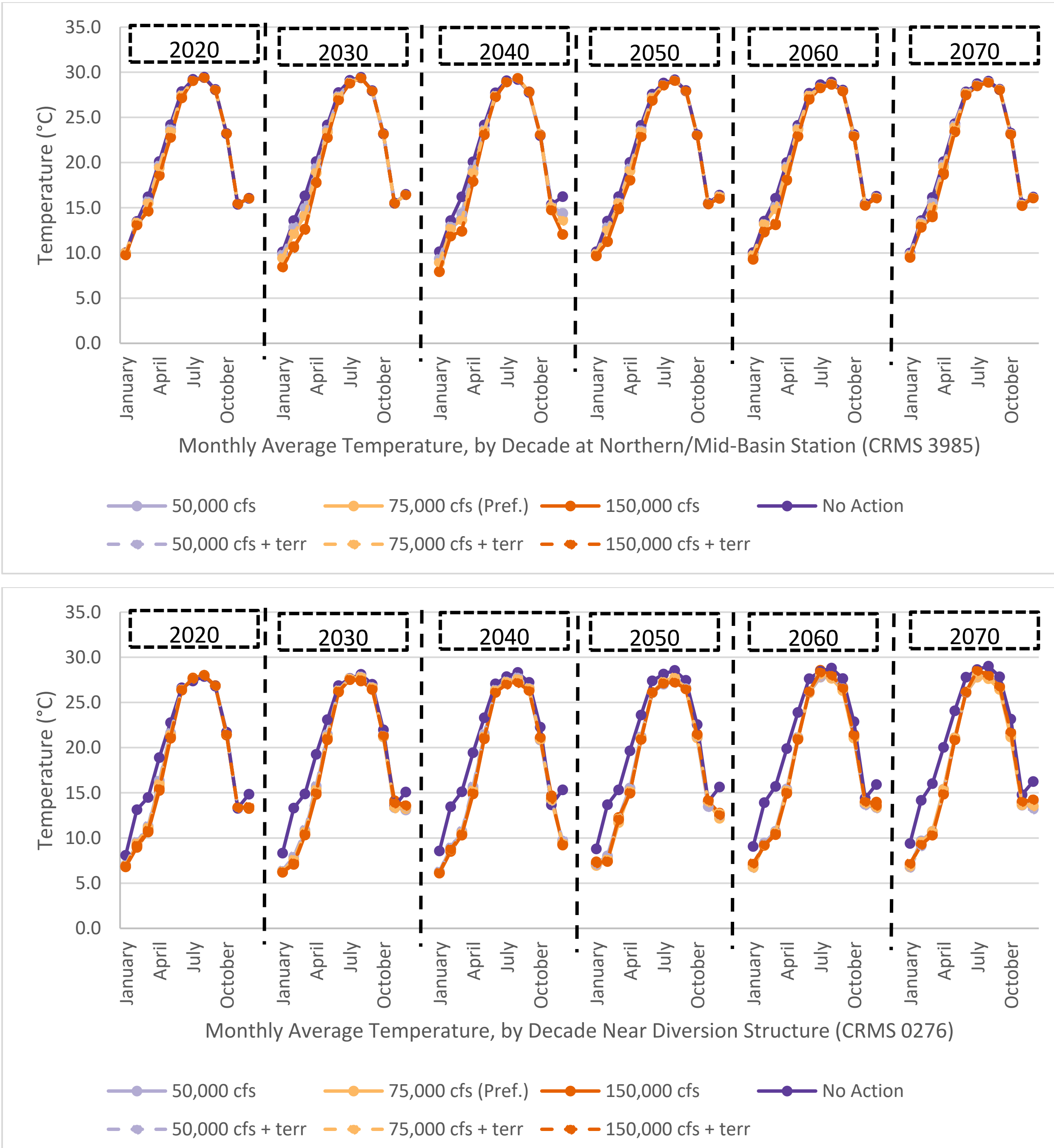
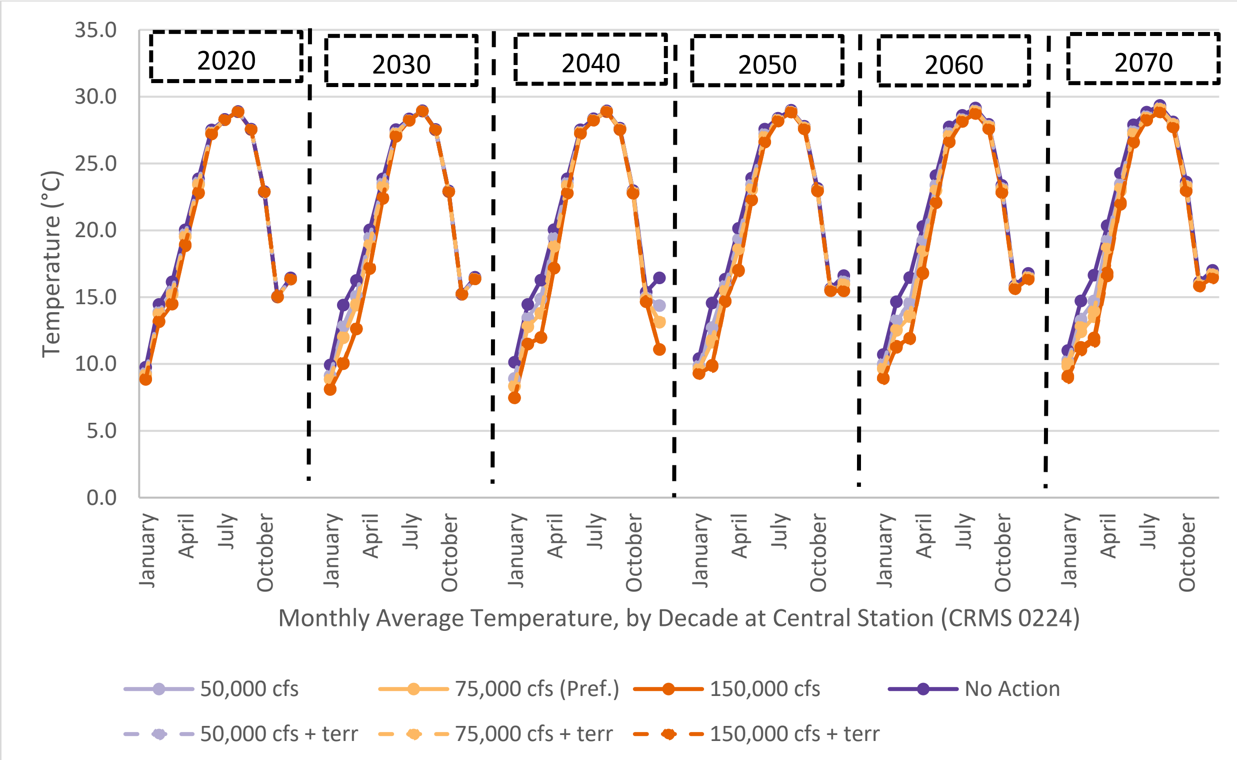


Figure 4.5-11. Average Modeled Temperature for at Two Stations in Northern Barataria Basin: the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.



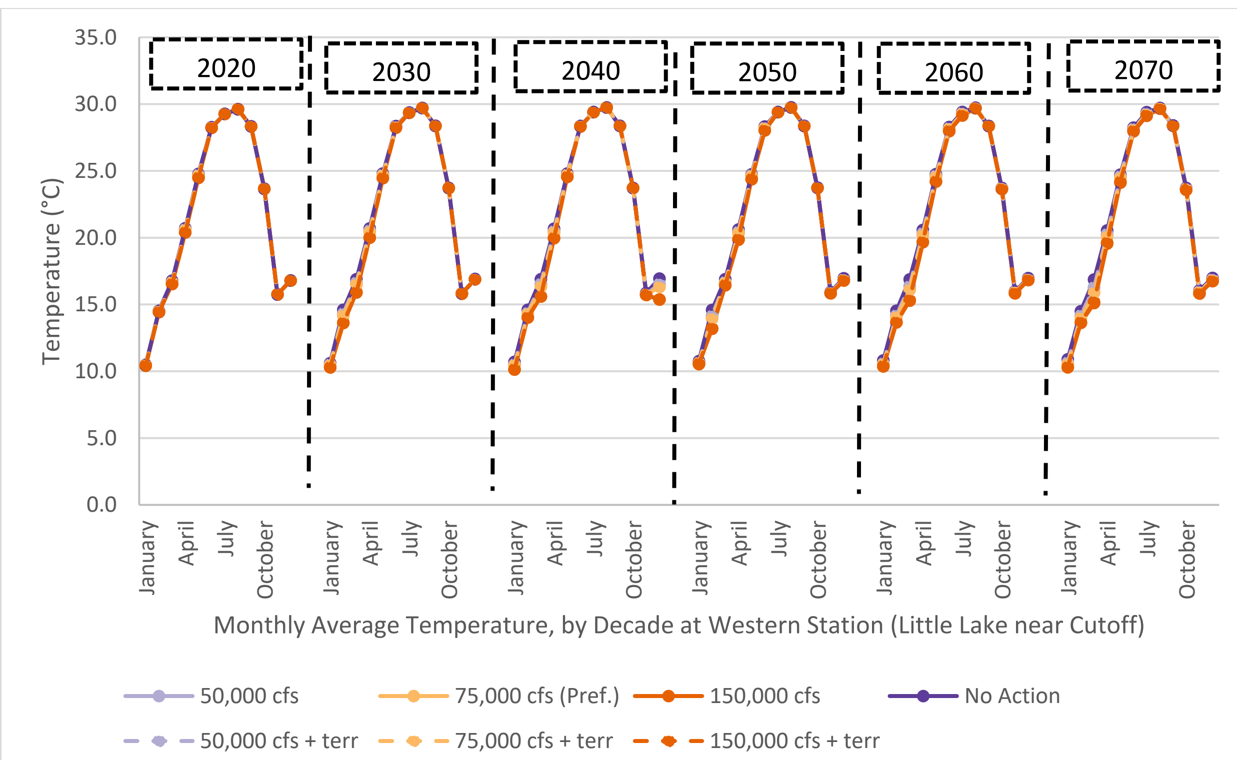
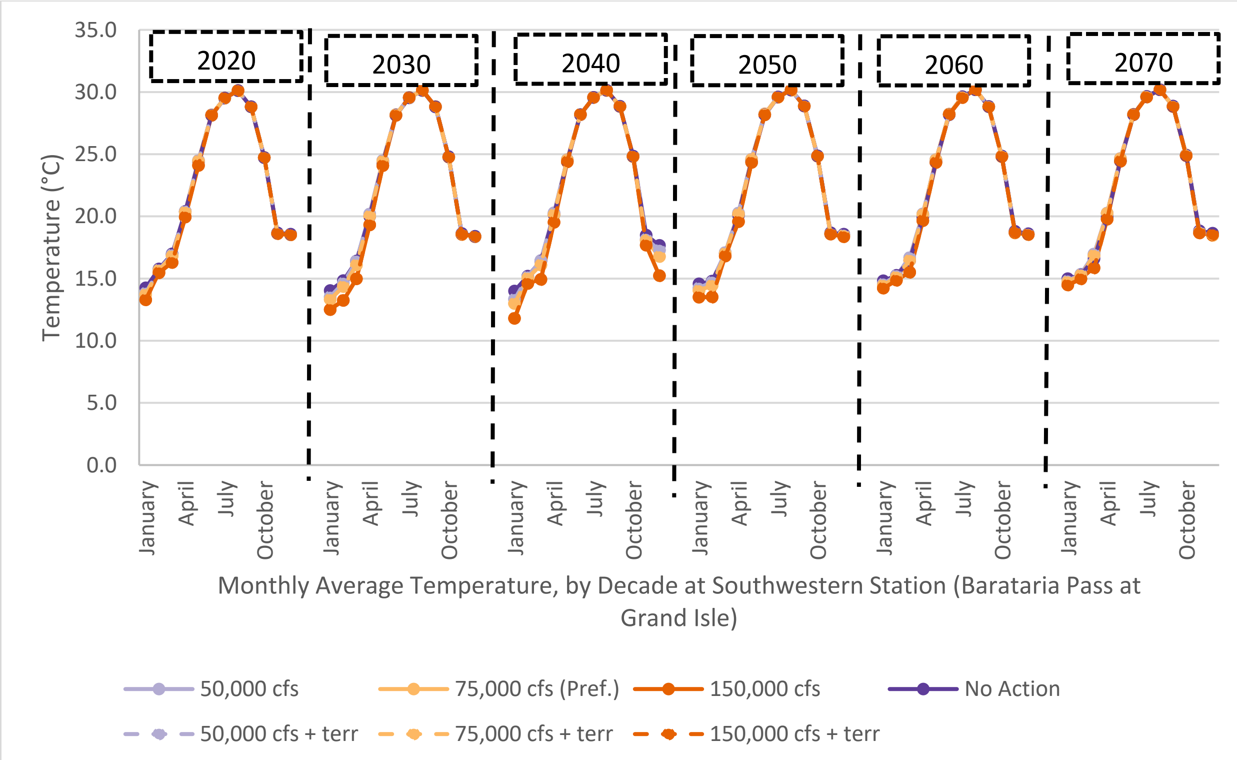


Figure 4.5-12. Average Modeled Temperature at Two Stations in Central and Western Barataria Basin: the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.



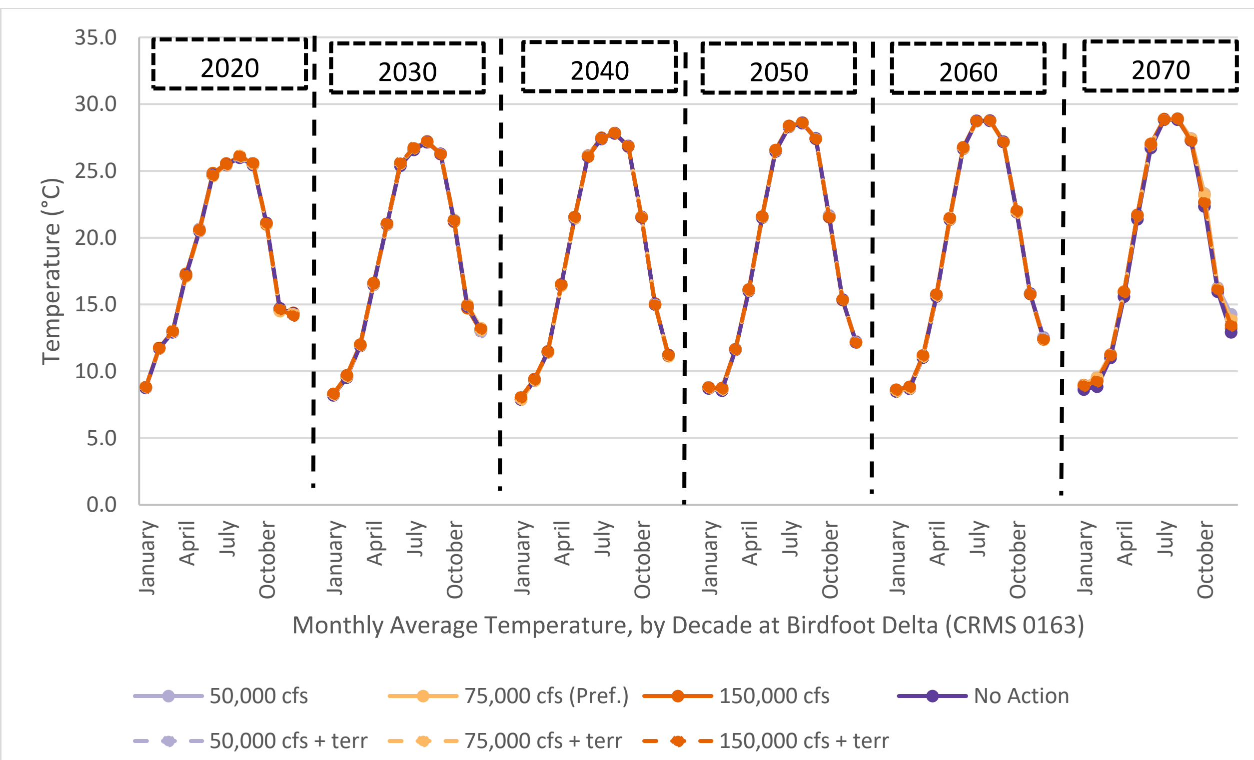


Figure 4.5-13. Average Modeled Temperature at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.

The modeled data project that average temperatures at the six representative stations would not exceed LDEQ's temperature criteria of a maximum of 90°F (32°C) for fresh water and 95°F (35°C) for salt water during the 50-year analysis period. The projected impacts on temperature of the Applicant's Preferred Alternative would not be beneficial or adverse to water quality itself, but they may have adverse or beneficial impacts on aquatic resources as described in Section 4.10 Aquatic Resources.

4.5.5.2.3 Other Action Alternatives

4.5.5.2.3.1 50,000 cfs and 150,000 cfs Alternatives

Modeled average monthly temperatures projected under the historical representative hydrograph for the 50-year analysis period (years 2020 to 2070) indicate that the 50,000 cfs and 150,000 cfs Alternatives would follow the same general seasonal trends but have minor differences in temperatures as compared to the Applicant's Preferred Alternative (see Figures 4.5-11 through 4.5-13). Accordingly, intermittent, permanent, minor decreases in water temperatures compared to the No Action Alternative are projected for all action alternatives throughout the basin during Project operations, except at the birdfoot delta station (CRMS 0163).

Temperatures are projected to return to No Action Alternative conditions within 1 month of when diversion flows would be reduced to the 5,000 cfs base flow for the 50,000 cfs and 150,000 cfs Alternatives. As seen in the Applicant's Preferred Alternative, temperature differences for all action alternatives at the birdfoot delta station (CRMS 0163) are projected to be negligible compared to the No Action Alternative until 2070, when minor increases are projected in the winter months. At all six stations, maximum temperatures are projected to be similar for all action alternatives. Minor differences in minimum temperatures, on the order of less than 2 to 4ºF (less than 1 to 2ºC) lower than the Applicant's Preferred Alternative, are projected for the 150,000 cfs Alternative. These differences are not projected at the birdfoot delta station (CRMS 0163).

4.5.5.2.3.2 Terrace Alternatives

In general, temperature impacts resulting from terrace alternatives would be similar to the impacts for the associated flow alternative without terraces, with the following exception:

- As compared with the Applicant's Preferred Alternative, minor differences in minimum temperatures, on the order of 2ºF (1ºC) higher than the Applicant's Preferred Alternative, are projected for the 75,000 cfs + Terraces Alternative at all stations except the birdfoot delta station (CRMS 0163). These differences would be most pronounced at the central station (CRMS 0224) and the northern/mid-basin station (CRMS 3985). These differences would likely be due to altered flow patterns caused by the terraces and the formation of the network of distributary channels that are projected to evolve in the splay downstream of the diversion.

4.5.5.3 Nitrogen

4.5.5.3.1 No Action Alternative

Under the No Action Alternative, current seasonal trends for nitrogen are expected to continue. As described in Chapter 3, Section 3.5 Surface Water and Sediment Quality, average monthly Total Nitrogen (TN) concentrations ranged from 3.0 mg/L (October) to 4.9 mg/L (July/September) in the Mississippi River at Belle Chasse between 1977 and 2017. An analysis of the LDEQ data in the Barataria Basin indicated that TN average monthly concentrations are lower throughout the basin than in the river, ranging from 0.74 mg/L (July) to 1.4 mg/L (January/February) between 2000 and 2017 (the years for which data were available), and exhibit a different seasonal variation than seen in the river. As discussed in Chapter 3, Section 3.5.1 in Surface Water and Sediment Quality, low DO linked to elevated nutrient loading, including nitrogen (nitrate/nitrite) is a cause of some water quality impairments in the upper portion of the basin, including areas north of Lake Salvador. TN is comprised of organic and inorganic forms of nitrogen; however, there were insufficient data to evaluate existing basin-wide organic and inorganic nitrogen conditions independently.

As described in Section 4.5.3, the Delft3D Basinwide Model was used to assess relative impacts of action alternatives on nitrogen concentrations during the 50-year analysis period of 2020 to 2070. Figures 4.5-14 through 4.5-16 include the modeled average monthly TN concentrations for the No Action Alternative over the 50-year analysis period at each of the six representative stations across the Barataria Basin. The model projects that under the No Action Alternative, TN concentrations would generally follow a seasonal pattern similar to that currently observed in the Barataria Basin, with lower concentrations in the summer/fall, and higher concentrations in the winter, with the exception of the birdfoot delta station (CRMS 0163). Projected TN for the birdfoot delta station (CRMS 0163), which is naturally impacted by Mississippi River inputs, indicates little variation in TN concentration over the 50-year analysis period.

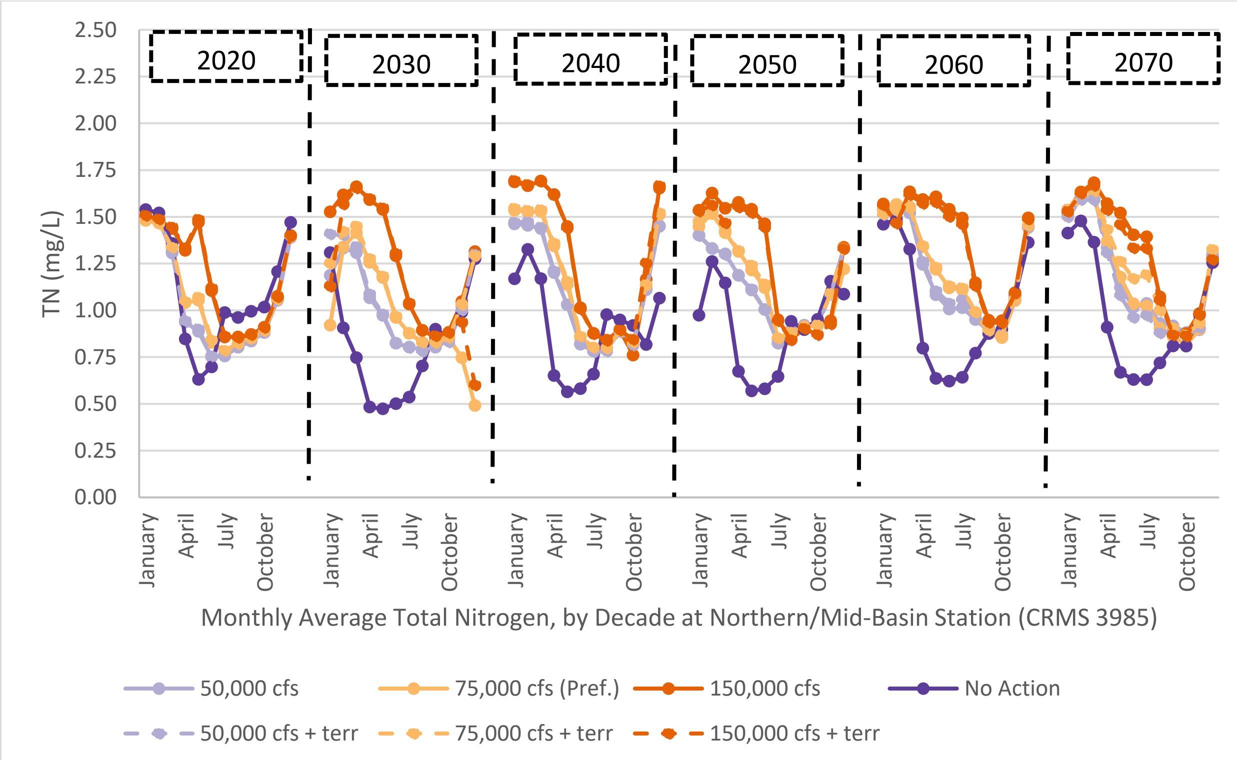
Only certain forms of nitrogen are considered “bioavailable,” meaning that they can be utilized by organisms for growth and other biological functions. The model projects that inorganic nitrate (NO_3), which generally represents the bioavailable form of nitrogen, would comprise between 0.06 percent to 80 percent of the TN under the No Action Alternative, and follow a similar seasonal variation as TN concentrations, except at the birdfoot delta station (CRMS 0163). At five of the six stations, lower NO_3 concentrations are projected in the summer and higher concentrations in the winter for the No Action Alternative. At the birdfoot delta station (CRMS 0163), projected NO_3 concentrations would follow a seasonal pattern similar to the other stations; however, the duration of elevated NO_3 concentrations is projected to increase over the 50-year analysis period. By 2050, NO_3 concentrations at the birdfoot delta station (CRMS 0163) would no longer exhibit seasonal minimums. This change may be due to the impacts of land subsidence and sea-level rise, which are factored into the Delft3D Basinwide Model for these decades, and which would result in water quality changing to become more similar to conditions in the Gulf of Mexico and less impacted by seasonal fluctuations of the Mississippi River. See Section 4.1.3 and Appendix E for more information about land subsidence and sea-level rise rates used for the Delft3D Basinwide Model.

The NO_3 fraction of TN for the No Action Alternative is presented in Figures 4.5-17 through 4.5-19. Between 2020 and 2040 under the No Action Alternative, the lowest NO_3 fraction of TN (0.3 percent) is projected to occur at the station nearest the diversion (CRMS 0276) and the highest NO_3 fraction of TN (77 percent) is projected to occur at the central station (CRMS 0224). After 2040, the maximum NO_3 fractions would approach 80 percent at all six stations. Minimum NO_3 fractions are projected to increase over the 50-year analysis period at all stations except the northern/mid-basin station (CRMS 3985), where they are projected to remain consistently below 10 percent. The projected increase over time may be due to cumulative increases in nitrogen inputs to the system. At all representative stations except the birdfoot delta station (CRMS 0163), the seasonal decrease in NO_3 concentrations roughly correlates with increasing water temperature and a return of base flow diversion operations. The northern/mid-basin station (CRMS 3985) may be less influenced due to freshwater inputs that are not associated with the proposed Project. TN and NO_3 concentration data for all modeled stations are presented in Appendix L.

4.5.5.3.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative is projected to cause permanent, minor to moderate impacts on average nitrogen concentrations in the Barataria Basin during Project operations. A shift in TN seasonal trends that would correspond to when the diversion would flow greater than the 5,000 cfs base flow is projected with maximum average TN concentrations expected to occur in the winter/spring months. TN concentrations are projected to be generally minor to moderately elevated over the No Action Alternative.

Similar to the No Action Alternative, the birdfoot delta station (CRMS 0163) does not exhibit a seasonal TN trend. A range of variability similar to the No Action Alternative is projected at the birdfoot delta station (CRMS 0163). While the modeled concentrations at the other five stations project a seasonal trend similar to the No Action Alternative, elevated TN concentrations are predicted to persist for an increasingly longer period into the spring as compared to the No Action Alternative over the lifetime of the proposed Project at these stations. The shift in seasonality of TN is more pronounced at the station nearest the diversion (CRMS 0276) and the central station (CRMS 0224) than at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI), western station (Little L. Cutoff), or the northern/mid-basin station (CRMS 3985). The projected shift in seasonality may be the result of an increase in the length of time that the diversion is projected to operate above base flow as time progresses through the 50 years of the Delft3D Basinwide Model simulation.



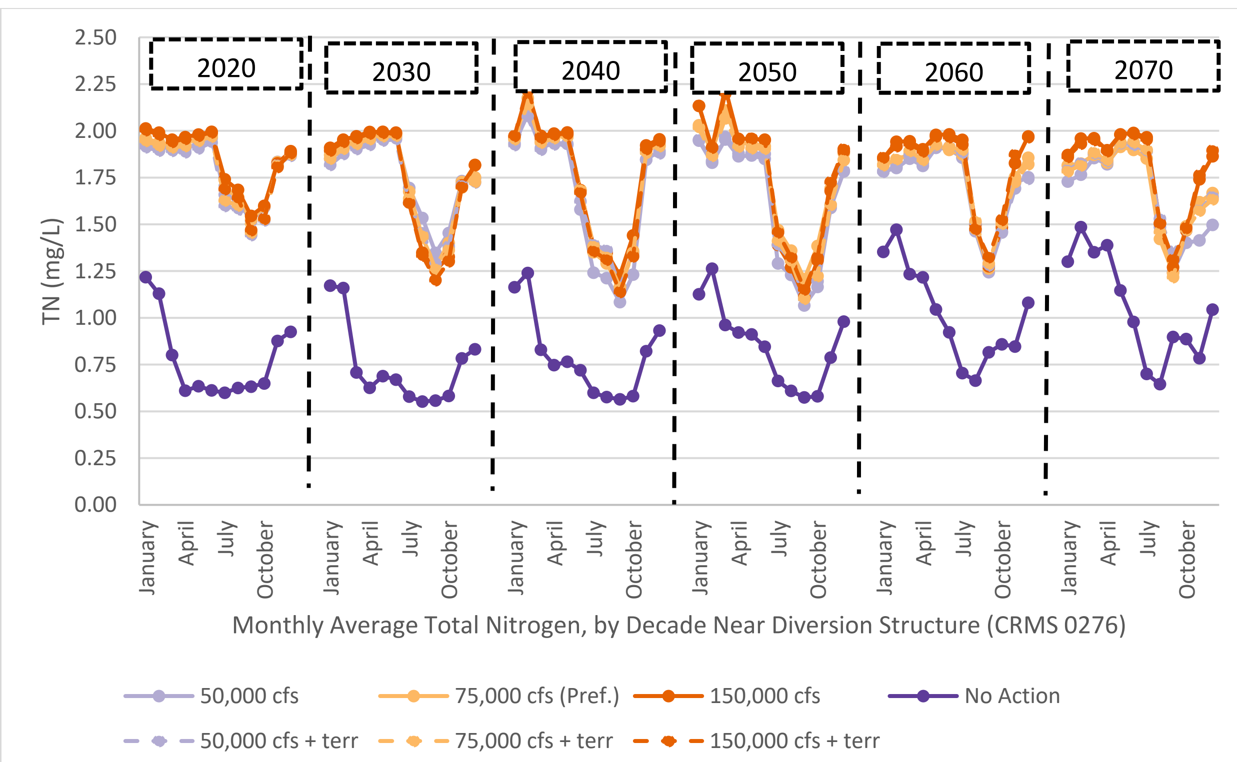


Figure 4.5-14. Average Modeled TN at the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.

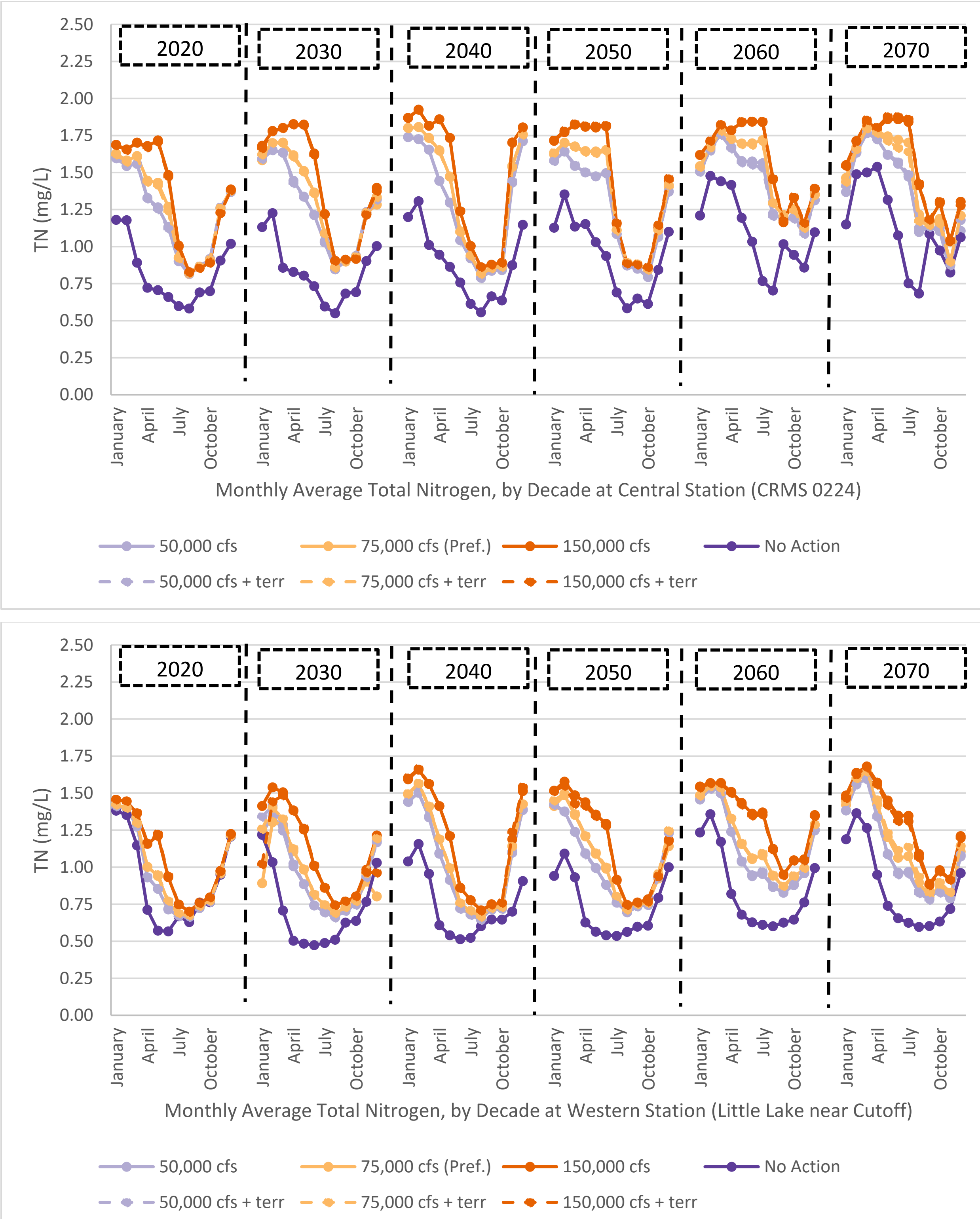
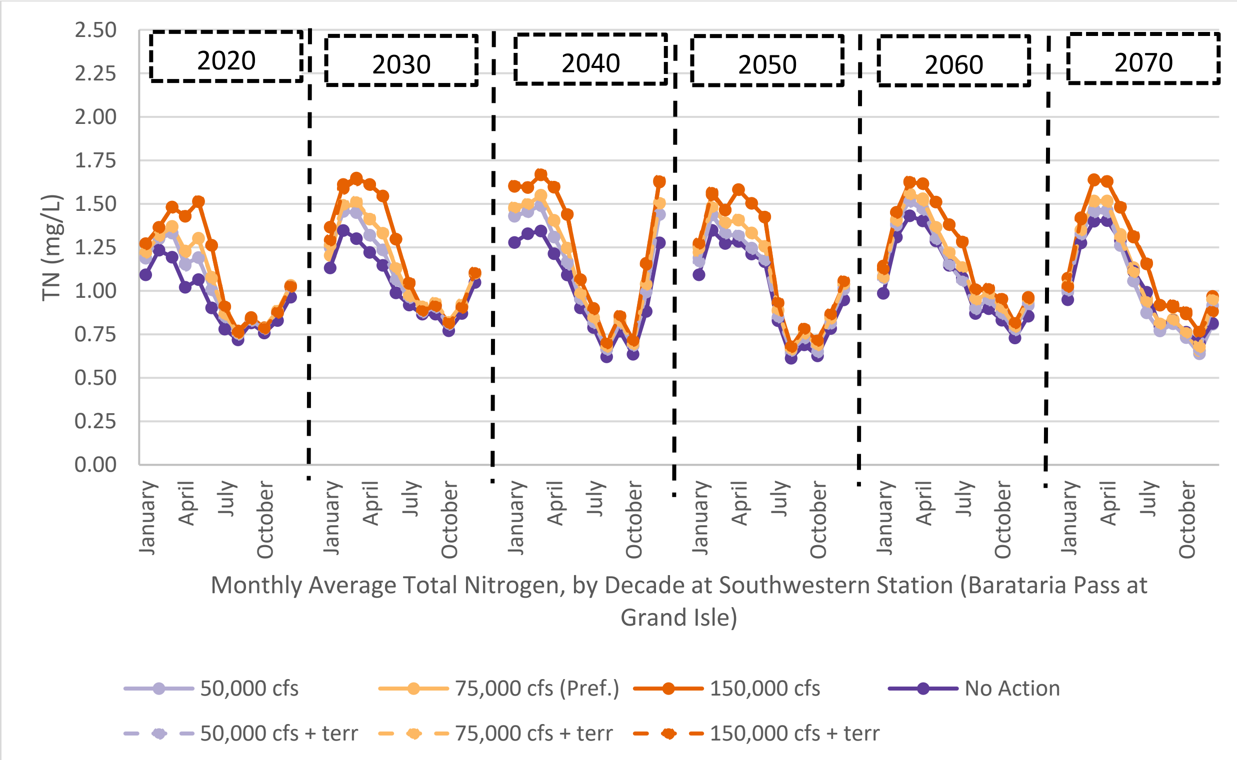


Figure 4.5-15. Average Modeled TN at the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.



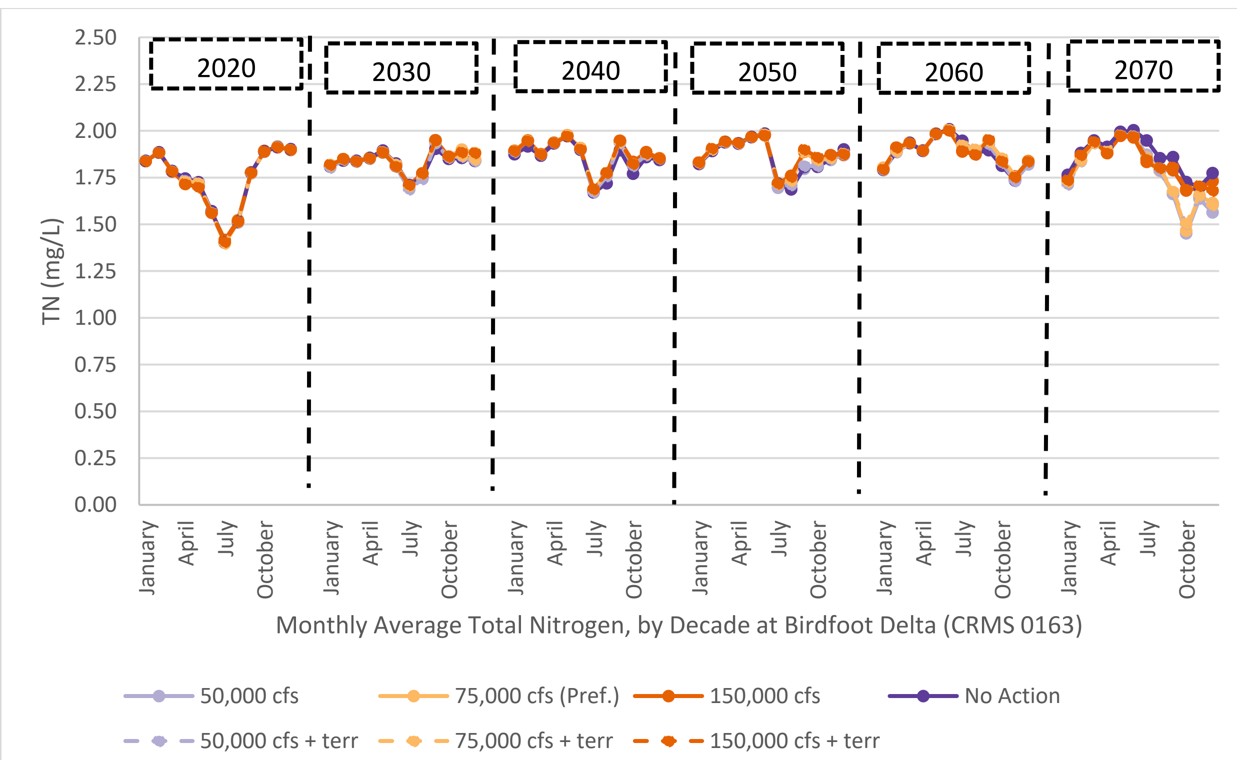
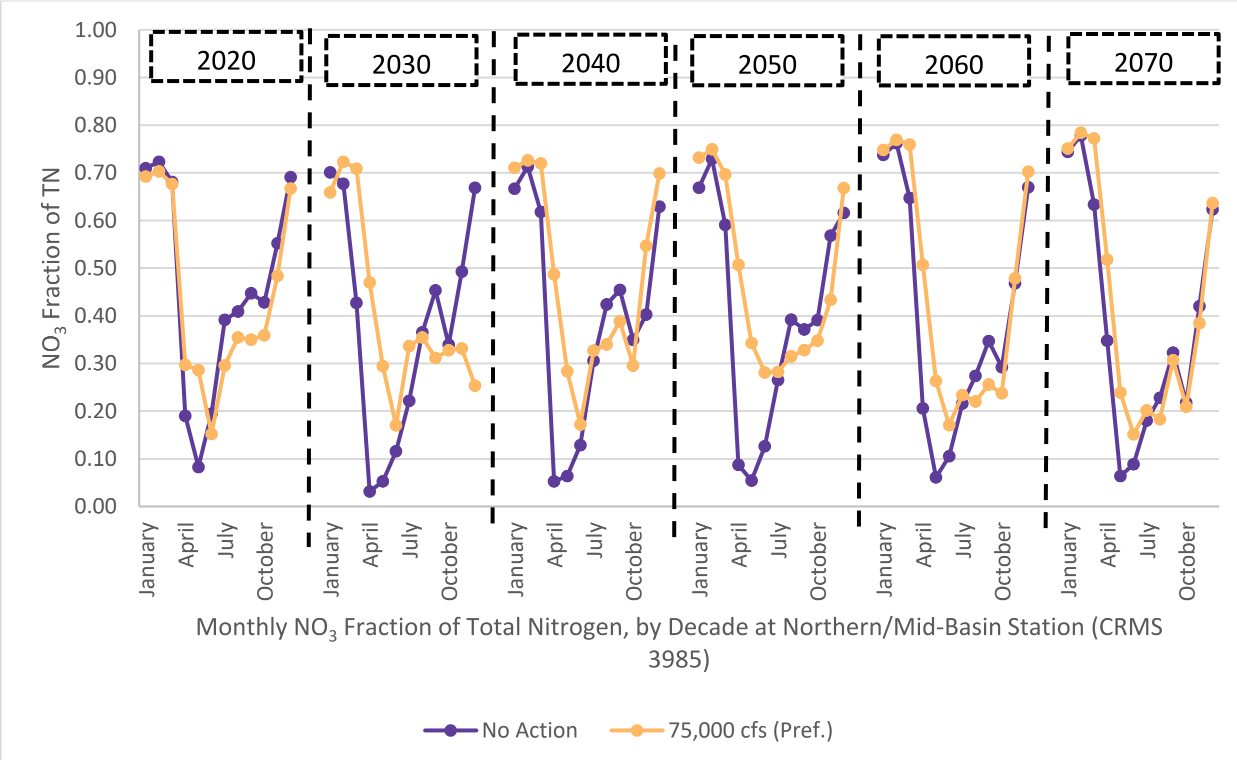


Figure 4.5-16. Average Modeled TN at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for All Alternatives under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.



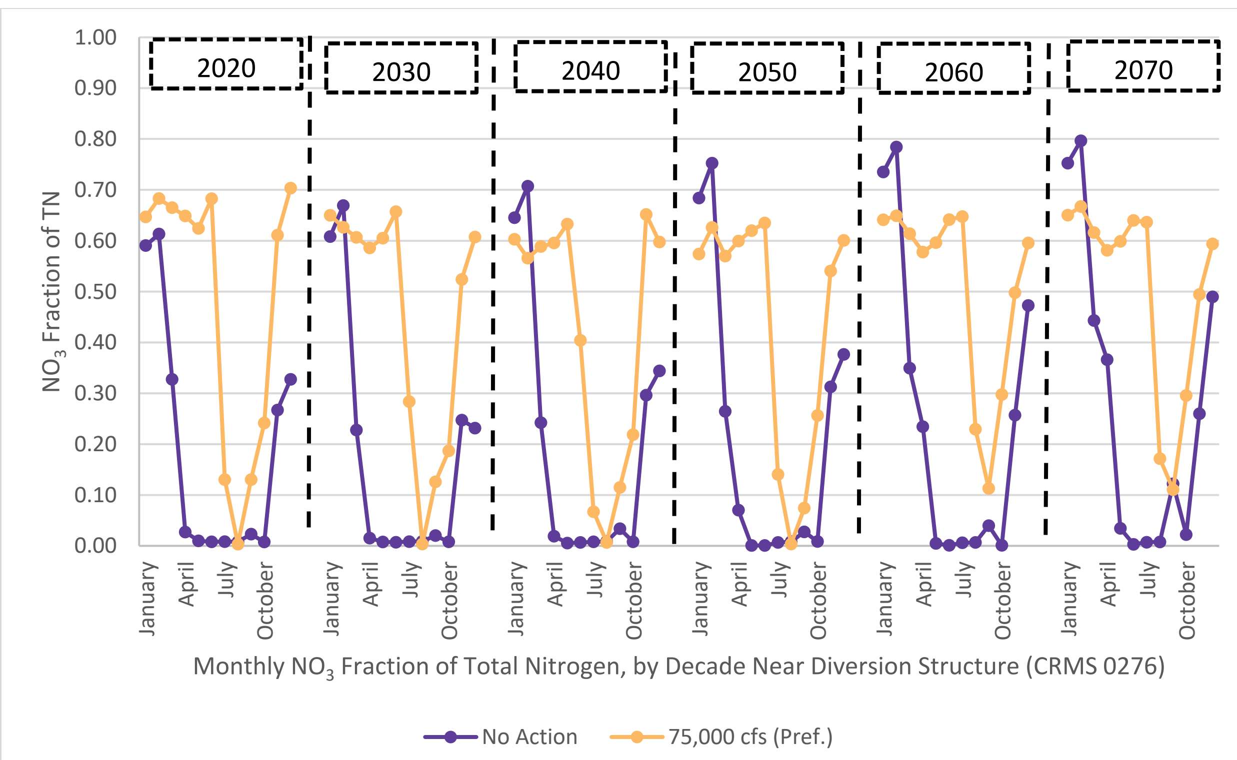
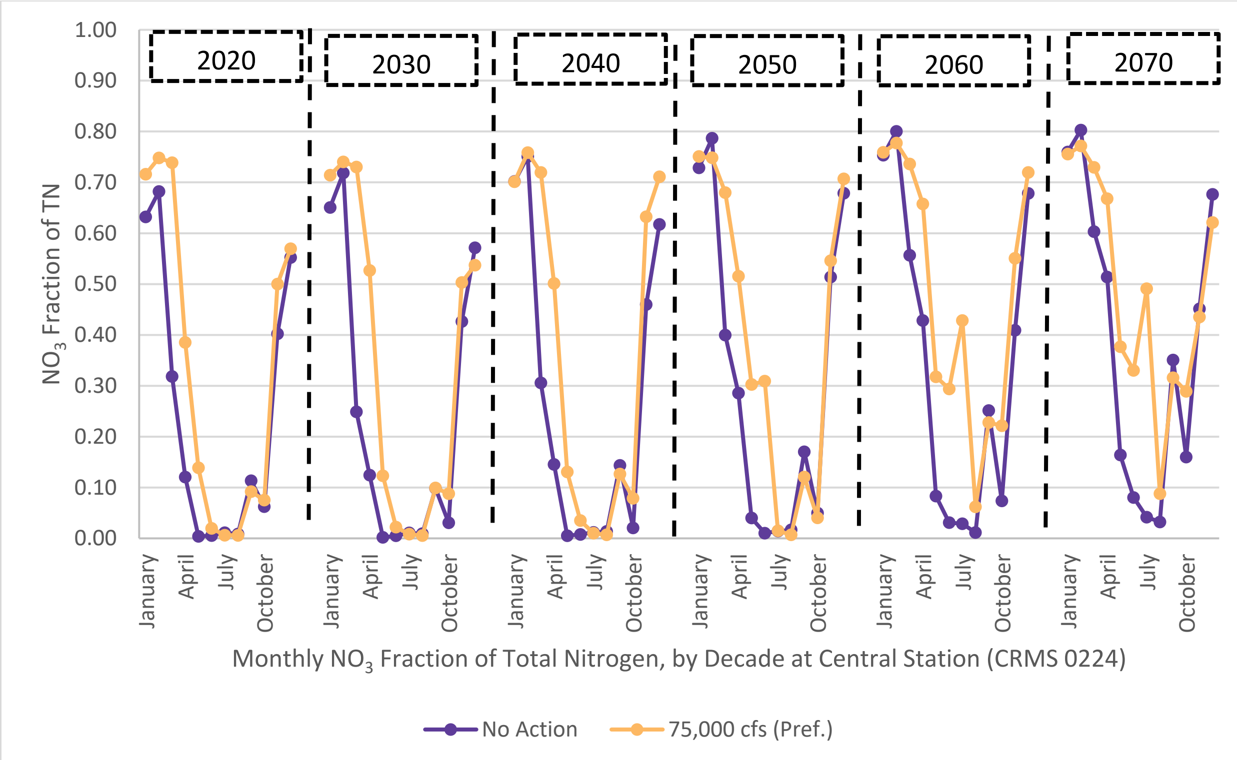


Figure 4.5-17. Average Modeled NO_3 fraction of TN at the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for No Action Alternative and Applicant's Preferred Alternative under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.



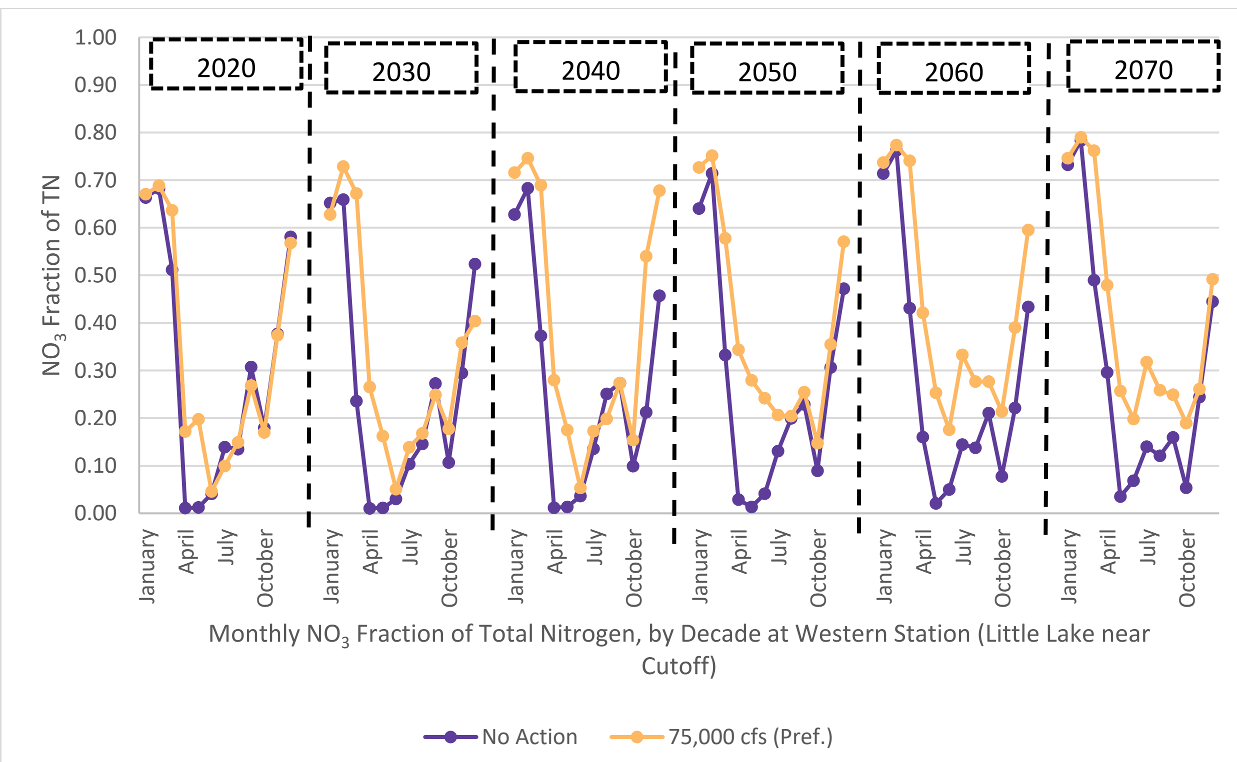


Figure 4.5-18. Average Modeled NO_3 fraction of TN at Two Stations in Central and Western Barataria Basin: the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for No Action Alternative and Applicant's Preferred Alternative under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.

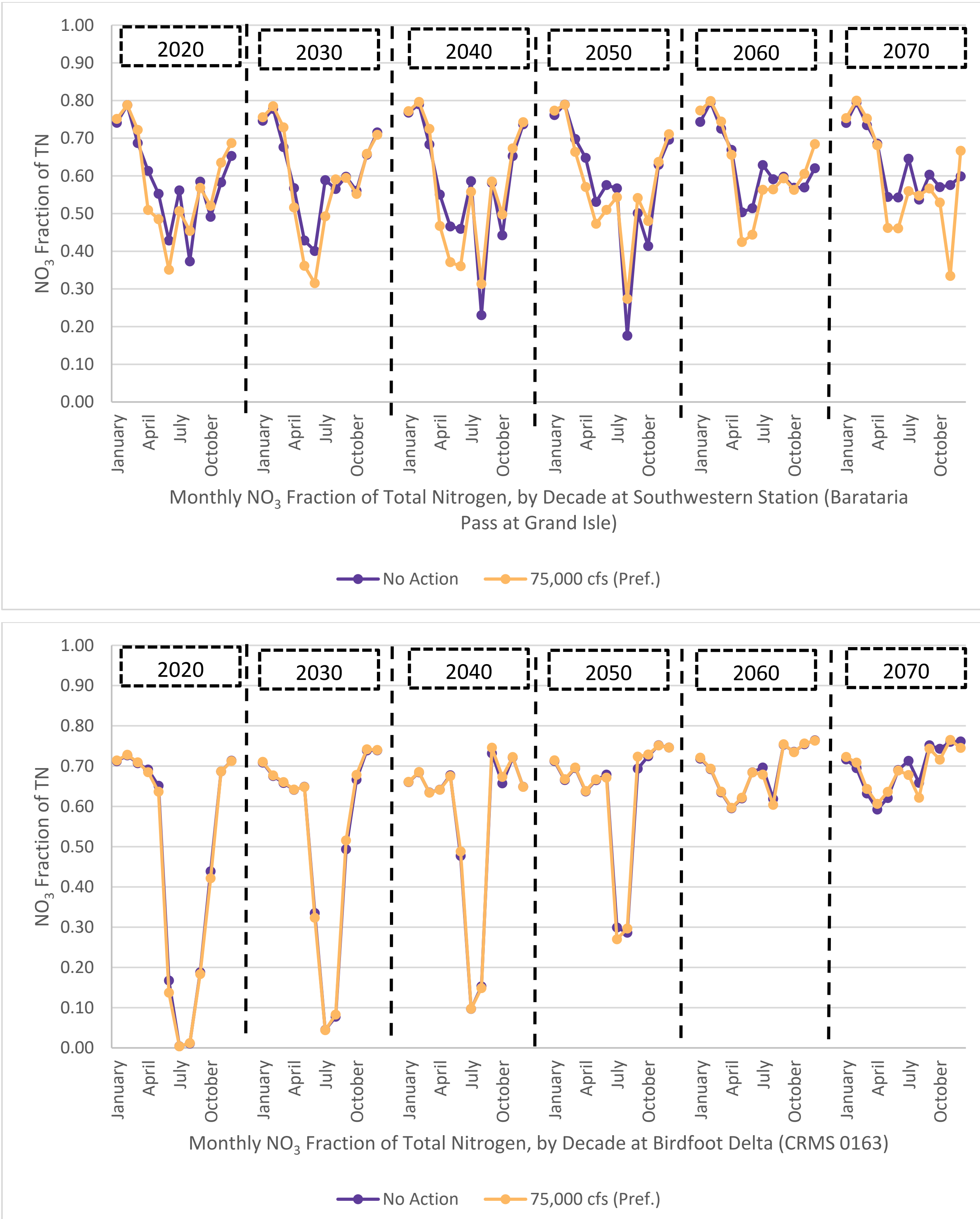


Figure 4.5-19. Average Modeled NO_3 fraction of TN at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for No Action Alternative and Applicant's Preferred Alternative under the Historical Representative Hydrograph. Overlapping graph lines indicate negligible differences in model projections.

At the five stations exhibiting seasonal TN trends, minimum average nitrogen concentrations are projected to occur in the late summer/fall months when the diversion is projected to be at 5,000 cfs base flow, and maximum average concentrations would occur in the winter/spring months when the diversion is projected to operate above base flow. Figures 4.5-14 through 4.5-16 depict the modeled average monthly TN concentrations for the Project alternatives, including the Applicant’s Preferred Alternative and the No Action Alternative, over the 50-year analysis period at each of the six representative stations across the Barataria Basin.

Under the Applicant’s Preferred Alternative, average TN concentrations are projected to be similar to the No Action Alternative at the birdfoot delta station (CRMS 0163). At the birdfoot delta station (CRMS 0163), the projected similarity to No Action Alternative conditions is likely due to consistent freshwater input from the Mississippi River. At the other five representative stations, in general, TN concentrations are projected to be more variable, but both minimum and maximum concentrations would be overall minor to moderately higher (ranging from 0 to approximately 1.3 mg/L higher) than the No Action Alternative (see Figures 4.5-14 through 4.5-16). At these five stations, elevated TN concentrations are projected to persist up to 5 months longer than projected for the No Action Alternative. Elevated TN concentrations are projected to persist longer at stations closer (flowing at the 5,000 cfs base flow) to the immediate outfall area. The increase in TN concentrations may be due to cumulative increases in nitrogen inputs to the system, as well as projected increases in vegetation and subsequent vegetative life cycle inputs within the Project area at the station nearest the diversion (CRMS 0276) and the central station (CRMS 0224). TN concentrations at these stations are not projected to return to No Action Alternative levels during the 50-year analysis period. At the northern/mid-basin station (CRMS 3985), TN concentrations are projected to be variable as compared to the other stations and are not projected to recover to No Action Alternative conditions until the late fall/winter months of 2050 to 2070. The variability projected at the northern/mid-basin station (CRMS 3985) may be due to freshwater inputs that are not associated with the proposed Project. At the western station (Little L. Cutoff) and the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI), TN closely approximates the No Action Alternative seasonal trends; however, the TN is projected to generally remain slightly elevated above the No Action Alternative (with some exceptions) throughout the 50-year analysis period.

Presently, Louisiana has narrative nutrient criteria (LAC 33:IX.1113.B.8), which state:

> “The naturally occurring range of nitrogen-phosphorous ratios shall be maintained. This range shall not apply to designated intermittent streams. To establish the appropriate range of ratios and compensate for natural seasonal fluctuations, the administrative authority will use site-specific studies to establish limits for nutrients. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters.”

Currently, average TN to total phosphorus (TP) ratios in the basin derived from data collected between 2000 through 2017 range from 6.8 in September to 15 in January. These data are not necessarily considered naturally occurring, as the basin has many anthropogenic nutrient inputs (see Chapter 3, Section 3.5 Surface Water and Sediment Quality). The Delft3D Basinwide Model projects that monthly average TN:TP ratios would decrease slightly under the Applicant's Preferred Alternative, ranging from 4.5 to 14.7 over the 50-year analysis period. The lowest ratio is projected at the northern/mid-basin station (CRMS 3985) in December of the second modeled decade, and the highest is projected at the station nearest the diversion (CRMS 0276) in August of the first modeled decade.

Section 4.10.4.4 states that under the Applicant's Preferred Alternative, an increased potential (and frequency) for phytoplankton blooms would be likely within the Project area. Whether or not these blooms would become HABs cannot be definitively determined based on currently available knowledge. Rather, the potential for bloom and HAB occurrence would be based on interacting and site-specific physical, chemical, and biological processes that would influence both phytoplankton abundance and composition (Bargu et al. 2019). This uncertainty is acknowledged in the impacts determination. It is unlikely that the impacts of the Applicant's Preferred Alternative would result in a change in the naturally occurring range of nitrogen-phosphorous ratios. Section 4.10.4.4.2.4 Nutrient Loading in Aquatic Resources is inconclusive as to whether nutrient inputs associated with the Applicant's Preferred Alternative would produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses. Similar to the No Action Alternative, the model projects that NO_3 would comprise between 0.3 percent to 80 percent of the TN in the Applicant's Preferred Alternative and follow a similar seasonal variation as TN concentrations at all six stations (see Figures 4.5-17 through 4.5-19). In general, lower percentages of NO_3 are projected in the summer when the diversion is projected to be at 5,000 cfs base flow, and higher percentages are projected in the winter when the diversion is projected to operate above base flow. The lowest NO_3 fraction of TN is projected to occur at the station nearest the diversion (CRMS 0276) and the highest NO_3 fraction of TN is predicted to occur at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI).

After 2040, the maximum NO_3 fractions are projected to approach 80 percent at all six stations, which is consistent with the No Action Alternative. As observed under the No Action Alternative, minimum NO_3 fractions are projected to moderately increase over the 50-year analysis period at all stations except the northern/mid-basin station (CRMS 3985). At the other four representative stations, the range of variability is similar to the No Action Alternative. Figures 4.5-17 through 4.5-19 present model results for each of the six station locations to show a comparison of the NO_3 fractions of TN predicted for the No Action Alternative and the Applicant's Preferred Alternative. TN and NO_3 concentration data for all modeled stations and hydrographs are presented in Appendix L.

The spatial and temporal trends in NO_3 concentration projected by the Delft3D Basinwide Model results largely follow expected trends documented in literature regarding freshwater introductions into estuarine systems. According to Lane (2003), several studies have shown that nitrate concentrations from freshwater flows are reduced through denitrification when introduced water passes through estuarine systems, with higher rates of denitrification occurring when water flows through vegetated wetlands.

The model results for the Applicant's Preferred Alternative project a negligible impact on TN or NO_3 at the birdfoot delta station (CRMS 0163). The negligible impact is likely due to the influence of Mississippi River water at the birdfoot delta station (CRMS 0163). An overall increase between 0 to approximately 1.3 mg/L in the TN and NO_3 concentrations is projected at the other five representative stations as compared to the No Action Alternative.

Although impacts on nitrogen concentrations would vary throughout the basin, overall minor to moderate, permanent impacts – including minor to moderately elevated concentrations and a shift in seasonal trend– are projected under the Applicant's Preferred Alternative. These impacts on water quality may have adverse or beneficial impacts on other aquatic resources, as described in Section 4.10.4.4.2.4 Nutrient Loading in Aquatic Resources.

4.5.5.3.3 Other Action Alternatives

Like the Applicant's Preferred Alternative, all alternatives are projected to result in permanent, minor to moderate increases in TN as compared to the No Action Alternative. The impacts from operation of all action alternatives on nitrogen concentrations would be similar to the Applicant's Preferred Alternative in terms of seasonal trends. Modeled average monthly TN and NO_3 concentrations under the historical representative hydrograph for the 50-year analysis period (years 2020 to 2070) project that the other alternatives would have minor differences in average nitrogen concentrations as compared to the Applicant's Preferred Alternative (see Figures 4.5-14 through 4.5-16) at the six representative stations. NO_3 trends are projected to be similar to TN trends. The differences between action alternatives appear to be flow-dependent.

4.5.5.3.3.1 50,000 cfs Alternative

In general, the 50,000 cfs Alternative would result in lower TN loading from the river and is projected to result in a minor decrease in nitrogen concentrations in the basin as compared to the Applicant's Preferred Alternative (see Figures 4.5-14 through 4.5-16).

4.5.5.3.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative is projected to result in minor increases in average nitrogen concentrations in the basin as compared to the Applicant's Preferred Alternative (see Figures 4.5-14 through 4.5-16). An exception is the birdfoot delta station (CRMS 0163): at this station, the model projects that TN and NO_3 for all alternatives would be similar to the Applicant's Preferred Alternative until 2070, when the 150,000 cfs Alternative is projected to produce a minor increase in TN. The increase in TN concentrations at the birdfoot delta station (CRMS 0163) may be due to cumulative increases in nitrogen inputs to the system, as well as projected increases in vegetation and subsequent vegetative life cycle inputs within the Project area.

4.5.5.3.3.3 Terrace Alternatives

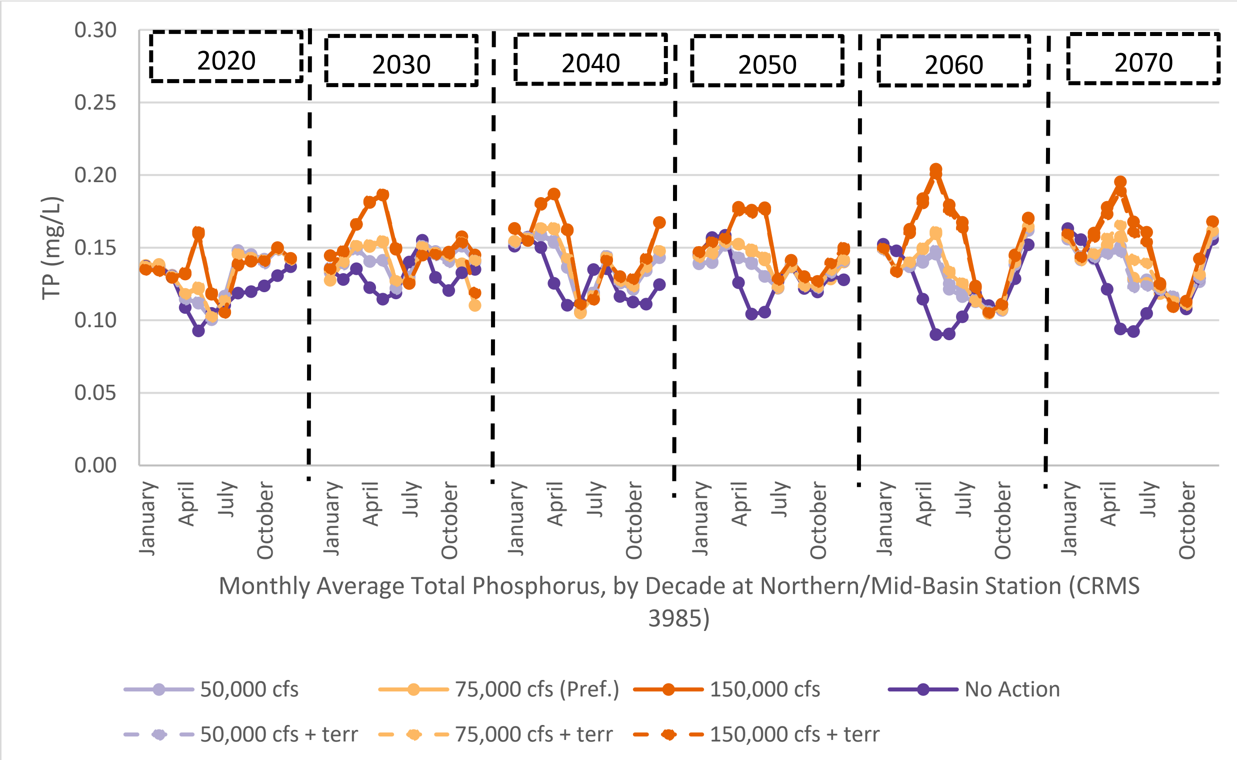
In general, nitrogen impacts resulting from terrace alternatives are projected to be similar to impacts for the associated flow alternatives without terraces. Minor differences as compared to the No Action and Applicant's Preferred Alternatives are shown on Figures 4.5-14 through 4.5-16.

4.5.5.4 Phosphorus

4.5.5.4.1 No Action Alternative

Currently, phosphorus concentrations trend seasonally, and differently, within the Mississippi River and in the Barataria Basin. As described in Chapter 3, Section 3.5 Surface Water and Sediment Quality, average monthly TP concentrations ranged from 0.27 mg/L (May) to 0.35 mg/L (July/December) in the Mississippi River at Belle Chasse between 1977 and 2017. An analysis of the LDEQ data in the basin indicated that TP average monthly concentrations are generally lower than in the river, ranging from 0.07 mg/L (April/May) to 0.53 mg/L (March) between 2000 and 2017. Nutrients such as TP are a suspected cause of water quality impairments in the Barataria Basin; however, literature has suggested that low phosphorus concentrations may limit plant growth in the basin (see Chapter 3, Section 3.5 Surface Water and Sediment Quality). TP is comprised of organic and inorganic forms of phosphorus; however, there were insufficient data to evaluate existing basin-wide organic and inorganic phosphorus conditions independently (see Chapter 3, Section 3.5 Surface Water and Sediment Quality for more information about existing trends in TP in the basin).

As described in Section 4.5.3, the Delft3D Basinwide Model was used to assess relative impacts of action alternatives on phosphorus concentrations during the Project 50-year analysis period of 2020 to 2070. Figures 4.5-20 through 4.5-22 include the modeled average monthly TP concentrations for the No Action Alternative over the 50-year analysis period at each of the six representative stations across the Barataria Basin. The model projects a seasonal variability in TP similar to the existing conditions at all six representative stations. The duration of minimum and maximum TP concentrations varies at each station. In general, maximums occur in the winter, and minimums occur in the summer.



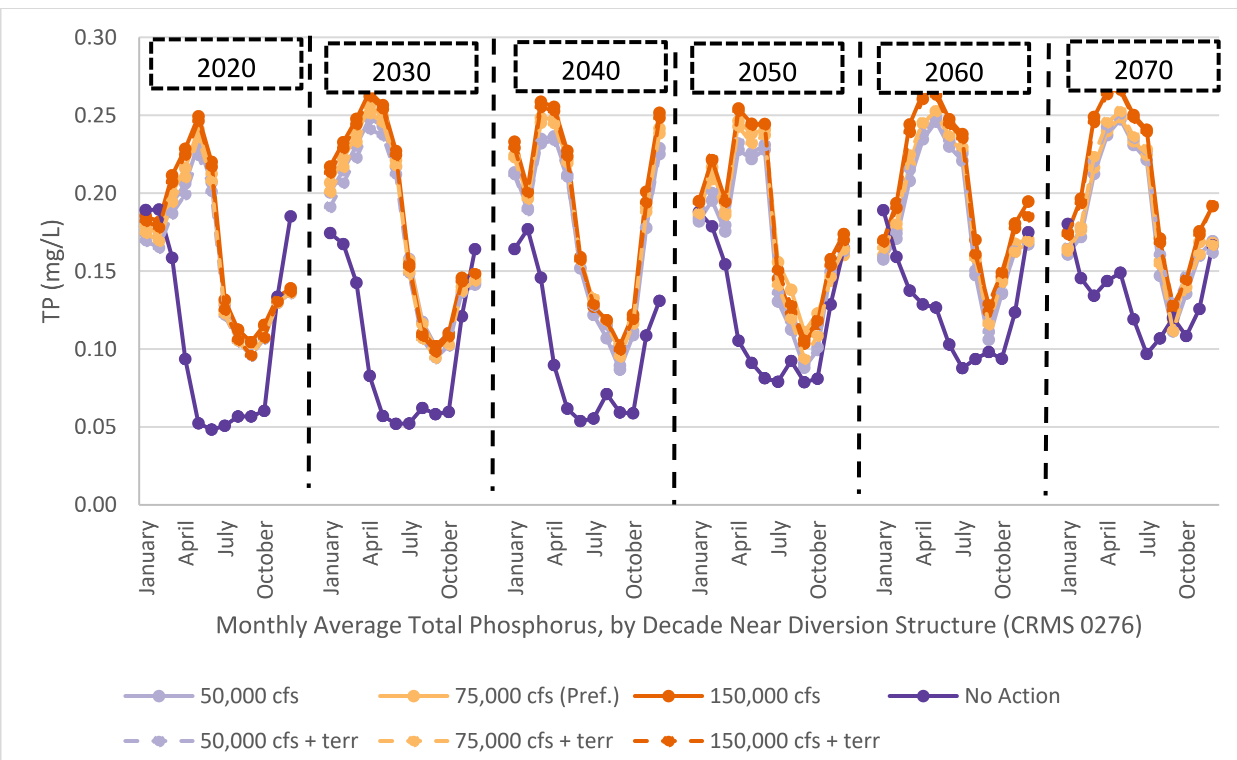


Figure 4.5-20. Average Modeled TP at Two Stations in Northern Barataria Basin: the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for All Alternatives under the Historical Representative Hydrograph.

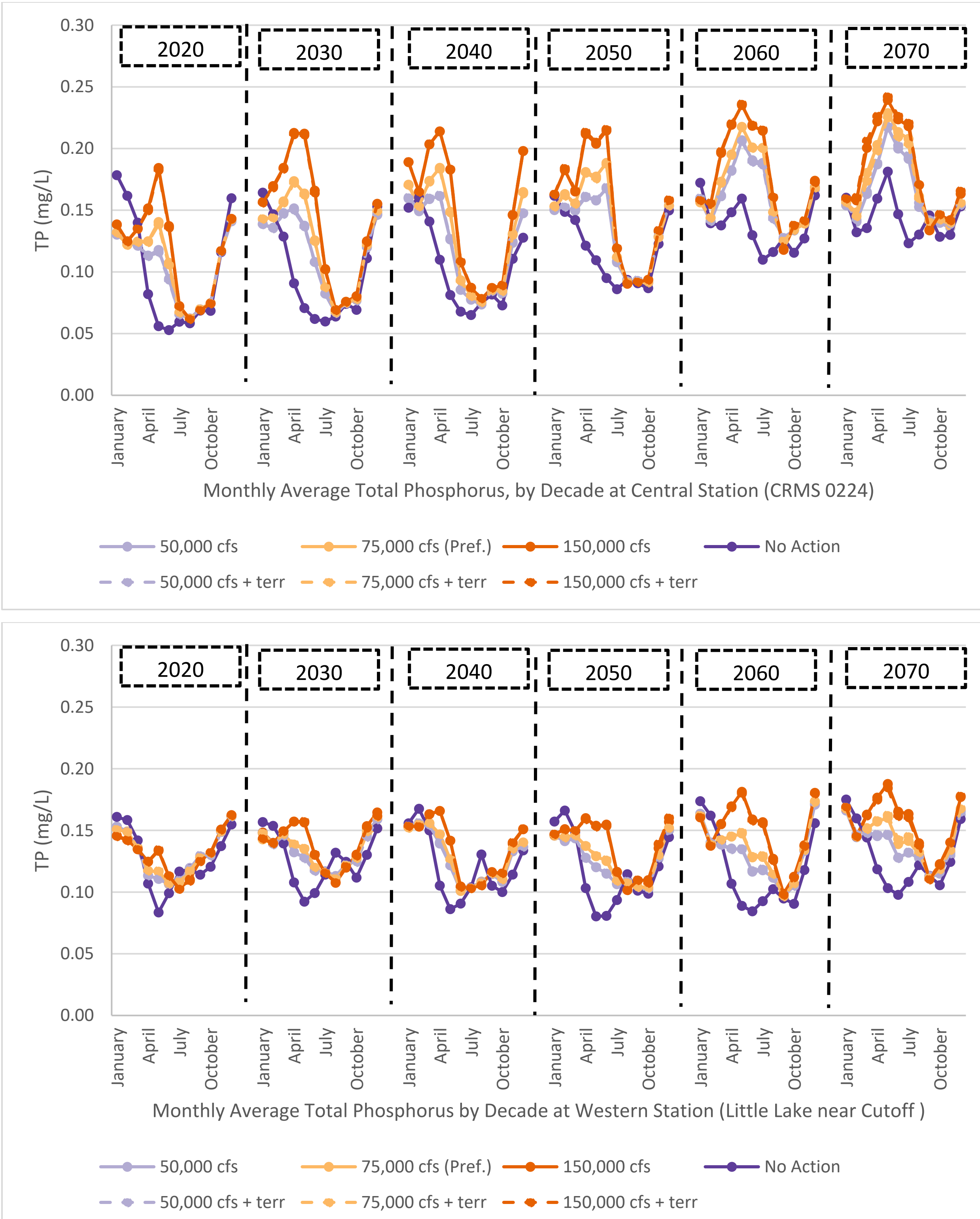
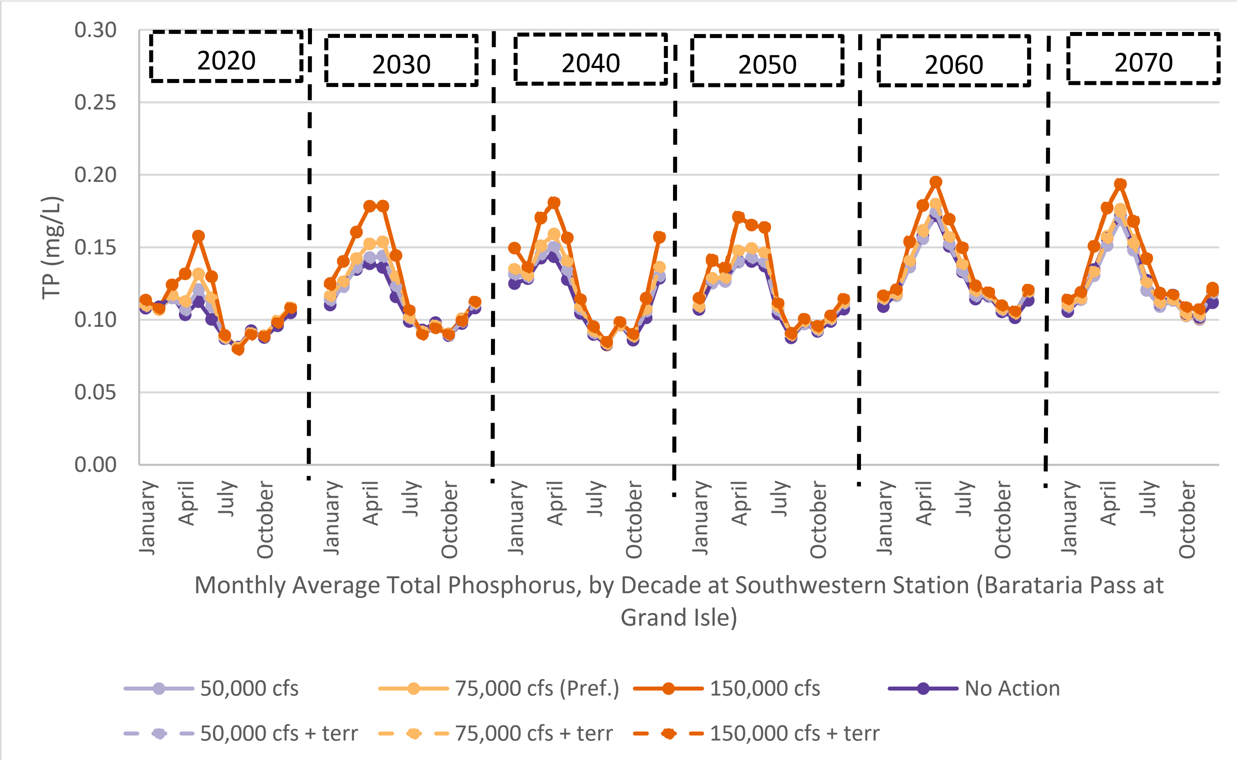


Figure 4.5-21. Average Modeled TP at Two Stations in Central and Western Barataria Basin: the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph.



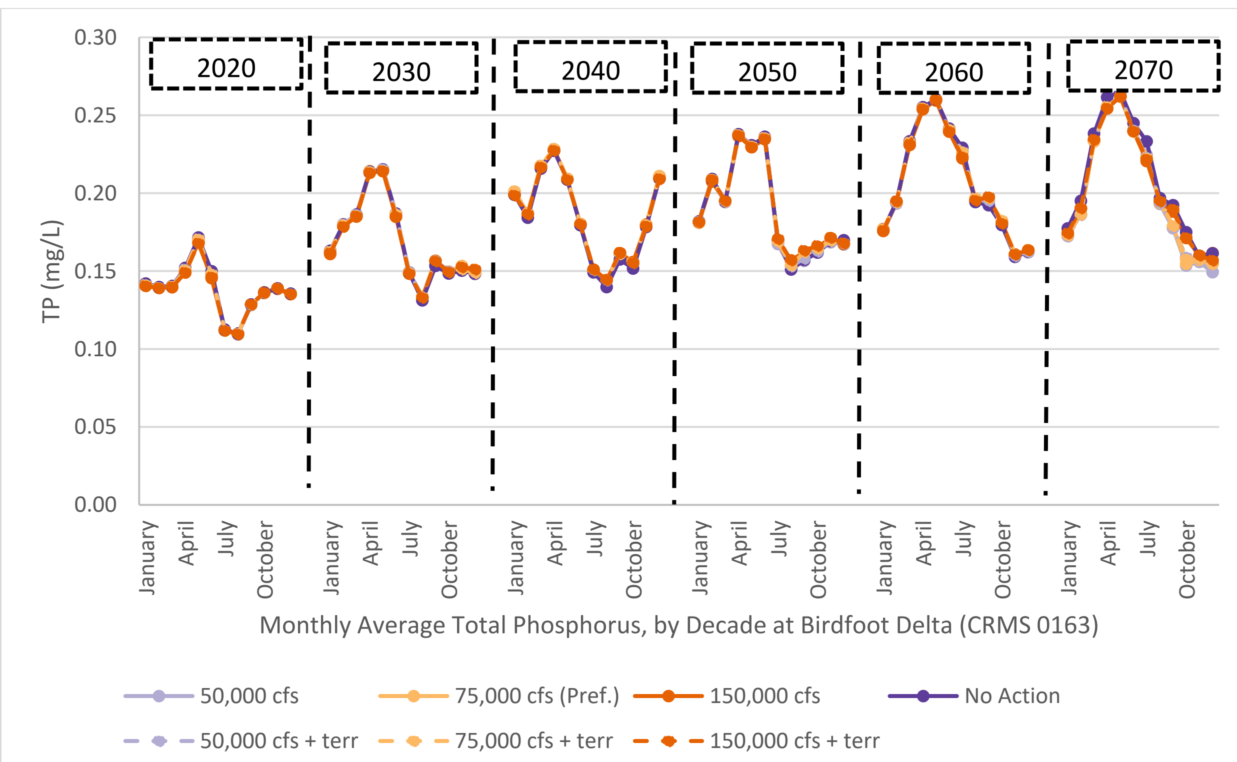


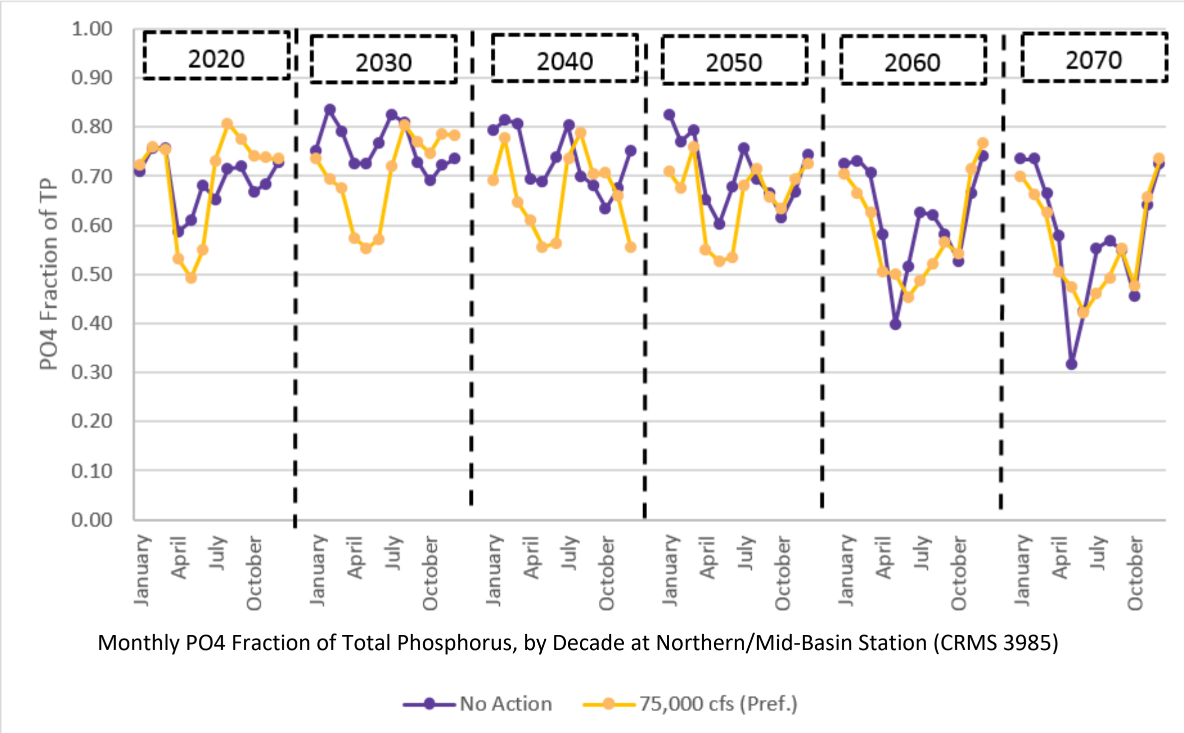
Figure 4.5-22. Average Modeled TP at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for All Alternatives under the Historical Representative Hydrograph.

The model projects that inorganic phosphate (PO_4), which generally represents the bioavailable phosphorus, would comprise between 5 percent to 88 percent of the TP. The PO_4 fraction of TP for the No Action Alternative is presented for comparison to the Applicant's Preferred Alternative in Figures 4.5-23 through 4.5-25. As shown in the graphs, the fraction of TP represented by PO_4 fluctuates seasonally under the No Action Alternative, and is generally projected to be higher in the winter and lower in the summer. The model projects that average PO_4 would not fall below 0.004 mg/L in the No Action Alternative, which is the level considered sufficient to support biological production as discussed in Chapter 3, Section 3.5 Surface Water and Sediment Quality (Robinson and DeRosa 2014). TP and PO_4 concentration data for all modeled stations are presented in Appendix L.

4.5.5.4.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative is projected to cause permanent, minor to moderate impacts on average phosphorus concentrations at five of the six representative stations during Project operations. Impacts on average phosphorus concentrations at the birdfoot delta station (CRMS 0163) are projected to be negligible. A shift in seasonal phosphorus trends that does not necessarily correspond to periods of diversion operation above base flow is projected. In general, minimum and maximum phosphorus concentrations are projected to be moderately elevated over the No Action Alternative throughout the basin.

Phosphorus concentrations projected for the Applicant's Preferred Alternative follow seasonal trends, but the trends differ from the No Action Alternative at all stations except the birdfoot delta station (CRMS 0163). As compared to the No Action Alternative, over the 50-year analysis period, the duration of elevated concentrations at the other five stations is projected to extend further into the summer months, and the onset of lower/minimum concentrations becomes delayed by as much as 5 months by 2040. By 2060, the seasonal variability of both TP and PO_4 are projected to be reversed from the variability projected for the No Action Alternative. The projected impact may be related to the extended length of time that the diversion is projected to operate above base flow in the last two modeled decades. The Mississippi River water would carry a more consistent load of sediment and TP into the basin during months when TP concentrations would historically be lower in the basin. Figures 4.5-20 through 4.5-22 depict the modeled average monthly TP concentrations for the Project alternatives, including the Applicant's Preferred Alternative and the No Action Alternative, over the 50-year analysis period at each of the six representative stations across the Barataria Basin.



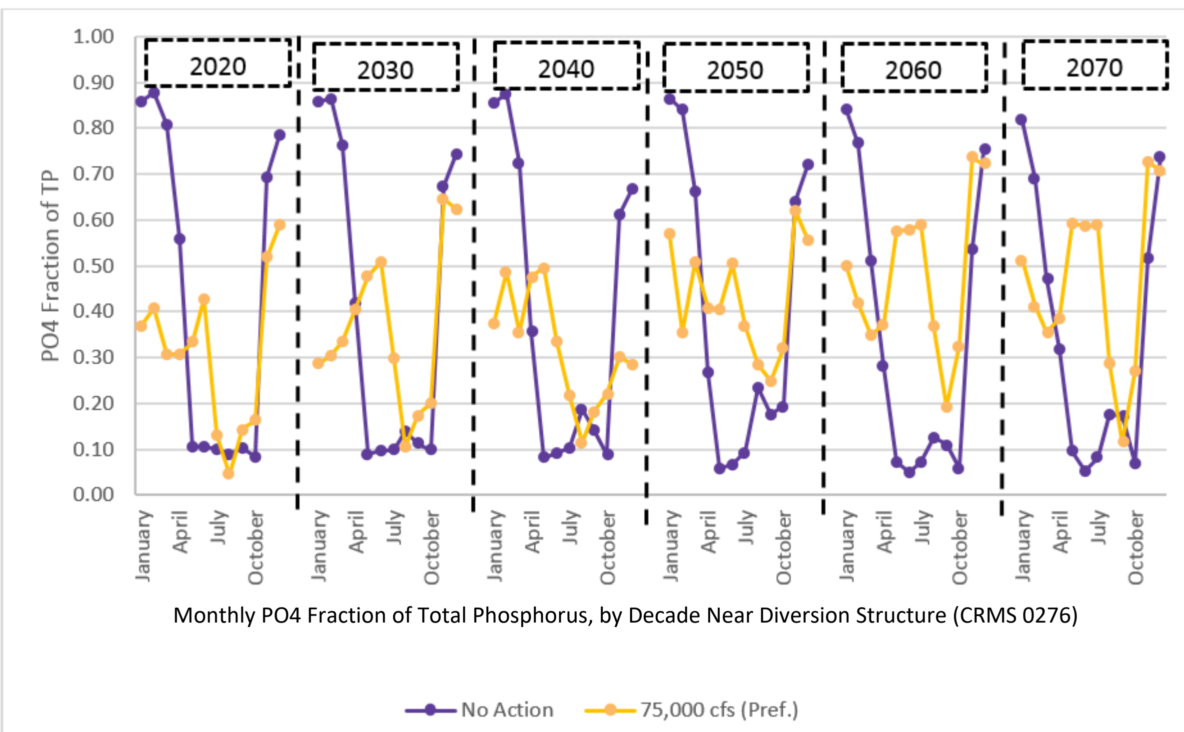
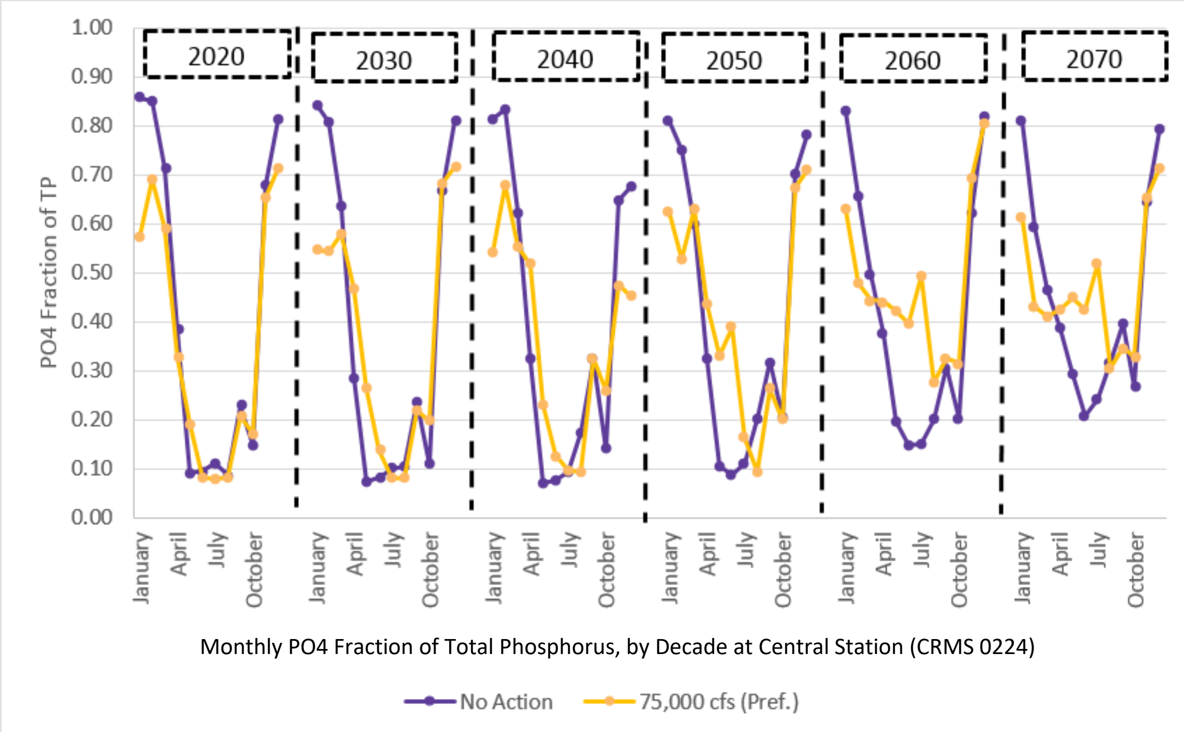


Figure 4.5-23. Average PO_4 fraction of TP at Two Stations in Northern Barataria Basin: the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for No Action Alternative and Applicant's Preferred Alternative under the Historical Representative Hydrograph.



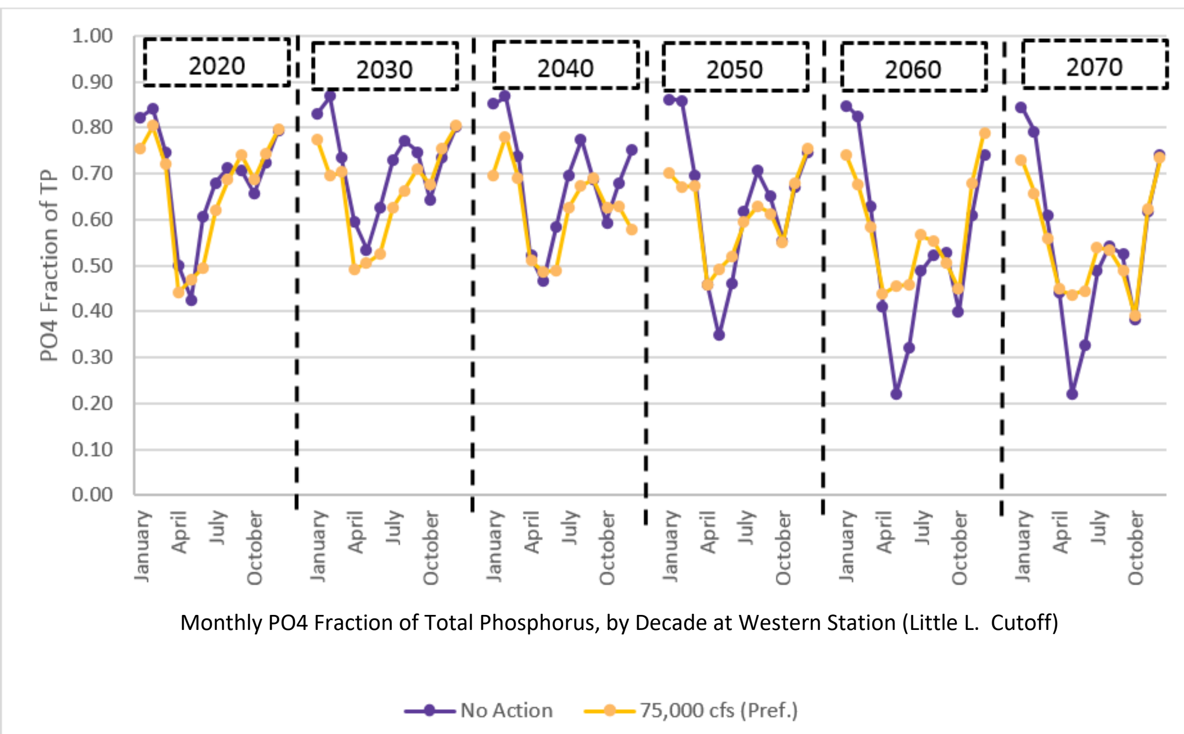
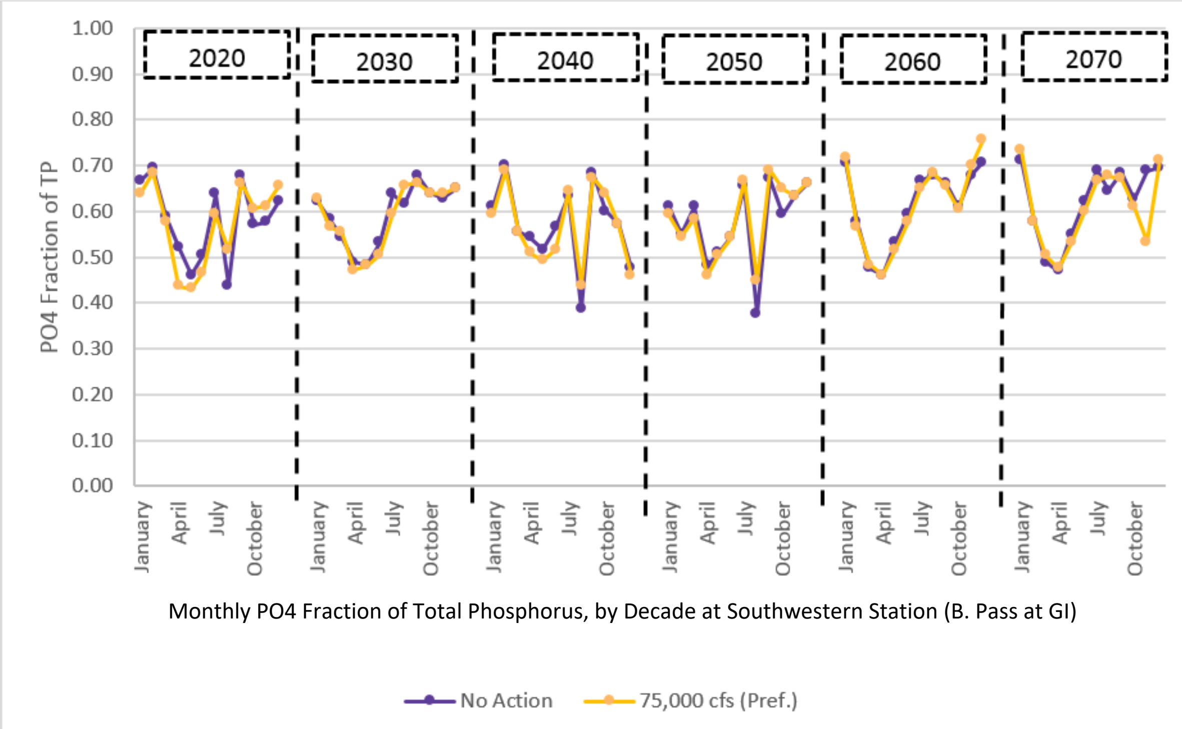


Figure 4.5-24. Average PO_4 fraction of TP at Two Stations in Central and Western Barataria Basin: the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph.



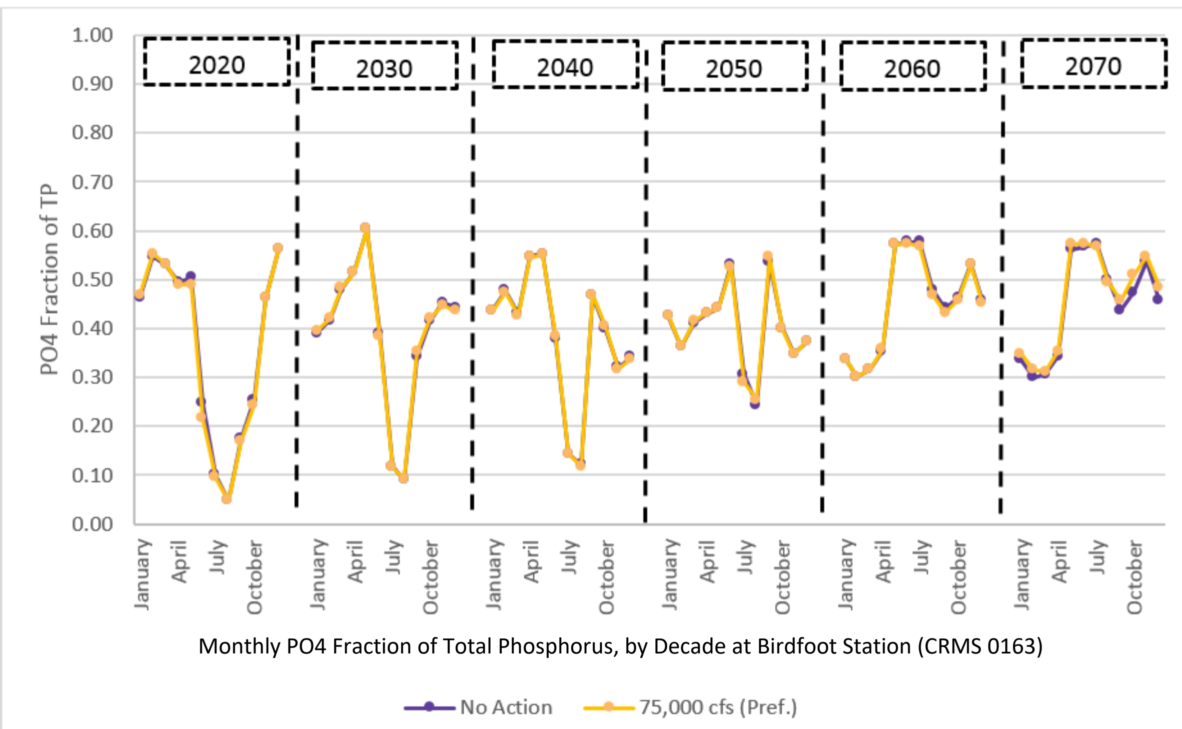


Figure 4.5-25. Average PO_4 fraction of TP at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for No Action Alternative and Applicant's Preferred Alternative under the Historical Representative Hydrograph.

Under the Applicant's Preferred Alternative, average TP and PO_4 concentrations are projected to be similar to the No Action Alternative at the birdfoot delta station (CRMS 0163). At the other five representative stations, both minimum and maximum average TP concentrations are projected to moderately increase (with some exceptions) with respect to the No Action Alternative over the duration of the proposed Project (see Figures 4.5-20 through 4.5-25). Differences between the Applicant's Preferred Alternative and the No Action Alternative range up to +/- 0.18 mg/L for TP and PO_4. Greater differences between the Applicant's Preferred Alternative and the No Action Alternative are projected at stations closer to the immediate outfall area due to the introduction of Mississippi River water to the system. Differences are projected to decrease with distance from the immediate outfall area as the newly introduced phosphorus is used by biomass and/or absorbed to sediments in the basin. TP and PO_4 concentrations at the station nearest the diversion (CRMS 0276) and the central station (CRMS 0224) are projected to remain higher than No Action Alternative concentrations throughout the 50-year analysis period, likely because of the proximity of these stations to the outfall, with minor exceptions: PO_4 concentrations are projected to return to No Action Alternative levels in the late fall/winter until 2050, and TP concentrations are projected to return to No Action Alternative levels in the late fall/winter in 2040 and 2050. At the western station (Little L. Cutoff) and the northern/mid-basin station (CRMS 3985), TP and PO_4 concentrations are projected to be variably higher or lower than the No Action Alternative depending on the time of year due to the aforementioned seasonality shift. The variability projected at these stations may be due to the influence on freshwater inputs at these locations. Both TP and PO_4 concentrations are projected to return to No Action Alternative levels in the fall/winter between 2050 and 2070 at these two stations. TP and PO_4 concentrations at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI) are projected to approximate No Action Alternative levels in winter/spring when the diversion would flow greater than the 5,000 cfs base flow, increase in the spring, and return to No Action Alternative levels within 1 month of the diversion closing (flowing at the 5,000 cfs base flow). In 2060 to 2070, when the diversion is projected to operate above base flow for portions of 11 months of the year, TP and PO_4 at this station approximate No Action Alternative concentrations except for the late fall/winter of 2070, when PO_4 concentrations are projected to be as much as 0.02 mg/L lower than No Action Alternative conditions. The southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI) is likely to be less impacted due to its distance from the immediate outfall area.

The model results project that the average PO_4 would not fall below 0.004 mg/L, which is the level considered sufficient to support biological production (Robinson and DeRosa 2014). Presently, Louisiana has narrative nutrient criteria (LAC 33:IX.1113.B.8), which state:

> "The naturally occurring range of nitrogen-phosphorous ratios shall be maintained. This range shall not apply to designated intermittent streams. To establish the appropriate range of ratios and compensate for natural seasonal fluctuations, the administrative authority will use site-specific studies to establish limits for nutrients. Nutrient concentrations that produce aquatic growth to the

extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters."

Currently average TN:TP ratios in the basin derived from data collected between 2000 and 2017 range from 6.8 in September to 15 in January. These data are not necessarily considered naturally occurring, as the basin has many anthropogenic nutrient inputs (see Chapter 3, Section 3.5 Surface Water and Sediment Quality). The Delft3D Basinwide Model projects that monthly average TN:TP ratios would decrease slightly under the Applicant's Preferred Alternative, ranging from 4.5 to 14.7 over the 50-year analysis period. The lowest ratio is projected at the northern/mid-basin station (CRMS 3985) in December of the second modeled decade, and the highest is projected at the station nearest the diversion (CRMS 0276) in August of the first modeled decade.

Section 4.10.4.4 states that under the Applicant's Preferred Alternative, an increased potential (and frequency) of phytoplankton blooms would be likely within the Project area. Whether or not these blooms would become HABs cannot be definitively determined based on currently available knowledge. Rather, the potential for bloom and HAB occurrence would be based on interacting and site-specific physical, chemical, and biological processes that would influence both phytoplankton abundance and composition (Bargu et al. 2019). This uncertainty is acknowledged in the impacts determination.

It is unlikely that the impacts of the Applicant's Preferred Alternative would result in a change in the naturally occurring range of nitrogen-phosphorous ratios.

Similar to the No Action Alternative, the model projects that PO_4 would comprise between 4 percent to 81 percent of the TP under the Applicant's Preferred Alternative (see Figures 4.5-23 through 4.5-25). The greatest fluctuations in the percentage of the PO_4 fraction of TP are projected to occur at the central station (CRMS 0224). The PO_4 fraction of TP is projected to trend similarly to the No Action Alternative the birdfoot delta station (CRMS 0163). The trends at the other five stations differ from the No Action Alternative, mimicking the trend difference in TP seasonality. TP and PO_4 concentration data for all modeled stations are presented in Appendix L.

Although impacts on phosphorus vary throughout the basin, overall minor to moderate, permanent impacts – a shift in seasonal phosphorus trends that does not necessarily correspond to periods of when the diversion would flow greater than the 5,000 cfs base flow, and minor to moderately elevated phosphorus concentrations as compared to the No Action Alternative – are projected under the Applicant's Preferred Alternative. The exception is the birdfoot delta station (CRMS 0163), which is projected to exhibit phosphorus concentrations similar to No Action Alternative levels throughout the 50-year analysis period. These impacts would not be beneficial or adverse to water quality itself; however, the seasonal shift in available nutrients (including phosphorus) may have adverse or beneficial impacts on other resources as described in Section 4.10.4.4.2.4 Nutrient Loading in Aquatic Resources and other relevant sections of this chapter.

4.5.5.4.3 Other Action Alternatives

As compared to the No Action Alternative, all action alternatives are projected to cause permanent, minor to moderate impacts on average phosphorus concentrations at all six basin stations with the exception of the birdfoot delta station (CRMS 0163), where impacts are projected to be negligible. The impacts from operation and maintenance of all action alternatives on phosphorus would be similar to the Applicant's Preferred Alternative in terms of seasonal trends.

Modeled average monthly phosphorus concentrations projected under the historical representative hydrograph for the 50-year analysis period (years 2020 to 2070) indicate that the other action alternatives would have negligible to moderate differences in average phosphorus concentrations compared to the Applicant's Preferred Alternative (see Figures 4.5-20 through 4.5-22). The differences between the action alternatives appear to be flow-dependent.

4.5.5.4.3.1 50,000 cfs Alternative

In general, the 50,000 cfs Alternative would result in lower TP loading from the river and is projected to result in minor to moderately lower phosphorus concentrations in the basin as compared to the Applicant's Preferred Alternative (see Figures 4.5-20 through 4.5-22).

4.5.5.4.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative is projected to result in minor to moderately higher average phosphorus concentrations in the basin as compared to the Applicant's Preferred Alternative (see Figures 4.5-20 through 4.5-22).

4.5.5.4.3.3 Terrace Alternatives

In general, phosphorus impacts resulting from terrace alternatives are projected to be similar to impacts for the associated flow alternatives without terraces. Minor differences as compared to the No Action and Applicant's Preferred Alternatives are shown on Figures 4.5-20 through 4.5-22.

4.5.5.5 Dissolved Oxygen

4.5.5.5.1 No Action Alternative

Under the No Action Alternative, current DO seasonal trends would continue. As described in Chapter 3, Section 3.5 Surface Water and Sediment Quality, average monthly DO concentrations ranged from 5.9 mg/L (July) to 12 mg/L (January) in the Mississippi River at Belle Chasse between 1977 and 2017. Individual sample concentrations in the river fall below the water quality standard of 5.0 mg/L in the summer months of July, August, and September. An analysis of the LDEQ data in the Barataria Basin showed that DO average monthly concentrations ranged from 6.1 mg/L (August) to 10 mg/L (January) between 2000 and 2017. While the basin is not impaired for DO, individual concentrations fell below 5.0 mg/L in samples collected from 2000 to 2017 in May, June, and August. See Chapter 3, Section 3.5 Surface Water and Sediment Quality for additional information about water quality standards in the Barataria Basin and Mississippi River.

As described in Section 4.5.3, the Delft3D Basinwide Model was used to assess alternative impacts on DO during the operational period 2020 to 2070. Figures 4.5-26 through 4.5-28 depict the modeled average monthly DO concentrations for the No Action Alternative over the 50-year analysis period at each of the six representative stations across the Barataria Basin (northern, central, and southern basin).

The model projects that seasonal trends similar to existing trends would continue at five of the six representative stations, with minimum DO concentrations occurring in the months of July through September, which coincide with warmer temperatures (see Figures 4.5-26 through 4.5-28). The onset of lower DO concentrations is projected to shift later in the year by 1 or 2 months (depending on the station) in the later modeled decades. At the birdfoot delta station (CRMS 0163, see Figure 4.5-28) the model projects a more variable trend that reflects Mississippi River influence. Average DO concentrations at the six representative stations would not fall below LDEQ's DO criterion at these stations, which range from 3.8 to 5.0 mg/L in selected months, during the 50-year analysis period. See Chapter 3, Section 3.5 Surface Water and Sediment Quality for additional information about water quality standards in the Barataria Basin and Mississippi River.

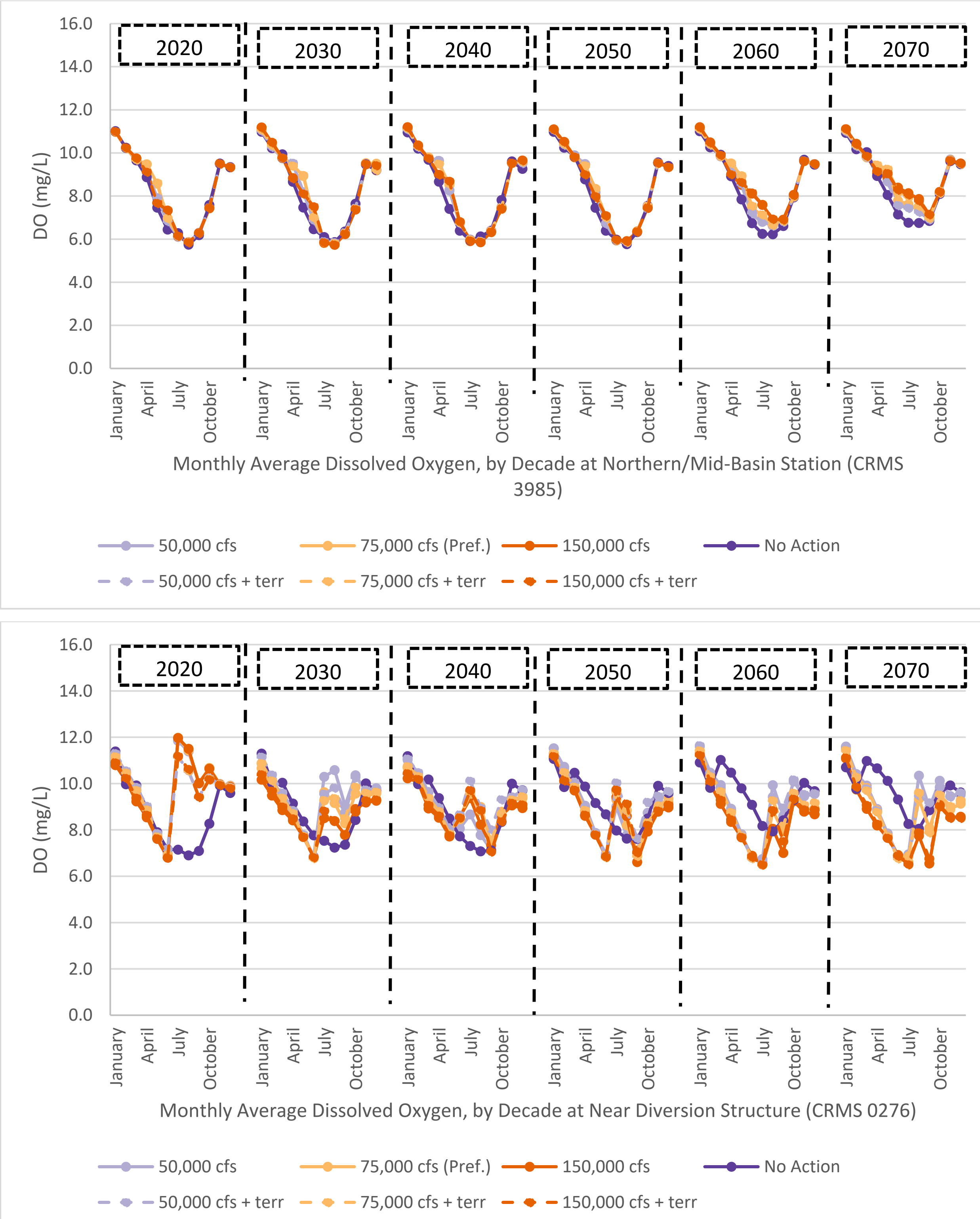


Figure 4.5-26. Average modeled dissolved oxygen at Two Stations in Northern Barataria Basin: the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for All Alternatives under the Historical Representative Hydrograph.

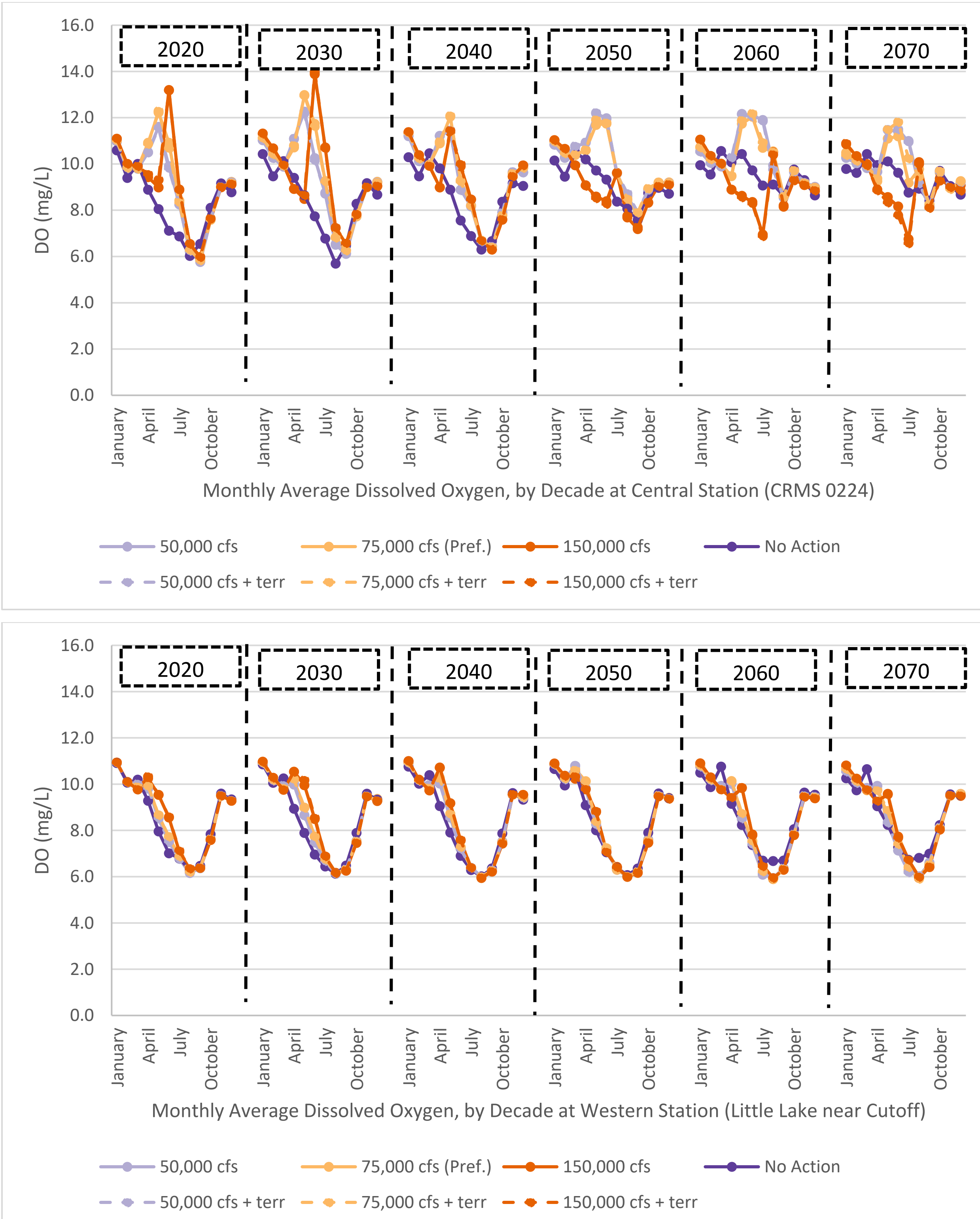
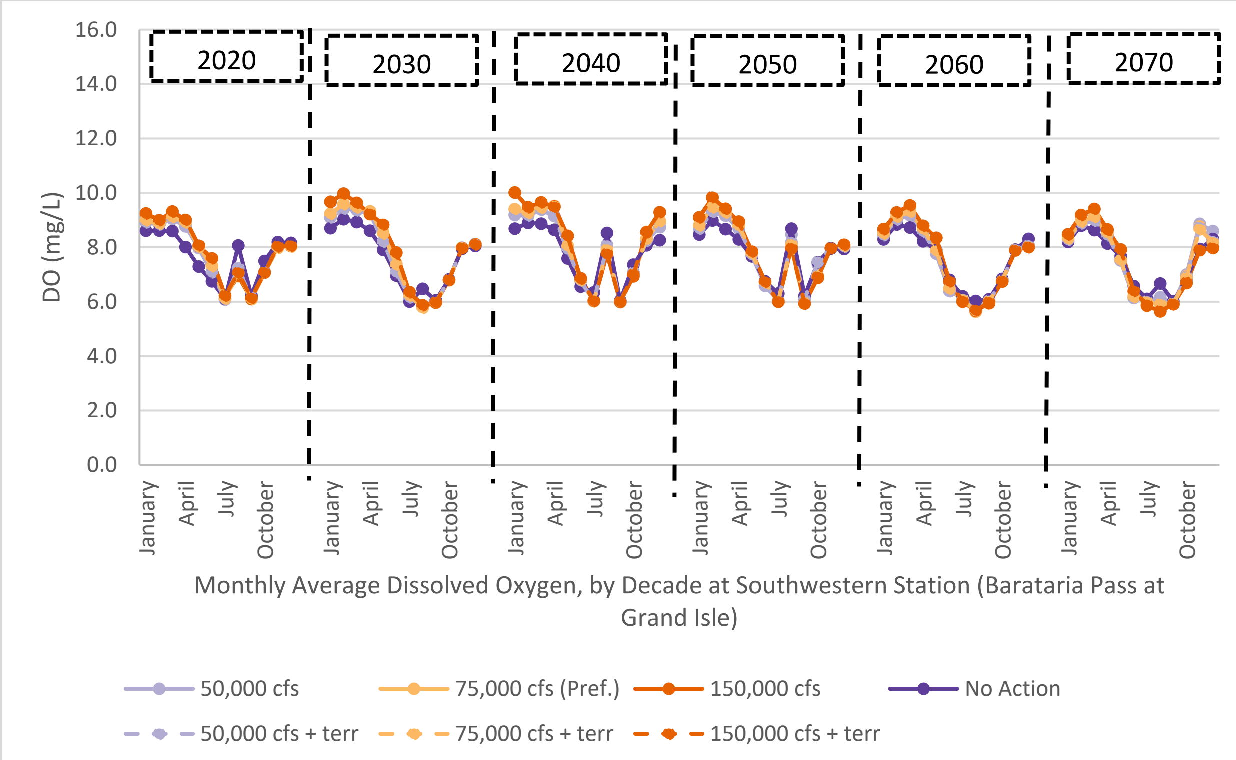


Figure 4.5-27. Average modeled dissolved oxygen at Two Stations in Central and Western Barataria Basin: the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph.



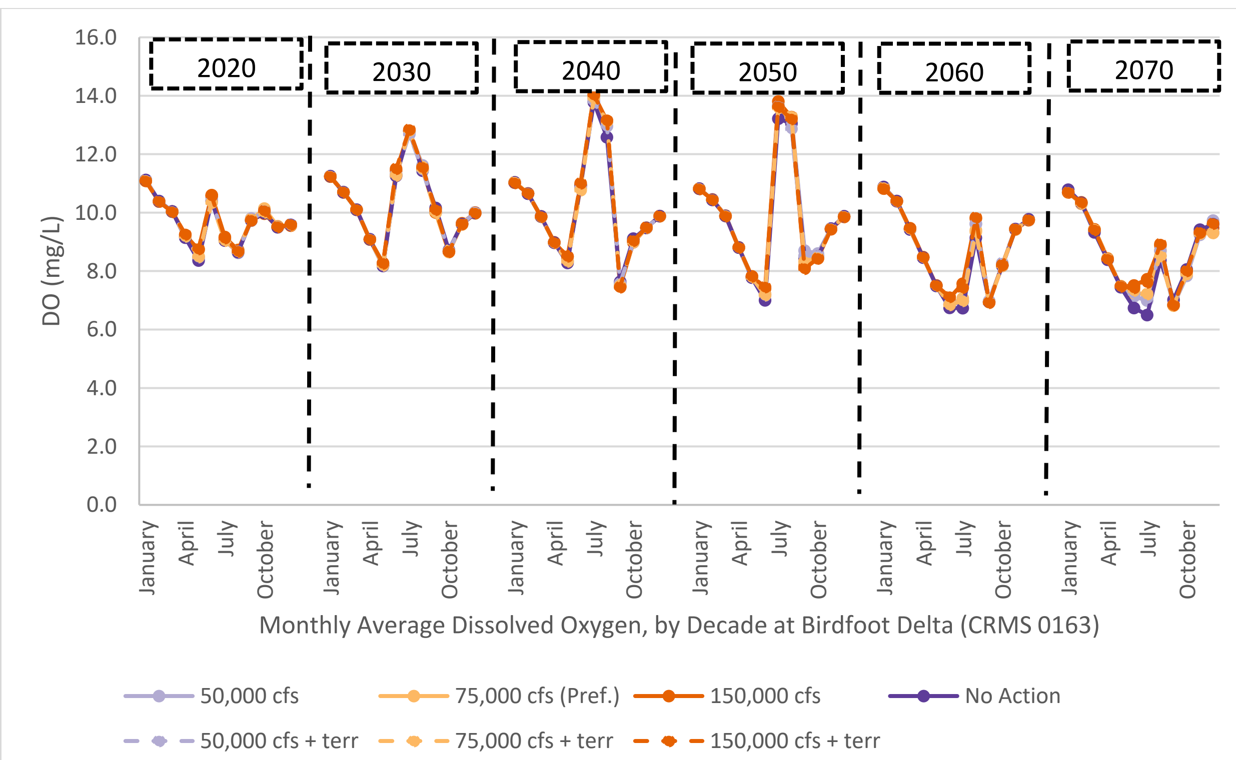


Figure 4.5-28. Average modeled dissolved oxygen at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for All Alternatives under the Historical Representative Hydrograph.

4.5.5.5.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative would cause permanent, minor to moderate impacts on average DO concentrations at five of the six modeled stations during Project operations. Moderate differences in DO trends and concentrations are projected for the Applicant's Preferred Alternative as compared to the No Action Alternative at the stations near the immediate outfall area (the station nearest the diversion [CRMS 0276], and the central station [CRMS 0224]) from the No Action Alternative. The differences become increasingly minor with distance from the immediate outfall area. Negligible to minor differences (in the last two modeled decades) are projected at the birdfoot delta station (CRMS 0163). Average monthly DO concentrations are not projected to decrease below 5 mg/L at any of the six stations during the Project analysis period. The majority of the Barataria Basin is shallow and not typically prone to stratification (Orlando et al. 1993). The model does not account for potential thermal stratification (see Section 4.1.3 for more information about the Delft3D Basinwide Model) and assumes the vertical water column is well mixed. Therefore, in limited areas or times when stratification may occur, the model does not include stratification impacts in its outputs.

Figures 4.5-26 through 4.5-28 depict the modeled average monthly DO concentrations for the Project alternatives, including the Applicant's Preferred Alternative and the No Action Alternative, over the 50-year analysis period at each of the six representative stations across the Barataria Basin. At the station nearest the diversion (CRMS 0276), DO concentrations are projected to decrease by up to 2.5 mg/L when the diversion would be operated above base flow (up to 75,000 cfs depending on river stages) as compared to the No Action Alternative. While the decreasing trend also occurs under the No Action Alternative, the greater decrease in concentrations for the Applicant's Preferred Alternative is likely reflective of the DO concentration in the introduced Mississippi River water, which decreases throughout the spring and into the summer months (but would still remain within water quality standards), and increasing water temperatures due to time of year and/or decreasing water depths resulting from the Project. In the first two modeled decades, DO is projected to moderately increase when diversion flows would be reduced to base flow to concentrations that are up to 5 mg/L higher than the No Action Alternative. In the final two modeled decades, the DO trend is projected to shift from the No Action Alternative trend such that minimum DO concentrations are projected in May through July rather than in July through September. These minimum DO concentrations are projected to be up to 2 mg/L lower than No Action Alternative concentrations. DO concentrations return to No Action Alternative levels (with some variability) in September through November before diversion flows would be reduced to base flow. The projected shifts in seasonal trend may be associated with increased phytorespiration from Project-related vegetative growth during the growing season.

At the central station (CRMS 0224), DO trends are projected to approximate No Action Alternative trends during the first three decades, with maximum DO concentrations occurring in April through June when the diversion would be operated above base flow (up to 75,000 cfs depending on river stages) and DO minimums occurring in August and September when diversion flows would be reduced to the 5,000 cfs base flow. Maximum concentrations are projected to be elevated over No Action Alternative maximums by up to 5 mg/L during these decades. This projected increase may be associated with increased phytorespiration and greater decreases in salinity projected at this location as compared to the other five stations, as oxygen is more soluble in fresh water than saltwater. In the final two modeled decades, the seasonal trend is projected to shift such that the maximum DO concentrations occur in May and June while the diversion would be operated above base flow (up to 75,000 cfs depending on river stages). DO concentrations are projected to return to No Action Alternative concentrations by September through November of each decade regardless of whether the diversion is flowing at base flow or above (up to 75,000 cfs depending on river stages), indicating that the proposed Project has a negligible impact during these times.

Projected DO trends and concentrations are projected to approximate No Action Alternative conditions at the other four modeled stations during the 50-year analysis period. Minor differences include slightly elevated or decreased concentrations (up to +/- 1 mg/L) with respect to the No Action Alternative.

Projected average monthly DO concentration ranges over the 50-year analysis period modeled under the No Action Alternative and the Applicant's Preferred Alternative are tabulated in Table 4.5-3. The projected differences in concentration ranges are minor to moderate and illustrate that the shifts in DO seasonal trends projected near the diversion are more pronounced than the shifts in average concentration on an annual basis. The modeled data indicate that monthly average DO concentrations at the six representative stations would not fall below LDEQ's DO criteria, which range from 3.8 to 5.0 mg/L in selected months, during the 50-year analysis period. DO concentrations associated with the Applicant's Preferred Alternative are projected to generally increase during the modeled period compared to the modeled projections for the No Action Alternative. The Delft3D Basinwide Model accounts for the influence of algal growth on nutrient and DO concentrations. The Delft3D Basinwide Model results do not suggest that that a hypoxic zone would form in the Barataria Basin due to Project implementation.

Although impacts on DO would vary throughout the basin, overall minor to moderate, permanent impacts are projected under the Applicant's Preferred Alternative. These impacts, including a shift in seasonal trend near the immediate outfall area, would not be beneficial or adverse to water quality itself; however, they may have adverse or beneficial impacts on other resources as described in the relevant sections of this chapter.

Table 4.5-3
DO Ranges at Six Barataria Basin Stations: Comparison between No Action Alternative and Applicant's Preferred Alternative (2020 to 2070)

Station	No Action Alternative	Applicant's Preferred Alternative	75,000 cfs+ Terraces	50,000 cfs	50,000 cfs + Terraces	150,000 cfs	150,000 cfs + Terraces
Northern/Mid-Basin Station (CRMS 3985)	5.7 to 11.0 mg/L	5.8 to 11.1 mg/L	5.8 to 11.1 mg/L	5.8 to 11.1 mg/L	5.8 to 11.1 mg/L	5.7 to 11.2 mg/L	5.8 to 11.2 mg/L
Station Nearest the Diversion (CRMS 0276)	6.9 to 11.4 mg/L	6.6 to 12.0 mg/L	6.5 to 11.4 mg/L	6.7 to 11.8 mg/L	6.6 to 11.6 mg/L	6.5 to 12.0 mg/L	6.5 to 11.2 mg/L
Central Station (CRMS 0224)	5.7 to 10.6 mg/L	5.9 to 13.0 mg/L	5.8 to 13.0 mg/L	5.8 to 12.3 mg/L	5.8 to 12.2 mg/L	6.0 to 13.9 mg/L	6.0 to 13.2 mg/L
Western Station (Little L. Cutoff)	6.0 to 10.9 mg/L	5.9 to 10.9 mg/L	5.9 to 10.9 mg/L	5.9 to 10.9 mg/L	5.9 to 10.9 mg/L	5.9 to 11.0 mg/L	5.9 to 11.0 mg/L
Southwestern Station, ear Grande Isle (B. Pass at GI)	6.0 to 9.0 mg/L	5.6 to 9.6 mg/L	5.7 to 9.6 mg/L	5.7 to 9.4 mg/L	5.7 to 9.4 mg/L	5.6 to 10.0 mg/L	5.7 to 10.0 mg/L
Birdfoot Delta Station (CRMS 0163)	6.5 to 13.8 mg/L	6.8 to 14.0 mg/L	6.8 to 13.9 mg/L	6.8 to 13.9 mg/L	6.8 to 13.8 mg/L	6.8 to 14.0 mg/L	6.8 to 14.0 mg/L

4.5.5.5.3 Other Action Alternatives

The impacts from operation of all other action alternatives on DO are projected to be similar to the Applicant's Preferred Alternative. Modeled average monthly DO concentrations for the historical representative hydrograph for the 50-year analysis period (years 2020 to 2070) project that the other alternatives would have negligible to moderate differences in DO concentrations as compared to the Applicant's Preferred Alternative (see Figures 4.5-26 through 4.5-28). DO concentrations modeled for all action alternatives would generally follow the same seasonal trends as the Applicant's Preferred Alternative. Average DO concentrations at the six representative stations would not fall below LDEQ's DO criteria, which range from 2.3 to 5.0 mg/L in selected months, during the 50-year analysis period under any action alternative.

4.5.5.5.3.1 <u>50,000 cfs Alternative</u>

Minor differences in DO concentrations are projected at all six representative stations as compared to the Applicant's Preferred Alternative. As described for the Applicant's Preferred Alternative, moderate differences in DO trends and concentrations as compared to the No Action Alternative are projected at the stations closest to the immediate outfall area (the station nearest the diversion [CRMS 0276], and the central station [CRMS 0224]). The differences become increasingly minor with distance from the immediate outfall area. The differences (up to +/- 0.9 mg/L) between 50,000 cfs and the 50,000 cfs + Terraces Alternatives and the Applicant's Preferred Alternative generally become more pronounced toward the end of the 50-year analysis period (see Figures 4.5-26 through 4.5-28).

4.5.5.5.3.2 150,000 cfs Alternative

Minor differences in DO concentrations are projected at five of the six representative stations as compared to the Applicant's Preferred Alternative. As described for the Applicant's Preferred Alternative, moderate differences in DO trends and concentrations as compared to the No Action Alternative are projected at the stations closest to the immediate outfall area (the station nearest the diversion [CRMS 0276], and the central station [CRMS 0224]). The differences become increasingly minor with distance from the immediate outfall area. The differences between the 150,000 cfs Alternative and the Applicant's Preferred Alternative range +/- 1.4 mg/L at all stations except the central station (CRMS 0224) and generally become more pronounced toward the end of the 50-year analysis period (see Figures 4.5-26 through 4.5-28).

At the central station (CRMS 0224), the model projects moderate impacts from more variable DO concentrations for the 150,000 cfs Alternative as compared to the Applicant's Preferred Alternative. Higher maximum DO (0 to 2.3 mg/L) and lower minimum DO concentrations (0 to 3.7 mg/L) are projected, with minimum DO concentrations deviating more from the Applicant's Preferred Alternative toward the end of the 50-year analysis period (see Figures 4.5-26 through 4.5-28). The model projects that the DO would be lowest in the last modeled decade (2060 to 2070) during the months when the DO would be highest under the Applicant's Preferred Alternative.

4.5.5.5.3.3 Terrace Alternatives

In general, impacts on DO resulting from terrace alternatives would be similar to the impacts for the associated flow alternative without terraces, with the following exceptions:

- As compared to the Applicant's Preferred Alternative, under the 75,000 cfs + Terraces Alternative, minor increases of up to 0.5 mg/L are projected in the second half of the year between 2060 to 2070 at the station nearest the diversion (CRMS 0276); and minor increases of up to 0.6 mg/L are projected during the summer months between 2040 to 2070 at the central station (CRMS 0224). These minor differences are likely due to altered flow patterns and the formation of a network of distributary channels that would evolve in the splay downstream of the diversion.

- The model projects moderate differences in DO concentrations (up to +/- 3.9 mg/L) between the 150,000 cfs and the 150,000 cfs + Terraces Alternatives during the second modeled decade (2020 to 2030) only. These differences are likely due to altered flow patterns and the formation of network of distributary channels that evolved in the splay downstream of the diversion.

4.5.5.6 Total Suspended Solids

4.5.5.6.1 No Action Alternative

As described in Chapter 3, Section 3.5 Surface Water and Sediment Quality, average monthly TSS concentrations ranged from 41 mg/L (September) to 199 mg/L (March) in the Mississippi River at Belle Chasse between 1977 and 2017. An analysis of LDEQ data in the Barataria Basin showed that TSS average monthly concentrations ranged from 19 mg/L (August) to 63 mg/L (January) between 2000 and 2017. Louisiana has not adopted water quality standards for TSS.

The model results project that under the No Action Alternative, TSS seasonal trends in the Barataria Basin would shift from the current trend of maximum TSS concentrations in January to a seasonal pattern of maximum TSS in February through May. This seasonality corresponds to the seasonal TSS pattern observed in the Mississippi River. This No Action Alternative seasonal pattern is projected at four of the six representative stations. This observed trend may be related to resuspension of bottom sediments caused by cold fronts during winter season. The exceptions are the northern/mid-basin station (CRMS 3985) and the birdfoot delta station (CRMS 0163). These two stations are influenced by freshwater inputs that are not related to the proposed Project, including Davis Pond Freshwater Diversion operations and Mississippi River flow, that are likely to impact TSS projections.

As described in Section 4.5.3, the Delft3D Basinwide Model was used to assess alternative impacts on TSS during the 50-year analysis period 2020 to 2070. Potential impacts on sediment transport and land change are discussed in Section 4.2 Geology and Soils. Figures 4.5-29 through 4.5-31 depict the modeled average monthly TSS concentrations for the No Action Alternative over the 50-year analysis period at each of the six representative stations across the Barataria Basin. Note that the y axis (TSS value) in these figures varies by station.

At all stations except the station nearest the diversion (CRMS 0276; where maximum TSS concentrations are projected to remain relatively consistent), maximum average TSS concentrations are projected to increase over time, while minimum average TSS concentrations would remain similar over the 50-year analysis period. The increase in maximums is likely related to increased salinity, which correlates to TSS, due to projected sea-level rise and land subsidence. TSS concentrations are projected to be consistently higher at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI) and the birdfoot delta station (CRMS 0163) than at the other four representative stations. Salinity at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI) is elevated in comparison to the other stations, and the birdfoot delta station (CRMS 0163) is impacted by inputs from the Mississippi River, which would result in increased TSS at these two locations.

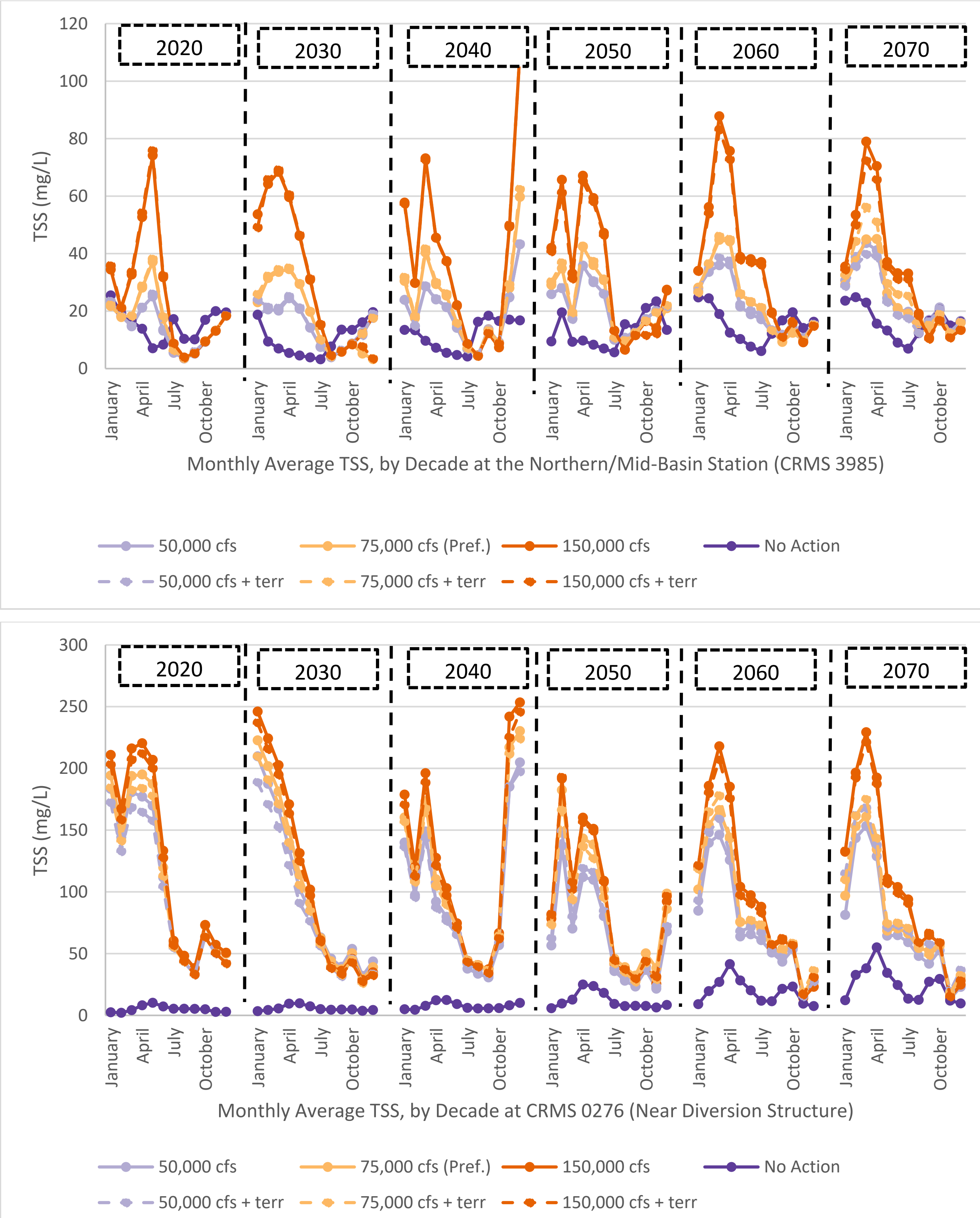


Figure 4.5-29. Average Modeled TSS at Two Stations in Northern Barataria Basin: the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for All Alternatives under the Historical Representative Hydrograph. Note the range of values on the y axis differs between figures.

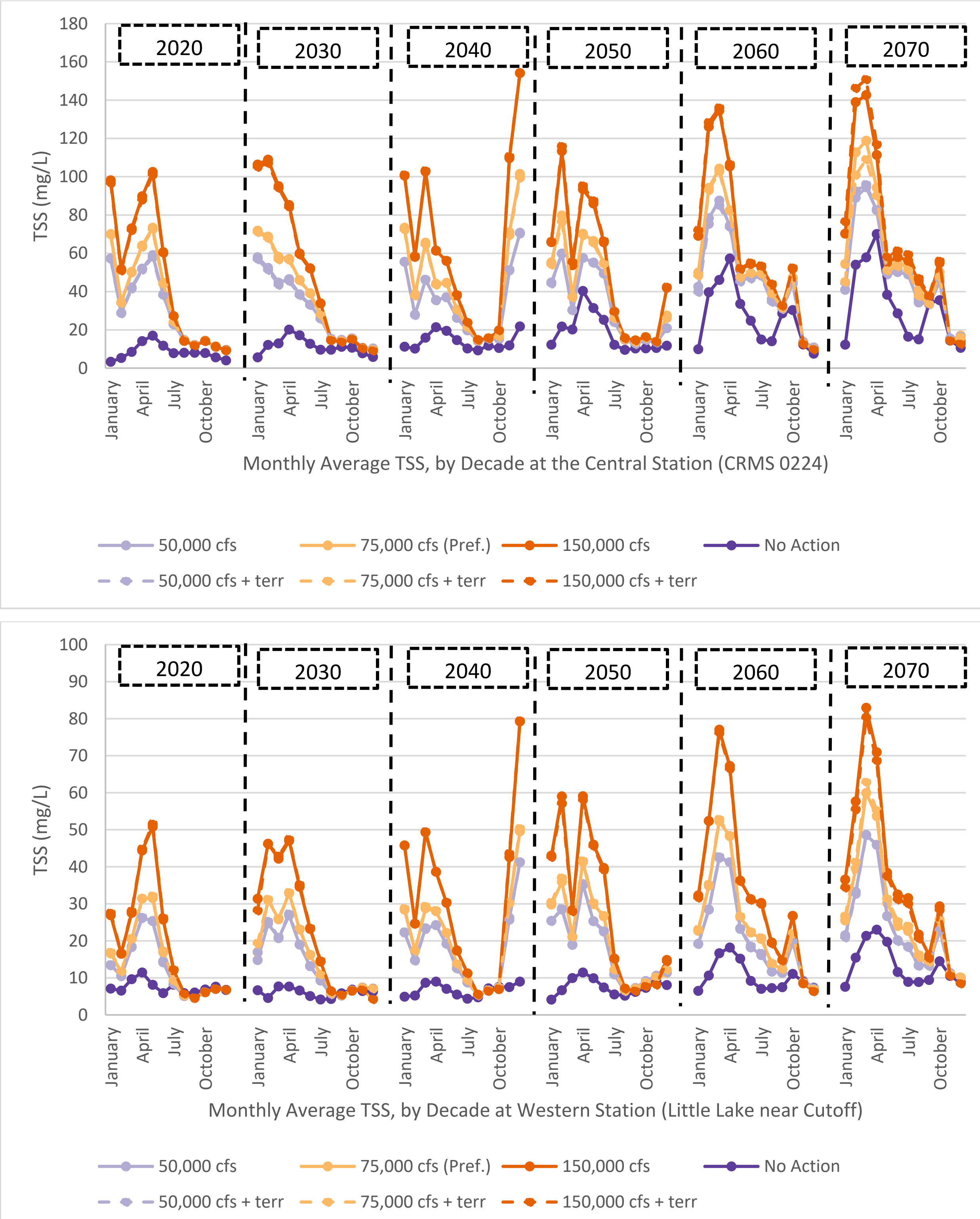


Figure 4.5-30. Average Modeled TSS at Two Stations in Central and Western Barataria Basin: the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph. Note the range of values on the y axis differs between figures.

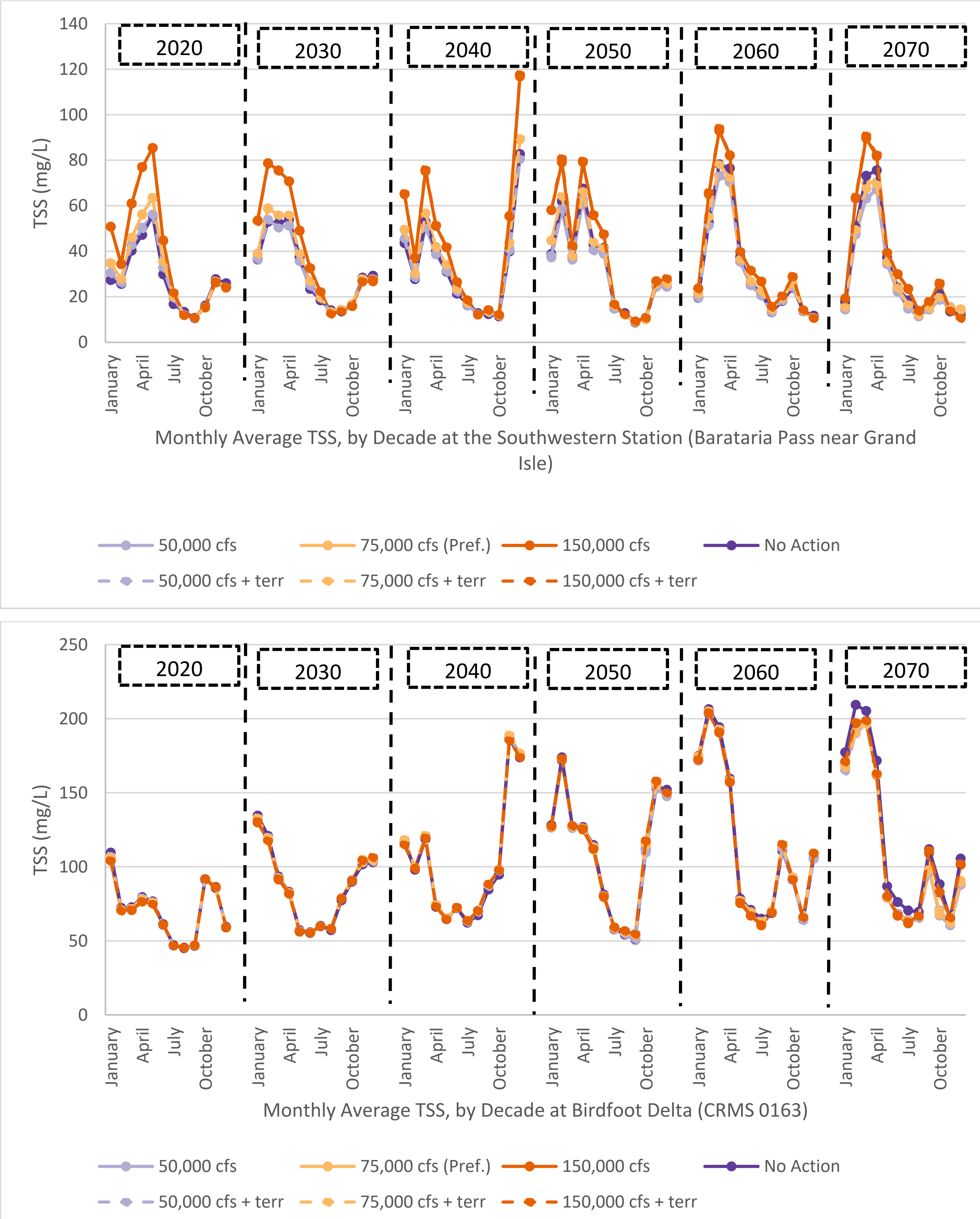


Figure 4.5-31. Average Modeled TSS at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for All Alternatives under the Historical Representative Hydrograph. Note the range of values on the y axis differs between figures.

4.5.5.6.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative is projected to cause a permanent, minor to moderate increase in average TSS concentrations in the Barataria Basin during Project operations. A shift in seasonal trends is projected at the northern/mid-basin station (CRMS 3985). Maximum TSS concentrations in the basin are projected to occur in February through April, when the diversion is projected to be flowing greater than the 5,000 cfs base flow and TSS concentrations are highest in the river. Figures 4.5-29 through 4.5-31 depict the modeled average monthly TSS concentrations for the Project alternatives, including the Applicant's Preferred Alternative and the No Action Alternative, over the 50-year analysis period at each of the six representative stations across the Barataria Basin.

At five of the six representative stations, projected TSS concentrations generally follow the same seasonal trends as the No Action Alternative. An exception is the northern/mid-basin station (CRMS 3985), where the seasonal trend under the Applicant's Preferred Alternative is projected to shift from the November through March maximums projected under the No Action Alternative to seasonal trends that are consistent with the Mississippi River with January through March maximums (see Figures 4.5-29 through 4.5-31). This projected shift in seasonal trends at the northern/mid-basin station (CRMS 3985) is related to the Project's projected decrease in salinity in the Barataria Basin, and the projected salinity decreases' subsequent impact on operations of Davis Pond.

Projected TSS concentration differences between the Applicant's Preferred Alternative and No Action Alternative vary at each of the six representative stations. Moderate increases in TSS concentrations are projected at the station nearest the diversion (CRMS 0276), the central station (CRMS 0224), the western station (Little L. Cutoff), and the northern/mid-basin station (CRMS 3985). The largest concentration differences are projected at the station nearest the diversion (CRMS 0276), where the TSS is projected to be up to 220 mg/L higher than No Action Alternative concentrations while the diversion is operating above base flow. TSS concentrations are not projected to return to No Action Alternative levels at the station nearest the diversion (CRMS 0276) during the 50-year analysis period. At the northern/mid-basin station (CRMS 3985) TSS concentrations are projected to increase as much as 30 mg/L as compared to the No Action Alternative in the spring months when the diversion is projected to be operating above the 5,000 cfs base flow (see Table 4.1-3 Mean Number of Days Diversion is Projected to be Operational by Decade in Section 4.1.3 Overview of Delft3D Basinwide Model for Impact Analysis).

The TSS is projected to drop by up to 11.5 mg/L below the No Action Alternative concentrations when diversion flows would be reduced to the 5,000 cfs base flow between 2020 and 2050. Between 2030 to 2040, the TSS is projected to increase above No Action Alternative levels with diversion operating above base flow again in December. TSS concentrations are projected to return to within 10 mg/L of No Action Alternative levels in the fall/winter months between 2050 and 2070 regardless of whether the diversion is operating at or above base flow, indicating that the proposed Project has a negligible impact during these times.

At the central station (CRMS 0224) and the western station (Little L. Cutoff), TSS concentrations are projected to remain elevated above No Action Alternative levels between January and September during the 50-year analysis period. At the central station (CRMS 0224), concentrations are projected to increase as much as 61 mg/L above No Action Alternative concentrations, and at the western station (Little L. Cutoff), concentrations are projected to increase as much as 35 mg/L during these months. As noted at the northern basin stations, between 2030 and 2040, the TSS is projected to increase above No Action Alternative levels with diversion flow greater than the 5,000 cfs base flow in December. TSS concentrations are projected to return to within 10 mg/L of No Action Alternative levels in the fall/winter months throughout the 50-year analysis period at the central station (CRMS 0224) and the western station (Little L. Cutoff).

Minor differences from the No Action Alternative are projected at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI) and the birdfoot delta station (CRMS 0163) throughout the analysis period (see Figure 4.5-31). The Applicant's Preferred Alternative concentrations are projected to differ +/- 7 mg/L from the No Action Alternative at the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI). At the birdfoot delta station (CRMS 0163) negligible differences from the No Action Alternative are projected until 2070. TSS concentrations are projected to be up to 18 mg/L lower than the No Action Alternative in 2070 only. These projected decreases in maximum concentrations are likely due to the projected decrease in salinity with respect to the No Action Alternative associated with the introduction of Mississippi River water in the basin. Projected minimum concentrations are similar to the No Action Alternative.

Louisiana has not adopted water quality standards for TSS. TSS influences turbidity, which is an optical measure of the amount of suspended particles within the water column. Louisiana's narrative turbidity criteria (LAC 33:IX.1113.B.9) state that turbidity other than that of natural origin shall not cause substantial visual contrast with the natural appearance of the waters of the state or impair any designated water use, and that turbidity shall not substantially exceed background. The established turbidity standard for the Mississippi River is 150 NTUs. The established turbidity standard for estuarine waterbodies is 50 NTU. It is difficult to predict whether Project operations would cause a turbidity impairment based on model projections for TSS concentrations. Suspension of TSS is dependent upon many factors including water flow, density, wind, and tidal mixing. See Chapter 3, Section 3.5 Surface Water and Sediment Quality for additional information about water quality standards in the Barataria Basin and Mississippi River.

Overall minor to moderate, permanent impacts on TSS are projected under the Applicant's Preferred Alternative. These impacts are not beneficial or adverse to water quality itself; however, the overall average increase in TSS projected under the Applicant's Preferred Alternative may result in adverse impacts on turbidity in some areas of the basin. Adverse or beneficial impacts of TSS to other resources are described in the relevant sections of this chapter.

4.5.5.6.3 Other Action Alternatives

Modeled average monthly TSS concentrations under the historical representative hydrograph for the 50-year analysis period indicate that the other alternatives would have negligible to moderate differences in TSS compared to the Applicant's Preferred Alternative (see Figures 4.5-29 through 4.5-31). The impacts from operation and maintenance of all action alternatives on TSS would be similar to the Applicant's Preferred Alternative. Seasonal trends and return to No Action Alternative conditions are projected to be similar to the Applicant's Preferred Alternative for all action alternatives.

4.5.5.6.3.1 <u>50,000 cfs Alternative</u>

Differences between the 50,000 cfs Alternative and the Applicant's Preferred Alternative are projected to be negligible at the birdfoot delta station (CRMS 0163). In general, the difference in concentrations compared to the Applicant's Preferred Alternative at the other five representative stations appears to be flow-dependent. Maximum TSS concentrations under the 50,000 cfs Alternative are expected to be between 0 to 23 mg/L lower than the Applicant's Preferred Alternative at these five stations. Minimum concentrations are projected to be similar to the Applicant's Preferred Alternative.

4.5.5.6.3.2 <u>150,000 cfs Alternative</u>

Differences between the 150,000 cfs Alternative and the Applicant's Preferred Alternative are projected to be negligible at the birdfoot delta station (CRMS 0163). In general, the difference in concentrations compared to the Applicant's Preferred Alternative at the other five representative stations appears to be flow-dependent. Maximum TSS concentrations are expected to be between 0 to 60 mg/L higher than the Applicant's Preferred Alternative at these stations. Minimum concentrations are projected to be similar to the Applicant's Preferred Alternative.

4.5.5.6.3.3 <u>Terrace Alternatives</u>

Differences between the terrace alternatives and the associated flow alternatives without terraces are projected to be negligible with the following exceptions:

- At the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI), the model projects that the 50,000 cfs + Terraces Alternative would result in TSS concentrations that are variably similar, slightly higher or slightly lower (up to +/- 12 mg/L) than the Applicant's Preferred Alternative for the first three decades. In the last decade, TSS concentrations are projected to be moderately higher (0 to 33 mg/L) than the Applicant's Preferred Alternative in the second half of the year. These differences are likely due to altered flow patterns and the formation of a network of distributary channels that would evolve in the splay downstream of the diversion.

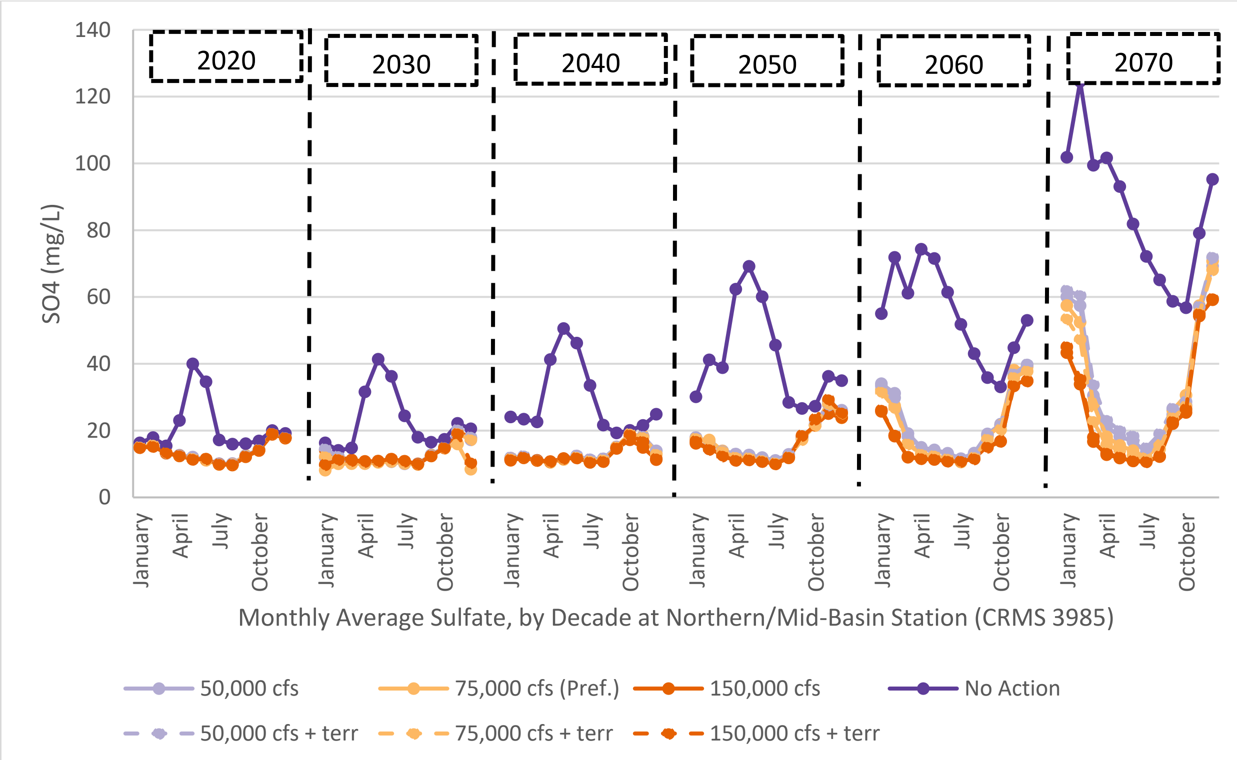
- Minor differences in maximum TSS concentrations between the 75,000 cfs + Terraces Alternative and the Applicant's Preferred Alternative are projected at all representative stations except the birdfoot delta station (CRMS 0163) in the last two modeled decades. The maximum TSS concentrations are projected to be +/- 0 to 14 mg/L compared to the Applicant's Preferred Alternative. These differences are likely due to altered flow patterns and the formation of a network of distributary channels that would evolve in the splay downstream of the diversion.

4.5.5.7 Sulfate

4.5.5.7.1 No Action Alternative

As described in Chapter 3, Section 3.5 Surface Water and Sediment Quality, average monthly sulfate concentrations ranged from 37 mg/L (April) to 136 mg/L (July) in the Mississippi River at Belle Chasse between 1977 and 2017. An analysis of LDEQ data in the Barataria Basin showed that sulfate average monthly concentrations are noticeably higher than in the river, ranging from 388 mg/L (July) to 1,042 mg/L (November) between 2000 and 2017. The Louisiana water quality criteria for sulfate are variable: in the Mississippi River at Belle Chasse and West Pointe A La Hache, the criterion is 120 mg/L; in the Barataria Basin the criteria range from 50 to 150 mg/L but are not applicable in estuarine subsegments. Existing concentrations and projected average concentrations for the No Action Alternative would continue to exceed water quality criteria on a seasonal basis where criteria are applicable.

As described in Section 4.5.3, the Delft3D Basinwide Model was used to assess alternative impacts on sulfate during the analysis period 2020 to 2070. Figures 4.5-32 through 4.5-34 depict the modeled average monthly sulfate concentrations for the No Action Alternative over the 50-year analysis period at each of the six representative stations across the Barataria Basin. Note the different values along the y axis in each figure.



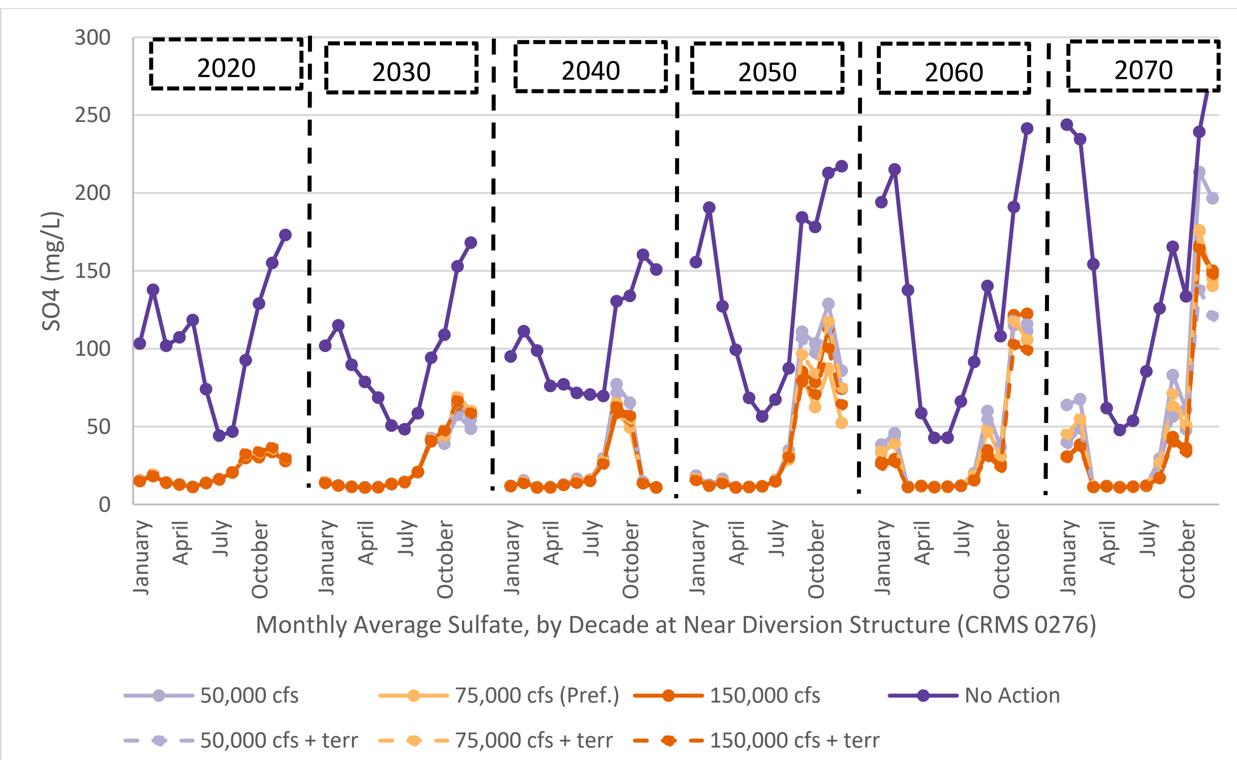
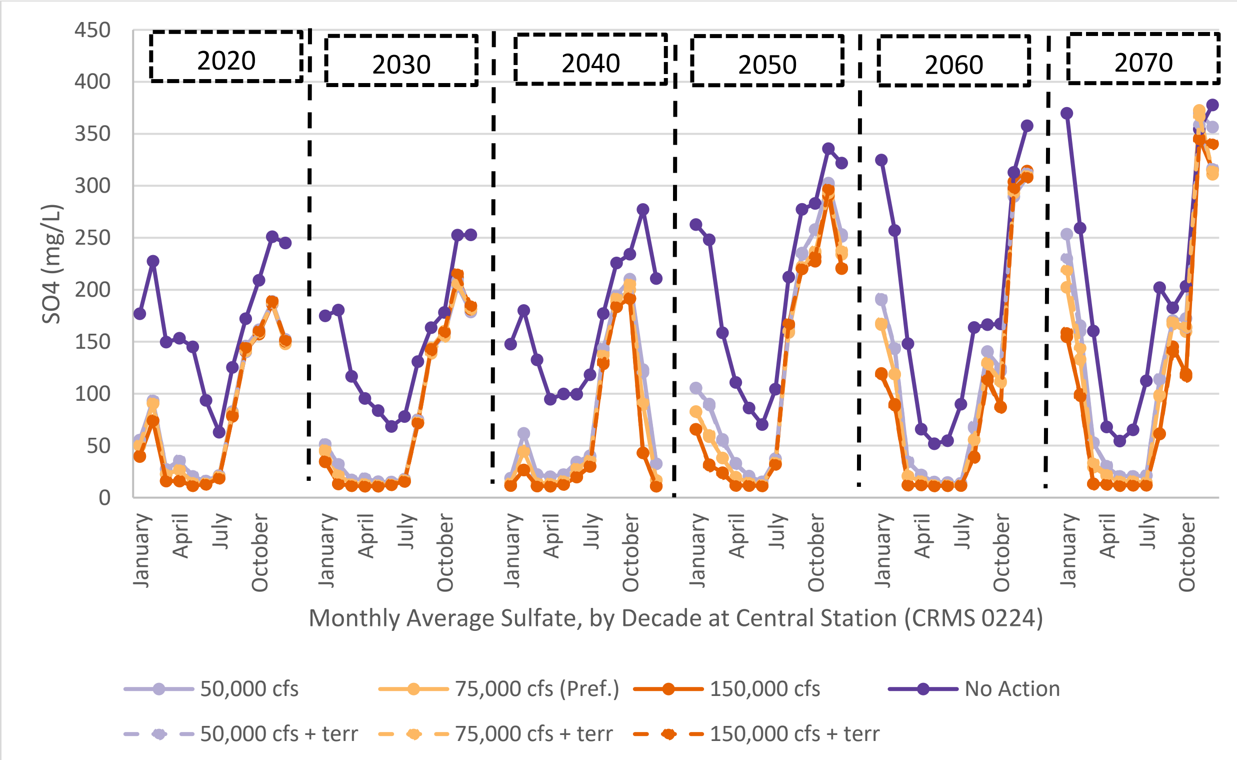


Figure 4.5-32. Average Modeled Sulfate at Two Stations in Northern Barataria Basin: the Northern/Mid-Basin Station (CRMS 3985) and the Station Nearest the Diversion (CRMS 0276) for All Alternatives under the Historical Representative Hydrograph. Note the range of values on the y axis differs between figures.



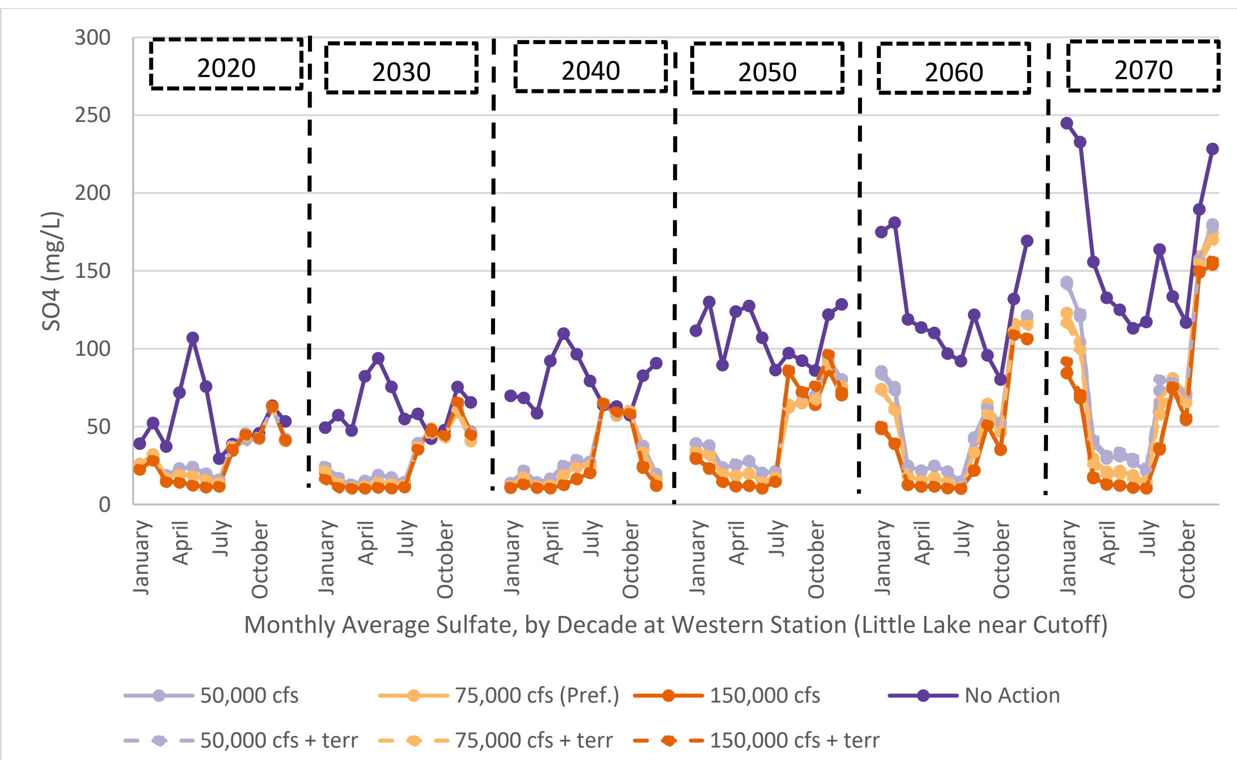


Figure 4.5-33. Average Modeled Sulfate at Two Stations in Central and Western Barataria Basin: the Central Station (CRMS 0224) and the Western Station (Little L. Cutoff) for All Alternatives under the Historical Representative Hydrograph. Note the range of values on the y axis differs between figures.

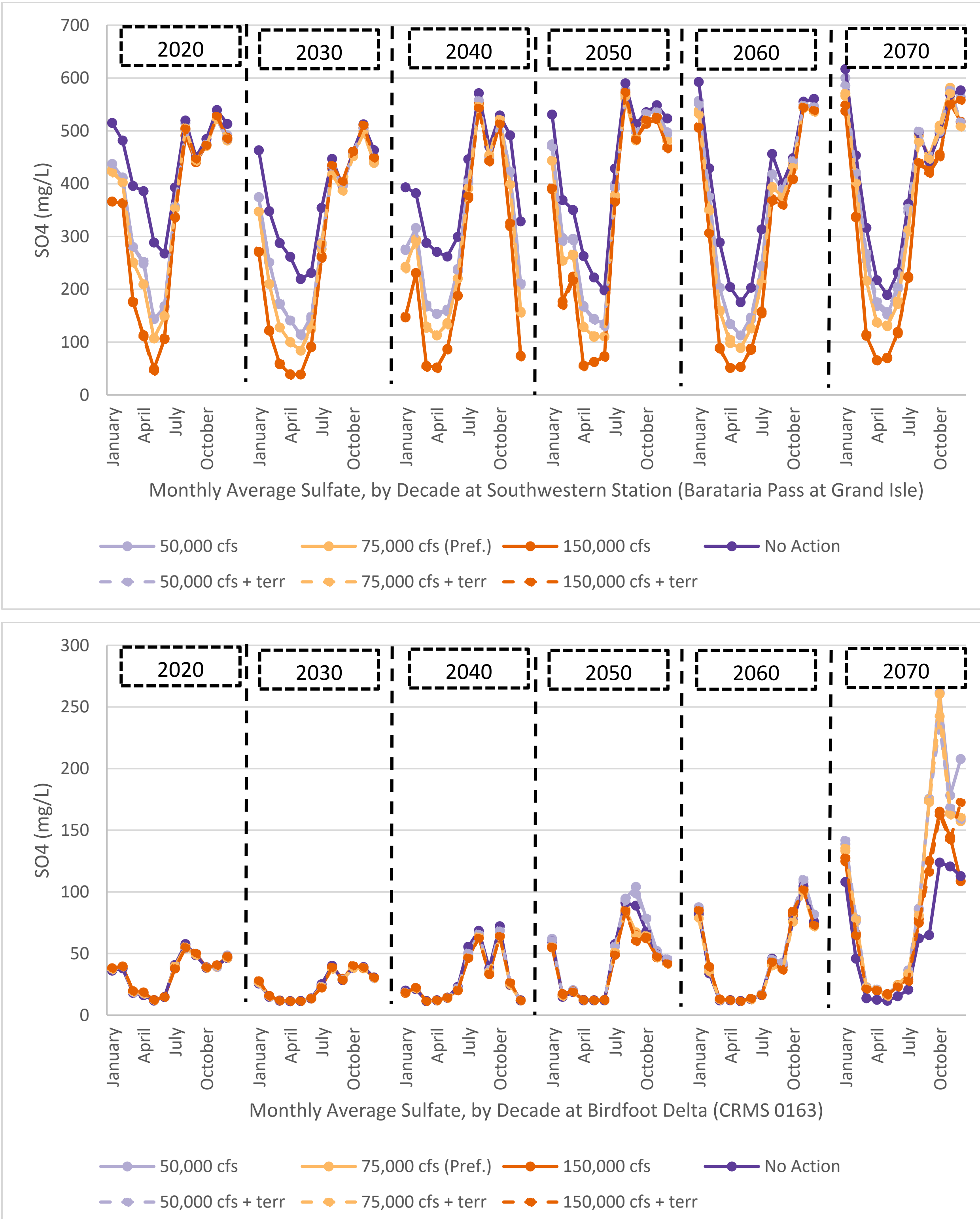


Figure 4.5-34. Average Modeled Sulfate at the Southwestern Station, at Barataria Pass near Grande Isle (B. Pass at GI) and the Birdfoot Delta Station (CRMS 0163) for All Alternatives under the Historical Representative Hydrograph. Note the range of values on the y axis differs between figures.

The model results project that in the No Action Alternative, sulfate seasonal trends would be similar to existing trends at the station nearest the diversion (CRMS 0276), the central station (CRMS 0224), and the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI). At the northern/mid-basin station (CRMS 3985), seasonal trends are projected to differ from existing trends: seasonal lows are projected to occur in March through May, and seasonal highs are projected to occur in September through December throughout the 50-year analysis period. At the western station (Little L. Cutoff), seasonal lows are projected to occur in March through May, and seasonal highs are projected to occur in September through December through 2060. Seasonal trends are projected to shift at the western station (Little L. Cutoff) in 2060 to 2070 to approximate the trends projected at the northern stations and the southwestern station, at Barataria Pass near Grande Isle (B. Pass at GI).

At all six representative stations, average sulfate concentrations are projected to increase over the Project analysis period (see Figures 4.5-32 through 4.5-34). Because sulfate in sea water contributes to salinity, the increase is likely due to projected sea-level rise and land subsidence allowing saline water to infiltrate the basin. The concentration increases are variable at each station: the greatest increases (up to 307 mg/L) are projected at the central station (CRMS 0224) and the lowest increases (up to 109 mg/L) are projected at the northern/mid-basin station (CRMS 3985).

4.5.5.7.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative is projected to cause permanent, minor to moderate decreases in average sulfate concentrations in the Barataria Basin during Project operations. Sulfate seasonal trends modeled for the Applicant's Preferred Alternative at all six representative stations are projected to be similar to seasonal trends noted for the northern and southern basin under the No Action Alternative, with minimum concentrations occurring in the spring/summer and maximums in the fall/winter. Figures 4.5-32 through 4.5-34 depict the modeled average monthly sulfate concentrations for the Project alternatives, including the Applicant's Preferred Alternative and the No Action Alternative over the 50-year analysis period at each of the six representative stations across the Barataria Basin.

Sulfate concentrations modeled for the Applicant's Preferred Alternative are generally lower than the No Action Alternative at all six representative stations. The introduction of lower sulfate Mississippi River water would be expected to lower the sulfate concentrations within the Barataria Basin. Lower concentrations are projected throughout the basin when the diversion is operating above base flow, but concentrations are projected to increase during the fall/winter regardless of when the diversion is projected to return to base flow conditions.

At five of the six representative stations, projected concentrations are generally minor to moderately lower than the No Action Alternative throughout the 50-year analysis period, ranging from 0 to 233 mg/L lower. The greatest differences in sulfate concentrations from the No Action Alternative are projected at the station nearest the diversion (CRMS 0276). This is presumably due to the influx of fresh water through the diversion. Project impacts are negligible to minor as compared to the No Action Alternative at the birdfoot delta station (CRMS 0163). Concentrations generally approximate No Action Alternative conditions until 2070 at the birdfoot delta station (CRMS 0163), when the model projects the Applicant's Preferred Alternative sulfate concentrations would exceed the No Action Alternative concentrations by as much as 137 mg/L in the final modeled year. The model outputs including the sulfate data for all modeled stations are included in Appendix L.

At all six representative stations, maximum average monthly sulfate concentrations remain consistently lower than No Action Alternative projected concentrations, but are projected to increase over the duration of the proposed Project, while average minimum concentrations remain similar over the Project analysis period. This increase is likely caused by the projected land subsidence and sea-level rise. At the station nearest the diversion (CRMS 0276), sulfate concentrations are not projected to return to No Action Alternative levels during the Project analysis period. At all other stations except the birdfoot delta station (CRMS 0163) where deviations from the No Action Alternative are negligible to minor, sulfate concentrations are projected to return to within 10 mg/L of No Action Alternative levels in the fall to winter of some modeled years.

Similar to the No Action Alternative, modeled average monthly sulfate concentrations are projected to seasonally exceed the LDEQ water quality criteria of 50 to 150 mg/L applicable to portions of the basin. The LDEQ water quality criteria are not applicable to the estuarine subsegments where the six representative stations are located. However, the generally lower sulfate concentrations projected by the model indicate that Project operations would improve water quality conditions with respect to sulfate.

Minor to moderate, permanent impacts on sulfate are projected under the Applicant's Preferred Alternative. The overall decrease in projected sulfate concentrations under the Applicant's Preferred Alternative would be beneficial with respect to attainment of water quality standards in the portions of the Barataria Basin where the standards apply.

4.5.5.7.3 Other Action Alternatives

The impacts from operation of all action alternatives on sulfate would be similar to the Applicant's Preferred Alternative. Modeled average monthly sulfate concentrations for the historical representative hydrograph for the 50-year analysis period (years 2020 to 2070) project that the other alternatives would have minor differences in sulfate concentrations compared to the Applicant's Preferred Alternative (see Figures 4.5-32 through 4.5-34). Seasonality trends are projected to be similar for all Project alternatives.

In all alternatives, modeled average sulfate concentrations, while lower than the No Action Alternative, would seasonally exceed the LDEQ water quality criteria of 50 to 150 mg/L applicable to portions of the basin. The LDEQ water quality criteria are not applicable to the estuarine subsegments where the six representative stations are located. However, as noted for the Applicant's Preferred Alternative, the generally lower sulfate concentrations projected by the model under all alternatives as compared to the No Action Alternative indicate that Project operations would improve water quality conditions with respect to sulfate.

4.5.5.7.3.1 50,000 cfs Alternative

In general, the 50,000 cfs Alternative is projected to result in slightly higher sulfate concentrations (0 to 46 mg/L) as compared to the Applicant's Preferred Alternative (see Figures 4.5-32 through 4.5-34). This would be consistent with the varying amount of lower sulfate Mississippi River water impacting the basin. As observed in the Applicant's Preferred Alternative, average maximum sulfate concentrations are projected to increase over the duration of the analysis period under all Project alternatives, while average minimum concentrations remain similar over the analysis period. This increase is likely due to projected sea-level rise and land subsidence.

4.5.5.7.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative is projected to result in slightly lower sulfate concentrations (0 to 62 mg/L). This would be consistent with the varying amount of lower sulfate Mississippi River water impacting the basin. As observed in the Applicant's Preferred Alternative, average maximum sulfate concentrations are projected to increase over the duration of the analysis period under all Project alternatives, while average minimum concentrations remain similar over the analysis period. This increase is likely due to projected sea-level rise and land subsidence.

4.5.5.7.3.3 Terrace Alternatives

Differences between the terrace alternatives and the associated flow alternatives without terraces are projected to be negligible (see Figures 4.5-32 through 4.5-34).

4.5.5.8 Fecal Coliform

4.5.5.8.1 No Action Alternative

Under the No Action Alternative, current fecal coliform trends as noted in Chapter 3, Section 3.5 Surface Water and Sediment Quality, are expected to continue. As described in Chapter 3, Section 3.4 Surface Water and Coastal Processes, Louisiana has adopted water quality standards for fecal coliform and, more recently, Enterococci. Average monthly fecal coliform concentrations in the Mississippi River at Belle Chasse from 1977 through 2017 ranged from 230 MPN/100 ml (April) to 2100 MPN/100 ml (October). The water quality in this subsegment of the river meets the LDEQ criteria for fecal coliform and fully supports its designated uses. One subsegment in the Mississippi River birdfoot delta (070401), and one subsegment in the Mississippi River Basin Coastal Bays and Gulf Waters (070601) are impaired by fecal coliform for the oyster propagation use. LDEQ lists the suspected bacterial sources as marina/boating sanitary on-vessel discharges and unknown sources (LDEQ 2020). A TMDL addressing fecal coliform has been approved for subsegment 070401. Implementation of the TMDL may result in improved water quality in this subsegment under the No Action Alternative. Average monthly fecal coliform concentrations in the Barataria Basin ranged from 3.5 MPN/100 ml (February) to 164 MPN/100 ml (December) between 2000 and 2017 (see Chapter 3, Section 3.4 Surface Water and Coastal Processes). Several subsegments within the Barataria Basin are listed as impaired by the LDEQ for not supporting designated uses, including subsegment 020904 where the Project outfall would be located. The oyster propagation use is listed as impaired by fecal coliform in subsegment 020904. No other subsegments within the Barataria Basin that are designated for oyster propagation are impaired for that use; however, subsegment 021102 in the Barataria Basin Coastal Bays and Gulf Waters is also impaired for the oyster propagation use. Twenty waterbody impairment combinations in 10 subsegments within the basin are impaired for designated uses of primary and secondary contact recreation (swimming and fishing) and outstanding natural resources. Bacterial contamination (fecal coliform or Enterococci) is the predominant parameter of concern for impairment for primary contact recreation. LDEQ lists the suspected bacterial sources for the Barataria Basin as waterfowl, wildlife other than waterfowl, natural sources, on-site sewage treatment systems, and/or permitted discharges from sewage treatment plants (LDEQ 2020). Agricultural runoff may also contribute to bacterial loads. TMDLs to address oxygen demand have been approved for 6 of the 11 impaired subsegments. Due to the lack of controls on bacteria loading entering the Barataria Basin, fecal coliform trends would be expected to continue under the No Action Alternative.

4.5.5.8.2 Applicant’s Preferred Alternative

Although the Mississippi River is not impaired for fecal coliform at the proposed diversion location, fecal coliform standards are more stringent in the Barataria Basin in the 10 basin subsegments designated for oyster propagation as compared to Mississippi River standards. Average monthly fecal coliform concentrations in the river (230 MPN/100 ml to 2,100 MPN/100 ml) are higher than the criteria set for oyster propagation use in the basin (14 MPN/100 ml to 43 MPN/100 ml) (see Chapter 3, Section 3.5.2.11 in Surface Water and Sediment Quality). The introduction of Mississippi River water containing elevated fecal coliform concentrations into oyster propagation areas could cause permanent, major, direct, adverse impacts on water quality by occasionally elevating fecal coliform concentrations in oyster propagation areas during Project operations. Elevated fecal coliforms may cause an oyster propagation use impairment. See Section 4.10 Aquatic Resources for more information about impacts on aquatic resources.

These adverse impacts may be ameliorated to some extent. Fecal coliform concentrations in the Mississippi River at Belle Chasse from 1977 through 2017 indicate decreasing concentrations with increasing river flow; higher river flows correlate with lower fecal coliform concentrations (see Chapter 3, Section 3.5.2.11 in Surface Water and Coastal Processes). Therefore, the direct impact of fecal coliform in the Barataria Basin during Project operations may be reduced because the diversion would discharge its maximum volume only during times when fecal coliforms would be lowest in the river. Additionally, mixing with Barataria Basin water could further reduce the impact of fecal coliform. A literature review of fecal coliform impacts from other projects in south Louisiana supports this hypothesis. A major decrease in fecal coliform concentrations was observed in Lake Pontchartrain during opening events of the Bonnet Carré Spillway (Adebayo 2017). Although periodic spikes in fecal coliform concentrations were observed in Lake Pontchartrain closest to stream outlets where the majority of sediment deposition occurred, the dilution effect combined with increased turbidity and decreased salinity and dissolved oxygen contributed to overall lower fecal coliform concentrations when the Bonnet Carré Spillway was open. A similar trend could be expected with implementation of the Applicant's Preferred Alternative. However, this lessening impact may not substantially reduce expected adverse impacts of fecal coliform on water quality in the basin from the introduction of Mississippi River water because even during high river flows in April, the lowest average concentrations in the river at Belle Chasse (230 MPN/100 ml) are considerably higher than oyster propagation standards in the basin.

4.5.5.8.3 Other Action Alternatives

4.5.5.8.3.1 50,000 cfs and 150,000 cfs Alternatives

Impacts from the other action alternatives would be similar to impacts from the Applicant's Preferred Alternative. The introduction of Mississippi River water containing elevated fecal coliform concentrations into oyster propagation areas could cause permanent, major, adverse impacts on water quality by occasionally elevating fecal coliform concentrations in oyster propagation areas during operations. Elevated fecal coliforms could impair the oyster propagation designated use of subsegments with this designation.

4.5.5.8.3.2 Terrace Alternatives

The three terracing alternatives would be expected to cause additional temporary, minor, localized adverse impacts as compared to the corresponding flow alternatives without terraces that may increase fecal coliform in the basin by impeding water movement and creating pools where fecal coliforms may concentrate and multiply.

4.5.5.9 Atrazine

4.5.5.9.1 No Action Alternative

In the Mississippi River at Belle Chasse, average monthly atrazine concentrations ranged from 0.06 μg/L (February) to 0.72 μg/L (May) between 2007 and 2017. Based on atrazine studies conducted in the basin in 2003 and 2014, atrazine concentrations in the Barataria Basin ranged from 0.01 μg/L to 0.84 μg/L (see Chapter 3, Section 3.5.2.12 in Surface Water and Coastal Processes). While the USEPA has not adopted a surface water standard for atrazine, the primary drinking water standard is 3 μg/L. Atrazine concentrations in both the Mississippi River and the Barataria Basin are below the primary drinking water standard. Under the No Action Alternative, current atrazine trends are expected to continue, as its use as an herbicide for agricultural practices is not expected to change.

4.5.5.9.2 Applicant's Preferred Alternative

The introduction of Mississippi River water into the Barataria Basin during Project operations is expected to have negligible impacts on atrazine concentrations in the basin. River (0.06 µg/L to 0.72 µg/L) and basin (0.01 µg/L to 0.84 µg/L) concentrations of atrazine are comparable and are well below the USEPA's primary drinking water standard of 3 µg/L. Furthermore, average atrazine concentrations in the river are at their highest in May through July. Depending on river flow conditions, the diversion may not be operating above base flow when elevated atrazine is present in the river. Results from a 2016 study conducted in the upper region of the Barataria Basin concluded that experimental atrazine exposure levels of 5, 50, and 200 µg/L (all of which are below concentrations typically found in the Mississippi River or Barataria Basin) triggered a stress response to phytoplankton communities only under low-nutrient conditions. The study also showed that phytoplankton communities grown under high-nutrient conditions, like those similar to the Project area, would likely recover from acute atrazine exposure (Starr et al. 2016).

4.5.5.9.3 Other Action Alternatives

Impacts on atrazine concentrations during operations of the five other action alternatives would be similar to the Applicant's Preferred Alternative. The introduction of Mississippi River water into the Barataria Basin is expected to have negligible impacts on atrazine concentrations in the basin.

4.5.5.10 Sediment Quality

The discussion in this section refers to the potential for Project operations to introduce sediments that may adversely impact the Barataria Basin. The sediment quality discussion below does not refer to sediment bed content for nutrients included in the Delft3D Basinwide Model sediment diagenesis model. See Section 4.2 Geology and Soils for a discussion of sediment bed impacts from loading, deposition, and resuspension as related to land building.

4.5.5.10.1 No Action Alternative

Under the No Action Alternative, sediment quality in the Mississippi River and the Barataria Basin are expected to remain similar to current conditions. Recent evaluations of Mississippi River sediments indicate that they are free from contaminants at concentrations that would result in detrimental impacts.

Studies of Barataria Basin sediments have indicated that sediment quality is generally good (see Chapter 3, Section 3.5.3 in Surface Water and Coastal Processes). For example, sediment sampling performed in 2002 in the Bayou Rigaud (north of Grand Isle) portion of the Barataria Bay Waterway revealed that only ammonia was present at levels requiring action. The bar channel reach of the Barataria Bay Waterway was evaluated for impacts from the DWH oil spill in 2010. Analytes indicative of oil contamination were present in shoal material only in trace amounts and at concentrations not expected to adversely impact benthic organisms (USACE 2010). Under the No Action Alternative, sediment quality in the Barataria Basin is expected to remain similar to current conditions. See Chapter 3, Section 3.5.3 in Surface Water and Sediment Quality for details about the existing sediment quality of the Mississippi River and Barataria Basin sediments.

4.5.5.10.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative is not expected to have impacts on sediment quality in the Mississippi River. As discussed in Chapter 3, Section 3.5 Surface Water and Sediment Quality, recent evaluations of Mississippi River sediments indicate that they are free from contaminants at concentrations that would result in discernible or measurable impacts from moving sediments into the Barataria Basin.

While the introduction of suspended sediments involves different processes than dredged material placement, there is no indication that the quality of sediments that would be carried by the Mississippi River via the proposed diversion complex would cause adverse discernible or measurable impacts on sediment quality in the Barataria Basin. The movement of sediment from the Mississippi River to the Barataria Basin during operations of the Applicant's Preferred Alternative is not expected to result in discernible or measurable impacts on sediment quality in the Barataria Basin.

The Project is not expected to disturb existing oiled sediment from the DWH oil spill. As stated in Section 4.4.4.2 in Surface Water and Coastal Processes, substantial scour potential exists primarily in the immediate outfall area. However, the extent of the DWH oiling has not been observed in the vicinity of the outfall area, as noted in Chapter 3, Section 3.10 Aquatic Resources, Figure 3.10-1.

Bed elevations are projected to decrease by 0.25 to 0.5 meter by 2070 due to reduced sediment load reaching the delta in areas observed to be impacted by oil. This decrease in elevation is similar to the projected decrease for the No Action Alternative.

4.5.5.10.3 Other Action Alternatives

Similar to the Applicant's Preferred Alternative, the other alternatives are not expected to impact the sediment quality of the Mississippi River or the Barataria Basin.

4.5.5.11 Hazardous Spills in the Mississippi River

As discussed in Chapter 3, Section 3.5.1.1 Mississippi River in Surface Water and Sediment Quality, the Mississippi River water quality in subsegment 070301, where the proposed Project diversion intake structure would be located, fully supports its designated uses. Designated uses for this subsegment include swimming, boating, fishing, and drinking water supply (LDEQ 2018b). The LDEQ's water quality assessment indicates that regulated substances are not present in concentrations that would cause a water quality impairment at the location of the intake structure.

LDEQ's assessment of this subsegment of the river includes contributions from industrial facilities' regulated discharges to the Mississippi River. In the event of accidental spills of hazardous substances into the river, these facilities would follow their required SPCC plan and SWPPP to minimize impacts of accidental releases.

As described in Chapter 2, Section 2.8.1.3 in Action Alternatives Carried Forward for Detailed Analysis and in Appendix F2 Preliminary Operations Water Control Plan, in the event of oil spills and other hazardous discharges into the Mississippi River upstream of the proposed MBSD intake structure, the diversion structure would be closed.

4.5.6 Summary of Potential Impacts

Table 4.5-4 summarizes the potential impacts on water and sediment quality for each alternative. Details are provided in Sections 4.5.4 and 4.5.5 above.

Table 4.5-4
Summary of Potential Impacts on Water and Sediment Quality from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No construction-related impacts would occur.
Operational Impacts	• Land subsidence and sea-level rise would continue, resulting in permanent elevated salinity, TSS, and sulfate throughout the basin. • Minor permanent increases in average minimum water temperatures in the basin. • Basin subsegments impaired by fecal coliforms would remain impaired. • Sediment quality in the Mississippi River and the basin would remain similar to current conditions.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Temporary, minor or moderate adverse construction impacts on water quality would result from the resuspension of fine sediments into the water column from in-water activities or runoff of sediment from adjacent work zones, resulting in increased turbidity and suspended sediments. • Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) to surface water in both the Mississippi River and the Barataria Basin. These impacts would be temporary and minor and mitigated by the implementation of SPCC and SWPPP plans.

Table 4.5-4
Summary of Potential Impacts on Water and Sediment Quality from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Permanent, minor to moderate decreases in salinity in the basin; minor increases in salinity in the birdfoot delta. • Permanent, minor decrease in basin water temperatures corresponding to diversion opening (flowing greater than the 5,000 cfs base flow). • Permanent shift in TN seasonal trends corresponding to diversion operating above the 5,000 cfs base flow; minor to moderately elevated TN concentrations throughout the basin. • Permanent shift in TP seasonal trends; minor to moderately elevated TP concentrations throughout the basin. • Permanent shift in DO seasonal trends corresponding to diversion opening (flowing greater than the 5,000 cfs base flow) near the immediate outfall area. Impacts on DO would vary throughout the basin, but overall minor to moderate, permanent impacts. • Permanent, minor to moderate increase in TSS concentrations throughout the basin; negligible to minor increases in TSS in the birdfoot delta; seasonal shift in TSS trends in the northern basin. • Permanent minor to moderate decrease in average sulfate concentrations in the basin. • Permanent, major adverse impacts caused by elevated fecal coliform concentrations in the basin possibly causing an oyster propagation use impairment. • Movement of sediment from Mississippi River to basin is not expected to result in measurable impacts on sediment quality in the basin.
50,000 cfs Alternative	
Construction Impacts	• Temporary, minor or moderate adverse construction impacts on water quality would result from the resuspension of fine sediments into the water column from in-water activities or runoff of sediment from adjacent work zones, resulting in increased turbidity and suspended sediment. • Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) to surface water in both the Mississippi River and the Barataria Basin. These impacts would be temporary and minor and mitigated by the implementation of BMPs and controls.

Table 4.5-4
Summary of Potential Impacts on Water and Sediment Quality from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Permanent, minor to moderate decreases in salinity in the basin; minor increases in salinity in the birdfoot delta. • Permanent, minor decrease in basin water temperatures corresponding to diversion opening (flowing greater than the 5,000 cfs base flow). • Permanent shift in TN seasonal trends corresponding to diversion opening (flowing greater than the 5,000 cfs base flow); minor to moderately elevated (slightly less elevated than Applicant's Preferred Alternative) TN concentrations throughout the basin. • Permanent shift in TP seasonal trends; minor to moderately elevated (slightly less elevated than Applicant's Preferred Alternative) TP concentrations throughout the basin. • Permanent shift in DO seasonal trends corresponding to diversion opening (flowing greater than the 5,000 cfs base flow) near the immediate outfall area. Impacts on DO would vary throughout the basin, but overall minor to moderate, permanent impacts. • Permanent, minor to moderate increase (slightly less elevated than Applicant's Preferred Alternative) in TSS concentrations throughout the basin; negligible to minor increases in TSS in the birdfoot delta; seasonal shift in TSS trends in the northern basin. • Negligible to moderate decrease (slightly less decreased than Applicant's Preferred Alternative) in average sulfate concentrations in the basin. • Permanent, major adverse impacts caused by elevated fecal coliform concentrations in the basin possibly causing an oyster propagation use impairment. • Movement of sediment from Mississippi River to basin is not expected to result in measurable impacts on sediment quality in the basin.
150,000 cfs Alternative	
Construction Impacts	• Temporary, minor or moderate adverse construction impacts on water quality would result from the resuspension of fine sediments into the water column from in-water activities or runoff of sediment from adjacent work zones, resulting in increased turbidity and suspended sediment. • Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) to surface water in both the Mississippi River and the Barataria Basin. These impacts would be temporary and minor and minimized by the implementation of BMPs and controls.

Table 4.5-4
Summary of Potential Impacts on Water and Sediment Quality from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Permanent, minor to moderate decreases in salinity in the basin; negligible to minor increases in salinity in the birdfoot delta. • Permanent, minor decrease in basin water temperatures corresponding to diversion opening (flowing greater than the 5,000 cfs base flow). • Permanent shift in TN seasonal trends corresponding to diversion opening (flowing greater than the 5,000 cfs base flow); minor to moderately elevated (slightly more elevated than Applicant's Preferred Alternative) TN concentrations throughout the basin. • Permanent shift in TP seasonal trends; minor to moderately elevated (slightly more elevated than Applicant's Preferred Alternative) TP concentrations throughout the basin. • Permanent shift in DO seasonal trends corresponding to diversion opening (flowing greater than the 5,000 cfs base flow) near the immediate outfall area. Impacts on DO would vary throughout the basin, but overall minor to moderate, permanent impacts. • Permanent, minor to moderate increase (slightly more elevated than Applicant's Preferred Alternative) in TSS concentrations throughout the basin; negligible to minor increases in TSS in the birdfoot delta; seasonal shift in TSS trends in the northern basin. • Negligible to moderate decrease (slightly more decreased than Applicant's Preferred Alternative) in average sulfate concentrations in the basin. • Permanent, major adverse impacts caused by elevated fecal coliform concentrations in the basin possibly causing an oyster propagation use impairment. • Movement of sediment from Mississippi River to basin is not expected to result in measurable impacts on sediment quality in the basin.
Terrace Alternatives	
75,000 cfs + Terraces Alternative	
Construction Impacts	• As compared to the No Action Alternative, this alternative would have the substantially similar construction impacts as that of the 75,000 cfs Alternative (see above). The construction of marsh terrace features in the immediate outfall area would have negligible additional impacts on surface water and sediment quality.
Operational Impacts	• As compared to the No Action Alternative, this alternative would have the same operational impacts as that of the 75,000 cfs Alternative (see above) with the exception of the following minor differences. ○ Slightly lower maximum monthly average salinities than the Applicant's Preferred Alternative closer to and downstream of the immediate outfall area are projected at the station nearest the diversion (CRMS 0276) and the central station (CRMS 0224). ○ Slightly higher minimum temperatures than the Applicant's Preferred Alternative at all stations except the birdfoot delta station (CRMS 0163) likely due to altered flow patterns caused by the terraces and the formation of the network of distributary channels that are projected to evolve in the splay downstream of the diversion. ○ Variable, negligible to minor differences in TN, TP, DO, TSS, and sulfate concentrations compared to the Applicant's Preferred Alternative. ○ Additional temporary, minor, localized adverse impacts as compared to the Applicant's Preferred Alternative caused by elevated fecal coliform in the basin due to impeded water movement creation of pools where fecal coliforms may concentrate and multiply.

Table 4.5-4 Summary of Potential Impacts on Water and Sediment Quality from Each Alternative	
Impact Type	**Impact Description (as Compared to No Action Alternative unless Otherwise Stated)**
50,000 cfs + Terraces Alternative	
Construction Impacts	• As compared to the No Action Alternative, this alternative would have the substantially similar construction impacts as that of the 50,000 cfs Alternative (see above). The construction of marsh terrace features in the immediate outfall area would have negligible additional impacts on surface water and sediment quality.
Operational Impacts	• As compared to the No Action Alternative, this alternative would have the same operational impacts as that of the 50,000 cfs Alternative (see above) with the exception of the following minor differences. o Variable, moderate differences in TSS concentrations are projected in the southern basin for the 50,000 cfs + Terraces Alternative vs. the 50,000 cfs Alternative. o Additional temporary, minor, localized adverse impacts as compared to the 50,000 cfs Alternative caused by elevated fecal coliform in the basin due to impeded water movement creation of pools where fecal coliforms may concentrate and multiply.
150,000 cfs + Terraces Alternative	
Construction Impacts	• As compared to the No Action Alternative, this alternative would have the substantially similar construction impacts as that of the 150,000 cfs Alternative (see above). The construction of marsh terrace features in the immediate outfall area would have negligible additional impacts on surface water and sediment quality.
Operational Impacts	• As compared to the No Action Alternative, this alternative would have the same operational impacts as that of the 150,000 cfs Alternative (see above) with the exception of the following minor differences. o Variable, moderate differences in DO concentrations are projected in the central basin for the 150,000 cfs + Terraces Alternative compared to the 150,000 cfs Alternative likely due to altered flow patterns and the formation of a network of distributary channels that would evolve in the splay downstream of the diversion. o Additional temporary, minor, localized adverse impacts as compared to the 150,000 cfs Alternative caused by elevated fecal coliform in the basin due to impeded water movement creation of pools where fecal coliforms may concentrate and multiply.

4.5.7 Section 408 Impacts

Based on Delft3D Basinwide Modeling results, Project operations are expected to reduce the frequency with which the USACE Davis Pond Freshwater Diversion Project (Davis Pond Freshwater Diversion) would be operated during certain months of the year to meet its current operational guidelines. From June through November, the Davis Pond Freshwater Diversion Operations Plan (2018) calls for Davis Pond to be operated to maintain a salinity of 5 ppt at the Little Lake Bay Dos Gris gauge (see Figure 4.5-35). From December through May, the Davis Pond Freshwater Diversion Operations Plan (2018) calls for Davis Pond to be operated to maintain the seasonal average salinity of 15 ppt line at the Barataria Bay N Grand Terre gauge (see Figure 4.5-35). The Delft3D Basinwide Model projects that salinity would fall below 5 ppt at the Little Lake Bay Dos Gris and/or the Barataria Waterway S of Lafitte gauge under all action alternatives including the Applicant's Preferred Alternative between March and

July during the 50-year analysis period. The model projects that under the No Action Alternative, salinity would remain above or near 5 ppt at the Little Lake Bay Dos Gris and the Barataria Waterway S of Lafitte gauge during the analysis period. Additionally, the Delft3D Basinwide modeled salinities for both the No Action Alternative and all action alternatives, including the Applicant's Preferred Alternative, are projected to decrease below 15 ppt at the Barataria Bay N Grand Terre gauge at various times in December through May over the 50-year analysis period.

Table 4.5-5 lists the number of days that the Delft3D Basinwide Model projects that the Davis Pond Freshwater Diversion would be open for each flow alternative during 2020 to 2029 (first modeled decade) and 2060 to 2069 (final modeled decade).

Source: CPRA 2019

Figure 4.5-35. Map of Salinity Gauges and Isohaline Lines in the Barataria Basin used for Operation of the Davis Pond Freshwater Diversion.

Table 4.5-5
Projected Davis Pond Freshwater Diversion Opening

Alternative	Number of Open Days 2020 to 2029	Number of Open Days 2060 to 2069
No Action	229	218
50,000 cfs	166	158
75,000 cfs (Applicant's Preferred)	168	132
150,000 cfs	158	111
Source: CPRA		

For comparison, Table 4.5-6 lists the number of days the Davis Pond Freshwater Diversion was open from 2015 to 2019.

Table 4.5-6
Davis Pond Freshwater Diversion Number of Open Days
2015 to 2019[a]

2015	108
2016	48
2017	152
2018	186
2019	44
Average 2015-2019	108

Source: USGS data recorded at the Davis Pond outfall station USGS 295501090190400 (USGS 2019)

[a] Days of operation were calculated by counting the number of days the daily average discharge was above 1,250 cfs. A base flow of 1,000 cfs is maintained; due to tidal fluctuations, the discharge at the gauge fluctuates above and below this base flow, even when the Davis Pond diversion structure is not operating.

4.6 WETLAND RESOURCES AND WATERS OF THE U.S.

4.6.1 Area of Potential Impacts

Direct impacts on wetlands associated with construction of the proposed Project would occur where wetlands are within the Project construction footprint (see Chapter 2, Figure 2.8-1). Indirect impacts (such as sedimentation due to runoff from construction) could impact wetlands adjacent to the Project construction footprint. During operations, the area of potential direct and indirect wetland impacts would extend throughout the Barataria Basin and the birdfoot delta, where the extent of wetlands would change as a result of the diversion of sediment and water from the Mississippi River to the basin.

4.6.2 Overview of Modeling Impact Analysis

As described in Section 4.1, the Delft3D Basinwide Model was used to project potential impacts on hydrodynamics, sediment transport, and water quality in the Barataria Basin and the birdfoot delta from implementation of the Project alternatives, including the No Action Alternative. The Applicant's Preferred Alternative would divert up to 75,000 cfs of fresh water and associated sediment and nutrients from the

Mississippi River into the Barataria Basin, directly impacting salinity, water surface elevations, above and belowground biomass, and organic and inorganic matter accretion (bed elevation). The available scientific literature found that each of these variables plays a role in the establishment, growth, and maintenance of coastal wetlands in the Mississippi River Deltaic Plain, and the combination of these factors influences the wetland losses and gains in the Project area over time. Impacts of the physical changes in salinity, hydrology, and elevation outputs (including inundation and accommodations for subsidence and sea-level rise) projected by the Delft3D Basinwide Model for hydrodynamic and sediment transport were used as inputs to the Delft3D Basinwide Model to project vegetation cover types and extent over the 50-year analysis period (2020 to 2070). The projected extent of vegetation, by cover type, was based on assumptions regarding the range of abiotic conditions (variations in salinity and inundation) that each wetland plant species can tolerate. Further, the Delft3D Basinwide Model for vegetation used plant species dominance to categorize wetlands by type (saline marsh is based on *Spartina alterniflora;* brackish on *Spartina patens;* fresh+intermediate on *Sagittaria lancifolia, Sagittaria latifolia*, *Phragmites australis*, *Typha* sp., and *Zizanipsis miliacea*). While there is no way to accurately predict future conditions, these model outputs provide reasonable projections that serve as a useful comparison tool to evaluate impacts from various diversion flows. The results of the Delft3D Basinwide Modeling as they relate to wetland impacts are discussed in Section 4.6.5.1 below. The projections presented in Section 4.6.5.1 assume 4.9 feet (1.5 meters) of sea-level rise by year 2100; additional modeling analyses were conducted with a lower level of sea-level rise over the analysis period, as described further in Appendix E. Additional information regarding the Delft3D Basinwide Model is included in Appendix E and Baustian et al. 2018.

4.6.3 Guidelines for Wetland Impact Determinations

Impact intensities for wetlands are based on the definitions provided in Section 4.1 and the following wetland-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on wetlands would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[57]
- minor: the impact on wetlands could be measurable but small in terms of area and the nature of the impact. A small impact on the size, integrity, or connectivity could occur; however, wetland function could not be impacted and natural restoration could occur if left alone;
- moderate: the action could cause a measurable impact on wetland indicators (size, integrity, or connectivity) or could result in a permanent loss of wetland

[57] The term “negligible” will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

acreage across local and adjacent areas. However, wetland functions could only be permanently altered in limited areas; and

- major: the action could cause a permanent loss or gain of wetlands across a widespread area. The character of the wetlands could be changed so that the functions typically provided by the wetland could be permanently altered.

4.6.4 Construction Impacts

4.6.4.1 Wetland Types and Extent

4.6.4.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. Limited changes to Project area wetlands due to ongoing trends of coastal erosion, subsidence, and sea-level rise are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project) (see Chapter 3, Section 3.6 Wetland Resources and Waters of the U.S. for more information about causes of wetland loss in the Project area).

In consideration of current, ongoing, and planned developments in the vicinity of the area of potential impacts, it is predictable to expect that at some future point the area may be developed for industrial or commercial purposes that could result in the loss or conversion of wetlands. However, it would be speculative to guess what exactly those future developments might be (see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future development impacting jurisdictional wetlands would be required to comply with the Clean Water Act and other applicable local, state, and federal environmental regulations.

4.6.4.1.2 Applicant’s Preferred Alternative

Adverse direct and indirect impacts on wetlands during Project construction would range from negligible to moderate, with short-term, negligible impacts occurring where Project construction impacts are temporary and wetlands are anticipated to return to preconstruction conditions; and permanent, minor to moderate, adverse impacts occurring in limited areas of the construction footprint where wetlands would be dredged or filled and converted to developed land, resulting in a permanent loss of wetland function or area. Beneficial impacts on wetlands would be permanent and moderate due to the beneficial use of dredged material for wetland creation and enhancement.

Wetlands within the proposed construction footprint were documented during wetland delineation surveys conducted by CPRA as well as a review of available aerial imagery and available National Wetlands Inventory data, and include forested, scrub/shrub, emergent wetland types. Forested wetlands in the construction footprint are dominated by invasive Chinese tallow and native species commonly found in disturbed, early-successional forested wetlands, rather than high-quality bottomland hardwood wetlands. Scrub/shrub were primarily observed along dredged areas with a higher elevation than the adjacent emergent wetlands and open water. Emergent wetlands in the Project footprint are dominated by smartweed (*Polygonum* sp.) and cattail (*Typha* sp.). These wetlands are within the permanent footprint of the Project facilities and would not be restored following construction. Therefore, they would no longer provide ecosystem functions such as wildlife habitat or water quality improvement, resulting in moderate, permanent, adverse impacts on wetlands in the Project construction footprint (see Chapter 3, Section 3.6.1 in Wetland Resources and Waters of the U.S.). However, as described in Section 4.6.5 below, the proposed Project would result in no net loss of wetlands because wetland losses during construction would be offset by gains in wetland acreage in the beneficial use areas and during operations (see Section 4.6.5), and the proposed Project would comply with Section 404 of the Clean Water Act. A total of 204.2 acres of wetlands would be dredged or filled within the Project construction footprint. In addition, 307.2 acres of open water (including waters of the U.S., other open water, and vegetated shallows containing SAV) would be within the Project construction footprint. Table 4.6-1 describes the total acreage of wetlands that would be directly impacted by construction. These wetlands are depicted in Figure 4.6-1. Impacts on SAV are addressed further in Chapter 4, Section 4.10.3.1, in Aquatic Resources.

CPRA would dredge emergent wetlands and open water in the immediate outfall area portion of the proposed construction footprint to create the outfall transition feature to increase the efficiency of water and sediment delivery to the Barataria Basin (see Chapter 2, Figure 2.8-1). While the area that would be dredged is primarily composed of open water, wetlands in the outfall transition feature would be converted to open water and may be maintained via dredging during operations to ensure continued transport of sediment to the Barataria Basin (see Table 4.6-1). CPRA also proposes to dredge an access channel for barge deliveries of construction materials and equipment during construction. The access channel would be dredged in two sections to increase depths for the passage of shallow-draft vessels. The first section that would be dredged is a portion of Bayou Dupont where it crosses the southern end of The Pen. The second section that would be dredged is located in the immediate outfall area of the Project. Overall, approximately 0.9 acres of emergent wetlands would be impacted, as depicted in Figure 4.6-1.

Table 4.6-1
Wetlands and Waters of the U.S. within the Project Construction Footprint[a]

Type	Acreage[b,c]
Wetlands	
Forested wetlands	27.1
Emergent wetlands	173.9
Scrub/shrub wetlands	3.2
Total, Wetlands	**204.2**
Other Waters of the U.S. and Open Water	
Vegetated shallows (SAV)	6.1
Waters of the U.S.	235.2
Other open waters	66.0
Total, Other Waters of the U.S.	**307.2**
Grand Total	**511.4**

[a] The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends. These data are based on field surveys and desktop delineations in consultation with CEMVN; therefore, wetland acreages differ from those presented in Section 4.18 (Land Use and Land Cover), which are based on land use data.

[b] The construction and operational footprint of the diversion complex, along with the river trestle dock, haul road, and access channel would affect wetlands. Other Project components, including disposal areas and deepening Bayou Dupont for access where it crosses The Pen would affect other Waters of the U.S.

[c] Impacts on 69.1 acres of emergent wetlands, 23.0 acres of scrub/shrub wetlands, and 375 acres of other waters in the beneficial use areas would also occur and would be beneficial because suitable dredged and excavated material would result in localized elevation increases that are expected to result in the establishment of wetland vegetation.

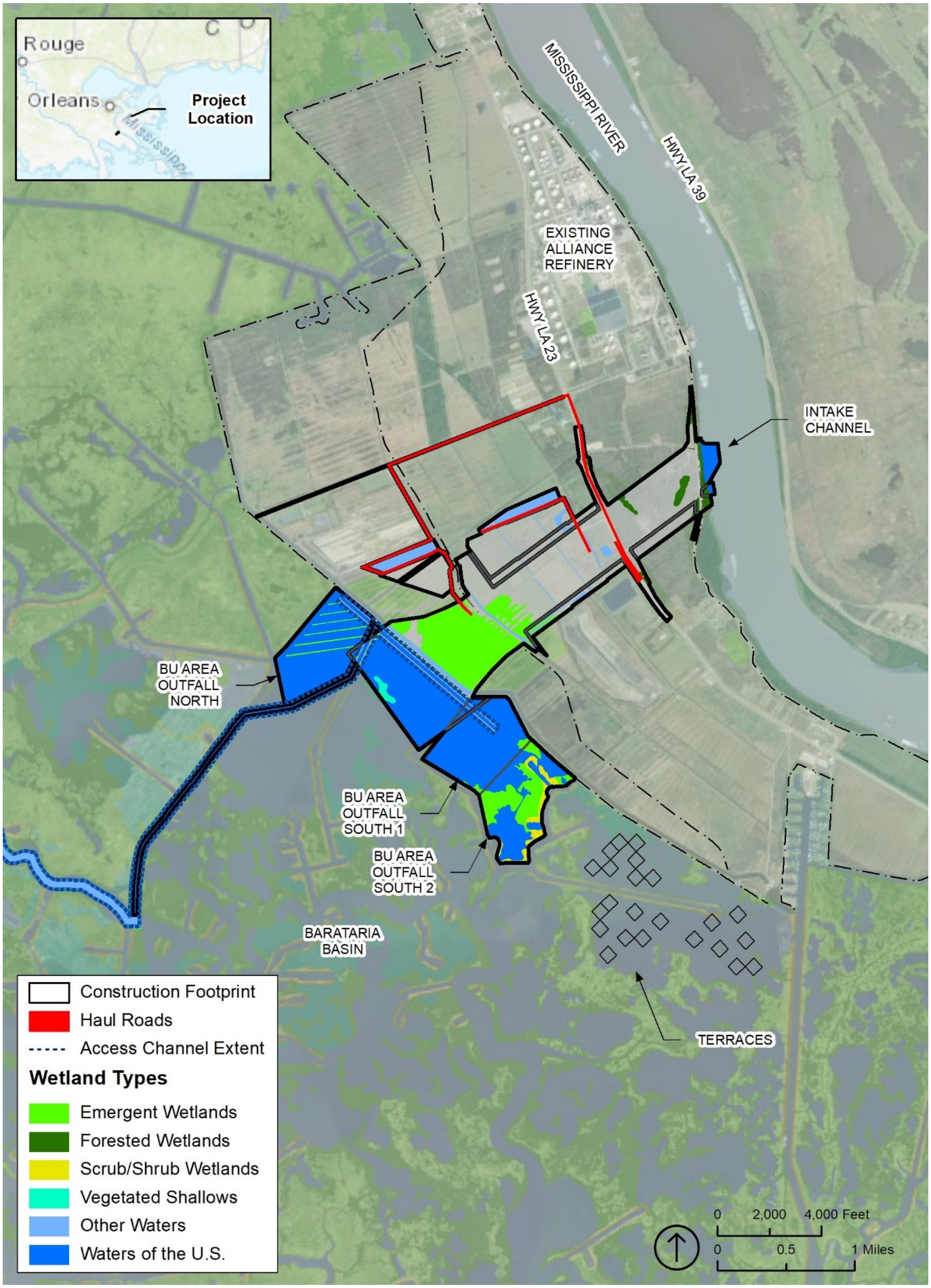


Figure 4.6-1. Wetlands within the Project Construction Footprint.

Dredging conducted in open water areas for barge access routes or other areas within the construction footprint (including the outfall transition feature) and the placement of dredged material would temporarily increase suspended sediment levels. As described in Chapter 3, Section 3.23 Hazardous, Toxic, and Radioactive Waste Assessment, known contamination is not present in the Project construction footprint where dredging would occur. Further, recent evaluations of Mississippi River sediments indicate that they are free from contaminants at concentrations that would result in detrimental impacts from placing dredged sediments in the Barataria Basin or elsewhere (see Section 4.5 Surface Water and Sediment for additional information about impacts of the proposed Project on sediment quality). Suspended sediments could reach wetlands and settle, contributing to marsh accretion. Because dredging and dredged material placement would be conducted in accordance with applicable water quality standards, impacts would be negligible.

CPRA would place suitable, excess material dredged and excavated during construction of the proposed Project in borrow pits on parcels adjacent to the Project facilities and in three beneficial use areas that total up to approximately 467 acres in the immediate outfall area near the proposed outfall transition feature. Beneficial use material would be used for wetland creation and enhancement, and construction would be concurrent with overall construction of the proposed Project. Overall, CPRA proposes to repurpose approximately 2.0 mcy of excavated material to create 375 acres of emergent marsh and nourish 92 acres of existing marsh during Project construction. These beneficial use site acreages are not included in the impact totals in Table 4.6-1 but are depicted as the Outfall South (1 and 2) and Outfall North beneficial use areas on Figure 4.6-1. The placement of material at the beneficial use areas would result in localized bed elevation increases at those sites and new wetland vegetation could be established. This marsh creation through beneficial use of excavated material would at minimum provide equivalent wetland value to that anticipated to be lost due to direct impacts from Project construction (see Section 4.27.2 Compensatory Mitigation). Therefore, the proposed Project would result in the creation of new wetlands in these areas, contributing a moderate, direct, permanent, beneficial impact.

Wetlands adjacent to the Project construction footprint could sustain minor, indirect, temporary, adverse impacts due to sedimentation or contaminants from runoff during construction that could inhibit vegetation growth and/or impact water quality. Impacts on water quality are addressed in detail in Section 4.5.3 in Surface Water and Sediment Quality. To minimize the potential for wetland impacts from sedimentation, CPRA would implement the measures in its SWPPP, including the use of erosion and sediment control measures (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan). Therefore, impacts would be minor, temporary, and localized. Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) that could reach wetlands during construction. The impact intensity of inadvertent releases of contaminants would depend upon the nature of the release. Accidental spills during routine construction activities such as fueling construction vehicles would likely be temporary and minor, whereas a substantial release, such as a fuel tank rupture, could have long-term, major adverse impacts on surface water or sediment quality (see Section 4.5.4.2 in Surface Water and Coastal Processes). Actions would be taken to avoid, minimize, or contain potential contaminants during construction, including adhering to measures in the Project SPCC Plan and SWPPP (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for more discussion about actions to minimize impacts). In addition, water could seep into the cofferdam during construction. CPRA would discharge any water seepage in the cofferdam back into the river to avoid disturbing adjacent soils and vegetation.

4.6.4.1.3 Other Action Alternatives

Direct and indirect impacts on wetlands due to the construction of the other five action alternatives would be similar to those described above for the Applicant's Preferred Alternative, and would include temporary to permanent, negligible to moderate adverse impacts and permanent, moderate beneficial impacts. Impacts would include minor to moderate, permanent, adverse impacts related to wetland losses within the Project construction footprint, which would be offset by wetlands created in the beneficial use areas and during Project operations. Temporary, negligible to minor, adverse impacts would also occur as a result of potential sedimentation and contamination during construction; these impacts would be minimized through implementation of the measures described in Section 4.27, Mitigation Summary. The greatest difference between the action alternatives would be the extent of beneficial impacts resulting from the placement of dredged material, since the alternatives with higher-flow volumes would require a greater volume of material dredged from the intake channel, as described below.

Three of the action alternatives propose the construction of terraces in the immediate outfall area adjacent to Wilkinson Canal (see Chapter 2, Figure 2.8-1), which would be designed to trap and/or direct sediment, nutrients, and fresh water during operation of the proposed Project. While construction of these terraces could result in additional temporary, moderate, adverse water quality impacts as described in Section 4.5.4 in Surface Water and Sediment Quality, impacts would subside once terrace construction is complete. The terraces would be constructed in an area predominated by open water; however, some areas of existing wetlands would be disturbed by the placement of materials to construct the terraces. The disturbance of existing wetlands for construction of the terraces under the three terrace alternatives could have short-term, direct, minor, adverse impacts due to potential vegetation mortality from material placement. However, permanent impacts would be similar to the placement of beneficial use material under the Applicant's Preferred Alternative and are addressed in Section 4.6.5, below. In addition, similar to the Applicant's Preferred Alternative, the placement of suitable materials in beneficial use areas would result in moderate, direct, long-term, beneficial impacts on wetlands in the area of potential impacts. The operational impacts associated with terraces are described in Section 4.6.5, below.

As compared with the Applicant's Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition feature would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes, but the overall construction footprint of all action alternatives would be similar. Additionally, construction timeframes for the 150,000 cfs Alternatives would be longer by several months and for the 50,000 cfs Alternatives would be shorter by several months as compared to the Applicant's Preferred Alternative. As such, the duration of potential temporary impacts due to sedimentation or contaminants from runoff that could inhibit vegetation growth and/or impact water quality would be longer or shorter, respectively, than the Applicant's Preferred Alternative. Impacts on water quality are addressed in detail in Section 4.5.4 in Surface Water and Sediment Quality. The relatively wider or narrower intake and conveyance channels associated with the 150,000 cfs and 50,000 cfs Alternatives, respectively, could result in more or less fill material available for placement in the beneficial use areas as compared with the Applicant's Preferred Alternative, resulting in a relatively larger or smaller area of long-term, beneficial impacts on wetlands in the beneficial use areas.

4.6.4.2 Wetland Invasive Plants

4.6.4.2.1 No Action Alternative

The No Action Alternative would not have any new construction elements, so no impacts on wetland invasive plants in the Project area would occur. Invasive plant species identified during CPRA's field delineations within the Project construction footprint include Chinese tallow and wild taro. Under the No Action Alternative, invasive species would persist, and the expansion of invasive species in the Project area are expected to continue without intervention. Because the construction period would endure for 5 or fewer years, only limited changes to the ongoing expansion of invasive species in the Project area are expected to occur (see Chapter 3, Section 3.6 Wetland Resources and Waters of the U.S. for more information about wetland invasive species in the Project area).

4.6.4.2.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative would include minor, direct, permanent, beneficial impacts related to the removal of invasive species in wetlands converted to developed land and open water for operation of the proposed Project. Minor to moderate indirect, long-term, adverse impacts would occur in the event that disturbance of the construction footprint results in the spread of aquatic invasive species. Wetlands within the footprint of the diversion complex and auxiliary features would be dredged or filled and converted to developed land, which would result in the mortality of invasive plant species where the Project components would be installed and a minor, direct, permanent, beneficial reduction in the extent of invasive plants that could spread to other wetlands in the Project area. Aquatic invasive faunal species and floating invasive plant species that could spread in the Project area are addressed in Section 4.10 Aquatic Resources.

The removal of existing wetland vegetation and soil disturbance during construction of the Applicant's Preferred Alternative could create conditions conducive to the establishment or spread of invasive species. If stockpiled soils or sediment-laden runoff were to travel outside of the construction footprint to adjacent wetlands, seeds or other propagules could be transported and result in the spread of invasive species to adjacent wetlands. Seeds and root mats could also be transported from the Project area by tracked construction equipment. CPRA would implement the measures in its SWPPP, described in Section 4.27, Mitigation Summary, to minimize the potential for run-off-induced off-site impacts and the associated spread of invasive species; therefore, impacts would be minor. Additionally, natural revegetation of upland areas cleared during construction could result in an increase in upland invasive species within the Project areas. Upland invasive species are discussed further in Section 4.9.3.2.3 in Terrestrial Wildlife and Habitat.

Dredging in wetlands for the creation of the outfall transition feature and access channel would result in the mortality of any invasive plant species within that wetland area. However, plants or plant parts could also be transported to the beneficial use areas during the placement of dredged material for wetland creation and enhancement, resulting in a moderate, indirect, permanent, adverse impact on the extent of invasive species in the beneficial use areas. Overall, minor, permanent, beneficial impacts would result from the removal of invasive species in wetlands converted to developed land and open water for operation of the proposed Project. Minor to moderate, permanent, adverse impacts would occur in the event that disturbance of the construction footprint or placement of beneficial use material results in the spread of aquatic invasive species.

4.6.4.2.3 Other Alternatives

Impacts related to aquatic invasive species due to the construction of the other five action alternatives would be similar to those described above for the Applicant's Preferred Alternative because each would have similar proposed features and construction activities. Impacts would include minor, permanent, beneficial impacts related to the removal of invasive species in wetlands converted to developed land and open water for operation of the proposed Project. Minor to moderate, permanent, adverse impacts would occur in the event that disturbance of the construction footprint or placement of beneficial use material results in the spread of aquatic invasive species.

4.6.5 Operational Impacts

4.6.5.1 Wetland Types and Extent

4.6.5.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur and major, direct and indirect, permanent, adverse impacts on wetlands would continue. Greater than 1 million acres of wetlands have been lost in coastal Louisiana since the late 19th century; the Barataria Basin has one of the highest rates of land loss in Louisiana. Approximately 29 percent of the total land area in the Barataria Basin was lost between 1932 and 2016 (though loss rates have slowed since the 1980s), and sea-level rise is expected to increase, accelerating the rate of future wetland loss (Couvillion et al. 2017). As described in detail in Chapter 3, Section 3.6.3 in Wetland Resources and Waters of the U.S., wetland losses result in part from subsidence and sea-level rise that cause increased flooding frequency and duration, which then result in the mortality of marsh vegetation and subsequent erosion. Storms, such as hurricanes, result in large-scale coastal wetland disturbance and can cause erosion and bring salt water inland, converting large areas of wetlands to open water. The construction of risk reduction levees along the Mississippi River has reduced freshwater and sediment inputs into the Barataria Basin, impacting vegetation growth and soil accretion. Where canals have been dredged for oil and gas development, they have directly converted wetlands to open water but also provide a conduit for saltwater intrusion into brackish, intermediate, and freshwater wetlands.

Under the No Action Alternative, the existing wetlands in the Project construction footprint would not be converted to developed land for operation of the proposed Project, and wetland losses due to inundation from fresh water diverted by the proposed Project would not occur; however, the loss of land mass and wetlands in the Barataria Basin would continue to occur as described above, and the wetland creation associated with the diversion of fresh water and sediment to the Project area would not occur.

Under this alternative, and as projected by the Delft3D Basinwide Model results, approximately 298,000 acres (80.4 percent) of wetlands would be lost over a 50-year period (2020 to 2070) in the Barataria Basin as the saltwater inundation of wetland resources in the basin continues. In the birdfoot delta, while wetland losses would be less than under the action alternatives, the loss of wetlands would continue. A projected 52,500 acres (89.1 percent) of wetlands in the birdfoot delta would be converted to open water by 2070. The greatest wetland losses across the Project area would occur near the end of the assessment period between 2060 and 2070, when impacts from sea-level rise and subsidence would likely be greatest. Table 4.6-2 presents the projected total acreage in the Project area under the No Action Alternative, by decade; Figures 4.6-2 through 4.6-7 depict the projected wetland vegetation under the No Action Alternative, by cover type and decade. These acreage projections from the Delft3D Basinwide Model utilized an assumed a sea-level rise rate of 4.9 feet (1.5 meters) by year 2100. As described in more detail in Appendix E, a different sea-level rise rate assumption would change modeled inundation frequency and depth, strength of tidal forcing, and erosional impacts such that a higher rate of sea-level rise would result in an increased rate of wetland loss and a lower rate of sea-level rise would result in a decreased rate of wetland loss under the No Action Alternative. A sensitivity run of the Delft3D Basinwide Model used an alternate sea-level rise rate of 2.6 feet (0.79 meter) by year 2100 to evaluate a lower sea-level rise scenario on wetlands. This sensitivity run projected that the extent of wetland area in the Project area would be 277,000 acres at the end of the analysis period, about 3.5 times greater than the wetland area under the 4.9-foot (1.5-meter) sea-level rise scenario presented in Table 4.6-2. Details regarding the magnitude of this difference are provided in Appendix E.

Table 4.6-2
Model-projected Total Wetland Area, by Basin, under the No Action Alternative[a]

Year	Total Wetland Area (acres) Barataria Basin only	Total Wetland Area (acres) Birdfoot Delta only	Project Area Total Wetland Area (acres)
2020	371,000	58,900	430,000
2030	340,000	41,300	382,000
2040	287,000	25,500	313,000
2050	218,000	17,400	235,000
2060	139,000	10,500	150,000
2070	72,800	6,410	79,200

[a] Modeled wetland acreages have been rounded to three significant digits.

Although not included in the Delft3D Basinwide Model setup or shown in Figures 4.6-2 through 4.6-7, additional wetlands in the birdfoot delta are expected to be created in the future from the beneficial use of dredged material occurring as part of CEMVN maintenance dredging in the Mississippi River Passes and through targeted restoration projects, such as the ongoing Delta-wide Crevasse Program under CWPPRA. For more information about reasonably foreseeable projects in the Project area, see Section 4.25 Cumulative Impacts.

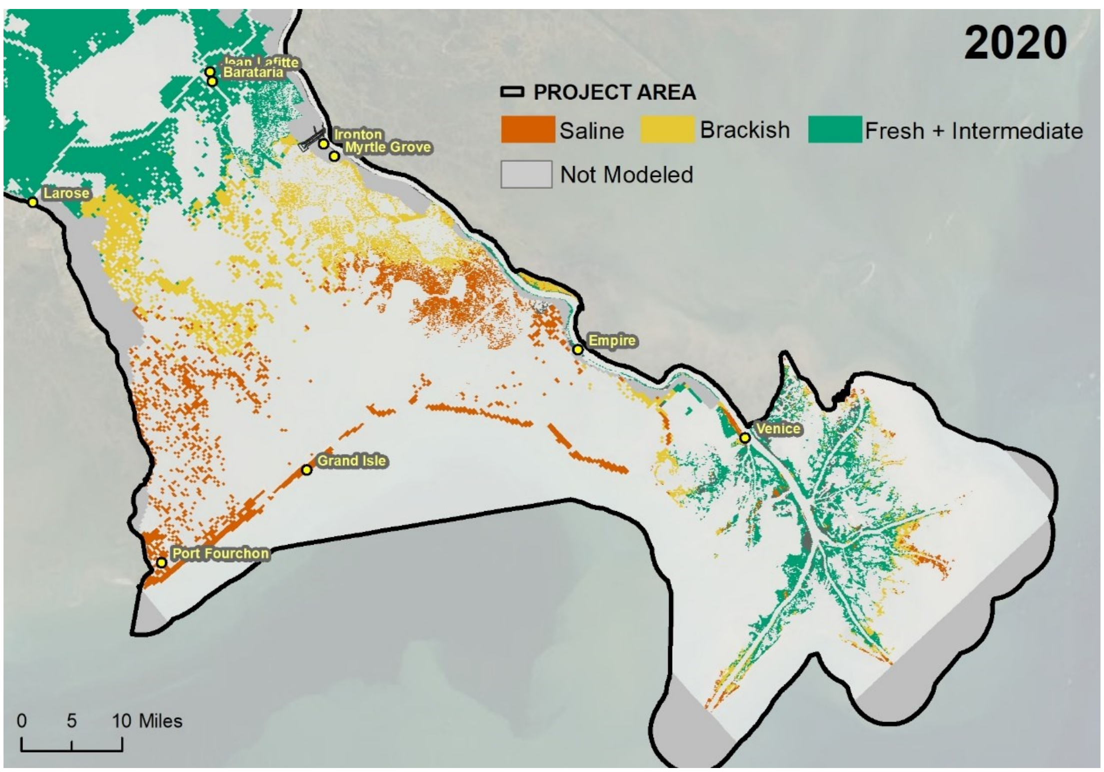


Figure 4.6-2. Wetlands under the No Action Alternative in 2020.

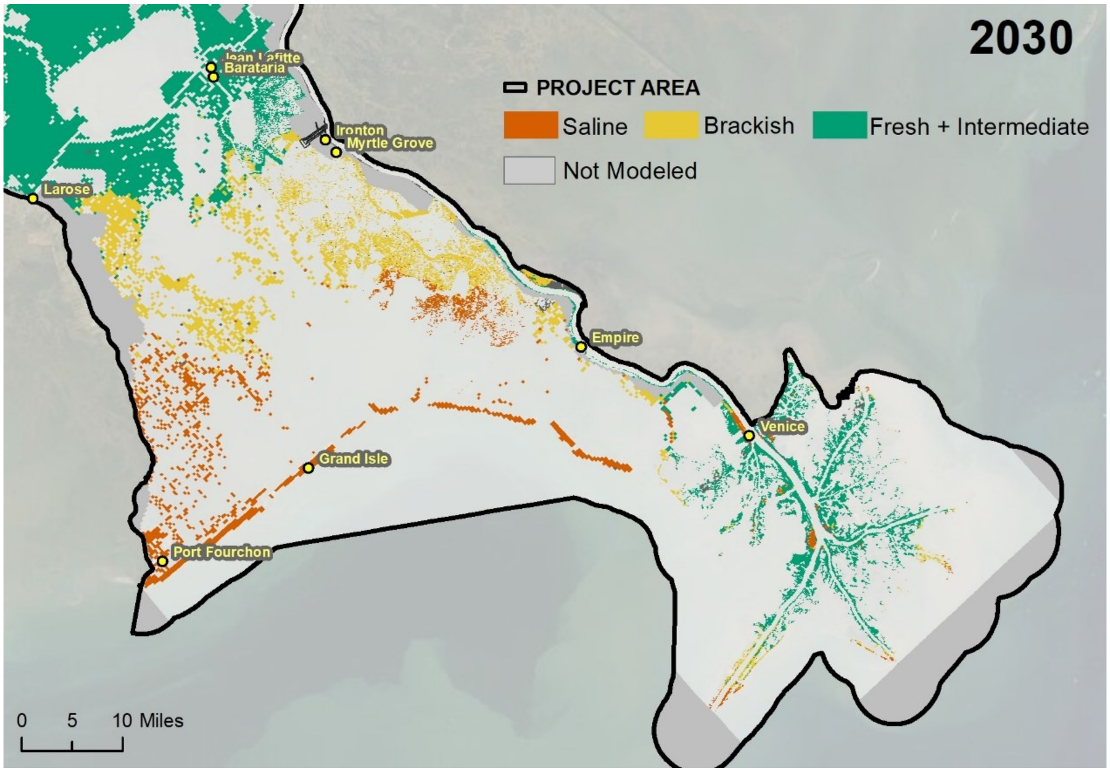


Figure 4.6-3. Wetlands under the No Action Alternative in 2030.

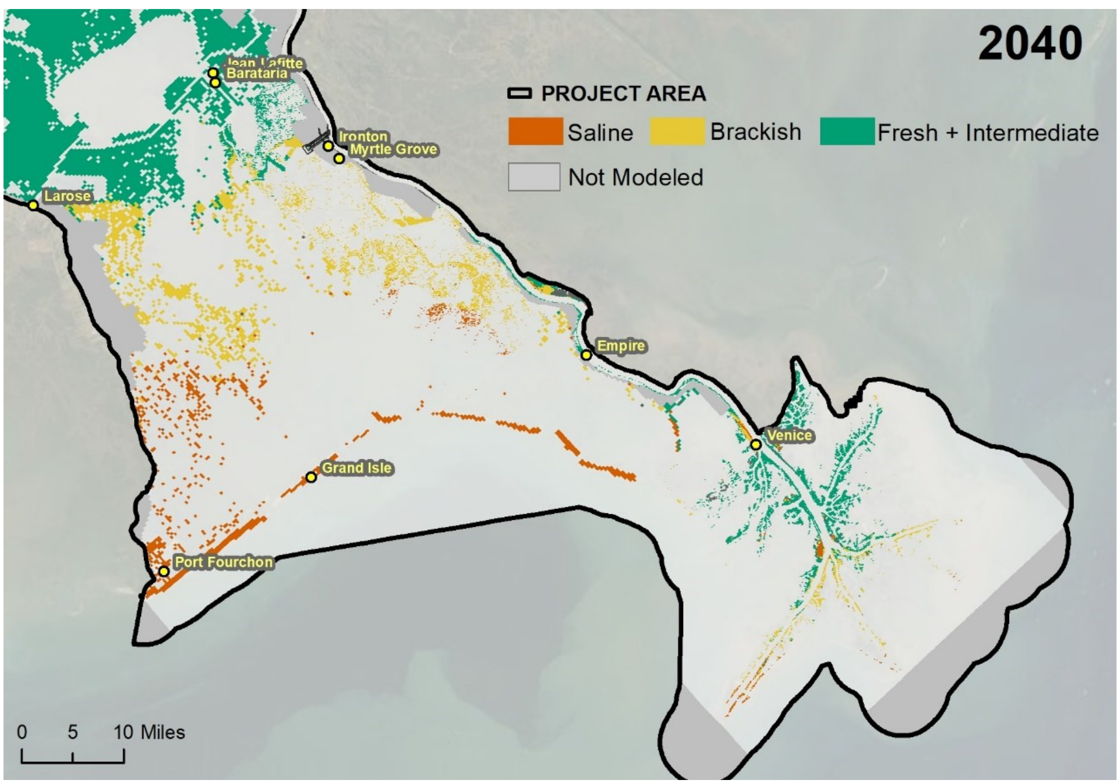


Figure 4.6-4. Wetlands under the No Action Alternative in 2040.

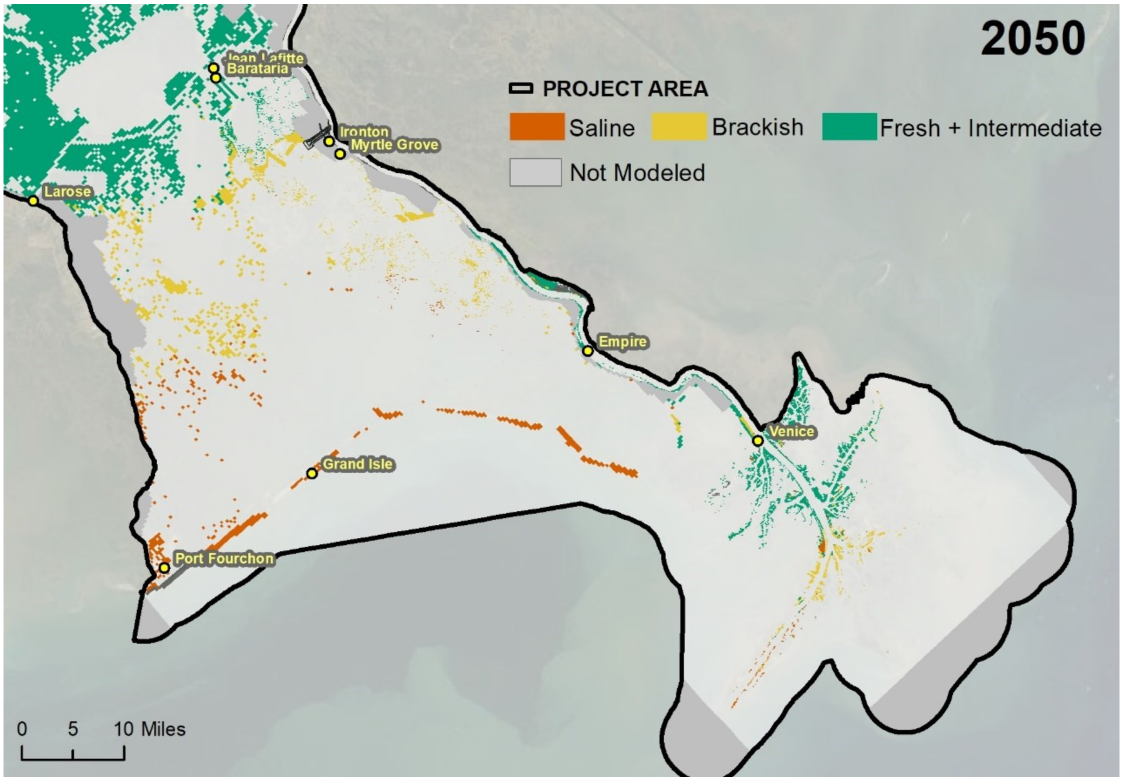


Figure 4.6-5. Wetlands under the No Action Alternative in 2050.

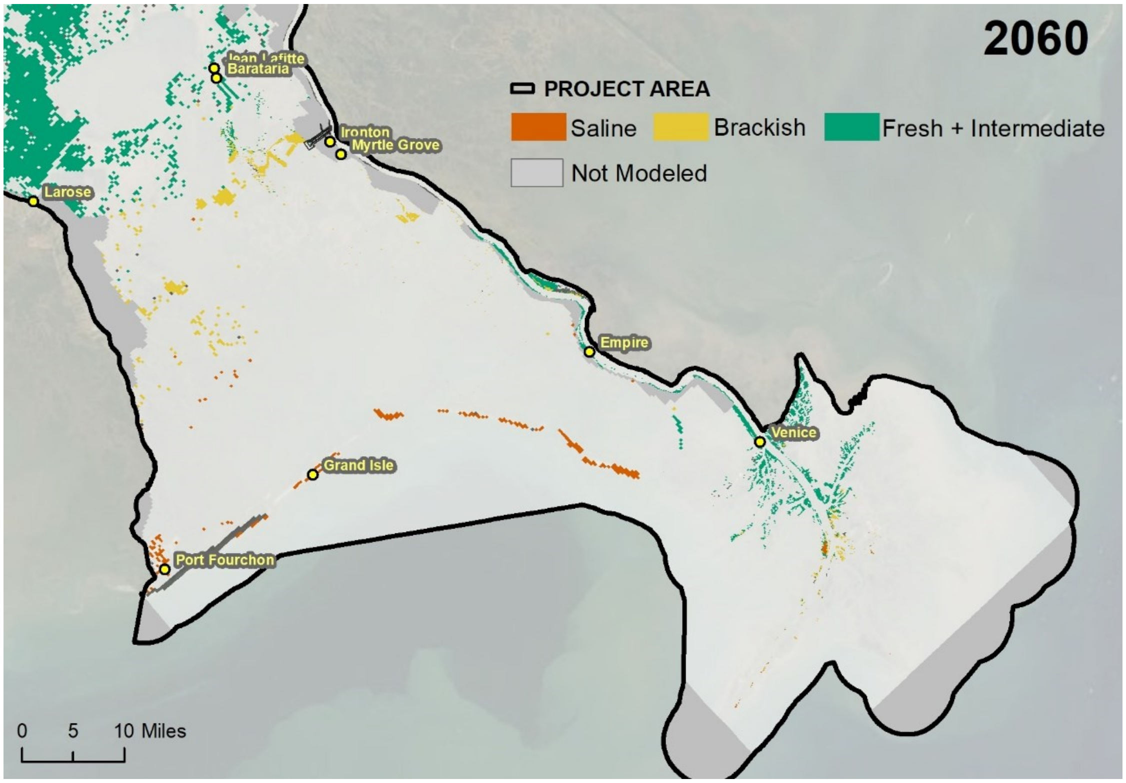


Figure 4.6-6. Wetlands under the No Action Alternative in 2060.

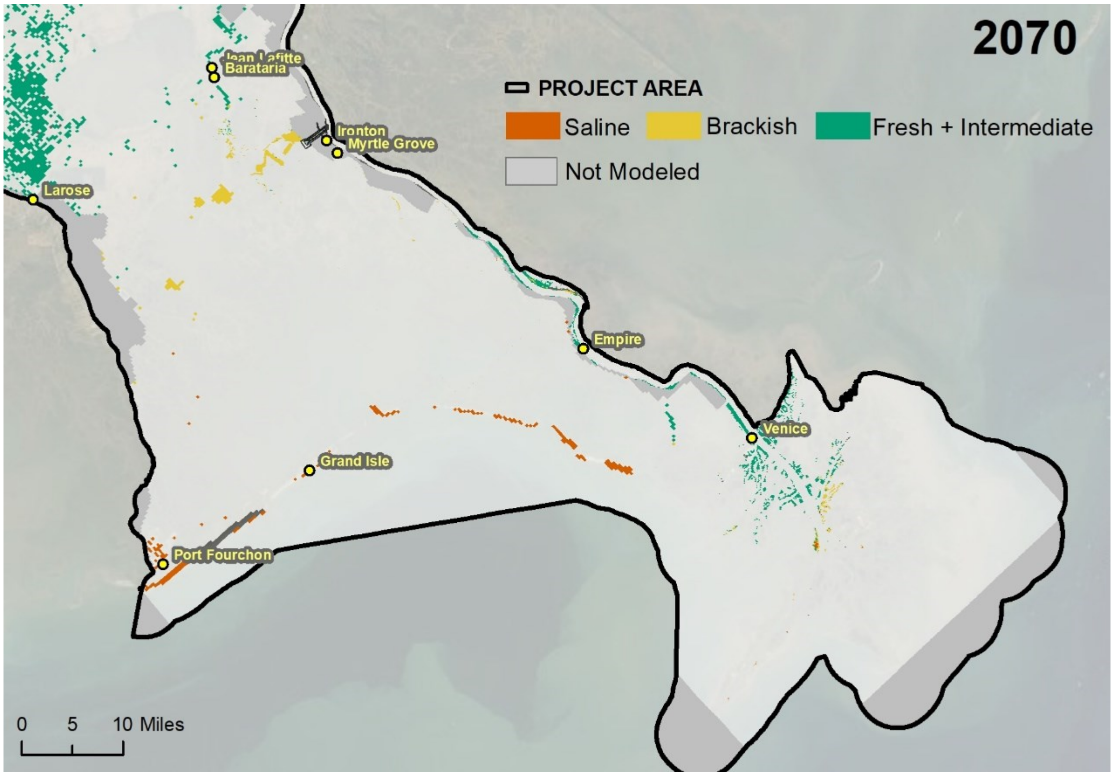


Figure 4.6-7. Wetlands under the No Action Alternative in 2070.

4.6.5.1.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative is anticipated to have major, permanent beneficial impacts on wetlands in the Barataria Basin where wetlands are sustained and created by the diversion of sediment and fresh water, and moderate, permanent, adverse impacts on wetlands in the birdfoot delta where wetlands are lost due to reduced sediment and freshwater inputs. Although the proposed Project is not anticipated to fully restore the Barataria Basin to its historic conditions, as described below, it is anticipated to create and/or maintain wetlands in a portion of the basin when compared to the No Action Alternative.

A review of available literature, including data from existing freshwater diversions, as well as Project-specific Delft3D Basinwide Modeling results to quantify wetland acreage changes, were assessed to identify expected impacts on wetlands due to implementation of the action alternatives. While this alternative would sustain and create wetlands in the Project area, significant wetland loss across the region due to subsidence and sea-level rise would be ongoing, resulting in a net loss of wetland acreage over the 50-year analysis period.

The purpose of the diversion of fresh water, sediments, and nutrients into the Barataria Basin under the Applicant's Preferred Alternative is to build, sustain, and maintain wetlands in an area that has been largely isolated from natural flooding inputs from the Mississippi River. Sediment accretion would raise the land elevation in submerged areas to allow wetland vegetation to establish and grow; nutrients transported as part of the proposed Project could benefit vegetation growth in early-successional marsh or contribute to increased primary production (above and belowground plant biomass); and changes in average annual salinity would allow for freshwater and intermediate wetland species to establish, survive, and potentially expand in areas that have been adversely impacted by saltwater intrusion. The projected changes in wetland habitat type are described further below (see Land Accretion).

While research on sediment diversions is limited, studies have documented the impacts of freshwater diversions on wetlands. Available literature describes variable short- and long-term impacts of diversions on wetland health, specifically with regard to plant productivity, surface elevations, and marsh soil shear strength (Teal et al. 2012). Studies that have shown positive impacts of diversions on wetlands show a stimulation of wetland plant production in response to lower salinities, increased available nutrients, and delivery of mineral sediments (Lane et al. 2007); higher bulk density and belowground vegetation that can maintain elevation against subsidence and sea-level rise (Day et al. 2009, DeLaune et al. 2003, Nyman et al. 1990); and increased soil strength and sediment retention through compaction and consolidation from pulsed operations (Day et al. 2011, Bentley et al. 2012). Alternatively, the introduction of nutrients may reduce soil shear strength, increase decomposition of organic matter, and adversely reduce marsh elevation (Wigand et al. 2009, Darby and Turner 2008, Teal et al. 2012). Adverse impacts on wetland accretion would occur in the birdfoot delta, which would receive less sediment from the Mississippi River due to the diversion of fresh water and sediment to the Barataria Basin. However, because a deep-draft navigation channel is maintained through the birdfoot delta, much sediment is lost to the deep Gulf. Given the very high subsidence rate in the birdfoot delta along with the sediment loss via the navigation channel, Mississippi River sediments would be more effectively used to sustain wetlands when introduced into the Barataria Basin via the diversion.

In addition to the impacts of the diversion, described further below, during the operational life of the Project, it is anticipated that maintenance dredging in the diversion complex and basin would be needed to maintain optimal discharge and delta development. While the timing and locations for maintenance dredging are uncertain, future maintenance dredging and placement in the basin would be done in a manner that takes into consideration habitat creation and delta development. Therefore, maintenance dredging and the beneficial use of associated dredged material, as applicable, may have a permanent, negligible to minor benefit on wetlands in the Project area. The frequency and volume of dredging would depend on the maintenance needs of the Project.

4.6.5.1.2.1 Salinity

The Applicant's Preferred Alternative would have long-term, minor to moderate freshening impacts on salinity in the Barataria Basin during Project operations (see Section 4.5.4 in Surface Water and Sediment Quality). As described in Chapter 3, Section 3.6.2 in Wetland Resources and Waters of the U.S., salinity, along with flooding frequency and duration, are the primary drivers of wetland vegetation assemblages in the Project area (Mitsch and Gosselink 1986, Bertness and Ellison 1987, McKee and Mendelssohn 1989). Plant diversity within marshes in the Barataria Basin and the birdfoot delta decreases as the salt content increases. Increased inundation (depth and duration) and salinity limit plant species diversity and productivity. At the same time, decreased salinity may limit overall productivity of salt-tolerant species by altering their root-to-shoot ratios. Therefore, changes in salinity and nutrients resulting from the fresh water diverted by the proposed Project into the Barataria Basin could influence the distribution (via salt tolerance) and growth characteristics (root-to-shoot ratios and productivity) of vegetation (Teal et al. 2012). In addition, higher salinity has been documented to have a negative relationship with marsh carbon accumulation (Baustian et al. 2017). Freshwater marshes tend to have higher soil carbon, nitrogen, and phosphorus than saltwater marshes, and may therefore have higher primary production and associated short-term carbon accumulation rates (Baustian et al. 2017). However, variable sediment accumulation rates also impact carbon sequestration rates (Chmura et al. 2003). Following hurricanes Katrina and Rita in 2005, erosion was greatest in fresh and intermediate marsh, which was also associated by Howes et al. (2010) with a weaker soil shear strength (partially due to a weak zone of soil at the base depth of rooting). However, Sasser et al. (2018) found different relationships between measured soil strength and marsh type (specifically, highest soil strength in fresh marshes). Vegetation mortality due to saltwater intrusion may also affect freshwater wetlands following a storm (Howes et al. 2010). However, data collected in the outfall areas of the Caernarvon Freshwater Diversion in Breton Sound documented increased areas of freshwater marsh, and rapid recovery of freshwater marsh in the outfall area was observed following disturbance by Hurricane Katrina (see review in Teal et al. 2012).

While average annual salinity in the basin is projected to decrease as a result of the diversion of sediment and fresh water from the proposed Project over the 50-year analysis period, salinity changes would be variable and dependent upon the volume transported to the Barataria Basin through the diversion structure as well as natural variability associated with the estuarine Barataria Basin system. Salinity in the basin varies naturally during the course of the year according to various environmental factors (see Section 4.5.5 in Surface Water and Sediment Quality, which describes the operational impacts on salinity associated with the proposed Project). Salinity under the Applicant's Preferred Alternative would generally follow seasonal trends, with minimum salinities occurring in the spring and early summer when the diversion would likely be operating above baseflow more often, and maximum salinities generally occurring between the early fall and winter months when the diversion would likely be operating at base flow.

Regardless of seasonal patterns, the mid- and western portions of the basin are projected to experience lower minimum and maximum salinities under the Applicant's Preferred Alternative as compared with the No Action Alternative, and to have less salinity variability (difference between minimum and maximum average monthly salinities) in the first three decades of Project operation. In latter decades (2060s and 2070s) of the Project 50-year analysis period, the western area of the basin is projected to follow a seasonal pattern more similar to the No Action Alternative. In the central and southern portions of the basin, the seasonal pattern of minimum and maximum salinities is projected to remain similar to that under the No Action Alternative, but minimum and maximum salinities are projected to be lower over all the decades in the central portion of the basin.

The Davis Pond Freshwater Diversion introduces water into the northern basin from the Mississippi River, north of Lake Salvador (see Figure 4.5-38 in Section 4.5 Surface Water and Sediment Quality). As described in Section 4.5.7, operation of the Project is expected to reduce the frequency with which the Davis Pond Freshwater Diversion would operate by decreasing salinities at the Little Lake Bay Dos Gris gauge in mid-basin during the months from March through July to below the current 15 ppt operational trigger. Delft3D Basinwide Modeling indicates that although Davis Pond Freshwater Diversion operations would be reduced due to salinity impacts of the proposed MBSD Project operations, the acreage of freshwater wetlands benefited by the Davis Pond Freshwater Diversion would not be impacted. This may be because, as compared to the No Action Alternative, the combined operation of the existing Davis Pond Freshwater Diversion and the proposed MBSD Project would introduce a greater total volume of fresh water into the Barataria Basin, and could therefore result in higher water levels and lower salinities near Lake Salvador (where the impact areas for each diversion are closest to overlapping), resulting in the same salinity reduction benefits as those produced by the Davis Pond Freshwater Diversion alone. The proposed MBSD Project's direct and indirect impacts on wetlands in the far northern basin, including the Davis Pond Freshwater Diversion impact area, would be negligible. Impacts on salinity in the northern portion of Barataria Basin are addressed further in Section 4.5.5.1 in Surface Water and Sediment Quality.

As described in Chapter 3, Section 3.6.2.2 in Wetland Resources and Waters of the U.S., fewer plant species are tolerant of higher salinities in estuarine wetlands, resulting in conspicuous plant zonation in salt marshes, compared with heterogeneous species mixes in freshwater marshes (Latham 1994). In some areas of the Barataria Basin, the seasonal change in salinity due to operation of the diversion above base flow (primarily during spring and early summer) and lower-flow conditions during fall and winter months would be large enough to temporarily change the wetland hydrology from a brackish to fresh or saline to brackish system. Those differences would be most pronounced in the portion of the basin nearest to the diversion structure and in the western basin during the later decades of operation (2060 and 2070; see Figures 4.5.4 through 4.5.6 in Surface Water and Sediment Quality). However, this seasonal variability is projected to be more pronounced under the No Action Alternative. While brackish marsh species, such as *Spartina patens,* are adapted to irregular or variable salinities, freshwater marsh species are not. Therefore, seasonally high salinity could restrict the establishment of freshwater marsh species in the outfall area and limit the establishment of freshwater wetland vegetation. This impact would be greatest at the marsh edges, which are more likely to be inundated during the drier fall and early winter months and therefore subject to seasonal salinity changes. In the southern basin, where salt marsh predominates, peak salinities would be within the range for salt marsh vegetation under the No Action and Applicant's Preferred Alternatives. The 5,000 cfs base flow is intended to provide a continuous source of fresh water to protect, sustain, and maintain newly vegetated or recently converted fresh, intermediate, and brackish marshes near the diversion outflow. Overall, impacts on wetlands from salinity changes associated with the proposed Project would be permanent, major, and beneficial. While seasonally high salinities could restrict the extent of freshwater marsh establishment in the mid- and western basin, impacts would be less than under the No Action Alternative.

4.6.5.1.2.2 Nutrients

Fresh water transported through diversions provides significant nutrient input to marshes (Teal et al. 2012, Lane et al. 2004, Elsey-Quirk et al. 2019). Fresh water transported by the proposed Project would also add nutrients that could stimulate plant production, and the Mississippi River carries more nutrients now than under historic conditions (Turner et al. 2007). Coastal wetlands in Louisiana are already documented to be eutrophic (characterized by an over-abundance of nutrients), in part due to the transport of nutrients from riverine inputs (Graham and Mendelssohn 2014, Parsons et al. 2006, Day et al. 2021a). While the Barataria Basin has been isolated from the Mississippi River, it is still subject to nutrient inputs from river water crossing the coastal zone via the GIWW, as well as from Southwest Pass, and eutrophic conditions occur in the basin (Wissel et al. 2005). Therefore, vegetation growth in the Project area is not expected to be limited by nutrient availability. However, study results suggest that the introduction of nutrients could increase the decomposition of organic matter in freshwater marsh soils and change biomass allocation in vegetation (Darby and Turner 2008, Deegan et al. 2012, Howes et al. 2010, Swarzenski et al. 2008).

Nutrient enrichment may be associated with reductions in root and rhizome biomass and soil carbon but is also associated with increases in aboveground production (Morris and Bradley 1999, Turner et al. 2009, Valiela et al. 1976). The increased decomposition of organic matter by microbes could adversely reduce marsh elevation, contributing to marsh subsidence and loss (Wigand et al. 2009, Darby and Turner 2008). This reduction in belowground biomass has been observed in more mature or established wetlands; however, nutrients can enhance belowground growth under conditions including continuous sedimentation and during early stages of succession (that is, the establishment of new vegetated habitats; Graham and Mendelssohn 2016). Therefore, the impact of nutrient loading on marshes in the Barataria Basin may differ in newly created or sustained marsh when compared with impacts on established wetlands. As described in Section 4.5.5.3 in Surface Water and Sediment Quality, several studies have shown that nitrate concentrations from freshwater flows are reduced through denitrification when introduced water passes through estuarine systems, with higher rates of denitrification occurring when water flows through vegetated wetlands. However, in a review of available literature, White et al. (2019) concluded that denitrification by microbes cannot lead to significant decomposition of soil organic matter or lead to significant impacts on soil stability due to the small fraction of available soil carbon used in microbial denitrification. The contribution of above and belowground plant biomass to vertical accretion are important factors in maintaining marsh elevations, especially during periods of relative sea-level rise (DeLaune et al. 1994).

As described in Section 4.5.5.9 in Surface Water and Sediment Quality, the introduction of Mississippi River water into the Barataria Basin during Project operations is expected to have negligible impacts on atrazine concentrations in the basin. While atrazine (an agricultural herbicide) has been shown to negatively impact tensile root strength of *Spartina patens*, impacts were observed at concentrations of 1 µg/L (Hollis and Turner 2019a), which is greater than river (0.06 µg/L to 0.72 µg/L) and basin (0.01 µg/L to 0.84 µg/L) concentrations of atrazine and therefore impacts on wetland vegetation from atrazine introduced by the proposed Project would be negligible. However, the introduction of multiple stressors (for example, nutrient enrichment, atrazine, and increased inundation) adversely affected tensile root strength at a greater degree than each stressor when assessed alone (Hollis and Turner 2021).

However, increased aboveground productivity could counteract some reductions in marsh elevation, particularly when augmented by mineral sediment accretion. Following 13 years of fertilization of a marsh in an intermediate-brackish marsh near Lake Pontchartrain, Graham and Mendelssohn found a negative impact on belowground biomass and associated shallow subsidence; however, that impact was balanced by greater organic matter accumulation, and the rate of marsh elevation change was not impacted by nutrient enrichment (2014). Overall, studies generally show positive or no impact of the addition of nutrients to marsh accretion (Elsey-Quirk et al. 2018). Wetland soil shear strength, which is determined by soil composition and vegetation roots and rhizomes, may also be adversely impacted by nutrient loadings (Bodker et al. 2015, Darby and Turner 2008, Deegan et al. 2012). Areas of marsh with relatively high-nutrient levels have been associated with greater incidence of hurricane damage (potentially due to lower soil shear strength); however, general marsh recovery has been documented during the next 1 to 2 years following major storms (Mo et al. 2020).

Where root-to-shoot ratios are modified and vegetation increases aboveground productivity, the reduced belowground (root) biomass may be less effective at maintaining marsh elevations and may weaken soil shear strength. In freshwater marshes, the addition of nutrients can result in a beneficial reduction of salinity stress on *Spartina patens,* although the same impact is not seen in more salinity-sensitive freshwater species (see review in Teal et al. 2012). Based on these variable results, the advisory panel to LCA Science & Technology Program and NOAA (Teal et al. 2012) concluded that, in general, aboveground biomass would increase and belowground production may either: (1) not be impacted, (2) increase, or (3) decrease in response to nutrient enrichment. Teal et al. (2012) also found that there is significant uncertainty regarding the impacts of nutrient loads on belowground decomposition of both roots and organic matter. The impacts of nutrients transported by the proposed Project would vary across the Project area; nutrients may not be available to plants (for example, nitrogen may be transformed from one available form to another), or other stressors such as salinity may limit vegetation growth (Darby and Turner 2008). Therefore, nutrient loading from the proposed Project may either benefit or adversely impact root biomass and, in turn, marsh resilience in the Project area. The Delft3D Basinwide Model for vegetation used to project plant biomass changes over time and to quantify wetland change as a result of the proposed Project assumes no limitations due to stress from nutrient limitation; however, it does simulate nutrient uptake and growth responses of herbaceous marsh vegetation via above and belowground biomass allocation.

4.6.5.1.2.3 Soil Shear Strength

Lower shear strength decreases the marsh's resiliency to storm scouring and makes soil more susceptible to erosion (Teal et al. 2012, Swarzenski et al. 2008). As described above, nutrient loading can result in increased decomposition of organic matter, reduced root-to-shoot ratios, and subsequently reduced soil shear strength (Bodker et al. 2015, Darby and Turner 2008, Deegan et al. 2012). Belowground biomass has been shown to be the greatest factor explaining marsh soil strength (Sasser et al. 2018). While belowground biomass appears to be inversely related to nutrient loading, an increase in nutrients may also allow for greater amounts of aboveground biomass, which would help retain surface soils, due to a reduction in energy requirements for nutrient uptake that results in potential increases in carbon fixation (Turner 2011). Turner found that soil strength in the surface layer of marsh soils was unchanged as a result of nutrient enrichment, but the addition of nitrogen and phosphorous did affect deeper (60 to 100 centimeters) soils (2011). During a more recent study, Turner et al. found that increased nutrient loading reduced soil shear strength throughout the entire profile of freshwater anchored and floating marsh, though the effects varied with depth (2020). Increased inundation may also adversely affect the production of biomass, thereby affecting soil shear strength. Sediment transported by the proposed Project is expected to have a higher bulk density than soils in the Project area, as described in Section 4.2.3.2.2 in Geology and Soils; increased soil shear strength is associated with higher bulk density and soil compaction. Therefore, overall the proposed Project could have both a permanent benefit on soil shear strength where sediments are deposited (Teal et al. 2012, Sasser et al. 2018), and a permanent adverse impact on soil shear strength where sediment is not deposited but where nutrients are transported by the proposed Project.

4.6.5.1.2.4 Land Accretion

The sediments transported by the proposed Project would be deposited on marsh surfaces and in open water areas and are expected to increase rates of land accretion where the sediment is deposited, which is primarily expected to be in the Barataria Basin. Vegetation would establish on new land and new plant growth, in turn, would trap additional sediment and result in further land growth and increasing marsh elevation (Teal et al. 2012). The success of sediment diversions such as the proposed Project is dependent on the balance between sediment supply and associated land building when compared with subsidence and sea-level rise. Sediment input is necessary to slow the rate of wetland losses via submergence in the Mississippi River Delta; however, the modern Mississippi sediment load is not sufficient to sustain the full extent of existing deltaic plain wetland surface area due to dams, other flood control structures (for example, levees), and soil management practices upstream of the Project area (Blum and Roberts 2009, Bentley et al. 2012). The transport of sediment to Project area wetlands would be expected to slow or stop wetland losses in some locations; however, the extent of wetland benefits would be dependent upon the sediment load diverted to the Barataria Basin. The deposition of sediment at marsh edges was found to decrease with distance from the Caernarvon Diversion structure, and was dependent on the frequency and duration of marsh inundation (Wheelock 2003). Sediment from the proposed Project would therefore likely have the greatest impact on accretion at marsh edges in areas nearest to the immediate outfall area.

Conversely, the greatest negative impacts on accretion would occur in the birdfoot delta, which would receive less sediment due to the diversion of fresh water and sediment to the Barataria Basin. The reduction in sediment input would limit the capability of wetlands to balance land building against subsidence and sea-level rise, resulting in greater losses than under the No Action Alternative. However, as described above, sediments would be more effectively used to sustain wetlands when introduced into the Barataria Basin via the diversion. Sediment transport, including the predicted sediment supply, are further addressed in Section 4.4.4.2.3, Tides, Currents, and Flow in Surface Water and Coastal Processes.

At some locations in the outfall area, prolonged inundation due to fresh water transported by the proposed Project could increase flood stress on wetlands during the 50-year analysis period, resulting in adverse impacts on wetland vegetation. As described in Chapter 3 Section 3.6.3.2 in Wetland Resources and Waters of the U.S., increased flooding frequency and duration stresses marsh vegetation and can result in mortality. Potential inundation stress would be greatest in the mid-basin nearest the diversion structure outfall, and would diminish with distance from the outfall. In areas of inundation-induced vegetation mortality, sediment deposition from the proposed diversion may not be sufficient to offset the loss of biomass due to localized vegetation mortality. Sediment accretion rates are primarily dependent on soil organic matter accumulation, since organic matter in the Louisiana deltaic marshes produces 22 or more times the elevation of mineral matter accumulation (Turner et al. 2000, Morris et al. 2016). However, higher bed elevations created by sediment deposition over the 50-year analysis period of the diversion structure would counteract those losses and contribute to wetland establishment and spread over time across the broader Project area (Elsey-Quirk et al. 2018).

While research limitations have resulted in uncertainty regarding the impacts of freshwater diversions, freshwater flows from sediment diversion operations are anticipated to lead to shifts toward more typical freshwater vegetation communities. As described in Chapter 3, Section 3.5.2.2 in Surface Water and Sediment Quality and Section 4.5.4 in Surface Water and Sediment Quality, salinities would continue to vary seasonally in the Barataria Basin, and would be generally fresh in the spring and summer to brackish in the fall and winter. These changes may then lead to increased herbivory by nutria or muskrats (and associated wetland loss) due to the better forage quality associated with nutrient enrichment (Teal et al. 2012; see Sections 4.9.2 in Terrestrial Wildlife and Habitat and 4.10.2 in Aquatic Resources for Project-related wildlife impacts). However, any adverse impacts from wetland loss due to increased herbivory are expected to be outweighed by beneficial land gains due to sediments transported by the proposed Project.

As described in Section 4.2.3.2.2 in Geology and Soils, the proposed Project would introduce significant volumes of sediment into the Barataria Basin over the 50-year analysis period of the proposed Project (years 2020 to 2070). These additions are projected to increase sediment bed elevations in the outfall area and result in the net creation of about 13,400 acres of land (12,700 acres of wetlands) by modeled year 2070 compared to the No Action Alternative (see Table 4.2-4 in Section 4.2 Geology and Soils). Conversely, due to the diversion of sediments that would otherwise reach the birdfoot delta via the Mississippi River, land losses are projected in the birdfoot delta. Section 4.4.4.2 in Surface Water and Coastal Processes projects the Project alternatives' impacts on water levels and sediment transport in the Project area based on the results of the Delft3D Basinwide Model, and Section 4.5.4 in Surface Water and Sediment Quality projects impacts on water quality (including salinity and nutrients [nitrogen and phosphorus]). Figure 4.6-8 shows the total area of wetlands, by wetland cover type, in the outfall area under the Applicant's Preferred Alternative at 10-year intervals over 50-year analysis period. Reductions in wetland extent depicted in Figure 4.6-8 over the analysis period would still occur due to sea-level rise and subsidence that would not be fully offset by the Project.

Land accretion would result in the establishment of vegetation on new land and new plant growth, in turn, would trap additional sediment and result in further land growth and increasing marsh elevation. The vegetation cover type established would depend on habitat conditions (including salinity). Figures 4.6-9 through 4.6-14 show the total area of wetlands, by wetland cover type, in the Barataria Basin and the birdfoot delta for each 10-year interval. Table 4.6-3 quantifies the acreage changes in wetlands by cover type over time. Table 4.6-4 summarizes the percent change in total wetland acreage compared with the No Action Alternative. Note that the extent of wetland changes presented in Tables 4.6-3 and 4.6-4 include projected changes in vegetated wetlands; acreages differ from the land gains presented in Table 4.2-4 (which presents all land gains, regardless of vegetation establishment). In general, freshwater vegetation and associated above and belowground biomass is projected to form in the outfall area under the action alternatives, where that biomass would be lost under the No Action Alternative. Changes in biomass, along with the other factors used in the Delft3D Basinwide Model, would result in the projected wetland extent depicted in the figures and table below. As described for the No Action Alternative, these projected acreages of wetland creation and maintenance are influenced in part by the sea-level rise rate assumed in the Delft3D Basinwide Model. A lower sea-level rise rate would lead to a higher projected rate of wetland creation and maintenance in the Barataria Basin and a lower rate of land loss in the birdfoot delta, and a higher sea-level rise rate would lead to a lower rate of projected wetland creation and maintenance in the Barataria Basin and higher rate of land loss in the birdfoot delta. A sensitivity run of the Delft3D Basinwide Model used an alternate sea-level rise rate of 2.6 feet (0.79 meter) by year 2100 to evaluate a lower sea-level rise scenario on wetlands. This sensitivity run projected that the extent of wetland area in the Project area would be 297,000 acres at the end of the analysis period under the Applicant's Preferred Alternative, about 3.75 times greater than the wetland area under the 4.9-foot (1.5-meter) sea-level rise scenario presented in Table 4.6-3. Details regarding the magnitude of this difference is provided in Appendix E.

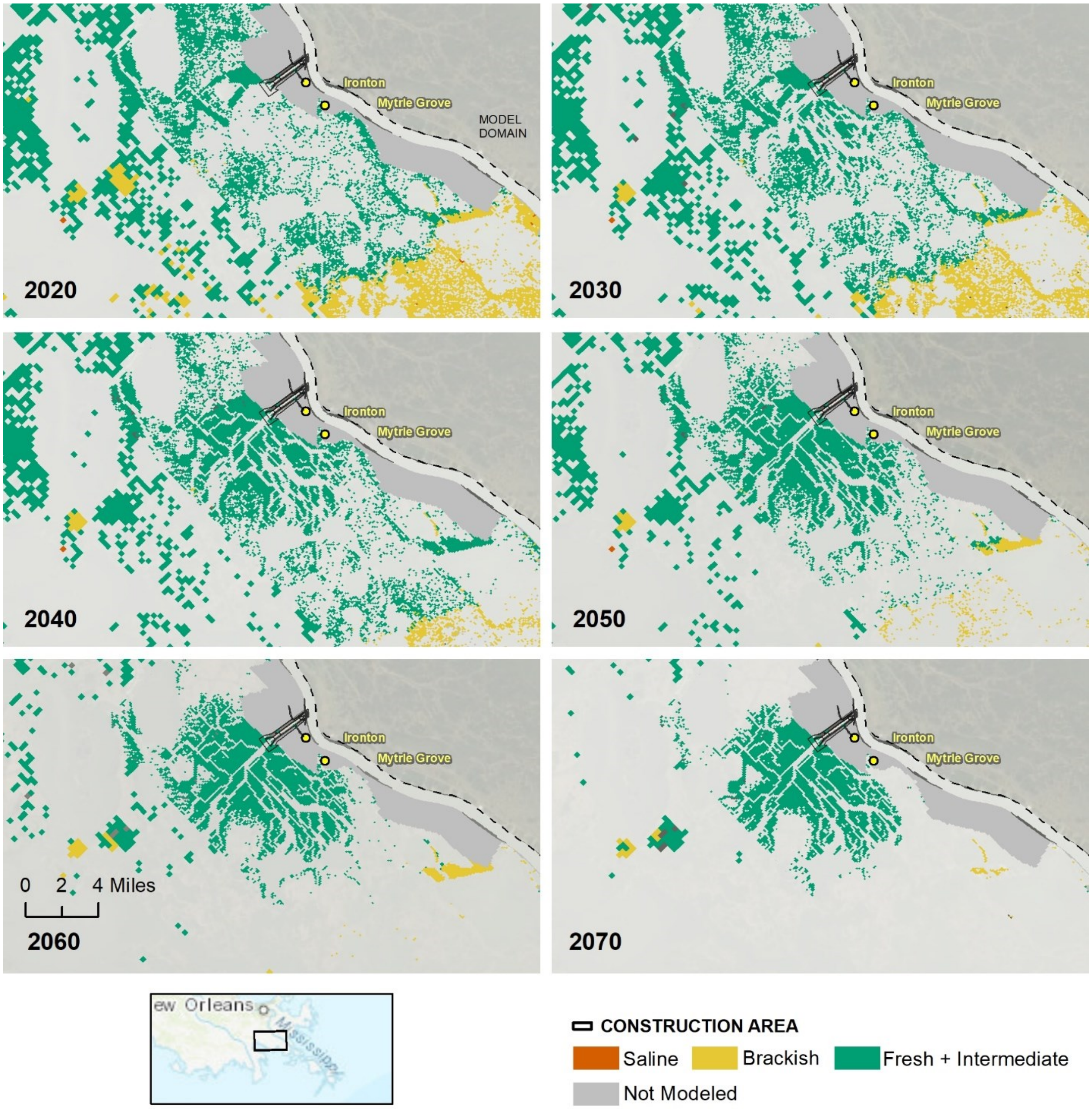


Figure 4.6-8. Wetland Extent Near the Outfall Area for the Applicant's Preferred Alternative, by Decade.

As shown in Table 4.6-3, the maximum difference in wetland extent between the No Action Alternative and the Applicant's Preferred Alternative in the Middle and Lower Barataria Basin is projected to occur in 2060, with a decreasing trend after that decade because of erosion and sea-level rise. Although all of the alternatives continue to have greater wetland area in the Barataria Basin compared to the No Action Alternative through 2070, the total wetland acreage of the Barataria Basin is projected to decline because of erosion and sea-level rise. Over the 50-year analysis period, the acres built and sustained by the Applicant's Preferred Alternative (and other alternatives) would make up a progressively larger share of wetlands in the Barataria Basin.

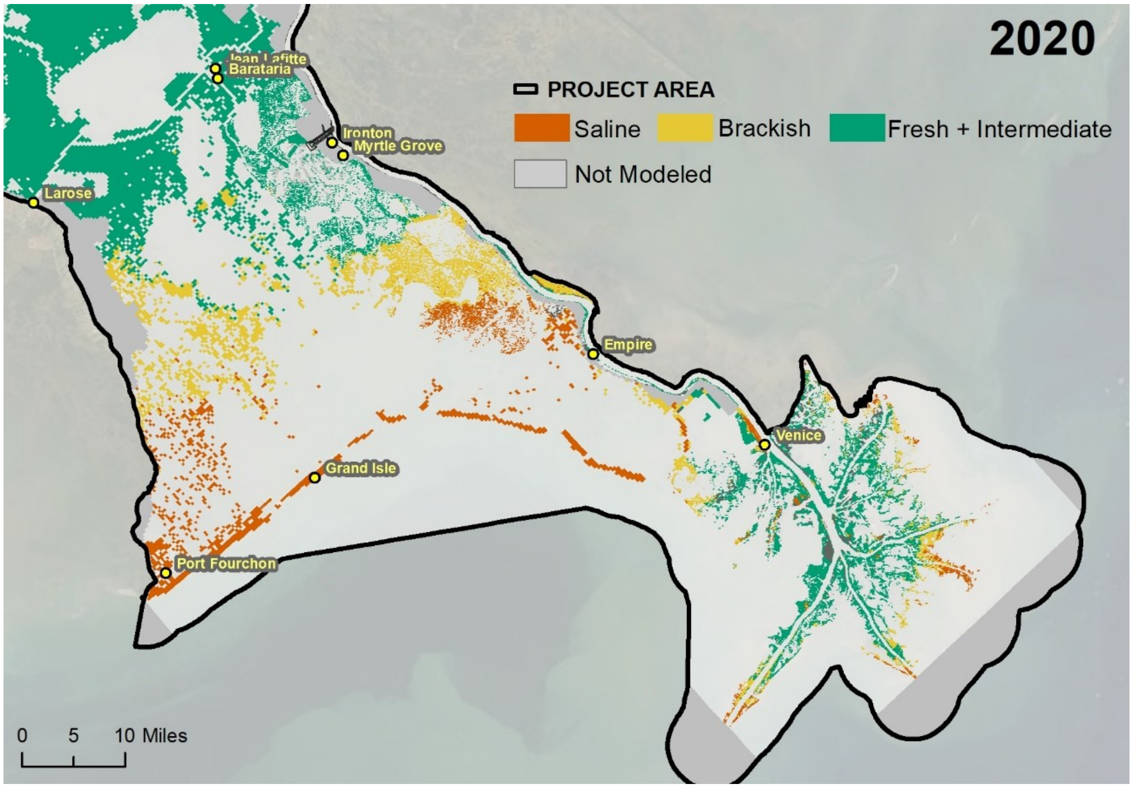


Figure 4.6-9. Wetlands under the Applicant's Preferred Alternative in 2020.

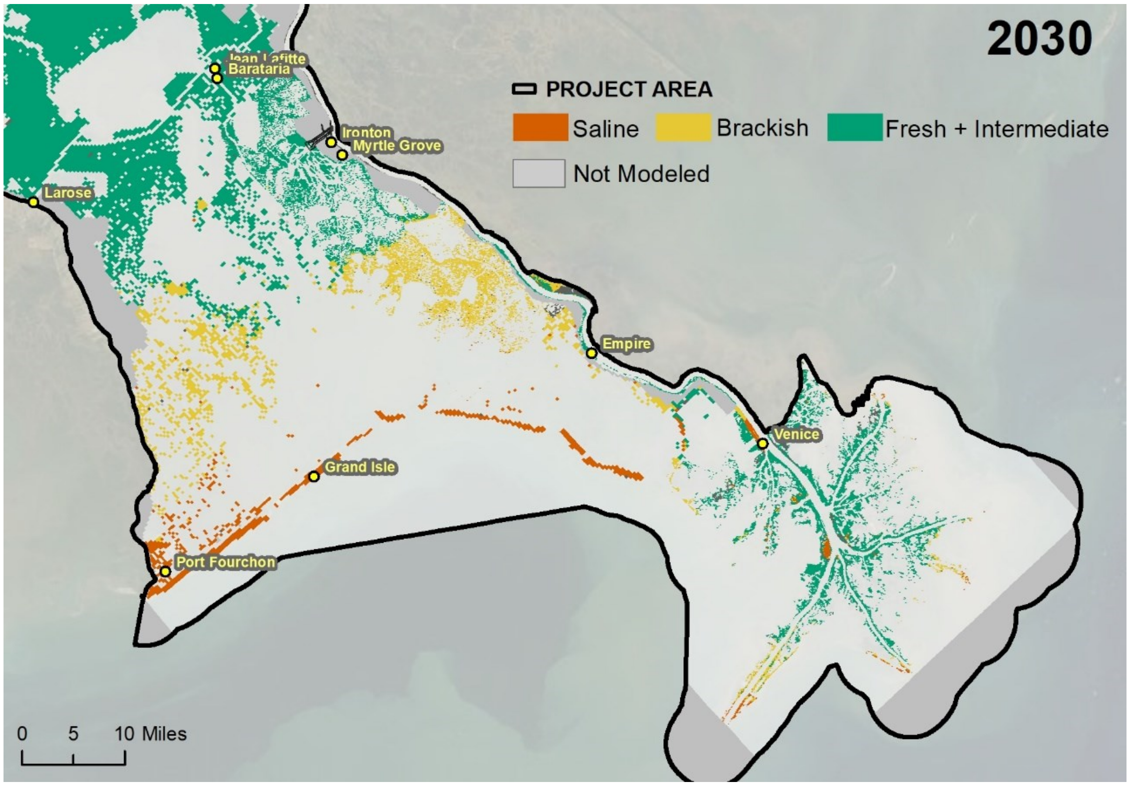


Figure 4.6-10. Wetlands under the Applicant's Preferred Alternative in 2030.

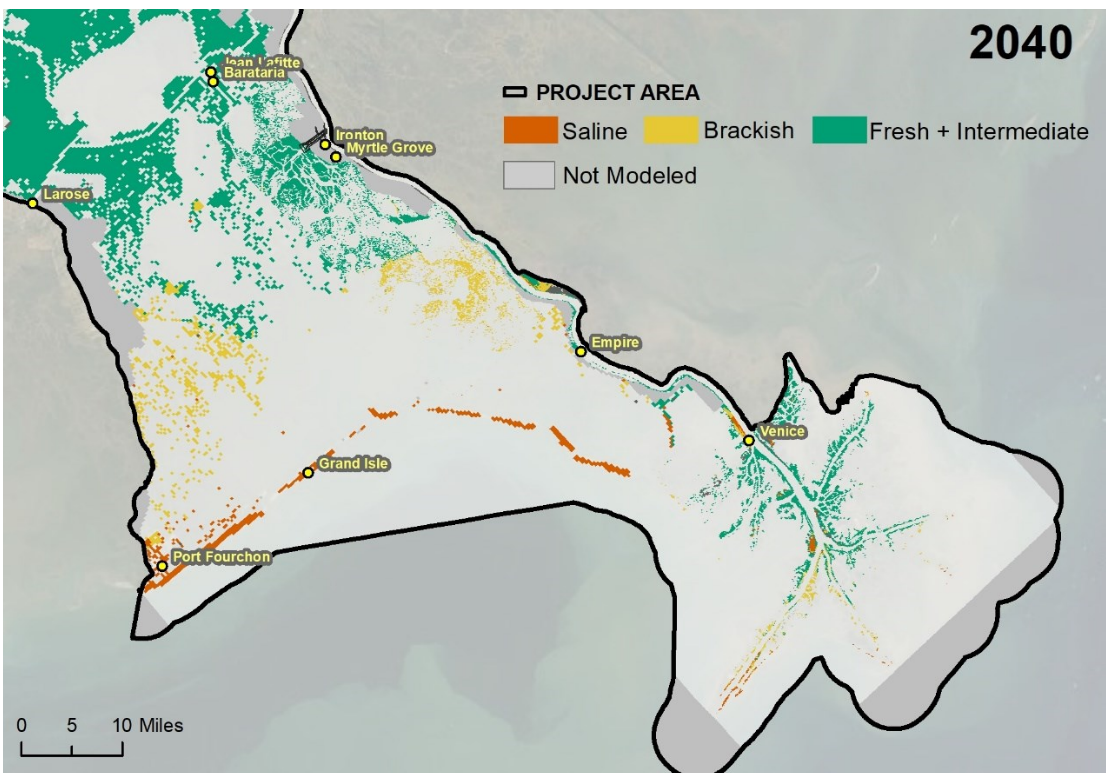


Figure 4.6-11. Wetlands under the Applicant's Preferred Alternative in 2040.

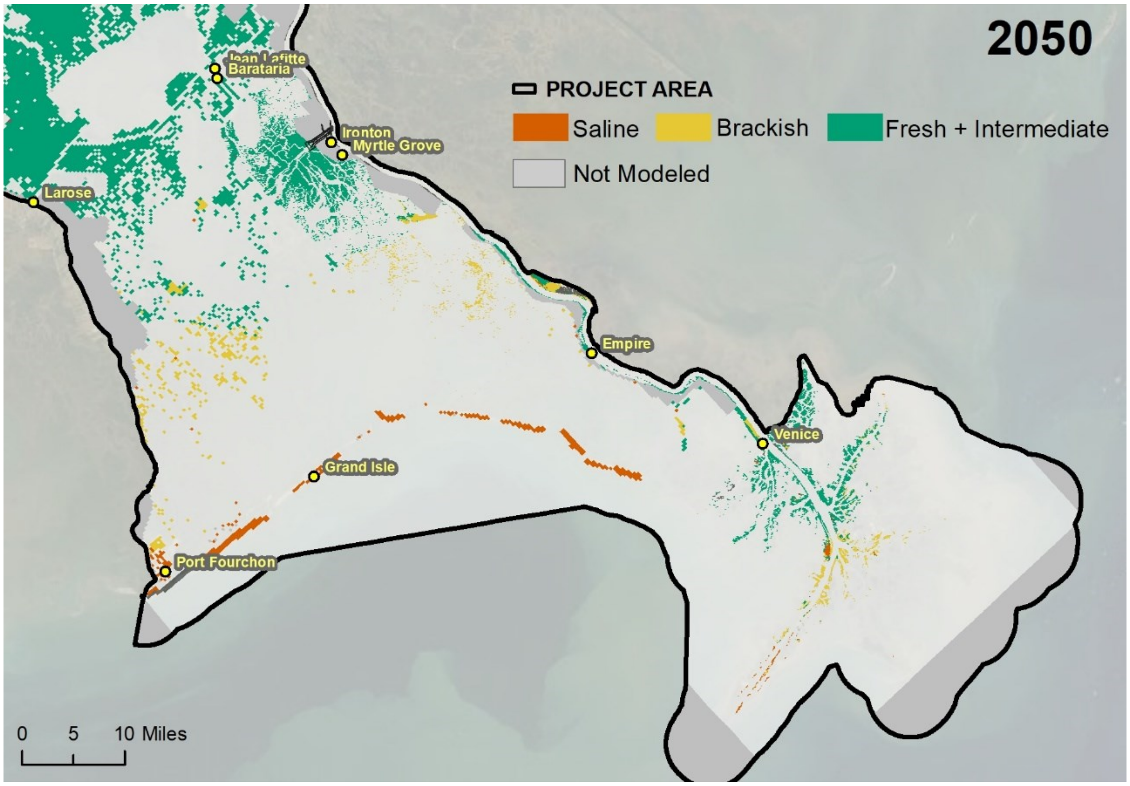


Figure 4.6-12. Wetlands under the Applicant's Preferred Alternative in 2050.

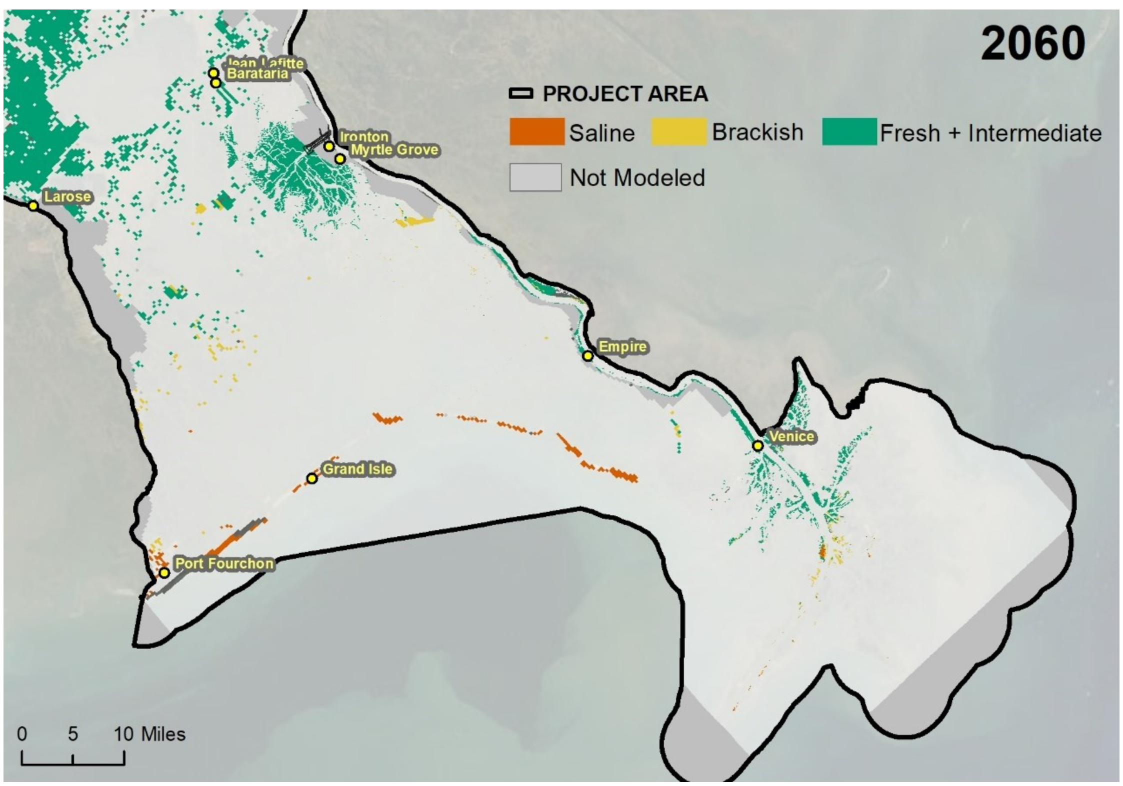


Figure 4.6-13. Wetlands under the Applicant's Preferred Alternative in 2060.

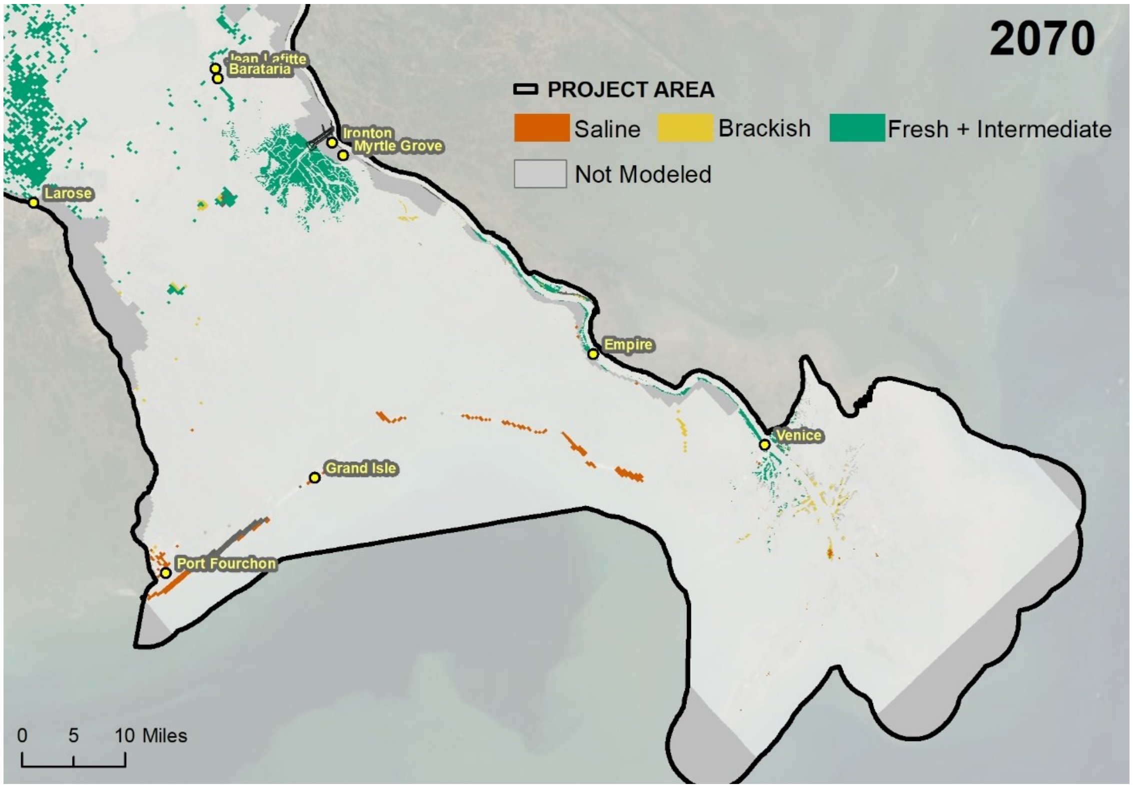


Figure 4.6-14. Wetlands under the Applicant's Preferred Alternative in 2070.

Table 4.6-3
Results of Vegetation Modeling and Projected Acreage of Wetland Acreage, by Decade and Wetland Type, for the Project Alternatives[a]

Alternative / Area	Wetland Cover Type	2020	2030	2040	2050	2060	2070	Total Acres of Wetland Loss[b]
No Action Alternative								
Barataria Basin	Fresh/ Intermediate Marsh	234,000	228,000	209,000	177,000	122,000	61,100	173,000
	Brackish Marsh	70,600	69,700	50,800	25,400	10,700	5,340	65,300
	Saline Marsh	66,800	43,000	27,100	15,500	6,670	6,330	60,400
	Total	371,000	340,000	287,000	218,000	139,000	72,800	298,000
Birdfoot Delta	Fresh/ Intermediate Marsh	44,400	35,900	19,200	12,700	8,930	5,270	39,200
	Brackish Marsh	10,300	3,520	4,820	3,720	1,250	1,010	9,330
	Saline Marsh	4,150	1,920	1,510	945	291	121	4,030
	Total	58,900	41,300	25,500	17,400	10,500	6,410	52,500
Applicant's Preferred Alternative								
Barataria Basin	Fresh/ Intermediate Marsh	270,000	271,000	253,000	207,000	145,000	77,700	156,000
	Brackish Marsh	58,100	54,100	30,900	16,600	4,530	1,710	68,900
	Saline Marsh	42,900	21,300	15,100	10,400	7,040	6,050	60,700
	Total	371,000	346,000	299,000	234,000	157,000	85,500	286,000
Birdfoot Delta	Fresh/ Intermediate Marsh	44,000	34,200	19,800	12,600	8,270	1,810	42,600
	Brackish Marsh	10,500	3,810	3,170	3,820	1,270	1,510	8,840
	Saline Marsh	4,450	1,790	1,450	911	293	201	3,950
	Total	58,900	39,800	24,500	17,300	9,830	3,510	55,400
75,000 cfs + Terraces								
Barataria Basin	Fresh/ Intermediate Marsh	271,000	271,000	253,000	207,000	145,000	78,100	156,000
	Brackish Marsh	57,500	54,300	31,400	16,700	4,610	1,730	68,900
	Saline Marsh	43,000	21,200	14,800	10,500	6,580	6,080	60,700
	Total	371,000	346,000	299,000	234,000	156,000	85,900	285,000
Birdfoot Delta	Fresh/ Intermediate Marsh	44,000	34,400	19,900	12,800	8,400	1,860	42,600
	Brackish Marsh	10,500	3,530	3,240	3,680	1,210	1,540	8,800
	Saline Marsh	4,450	1,850	1,390	937	284	121	4,030
	Total	59,000	39,800	24,500	17,400	9,900	3,520	55,400

Table 4.6-3
Results of Vegetation Modeling and Projected Acreage of Wetland Acreage, by Decade and Wetland Type, for the Project Alternatives[a]

Alternative / Area	Wetland Cover Type	2020	2030	2040	2050	2060	2070	Total Acres of Wetland Loss[b]
50,000 cfs								
Barataria Basin	Fresh/ Intermediate Marsh	266,000	267,000	247,000	201,000	140,000	74,100	159,000
	Brackish Marsh	58,900	54,700	34,000	18,100	5,140	1,810	68,800
	Saline Marsh	46,600	23,200	16,100	11,100	5,760	6,080	60,700
	Total	371,000	345,000	297,000	230,000	151,000	82,000	289,000
Birdfoot Delta	Fresh/ Intermediate Marsh	44,100	34,600	19,600	11,500	7,600	1,700	42,700
	Brackish Marsh	10,500	3,650	3,780	4,450	1,560	1,780	8,560
	Saline Marsh	4,380	1,760	1,440	948	312	198	3,950
	Total	59,000	40,000	24,800	16,900	9,470	3,680	55,200
50,000 cfs + Terraces								
Barataria Basin	Fresh/ Intermediate Marsh	266,000	266,000	247,000	201,000	140,000	74,200	159,000
	Brackish Marsh	58,900	55,400	33,900	18,200	5,290	1,790	68,800
	Saline Marsh	46,100	23,200	16,200	11,200	5,790	6,110	60,700
	Total	371,000	345,000	297,000	230,000	151,000	82,100	289,000
Birdfoot Delta	Fresh/ Intermediate Marsh	44,000	34,700	19,000	11,600	7,650	1,950	42,500
	Brackish Marsh	10,500	3,590	4,180	4,390	1,500	1,600	8,750
	Saline Marsh	4,400	1,760	1,490	946	297	128	4,020
	Total	58,900	40,100	24,600	16,900	9,450	3,680	55,300
150,000 cfs								
Barataria Basin	Fresh/ Intermediate Marsh	278,000	281,000	270,000	227,000	163,000	93,600	140,000
	Brackish Marsh	56,000	51,400	23,500	11,300	1,780	793	69,800
	Saline Marsh	36,900	16,500	14,000	10,000	4,430	4,170	62,600
	Total	371,000	349,000	308,000	248,000	170,000	98,600	272,000
Birdfoot Delta	Fresh/ Intermediate Marsh	43,700	32,800	18,600	11,900	7,370	2,440	42,000
	Brackish Marsh	10,800	3,890	3,300	3,520	1,180	1,090	9,250
	Saline Marsh	4,550	2,010	1,450	936	357	174	3,980
	Total	59,000	38,700	23,300	16,400	8,910	3,710	55,200

Table 4.6-3
Results of Vegetation Modeling and Projected Acreage of Wetland Acreage, by Decade and Wetland Type, for the Project Alternatives[a]

Alternative / Area	Wetland Cover Type	2020	2030	2040	2050	2060	2070	Total Acres of Wetland Loss[b]
150,000 cfs + Terraces								
Barataria Basin	Fresh/ Intermediate Marsh	277,000	281,000	270,000	226,000	164,000	93,500	140,000
	Brackish Marsh	56,800	51,100	23,700	11,900	1,460	1,010	69,600
	Saline Marsh	37,100	18,200	14,200	9,940	5,700	4,640	62,100
	Total	371,000	351,000	308,000	248,000	171,000	99,200	272,000
Birdfoot Delta	Fresh/ Intermediate Marsh	43,700	32,900	18,700	12,000	7,680	2,470	42,000
	Brackish Marsh	10,700	3,780	3,140	3,460	1,040	1,340	9,010
	Saline Marsh	4,580	2,040	1,390	935	316	168	3,980
	Total	59,000	38,700	23,200	16,400	9,040	3,970	55,000

a Modeled wetland acreages have been rounded to three significant digits.
b As compared with the No Action Alternative in 2020.

Table 4.6-4
Percentage of Wetland Gains and Losses when Compared with the No Action Alternative
Acres (Percent)[a]

Alternative	Watershed	2020	2030	2040	2050	2060	2070
Applicant's Preferred Alternative	Barataria Basin	33	5,590	12,300	16,700	17,100	12,700
		(<0.1%)	(1.6%)	(4.3%)	(7.6%)	(12.3%)	(17.4%)
	Birdfoot Delta	-9	-1,510	-1,040	-120	-642	-2,890
		(<-0.1%)	(-3.7%)	(-4.1%)	(-0.7%)	(-6.1%)	(-45.1%)
	Total	24	4,080	11,300	16,500	16,500	9,790
		(<0.1%)	(1.1%)	(3.6%)	(7.0%)	(11.0%)	(12.4%)
75,000 cfs + Terraces	Barataria Basin	57	5,870	12,400	16,600	16,700	13,100
		(<0.1%)	(1.7%)	(4.3%)	(7.6%)	(12.0%)	(18.0%)
	Birdfoot Delta	36	-1,550	-1,010	20	-581	-2,890
		(<0.1%)	(-3.8%)	(-3.9%)	(0.1%)	(-5.5%)	(-45.1%)
	Total	92	4,310	11,400	16,600	16,100	10,200
		(<0.1%)	(1.1%)	(3.7%)	(7.1%)	(10.8%)	(12.9%)
50,000 cfs	Barataria Basin	-4	4,330	9,810	12,100	11,200	9,240
		(<-0.1%)	(1.3%)	(3.4%)	(5.6%)	(8.0%)	(12.7%)
	Birdfoot Delta	26	-1,355	-682	-493	-1,007	-2,721
		(<0.1%)	(-3.3%)	(-2.7%)	(-2.8%)	(-9.6%)	(42.5%)
	Total	22	2,970	9,130	11,600	10,200	6,520
		(<0.1%)	(0.8%)	(2.9%)	(4.9%)	(6.8%)	(8.2%)
50,000 cfs + Terraces	Barataria Basin	66	4,400	9,670	12,400	11,600	9,320
		(<0.1%)	(1.3%)	(3.4%)	(5.7%)	(8.3%)	(12.8%)
	Birdfoot Delta	-3	-1,260	-857	-489	-1,030	-2,730
		(<-0.1%)	(-3.1%)	(-3.4%)	(-2.8%)	(-9.8%)	(-42.6%)
	Total	63	3,140	8,810	11,900	10,500	6,590
		(<0.1%)	(0.8%)	(2.8%)	(5.1%)	(7.0%)	(8.3%)
150,000 cfs	Barataria Basin	-248	8,460	20,800	30,400	30,300	25,800
		(<-0.1%)	(2.5%)	(7.2%)	(14.0%)	(21.8%)	(35.4%)
	Birdfoot Delta	29	-2,590	-2,190	-1,020	-1,570	-2,700
		(<0.1%)	(-6.3%)	(-8.6%)	(-5.9%)	(-15.0%)	(-42.1%)
	Total	-220	5,880	18,600	29,400	28,700	23,100
		(-0.1%)	(1.5%)	(5.9%)	(12.5%)	(19.2%)	(29.2%)
150,000 cfs + Terraces	Barataria Basin	-207	10,100	20,800	30,300	31,800	26,400
		(<-0.1%)	(3.0%)	(7.2%)	(13.9%)	(22.8%)	(36.3%)
	Birdfoot Delta	43	-2,590	-2,260	-1,020	-1,440	-2,430
		(<0.1%)	(-6.3%)	(-8.9%)	(-5.9%)	(-13.7%)	(-38.0%)
	Total	-165	7,560	18,500	29,300	30,300	24,000
		(<-0.1%)	(2.0%)	(5.9%)	(12.5%)	(20.2%)	(30.3%)

[a] Modeled wetland acreages have been rounded to three significant digits. Percent change is based on modeled output prior to rounding.

The impacts of the Applicant's Preferred Alternative on wetlands in the Project area would evolve over the 50-year analysis period. Immediately following initial diversion operations, localized erosion and loss of some emergent wetlands near the outfall transition feature would likely occur due primarily to scouring and inundation impacts and secondarily due to high-water velocities of the diverted water coming out of the proposed diversion channel. Similar land losses were documented during the first few years following the opening of the Davis Pond Diversion (Turner et al. 2019). However, those impacts for the proposed Project would be offset by marsh building in the outfall area by 2030 (see Figure 4.6-8). As described in Section 4.2.3.2 in Geology and Soils, the influx of mineral sediment into existing highly organic marshes would change the soil composition of these existing marshes, likely resulting in sediment grain size changes, with higher sand content and increased bulk densities. Finer-grained silts and clays introduced into Barataria Basin would also play an important role in nourishing and sustaining existing wetlands further removed from the immediate outfall area even if they are less likely to contribute directly to land building. Added sediment could benefit marsh vegetation by increasing marsh elevation, or could inhibit seedling emergence, making them more prone to loss (Jurik et al. 1994). However, these moderate, temporary to short-term, adverse wetland impacts would be offset when total wetland impacts are considered over the 50-year analysis period (Meselhe et al. 2014; see Section 4.2.2 in Geology and Soils).

When compared with the No Action Alternative, after 10 years of diversion operations (2030), larger areas of freshwater and intermediate wetlands would occur within the Project area under the Applicant's Preferred Alternative, while brackish and saline marsh areas would decrease as compared to the No Action Alternative. Over the next two decades, an overall increase in wetland acreage relative to the No Action Alternative would occur as the shallower open water areas in the delta formation area begin to fill in and become colonized by intermediate marsh species. The most significant impacts on sedimentation would occur within approximately 10 miles of the diversion structure outlet, with moderate and minor impacts extending farther, primarily southward. During this period, trends toward freshwater and intermediate wetlands would continue.

Figures 4.6-9 through 4.6-14 depict the habitat transitions projected in the Barataria Basin over the analysis period. In general, the freshening effects of the Project would result in a shift from brackish marsh to fresh/intermediate marsh in the mid- to lower-basin when compared with the No Action Alternative over the analysis period. The extent of brackish wetlands would shift further south within the Barataria Basin when compared with the No Action Alternative (depicted in Figures 4.6-2 through 4.6-7), before declining in total area between 2050 and 2070. The extent of saline marsh, which extends inland from the Gulf of Mexico shoreline under 2020 conditions, would be limited to the barrier islands by the end of the analysis period in 2070.

Over the 50-year analysis period, total wetland acreage in the Barataria Basin would decrease under the Applicant's Preferred Alternative due to sea-level rise and subsidence; however, this alternative would result in a projected 17.4 percent greater total wetland area in 2070 (about 85,500 acres) when compared with the No Action Alternative (about 72,800 acres). Over the course of the Project lifecycle, freshwater and intermediate marshes would be lost throughout the Barataria Basin; south and east of Lake Salvador, the remaining wetlands would be limited almost completely to those wetlands in the delta formation area, and brackish wetlands would be limited to a few discrete locations as shown in Figure 4.6-8. No saline wetlands would remain in the delta formation area, although saline wetlands would remain along the Gulf-facing barrier islands. By comparison, under the No Action Alternative, almost all freshwater and intermediate wetlands south and east of Lake Salvador would be lost and wetlands within this area of the Barataria Basin would be limited to a few discrete areas of brackish and saline marsh.

Hurricanes could disrupt wetlands created and sustained by the Project over the 50-year analysis period. More frequent, strong (Category 3 and higher) hurricanes are expected to occur in the Project area as a result of climate change (Day et al. 2021b). Storm damage to wetlands could result in vegetation mortality due to inundation, saltwater intrusion from storm surge, and erosion (Howes et al. 2010). If nutrient loading associated with the Project results in decreases in soil shear strength, as described above, marsh may be more susceptible to damage from storms (Turner 2011, Turner et al. 2020, Howes et al. 2010, Mo et al. 2020). In particular, freshwater marsh is subject to potential damage from saltwater inundation from storm surge and has been documented to sustain greater damage from storms (Mo et al. 2020, Howes et al. 2010). As described above, rapid recovery of freshwater marsh in the outfall area has been observed at other diversions following disturbance by Hurricane Katrina (see review in Teal et al. 2012). Further, over the 50-year analysis period, the Applicant's Preferred Alternative is projected to increase the total area of fresh/intermediate, brackish, and saline marsh as compared with the No Action Alternative, thereby providing a larger wetland area to buffer the effects of storms on coastal land and to provide a larger area of marsh available for post-storm recovery.

In the birdfoot delta, wetland losses would be greater under the Applicant's Preferred Alternative as compared to the No Action Alternative (see Table 4.6-3). However, only 10.9 and 6.0 percent (6,410 and 3,510 acres) of the wetlands present in the birdfoot delta are projected to remain under the No Action Alternative and Applicant's Preferred Alternative, respectively, in 2070, and almost all wetlands in the birdfoot delta would be lost under either alternative scenario (see Figure 4.6-8). Therefore, this impact would be moderate, permanent, and adverse.

As described in Chapter 3, Section 3.6.1 in Wetland Resources and Waters of the U.S., wetlands in the Project area provide ecosystem services including habitat and forage for wildlife and aquatic species (including species of greatest conservation concern; see Section 4.9.2 in Terrestrial Wildlife and Habitat and Section 4.10.2 in Aquatic Resources for Project-related impacts), improve water quality, and sequester carbon. Wetlands also support commercial fisheries and provide flood control and protection from storm surges. Freshwater marsh habitat is imperiled in Louisiana because it is vulnerable to extirpation; intermediate, salt, and brackish marsh are also classified as vulnerable to extirpation (see Table 3.6-2 and LDWF 2015). While the trend toward wetland losses in the Barataria Basin would result in the continued reduction in these wetland functions, the wetlands that are created or sustained by the proposed Project would provide valuable functions (Caffey and Petrolia 2014). As the total acreage of wetlands in the Barataria Basin decreases over time, the relative importance of remaining wetlands is greater. Additional detail regarding the value of wetlands in the Project area under each alternative scenario is provided in the Wetland Value Assessment in Section 4.6.5.3, below.

4.6.5.1.3 Other Alternatives

The types of impacts from the diversion of fresh water and sediment from the other action alternatives would be similar to those described above for the Applicant's Preferred Alternative, although the degree would vary. As compared with the No Action Alternative, the other action alternatives would have major, permanent, beneficial impacts on wetlands in the Barataria Basin with respect to distribution and extent, and moderate, permanent, adverse impacts on wetlands in the birdfoot delta due to reduced sediment delivery. However, the alternatives would vary in the total acreage of wetland impacts since they would transport different volumes of material from the Mississippi River to the Barataria Basin. Similar to the Applicant's Preferred Alternative, the impacts of the other alternatives would evolve over the analysis period. Immediately following initial diversion operations, loss of some emergent wetlands would occur near the outfall transition feature due primarily to scouring and inundation. These moderate, temporary to short-term, adverse wetland impacts would be offset when total wetland impacts are considered over the 50-year analysis period. When compared with the No Action Alternative, after 10 years of diversion operations (2030), larger areas of freshwater and intermediate wetlands would occur within the Project area, while brackish and saline marsh areas would decrease as compared to the No Action Alternative. Over the next two decades, an overall increase in wetland acreage relative to the No Action Alternative would occur as the shallower open water areas near the diversion outfall begin to fill in and become colonized by intermediate marsh species. The most significant impacts on sedimentation would occur within approximately 10 miles of the diversion structure outlet, with moderate and minor impacts extending farther, primarily southward. During this period, trends toward freshwater and intermediate wetlands would continue. Over the remainder of the proposed Project lifecycle, freshwater and intermediate marshes would be lost throughout the Barataria Basin; south and east of Lake Salvador, the remaining wetlands would be limited almost completely to those wetlands in the delta formation area. The impacts of the other alternatives on wetland function would be similar to the Applicant's Preferred Alternative, and would scale with the different capacities of the alternatives.

In addition, the terrace alternatives would add 18 chevron features oriented into the diversion discharge current within an 80.0 to 90.0-acre area at the initiation of operations; the terraces are expected to support marsh vegetation and would have some minor impacts on the formation and types of wetlands over the analysis period. A summary of the changes in wetland area in the Barataria Basin and the birdfoot delta for each alternative is presented in Table 4.6-3, and summarized for each alternative below. Figure 4.6-15 presents the results of the Delft3D Basinwide Model for vegetation for each action alternative in modeled year 2070, for comparison, in the delta formation area. Figures 4.6-16 through 4.6-19 show the total area of wetlands, by wetland cover type, in the Barataria Basin and the birdfoot delta for the No Action Alternative and each action alternative in 2070.

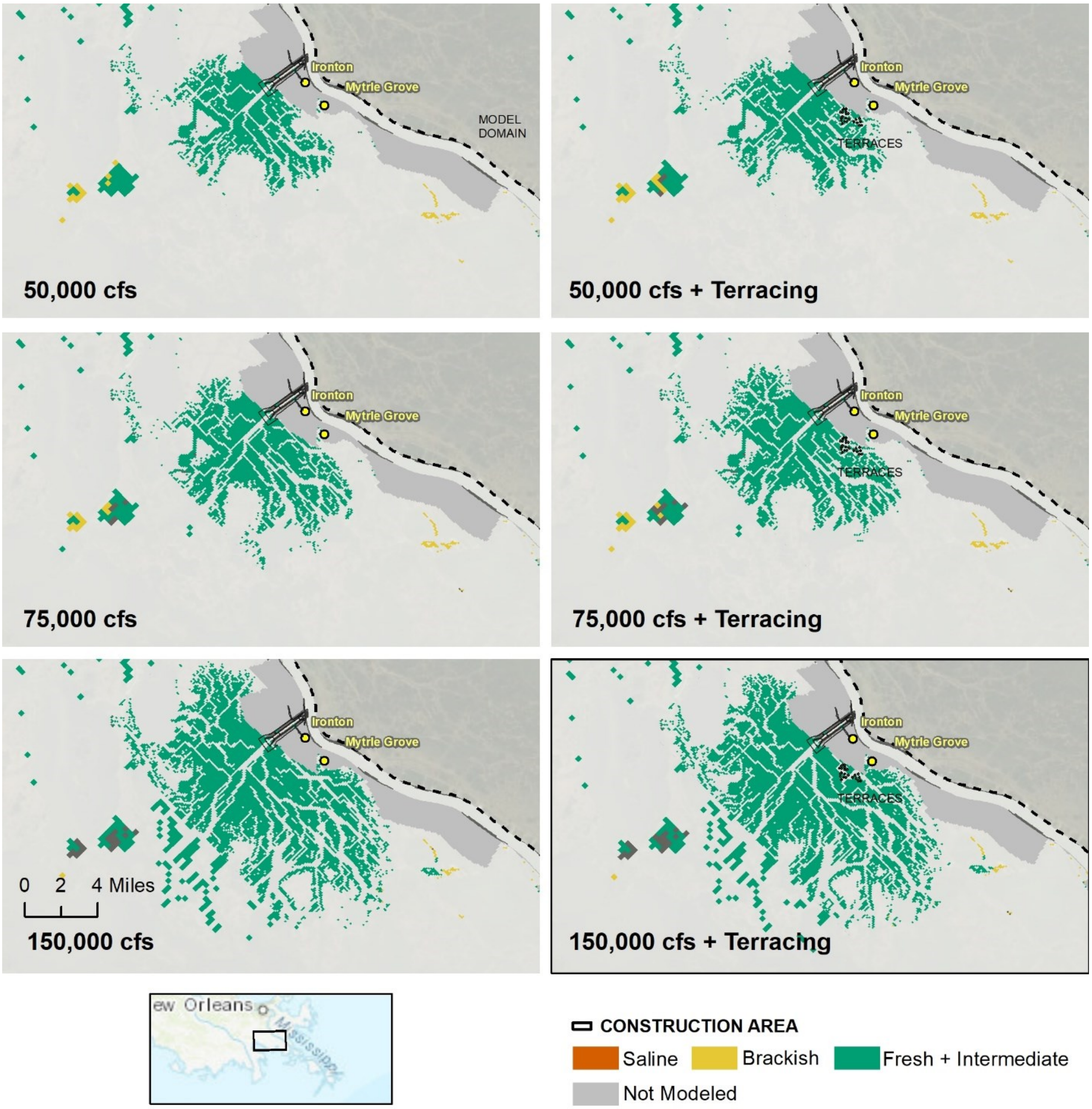


Figure 4.6-15. Wetland Extent Near the Delta Formation Area for Each Action Alternative in 2070.

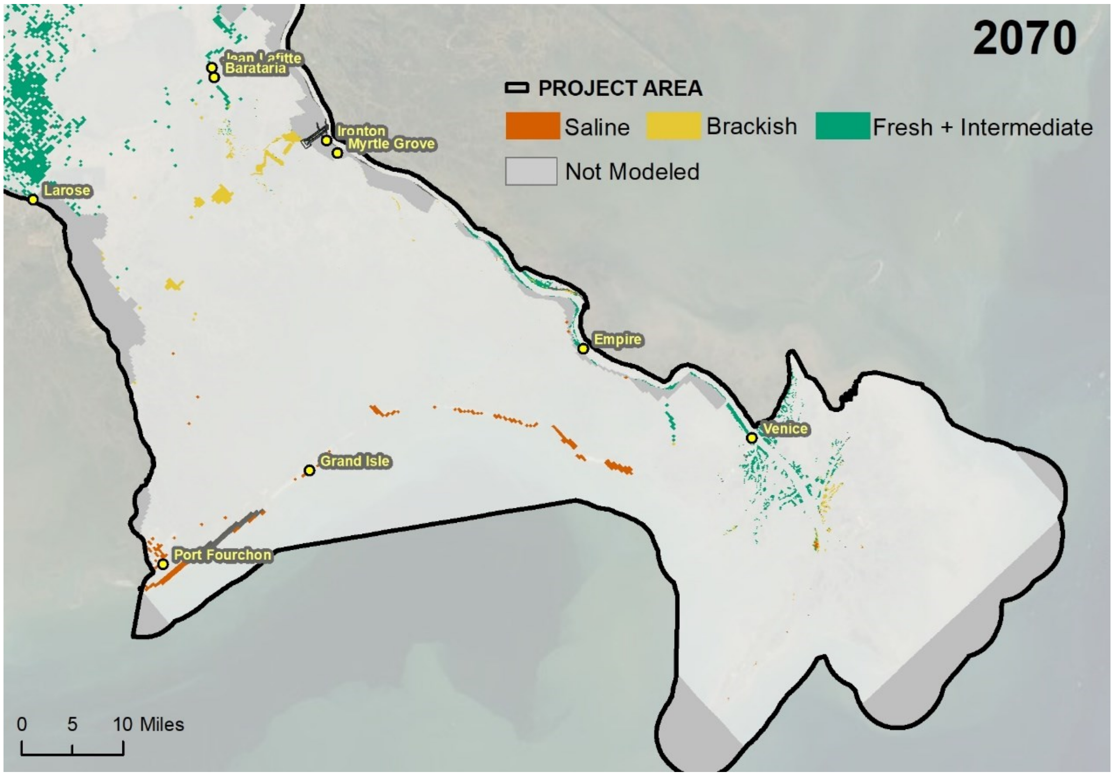


Figure 4.6-16. Wetlands under the No Action Alternative in 2070.

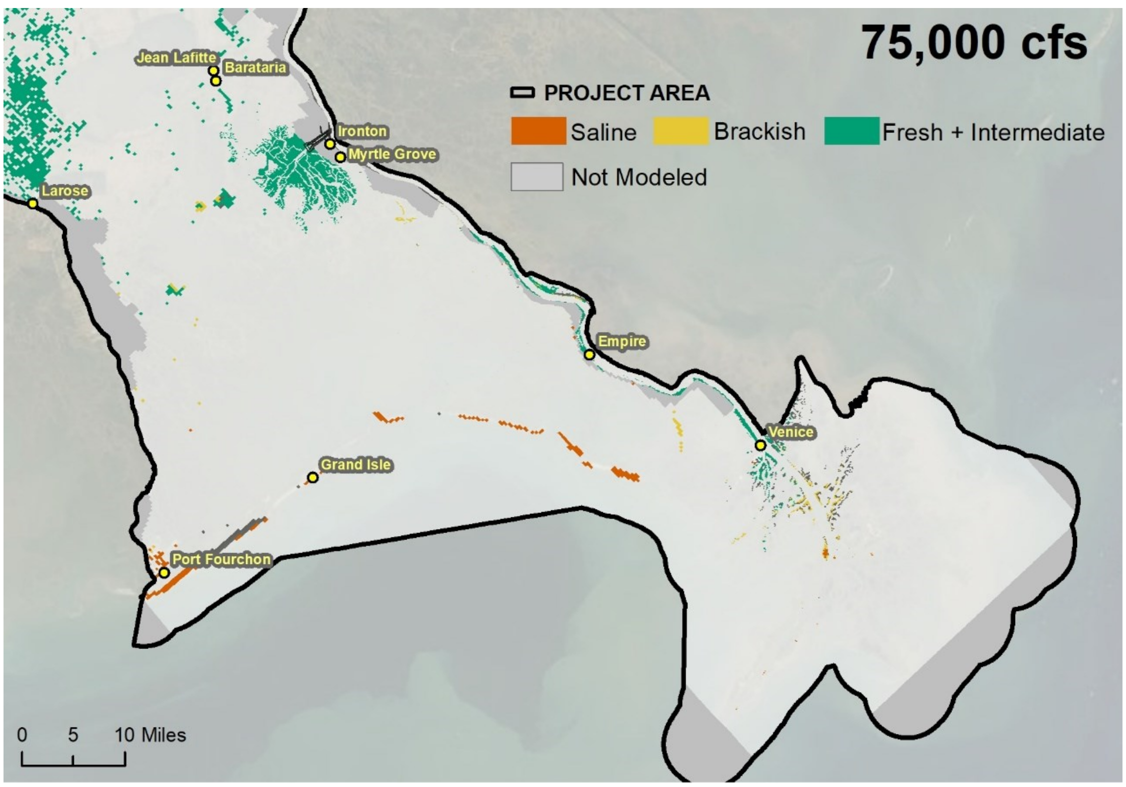


Figure 4.6-17. Wetlands under the Applicant's Preferred Alternative in 2070.

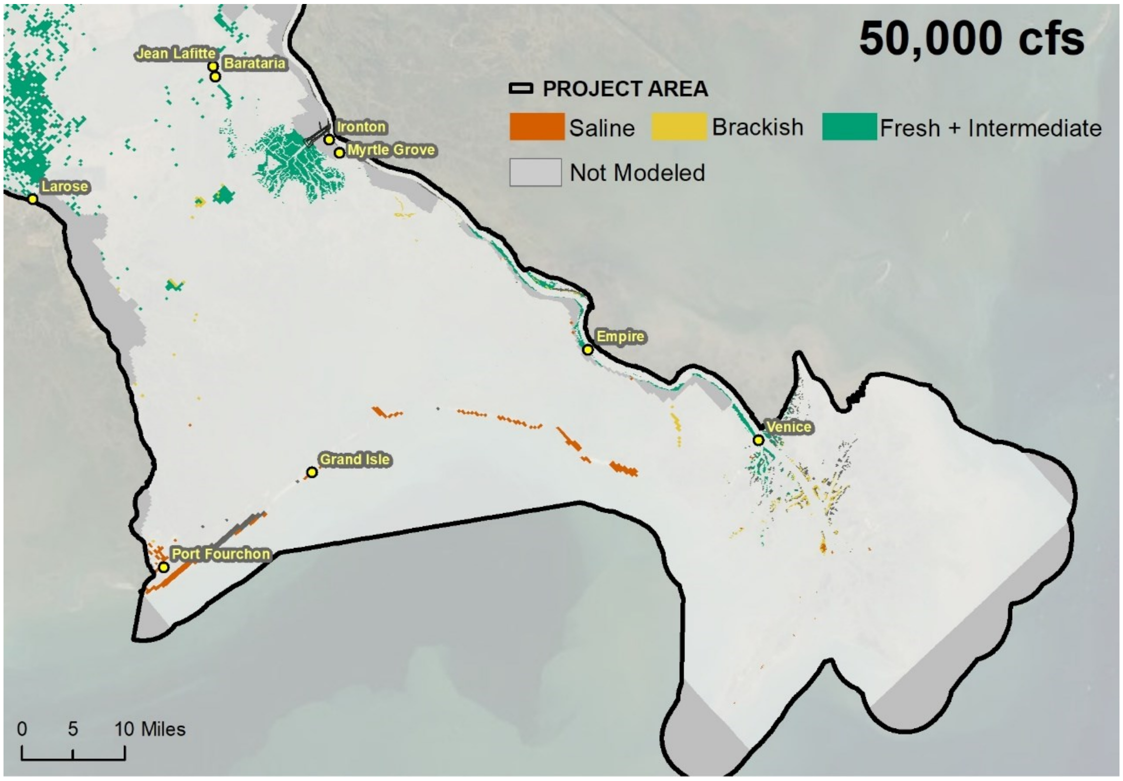


Figure 4.6-18. Wetlands under the 50,000 cfs Alternative in 2070.

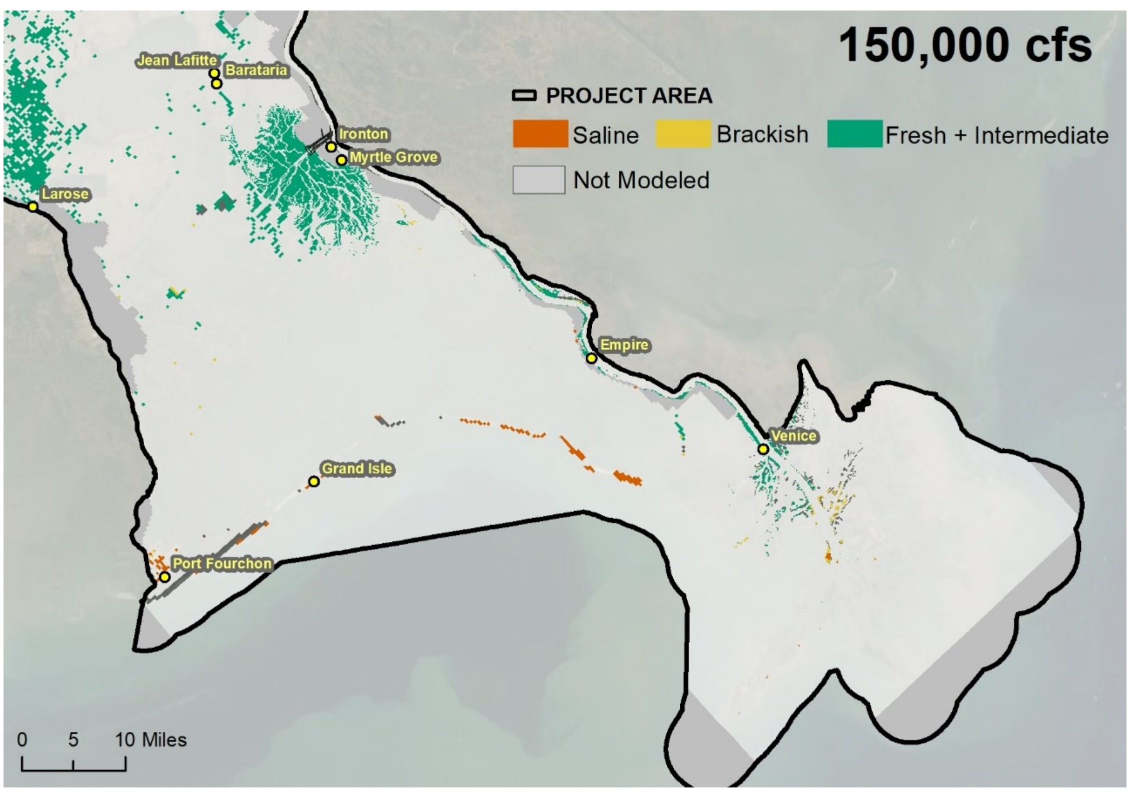


Figure 4.6-19. Wetlands under the 150,000 cfs Alternative in 2070.

4.6.5.1.3.1 50,000 cfs Alternative

The 50,000 cfs Alternative would have major, permanent, beneficial impacts on wetlands in the Barataria Basin that would be sustained or created by the diversion of sediment, fresh water, and nutrients. The alternative would also have moderate, permanent, adverse impacts on wetlands in the birdfoot delta. These direct and indirect impacts from operation and maintenance of the 50,000 cfs Alternative on wetlands would result in an increase of about 12.7 percent of total vegetated wetland area within the Barataria Basin over the No Action Alternative in year 2070 (see Table 4.6-4). The lower volume of sediment, fresh water, and nutrients transported by this alternative would result in less wetland creation than the Applicant's Preferred Alternative.

Conversely, since sediments, fresh water, and nutrients transported by the alternative would be diverted away from the birdfoot delta, that area would experience an additional projected loss of 42.5 percent of wetland cover by 2070 when compared with the No Action Alternative (see Figure 4.6-15), representing moderate, permanent, adverse impacts. This alternative would result in 3,680 acres of wetlands in the birdfoot delta by 2070.

4.6.5.1.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative would have major, permanent, beneficial impacts on wetlands in the Barataria Basin that would be sustained or created by the diversion of sediment and fresh water. The alternative would also have moderate, permanent, adverse impacts on wetlands in the birdfoot delta. These direct and indirect impacts from operation and maintenance of the 150,000 cfs Alternative on wetlands would result in an increase of about 35.4 percent of total vegetated wetland area within the Barataria Basin over the No Action Alternative in year 2070 (see Table 4.6-4). The greater volume of sediment and fresh water transported by this alternative would result in more wetland creation than the Applicant's Preferred Alternative and greater beneficial wetland impacts.

Conversely, since sediments, fresh water, and nutrients transported by the alternative would be diverted away from the birdfoot delta, that area would experience a projected loss of 42.1 percent of wetland cover by 2070 when compared with the No Action Alternative; impacts would be less than the Applicant's Preferred Alternative (see Figure 4.6-15), representing moderate, permanent, adverse impacts.[58] This alternative would result in 3,710 acres of wetlands in the birdfoot delta by 2070.

[58] Under each alternative scenario, the Delft3D Basinwide Model predicts a levee breach along the Mississippi River and the subsequent emergence of a crevasse splay in the southern part of Breton Sound, which changes the availability of sediment for land building in the birdfoot delta. The timing of this development varies among alternatives and is the reason that impacts on the birdfoot delta would be less in 2070 than the Applicant's Preferred Alternative under the 150,000 cfs and 150,000 cfs + Terraces Alternatives.

4.6.5.1.3.3 Terrace Alternatives

Terraces constructed for each capacity alternative would serve to capture sediment in the immediate outfall area; therefore, the terrace alternatives would result in slightly more wetland creation in the Barataria Basin when compared with the alternatives without terraces. However, the terraces could also prevent that sediment from traveling farther into the basin and therefore wetland creation would occur over a smaller overall area as compared with the alternatives without terraces. As compared to the No Action Alternative, the terrace alternatives would have major, permanent, beneficial impacts on wetlands in the Barataria Basin that would be sustained or created by the diversion of sediment and fresh water. The terrace alternatives would also have moderate, permanent, adverse impacts on wetlands in the birdfoot delta. These direct and indirect impacts from operation and maintenance of the terrace alternatives would scale with the volume of fresh water and sediment associated with each alternative. The direct and indirect impact from operation and maintenance of the 50,000 cfs, 75,000 cfs, and 150,000 cfs + Terraces Alternatives on wetlands would result in an increase of about 12.8, 18.0, and 36.3 percent of total vegetated wetland area within the Barataria Basin over the No Action Alternative by 2070, respectively (see Table 4.6-4). The birdfoot delta would experience an additional projected loss of 45.1, 42.6, and 38.0 percent of wetland cover by 2070 under the 50,000 cfs, 75,000 cfs, and 150,000 cfs + Terraces Alternatives, respectively, when compared with the No Action Alternative (see Table 4.6-4), representing moderate, permanent, adverse impacts.

4.6.5.2 Wetland Invasive Plants

4.6.5.2.1 No Action Alternative

The net impact on wetland invasive plants under the No Action Alternative would be minor, permanent, and adverse. Under the No Action Alternative, construction of the proposed Project would not occur. The loss of land mass and wetlands in the Barataria Basin would continue to occur as described in Chapter 3, Section 3.6.3 in Wetland Resources and Waters of the U.S. Invasive plant species in Project area wetlands are expected to continue to persist and expand while the habitat conditions that support their growth and survival persist. Changes in salinity and inundation due to sea-level rise and subsidence would continue to disturb existing wetlands, providing opportunities for the establishment and expansion of invasive plant species. Because invasive wetland plant species in the Project area are associated with freshwater and brackish habitat (see Chapter 3, Section 3.6 Wetland Resources and Waters of the U.S., Table 3.6-3 and Kravitz et al. 2005), where fresh and brackish marshes are converted to saline habitat, the range of some invasive species may be restricted or reduced. Further, continued wetland loss in the Barataria Basin and the birdfoot delta would eventually result in the mortality of some aquatic invasive plants.

4.6.5.2.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative could result in minor to moderate, permanent, adverse impacts from the spread of invasive species in the Barataria Basin.

Alternatively, negligible to minor, permanent, beneficial impacts on the spread of invasive species could occur in the birdfoot delta. Operation of the proposed Project could result in the introduction or spread of invasive wetland plant species in the Barataria Basin. As described in Chapter 3, Section 3.6.3.3 in Wetland Resources and Waters of the U.S., invasive species can displace native plant communities, reduce the ability of streams to convey water, and degrade aquatic habitats. Wetland invasive plant species are generally transported through water dispersion pathways such as flotation from upstream watersheds (Zedler and Kercher 2004). During operation of the proposed Project, water and sediment transported from the Mississippi River into the Barataria Basin to create wetlands would provide a vector for the spread and establishment of invasive wetland plants. The diversion of fresh water to the outfall area would cause a shift in native and invasive plant communities due to decreased salinity concentrations combined with increased nutrient loading downstream (see Section 4.6.5.1). Nutrient enrichment may provide a competitive advantage to invasive species, which are capable of rapid nutrient uptake and growth (Teal et al. 2012). Therefore, freshwater and brackish wetland invasive plants could expand as a result of reduced salinity and increased nutrients (Teal et al. 2012). Some plant species, such as alligatorweed would be transported as floating propagules and therefore, may become established in newly created wetlands more readily than other native species. Freshwater diversions have been shown to provide opportunities for aquatic invasive species such as water hyacinth and Eurasian watermilfoil to become established, and vegetation data near the Davis Pond Freshwater Diversion show an increase in the vegetation cover of alligatorweed at monitoring sites in the vicinity of the diversion since the early 2000s (Kravitz et al. 2005, CPRA 2019a; see Chapter 3, Section 3.5.3 in Surface Water and Sediment Quality). Aquatic invasive species that could spread in the Project area are addressed in Section 4.10 Aquatic Resources.

Because of the rapid growth characteristic of invasive plants, if transported by the diversion, they would likely become established in new wetlands that result from Project operations and may spread to wetlands sustained by sediments transported by the proposed Project. While the presence of invasive species may degrade wetland functions, the establishment of wetland plants (including invasive species) in newly created wetlands would reduce soil erosion and trap sediment, potentially contributing to wetland accretion. Given the presence of invasive plant species in the Barataria Basin under current conditions as described in Chapter 3, Section 3.6.3.3 in Wetland Resources and Waters of the U.S., impacts on the spread and introduction of invasive species in new wetlands resulting from Project operations would be minor to moderate, permanent, and adverse.

Herbivory by nutria primarily occurs in freshwater to brackish marshes that would be sustained by the proposed Project. If nutrients transported by the proposed Project result in better forage quality, as described in Section 4.6.5.1 above, impacts from nutria herbivory could be greater and would have adverse impacts on wetlands in the outfall area (Teal et al. 2012, Peyronnin et al. 2017, McFalls et al. 2010). Nutria are addressed in greater detail in Section 4.9.3 in Terrestrial Wildlife and Habitat.

Invasive wetland plant species in the Project area are predominantly associated with freshwater habitat (see Chapter 3, Section 3.6 Wetland Resources and Waters of the U.S., Table 3.6-3 and Kravitz et al. 2005). Therefore, the increased salinity in the birdfoot delta resulting from diversion of fresh water away from the Mississippi River could restrict the range of some invasive species, or preclude their establishment. For example, giant salvinia may be successfully controlled by the introduction of saltwater (Savoie 2003). Therefore, the Project could contribute negligible to minor, permanent, beneficial impacts on the spread of invasive species in the birdfoot delta.

4.6.5.2.3 Other Alternatives

Each alternative would have minor, permanent, adverse impacts on the spread and introduction of invasive species in the Barataria Basin and negligible to minor, permanent, beneficial impacts on the spread and introduction of invasive species in the birdfoot delta. Impacts related to aquatic invasive species due to the operation of the other five action alternatives would be similar to those described above for the Applicant's Preferred Alternative, and would scale with the different acres of wetland impacts (see Table 4.6-3).

4.6.5.3 Wetland Value Assessment

4.6.5.3.1 Overview

Quantitative assessments of the value of wetlands established, enhanced, or lost from the proposed Project were determined by the Habitat Evaluation Team (HET) led by the USFWS using the Wetland Value Assessment (WVA) Methodology for Coastal Marsh Community Models, developed by the CWPPRA Environmental Work Group to determine the suitability of marsh and open water habitats in the Louisiana coastal zone (CWPPRA Environmental Work Group 2006). The intent of the model is to define an optimal combination of habitat conditions for fish and wildlife species living in Louisiana coastal marsh ecosystems, and is used by the USFWS to assess impacts on wildlife resources in fulfillment of its responsibilities under the Fish and Wildlife Coordination Act.

The WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is projected and expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of: (1) a list of variables that are considered important in characterizing community-level fish and wildlife habitat values (for example, percent cover by emergent vegetation, percent open water dominated by SAV, and salinity); (2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values (variables range from 0.1 to 1.0, with 1.0 representing optimal conditions); and (3) a mathematical formula that combines the Suitability Indices for each variable into a single value for wetland habitat quality, termed the HSI. The product of an HSI value and the acreage of available habitat for a given target year is known as the Habitat Unit (HU) and is the basic unit for measuring the proposed Project impacts on fish and wildlife habitat. HUs are annualized over the analysis period to determine the Average Annual Habitat Units (AAHUs) available for each habitat type. The change (increase or decrease) in AAHUs for each action alternative, compared to conditions under the No Action Alternative, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the proposed Project would be beneficial to the fish and wildlife community within that habitat type; a net loss of AAHUs indicates that the proposed Project would adversely impact fish and wildlife resources.

WVA models for the proposed Project were used to estimate the net gain and loss in AAHUs associated with construction of the Project facilities, as well as operation of each action alternative, by decade. The USACE Civil Works WVA – Intermediate and Brackish Marsh Model Version 2.0 was used for the analysis. It is typical and within the standard operating procedure of the WVA model to lump a small amount of one habitat type with the majority of another where appropriate. The fresh and intermediate habitats present within the Project area were combined and analyzed in the Intermediate Marsh Model because the resolution of the Delft3D Basinwide Model is within the uncertainty range for fresh habitats (those habitats with a salinity of up to 0.5 ppt) and because vegetation types overlap between fresh and intermediate marshes. As a result, most of the fresh/intermediate habitats were interpreted as intermediate, with minimal amounts of fresh. Similarly, saline habitats were combined into the brackish model because of the extremely small amount of saline habitat within the area impacted by the proposed Project.

The model consists of six variables: (1) percent of wetland covered by emergent vegetation, (2) percent open water dominated by SAV, (3) degree of marsh edge and interspersion, (4) percent of open water less than or equal to 1.5 feet deep, (5) salinity, and (6) aquatic organism access. Changes in each variable were predicted for the No Action Alternative and each action alternative, by decade, over a 50-year analysis period. All Project-related direct impacts during construction were assumed to occur in year 1. Further, beneficial use of material from excavation associated with Project construction would be used for wetland creation and enhancement; a WVA analysis of these impacts is included in Section 4.27.2, Compensatory Mitigation, and, at minimum, marsh creation through beneficial use of excavated material would provide equivalent AAHUs to the identified AAHUs anticipated to be lost due to direct impacts from Project construction. The proposed Project beneficial use wetland creation feature would be constructed concurrently with overall construction of the proposed Project.

The Delft3D Basinwide Model provided the outputs that were used either directly or indirectly to derive all relevant WVA input variables, by habitat type (including wetlands and open water areas): distribution of land (land and water acres), shallow open water (less than 1.5 feet deep), total open water, salinity, vegetation habitat type, and total suspended sediment by decade. The Delft3D Basinwide Model SAV outputs were not used because the data were deemed unreliable by the Delft3D Basinwide Modeling Work Group. Instead, Delft3D Basinwide Model outputs including TSS, exposure (distance to land), salinity, and water depth were used for predicting the extent of SAV, and the baseline SAV coverage was determined using USGS' remotely-sensed data. A detailed description of the Delft3D Basinwide Model and associated outputs is included in Appendix E; a detailed description of the WVA assessment is included in Appendix G.

4.6.5.3.2 Results

The results of the WVA analysis are presented in Tables 4.6-5 through 4.6-8. Table 4.6-5 includes the results (AAHUs) associated with construction impacts. To account for wetlands that would be permanently converted or filled due to Project construction, WVAs were conducted on emergent wetlands (wet pasture) located between Louisiana Highway 23 and the existing NOV-NFL Levee, emergent wetlands (marsh, scrub/shrub, vegetated shallows, and waters) located in the basin area, and forested wetlands located in the batture area and between the basin and the river. Wetlands that would be restored following construction of the Project facilities are not included in the net acreages presented in Table 4.6-5.

Table 4.6-5
Results of the Wetland Value Assessment in Net Acres and AAHUs for Project Construction Impacts

Type	Net Acreage[a,b]	AAHUs[b]
Wetlands		
Forested wetlands	-26.1	-14.9
Emergent wetlands (wet pasture)	-163.4	-66.9
Emergent wetlands (marsh, shrub/scrub wetlands)	-3.6	-20.3
Total, Project Construction Impacts	**-193.1**	**-102.0**

[a] The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends. These data are based on the total wetland area that would be permanently encumbered by the Project facilities, and does not include wetlands that would revegetate following construction; therefore, wetland acreages differ from those presented in Table 4.6-1, which present all wetlands that may be affected by construction.
[b] Overall, the beneficial use sites could result in the creation of 402 net acres (158 AAHUs).

Table 4.6-6 includes the results (AAHUs) by target year for each alternative during Project operations; fresh/intermediate marsh and brackish marsh AAHUs are combined. Conversely, Tables 4.6-7 and 4.6-8 include fresh/intermediate marsh and brackish marsh AAHUs separately.

As compared with the No Action Alternative, all action alternatives are projected to result in a loss of AAHUs in year 2020 (see Table 4.6-6). The 150,000 cfs Alternative with and without terraces would yield positive AAHUs by 2030, and the 50,000 cfs and 75,000 cfs Alternatives with and without terraces would yield positive AAHUs by 2040. As compared with the No Action Alternative, the Applicant's Preferred Alternative (75,000 cfs), the 50,000 cfs Alternative, and the 150,000 cfs Alternative are projected to yield 3,848, 2,439, and 8,909 AAHUs, respectively, by 2070.

Table 4.6-6
Results of the Wetland Value Assessment in Net AAHUs for the Project Alternatives as Compared with the No Action Alternative, by Decade

Alternative/ Area	2020	2030	2040	2050	2060	2070
Applicant's Preferred Alternative	-2,727	-1,221	807	2,465	3,457	3,848
75,000 cfs + Terraces	-2,711	-1,209	802	2,448	3,432	3,837
50,000 cfs	-2,221	-1,392	94	1,370	2,115	2,439
50,000 cfs + Terraces	-1,352	-1,352	124	1,412	2,182	2,516
150,000 cfs	-781	1,258	3,954	6,502	8,190	8,909
150,000 cfs + Terraces	-610	1,339	3,973	6,487	8,164	8,890

A closer look at the habitat-specific impacts shown in Tables 4.6-7 and 4.6-8 indicates that large decreases in brackish marsh habitat by 2030 would not be offset by increases in fresh/intermediate habitats until 2040 under the 50,000 cfs and 75,000 cfs Alternative scenarios (see Table 4.6-8). The relatively rapid infilling of shallow water and conversion to marsh associated with the larger diversions (150,000 cfs Alternatives) in the delta formation area are projected to result in greater benefits exhibited early and throughout the analysis period (see Table 4.6-3 for additional detail on wetland habitat acreage impacts). By 2040, all the alternatives are anticipated to yield positive AAHUs as compared with the No Action Alternative (see Table 4.6-6).

The general trend consistent with each of the alternatives is a decrease in brackish marsh AAHUs and an increase in fresh and intermediate marsh AAHUs over the 50-year analysis period (see Tables 4.6-7 and 4.6-8). This outcome is expected, as the brackish marshes would freshen under the influence of the diversion alternatives, causing vegetation communities to transition from brackish to fresh/intermediate over time. The greatest net rate of increase in AAHUs is projected to occur between 2040 and 2050 (see Table 4.6-6). This is expected, as sedimentation from 30 years of proposed Project operations would continue to fill the shallow open water areas, providing substrate for fresh and intermediate plant species to colonize and spread. Vegetation establishment would initiate positive feedback between the plants and the marsh platform by trapping sediments, increasing belowground biomass, and depositing organic matter, all of which would contribute to sustainability during periods of rising sea level. AAHUs would continue to increase between years 2050 and 2070 for all alternatives but to a lesser degree as sea-level rise would offset vertical accretion and land gain. Note that 2070 is the end date of the period of analysis given the 50-year planning horizon; however, additional benefits beyond this date are anticipated, albeit at a reduced rate of increase given the impacts of increasing sea-level rise over time.

Table 4.6-7
Results of the Wetland Value Assessment for Fresh/Intermediate Habitats in Net AAHUs for the Project Alternatives as Compared with the No Action Alternative, by Decade

Alternative/ Area	2020	2030	2040	2050	2060	2070
Applicant's Preferred Alternative	4,042	8,609	9,147	9,809	10,139	10,108
75,000 cfs + Terraces	4,057	8,614	9,135	9,787	10,110	10,093
50,000 cfs	2,571	5,499	5,878	6,419	6,676	6,703
50,000 cfs + Terraces	2,587	5,541	5,911	6,463	6,745	6,782
150,000 cfs	6,438	14,279	16,012	17,581	18,453	18,651
150,000 cfs + Terraces	6,326	14,088	15,874	17,455	18,338	18,556

Table 4.6-8
Results of the Wetland Value Assessment for Brackish/Saline Habitats in Net AAHUs for the Project Alternatives as Compared with the No Action Alternative, by Decade

Alternative/ Area	2020	2030	2040	2050	2060	2070
Applicant's Preferred Alternative	-6,769	-9,830	-8,340	-7,344	-6,682	-6,260
75,000 cfs + Terraces	-6,768	-9,823	-8,333	-7,339	-6,678	-6,256
50,000 cfs	-4,792	-6,890	-5,784	-5,049	-4,562	-4,264
50,000 cfs + Terraces	-4,792	-6,893	-5,787	-5,051	-4,563	-4,266
150,000 cfs	-7,219	-13,020	-12,058	-11,079	-10,263	-9,741
150,000 cfs + Terraces	-6,936	-12,749	-11,901	-10,968	-10,174	-9,667

4.6.6 Summary of Potential Impacts

Table 4.6-9 summarizes the potential impacts on wetlands for each alternative. Details are provided in Sections 4.6.1 through 4.6.5 above. One of the major considerations for the proposed Project is to build and maintain coastal wetlands. While construction of the proposed Project would result in adverse impacts on wetlands, its operation would result in greater wetland acreage within the Barataria Basin as compared to the No Action Alternative. Therefore, the proposed Project is determined to be consistent with Executive Order 11990 for the Protection of Wetlands, which requires federal agencies to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands."

Table 4.6-9
Summary of Potential Impacts on Wetlands from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on wetlands from construction of the proposed Project would occur. • Future development in the proposed Project vicinity could result in the loss or conversion of wetlands resulting in minor to moderate, short- to long-term, adverse impacts. • Any future impacts would be required to comply with applicable permit and compensatory mitigation requirements.
Operational Impacts	• Major, permanent, adverse impacts due to the continued loss or conversion of wetlands in the Barataria Basin and birdfoot delta. • By year 2070, total wetland acres would be 72,800 in the Barataria Basin and 6,410 acres in the birdfoot delta. • The net impact on invasive plants under the No Action Alternative would be minor, permanent, and adverse as invasive plant species would continue to persist.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Minor to moderate, permanent, adverse impacts due to dredging and filling wetlands to construct the Project features. • Negligible impacts on existing wetlands due to increased suspended sediment levels during and immediately after dredging and construction. • Negligible changes to surface water elevation that could impact wetlands adjacent to barge access channels during dredging. • Moderate, permanent, beneficial impacts in beneficial use areas due to creation and enhancement of wetlands. • Minor, temporary, adverse, localized impacts on wetlands adjacent to construction footprint due to sedimentation and contaminants from runoff during construction. • Minor, permanent, localized beneficial impacts in the Project construction footprint due to invasive species mortality during excavation activities and minor to moderate, long-term, adverse impacts in the event that construction results in the spread of invasive species.
Operational Impacts	• Major, permanent, beneficial impacts on wetlands in the delta formation area and new marsh/marsh creation projects in the diversion outfall area that would be sustained or created by the diversion of sediment and fresh water. • Negligible impacts on wetlands outside of the delta formation area. • During the first three decades of diversion operations, larger areas of freshwater and intermediate wetlands would occur in the Barataria Basin relative to the No Action Alternative; the most significant impacts on sedimentation would occur within the delta formation area; during the remainder of the Project lifecycle, wetlands outside the delta formation area. • By year 2070, total wetland acres would be 85,500, representing greater wetland acres than the No Action Alternative (72,800 acres). • Overall, wetland losses would continue in the Barataria Basin; however, wetland losses would be 17.4 percent less than the No Action Alternative by modeled year 2070. • Moderate, permanent, adverse impacts on wetlands in the birdfoot delta. By year 2070, total wetland acres would be reduced to 3,510 acres, representing fewer wetland acres than the No Action Alternative (6,410 acres by 2070). • Moderate, short-term, adverse impacts due to erosion and loss of some emergent wetlands near the immediate outfall area, which would be offset when total wetland impacts are considered over the 50-year analysis period. • Minor to moderate, permanent, adverse impacts by increasing the spread of invasive species in the Barataria Basin.

Table 4.6-9
Summary of Potential Impacts on Wetlands from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	• Negligible to minor, permanent, beneficial impacts on the spread of invasive species in the birdfoot delta.
50,000 cfs Alternative	
Construction Impacts	• Minor to moderate, long-term, adverse impacts due to dredging and filling wetlands to construct the Project features. • Negligible impacts due to increased suspended sediment levels during and after dredging and construction. • Negligible changes in surface water elevation that could affect wetlands adjacent to barge access channels due to dredging. • Moderate, permanent, beneficial impacts in beneficial use areas due to creation and enhancement of wetlands. • Minor, temporary, adverse, localized impacts on wetlands adjacent to the construction footprint due to sedimentation and contaminants from runoff during construction. • Minor, short-term, adverse impacts from the disturbance of existing wetlands for construction of the terraces due to potential vegetation mortality from material placement. • Minor, permanent, localized beneficial impacts in the Project construction footprint due to invasive species mortality during excavation activities and minor to moderate, long-term, adverse impacts in the event that construction results in the spread of invasive species.
Operational Impacts	• Major, permanent, beneficial impacts on wetlands in the delta formation area and new marsh/marsh creation projects in the diversion outfall area that would be sustained or created by the diversion of sediment and fresh water. • Negligible impacts on wetlands outside of the delta formation area. • During the first three decades of diversion operations, larger areas of freshwater and intermediate wetlands would occur in the Barataria Basin relative to the No Action Alternative; the most significant impacts on sedimentation would occur within the delta formation area; during the remainder of the Project lifecycle, wetlands outside the delta formation area would be lost. • By year 2070, total wetland acres would be 82,000, representing greater wetland acres than the No Action Alternative (72,800 acres). • Overall, wetland losses would continue in the Barataria Basin; however, wetland losses would be 12.7 percent less than the No Action Alternative by modeled year 2070. • Moderate, permanent, adverse impacts on wetlands in the birdfoot delta. By year 2070, total wetland acres would be reduced to 3,680, representing fewer wetland acres than the No Action Alternative (6,410 acres by 2070). • Moderate, temporary to short-term, localized erosion and loss of some emergent wetlands near the immediate outfall area, which would be offset when total wetland impacts are considered over the 50-year analysis period. • Minor to moderate, permanent, adverse impacts by increasing the spread of invasive species in the Barataria Basin. • Negligible to minor, permanent, beneficial impacts on the spread of invasive species in the birdfoot delta.
150,000 cfs Alternative	
Construction Impacts	• Minor to moderate, adverse impacts due to dredging and filling wetlands to construct the Project features. • Negligible impacts due to increased suspended sediment levels during and after dredging and construction. • Negligible changes in surface water elevation that could impact wetlands adjacent to barge access channels due to dredging.

Table 4.6-9
Summary of Potential Impacts on Wetlands from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	• Moderate, permanent, beneficial impacts in beneficial use areas due to creation and enhancement of wetlands. • Minor, temporary, adverse, localized impacts on wetlands adjacent to the construction footprint due to sedimentation and contaminants from runoff during construction. • Minor, permanent, localized beneficial impacts in the Project construction footprint due to invasive species mortality during excavation activities and minor to moderate, long-term, adverse impacts in the event that construction results in the spread of invasive species.
Operational Impacts	• Major, permanent, beneficial impacts on wetlands in the delta formation area and new marsh/marsh creation projects in the diversion outfall area that would be sustained or created by the diversion of sediment and fresh water. • Negligible impacts on wetlands outside of the delta formation area. • During the first three decades of diversion operations, larger areas of freshwater and intermediate wetlands would occur in the Barataria Basin relative to the No Action Alternative; the most significant impacts on sedimentation would occur within the delta formation area; during the remainder of the Project lifecycle, wetlands outside the delta formation area would be lost. • By year 2070, total wetland acres would be 98,600, representing greater wetland acres than the No Action Alternative (72,800 acres). • Overall, wetland losses would continue in the Barataria Basin; however, wetland losses would be 35.4 percent less than the No Action Alternative by modeled year 2070. • Moderate, permanent, adverse impacts on wetlands in the birdfoot delta. By year 2070, total wetland acres would be reduced to 3,710, representing fewer wetland acres than the No Action Alternative (6,410 acres by 2070). • Moderate, temporary, short-term, localized erosion and loss of some emergent wetlands near the immediate outfall area feature, which would be offset when total wetland impacts are considered over the 50-year analysis period. • Minor to moderate, permanent, adverse impacts by increasing the spread of invasive species in the Barataria Basin. • Negligible to minor, permanent, beneficial impacts by decreasing the spread of invasive species in the birdfoot delta.
Terraces Alternatives	
75,000 cfs + Terraces Alternative	
Construction Impacts	• This alternative would have the substantially similar overall construction impact determinations as listed above for the 75,000 cfs Alternative. • Minor, short-term, adverse impacts from the disturbance of existing wetlands for construction of the terraces due to potential vegetation mortality from material placement. • As compared with the No Action Alternative, this alternative would cause greater construction impacts due to the disturbance of existing wetlands than those listed above for the 75,000 cfs Alternative (Applicant's Preferred).
Operational Impacts	• As compared to the No Action Alternative, this alternative would have substantially similar impacts as those of the 75,000 cfs Alternative (Applicant's Preferred) listed above. • By year 2070, an additional 445 wetland acres in the Barataria Basin are projected as compared to the Applicant's Preferred Alternative. • The incremental difference in marsh loss in the birdfoot delta from terraces is negligible compared to the Applicant's Preferred Alternative.

Table 4.6-9
Summary of Potential Impacts on Wetlands from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
50,000 cfs + Terraces Alternative	
Construction Impacts	• This alternative would have substantially similar overall construction impact determinations as listed above for the 50,000 cfs Alternative. • Minor, direct, short-term, adverse impacts from the disturbance of existing wetlands for construction of the terraces due to potential vegetation mortality from material placement. • As compared with the No Action Alternative, this alternative would cause greater construction impacts due to the disturbance of existing wetlands than those listed above for the 50,000 cfs Alternative.
Operational Impacts	• As compared to the No Action Alternative, this alternative would have substantially similar impacts as those of the 50,000 cfs Alternative (Applicant's Preferred) listed above. • By year 2070, an additional 81 wetland acres in the Barataria Basin are projected as compared to the 50,000 cfs Alternative. • The incremental difference in marsh loss in the birdfoot delta from terraces is negligible compared to the 50,000 cfs Alternative.
150,000 cfs + Terraces Alternative	
Construction Impacts	• This alternative would have substantially similar overall construction impact determinations as listed above for the 150,000 cfs Alternative. • Minor, short-term, adverse impacts from the disturbance of existing wetlands for construction of the terraces due to potential vegetation mortality from material placement. • As compared with the No Action Alternative, this alternative would cause greater construction impacts due to the disturbance of existing wetlands than those listed above for the 150,000 cfs Alternative.
Operational Impacts	• As compared to the No Action Alternative, this alternative would have substantially similar impacts as those of the 75,000 cfs Alternative (Applicant's Preferred) listed above. • By year 2070, an additional 608 wetland acres in the Barataria Basin are projected as compared to the 150,000 cfs Alternative. • The incremental difference in marsh loss in the birdfoot delta from terraces is negligible compared to the 150,000 cfs Alternative. By year 2070, an additional 264 wetland acres are projected as compared to the 150,000 cfs Alternative.

4.7 AIR QUALITY

4.7.1 Area of Potential Impacts

The area of potential impacts for the evaluation of construction impacts on air quality is the immediate vicinity (within about 0.5-mile) of the construction footprint because construction emissions are highly localized. Impacts during construction would also occur along the road and waterways that would be used to transport equipment and construction personnel to the Project construction area. During operations, emissions due to ongoing maintenance (including dredging and vegetation maintenance) would be similarly localized.

4.7.2 Guidelines for Air Quality Impact Determinations

Impact intensities for air quality are based on the definitions provided in Section 4.1 and the following air-quality-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on air quality would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[59]
- minor: the impact on air quality may be measurable, but would be localized and temporary, such that the emissions do not exceed USEPA's *de minimis* criteria for a general conformity determination under the Clean Air Act (40 CFR 93.153);
- moderate: the impact on air quality would be measurable and limited to local and adjacent areas. Emissions of criteria pollutants would be at USEPA's *de minimis* criteria levels for general conformity determination; and
- major: the impact on air quality would be measurable over a widespread area. Emissions would be high, such that they could exceed USEPA's *de minimis* criteria for a general conformity determination.

4.7.3 Construction Impacts

4.7.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The air quality in the Project area would not be affected by fugitive dust and other pollutants described for construction of the action alternatives. In consideration of current and planned developments in the area of the proposed Project's construction footprint, it is predictable that at some future point the area may be developed for industrial or commercial purposes that would likely have some adverse impact on air quality in and around the area proposed for construction of the diversion complex. However, it would be speculative to guess what exactly those future developments might be during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project; but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state and federal air quality standards.

[59] The term "negligible" will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

4.7.3.2 Applicant's Preferred Alternative

Temporary, direct minor to moderate, adverse impacts on air quality would occur during construction of the Project. Construction would require the use of combustion-powered equipment that would emit criteria pollutants (PM_{10}, $PM_{2.5}$, NO_x, CO, VOCs, and sulfur oxide [SO_x]), HAPs, and GHGs; these pollutants would also be emitted by barges delivering construction materials and equipment, and trucks, equipment, and workers traveling to and from the Project construction area. In addition, fugitive dust emissions would be generated by off-road vehicle use, earthwork (such as land clearing and ground excavation), aggregate and material handling (including concrete manufacturing), and wind erosion of exposed piles of dredged and excavated material.

Construction would occur in several phases over a 3- to 5-year period, and construction equipment would be operated intermittently over that period as needed. Typical equipment used during construction may include excavators, trucks, loaders, dozers, rollers, drills, pumps, pile drivers, dredges, barges, cranes, graders, compactors, scrapers, and pavers. Construction criteria pollutant emissions would be temporary and spread out over three to five years, therefore, impacts resulting from the construction of the Project would be direct, minor, temporary, and adverse. As described in Chapter 3, Section 3.7 Air Quality, a general conformity determination is not applicable to the Project since the Project area is in attainment of the NAAQS.

Emissions of particulate matter such as fugitive dust could result in dust plumes that affect visibility in the construction impact area and in roadways where trucks transporting materials are likely to give rise to airborne dust. In addition, particulate matter emitted from open burning of brush, slash, or other materials generated from construction activities could occur if permissible under applicable laws. The operation of the proposed on-site, mobile concrete manufacturing plant, which would include the transfer of sand and aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion, would emit fugitive dust such as PM_{10} and $PM_{2.5}$. The concrete manufacturing plant would be located within the construction footprint (shown in Chapter 2, Figure 2.8-1) and would potentially produce 300 to 400 cubic yards/hour of concrete on-site. The plant would likely include an overhead aggregate bin, aggregate batcher, cement batcher, batch transfer belt, storage silos, and complete air system. The concrete manufacturing plant would likely also have dust collector ducting, suction shrouds, a water sprayer, and baghouses to control emissions. Table 4.7-1 describes the potential emissions from the concrete manufacturing plant.

The concrete manufacturing plant would potentially have temporary, direct moderate, adverse impacts on air quality because the impacts would be measurable and likely exceed USEPA's *de minimis* criteria, and they would be limited to local and adjacent areas during construction. However, because the Project is in an attainment area, a general conformity determination is not applicable and *de minimis* criteria would not apply.

Due to the final location and size of the plant, an LDEQ regulatory permit for concrete manufacturing facilities would be required (see LAC 33.315). Further, all construction activities planned for the Project would be required to meet the standards for control of particulate emissions (fugitive dust) codified in LAC 33.13.13.

Table 4.7-1
Summary of Potential Emissions from Concrete Manufacturing Plant (Tons per Day)

Emission Source	PM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO	VOC	Total HAPs
Materials Handling and Loading	0.08	0.03	0.00	-	-	-	-	-
Auxiliary Heater(s)	0.63	1.03	0.80	0.07	6.26	1.56	0.11	0.17
Non-Emergency Engines	2.30	2.30	2.30	0.04	78.84	18.07	2.32	0.10
Emergency Generators	0.28	0.28	0.28	0.26	3.88	0.84	0.31	0.0033
Vehicle Traffic	0.44	0.12	-	-	-	-	-	-
Storage Piles	0.0004	0.0002	-	-	-	-	-	-
Solvent Degreasing	-	-	-	-	-	-	0.01	0.0060
Total Controlled Emissions	3.72	3.75	3.38	0.36	88.97	20.47	2.73	0.275

Once Project construction is completed, the combustion and fugitive emissions described above would no longer occur and the area of potential impacts would return to preconstruction conditions, except for the operational impacts described in Section 4.7.4 and potential air impacts associated with reasonably foreseeable projects in the Project area. In addition, while tree cover can improve air quality via uptake of pollutants, the proposed Project would require clearing of some of the forest areas between the nearby community of Ironton and existing sources of air pollution in the Project vicinity (that is, the existing Alliance Refinery[60]). However, as depicted in Chapter 4, Section 4.18 Land Use and Land Cover, Figure 4.18-1, forest vegetation would remain on either side of the diversion structure and would continue to provide some buffer to air emissions from the Alliance Refinery and dust from the grain terminal for the community of Ironton. Further, construction of the Project is not expected to cause a change in air quality sufficient to affect compliance with the NAAQS. See Section 4.25 Cumulative Impacts for more details about reasonably foreseeable projects assessed in the cumulative impacts analysis.

4.7.3.3 Other Action Alternatives

All action alternatives would have a similar construction footprint as that of the Applicant's Preferred Alternative. As such, the impacts from construction of all other

[60] In November 2021, Phillips 66 announced its plan to cease operation of its Alliance refinery and convert the site to terminal storage.

action alternatives on air quality would be similar in nature to those described above for the Applicant's Preferred Alternative. However, construction timeframes for the 150,000 cfs Alternatives would be longer by several months and for the 50,000 cfs Alternatives would be shorter by several months as compared to the Applicant's Preferred Alternative. As such, the duration of potential temporary impacts on air quality would be slightly longer for the 150,000 cfs Alternatives and slightly shorter for the 50,000 cfs Alternatives. Additional impacts on air quality from operation of construction equipment for terracing would be negligible as compared to the alternatives without terracing. Therefore, as compared to the No Action Alternative, the three terrace alternatives would have the same construction impacts on air quality as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives without terraces.

4.7.4 Operational Impacts

4.7.4.1 No Action Alternative

Under the No Action Alternative, the emissions associated with operations and maintenance of the action alternative would not occur. The air quality in the Project area would not be affected by combustion emissions associated with maintenance activities. However, the No Action Alternative would not result in the wetland creation and establishment associated with the action alternatives (see Section 4.6 Wetland Resources and Waters of the U.S.), nor would existing wetlands be sustained and nourished in the same manner as expected with the action alternatives. As described in Chapter 3, Section 3.6.1 in Wetland Resources and Waters of the U.S., due to their anoxic, wet conditions, wetlands provide a natural environment for sequestration and storage of carbon from the atmosphere. While wetlands often function as net carbon sinks, they do release methane into the atmosphere (Mitra et al. 2005). Salt marshes, such as those that dominate the Project area, have high primary productivity and trap carbon-rich sediments from their watersheds; losses of these wetlands release carbon into the atmosphere (Mitra et al. 2005 and Chmura et al. 2003). Continued loss of wetlands in the Barataria Basin via conversion to open water, which would occur under the No Action Alternative, would release methane and CO_2 trapped in plant biomass and marsh sediments, contributing to increased atmospheric GHGs.

4.7.4.2 Applicant's Preferred Alternative

Intermittent but permanent, direct adverse impacts on air quality due to operations and maintenance would occur over the 50-year analysis period; however, these emissions would be negligible, only occurring during active maintenance activities. Conversely, the Project would result in permanent, indirect, minor, beneficial impacts on carbon sequestration and atmospheric GHG concentrations due to wetland creation and restoration within the Barataria Basin.

During operation of the Project, combustion emissions would be limited to those generated by operation of back-up generators at the diversion structure and emissions associated with ongoing maintenance activities (such as dredging and mowing of vegetation). The diversion structure would be powered by electricity; therefore, its operation would not result in local emissions except in the case of electrical power interruptions, at which time combustion-powered generators would be used. A small diesel-powered generator would serve as the back-up generator for the diversion structure. Emissions from the generator are estimated to be minimal (see Table 4.7-2).

Table 4.7-2
Summary of Potential Emissions from Back-up Generator (Tons per Year)

Emission Source	PM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO	VOC	Total HAPs
Back-up Generator (600 hp)	0.33	0.33	0.33	0.31	4.65	1.00	0.37	0.004

To the extent needed based on monitoring during Project operations, CPRA would conduct maintenance dredging of the conveyance channel, outfall transition feature, immediate outfall area, and federally maintained navigation channels in the basin (the GIWW, Barataria Bay Waterway, and Bayou Lafourche) to ensure that the appropriate water depths are maintained due to shoaling or navigational issues. Maintenance dredging using mechanical and hydraulic dredges similar to other maintenance dredging conducted along the Mississippi River.

Mowing and other vegetation maintenance would be conducted in vegetated areas at the diversion complex permanent rights-of-way and on the Mississippi River Levee. These activities would occur intermittently and would be consistent with other periodic vegetation maintenance activities in the area of potential impacts, such as the mowing of roadside vegetation and lawns on developed land and maintenance dredging of navigational channels. The quantities of pollutants emitted during these maintenance activities would be minimal; emissions would be intermittent and are not expected to contribute to violations of any federal, state, or local air regulations.

The Project would result in permanent, indirect, minor, beneficial impacts on carbon sequestration and atmospheric GHG concentrations due to wetland creation and restoration within the Barataria Basin. These benefits would occur over the life of the Project and would continue past the 50-year analysis period where established wetlands would persist and continue to sequester carbon and protect other wetlands from erosion and soil carbon loss. Creation of new wetlands would remove atmospheric CO2 through photosynthesis and the burial of fixed carbon, while the prevention of further wetland loss would avoid the release of carbon in wetland soils and plant biomass associated with the conversion of wetlands to open water. Krauss et al. (2016) found that net CO_2 uptake with a freshwater diversion (Davis Pond Freshwater Diversion) was about 290 g C /m^2/year; while a deteriorating brackish marsh released approximately 182 g C /m^2/year. As described above (see Section 4.7.4.2), salt marshes are a net carbon sink and the wetlands created by the Project would reduce atmospheric GHGs. Carbon sequestration in the newly created wetlands could offset some releases of GHGs due to the Project, thereby reducing some of the impacts associated with GHGs and climate change discussed in Chapter 3, Section 3.1.3 in the Introduction.

In addition to the Project impacts described above, once construction of the proposed NOGC railroad modifications is complete, adverse impacts due to train-induced air emissions from combustion-powered engines are expected due to trains traversing the proposed railroad bridge and the extension of the track termination point to be 600 feet closer to Ironton. However, given the short distance of additional track, impacts would be negligible. See Section 4.22 Land-Based Transportation for additional detail regarding railroad impacts.

4.7.4.3 Other Action Alternatives

4.7.4.3.1 50,000 cfs Alternative

The impacts of the 50,000 cfs Alternative on air quality would be similar to those described above for the Applicant's Preferred Alternative; however, wetland creation in the Barataria Basin during operations would be less as described in Section 4.6 Wetland Resources and Waters of the U.S. Therefore, the alternative would provide a lower capacity for carbon sequestration, as compared with the Applicant's Preferred Alternative.

4.7.4.3.2 150,000 cfs Alternative

The impacts of the 150,000 cfs Alternative on air quality would be similar to those described above for the Applicant's Preferred Alternative; however, wetland creation in the Barataria Basin during operations would be greater as described in Section 4.6 Wetland Resources and Waters of the U.S. Therefore, the alternative would provide greater capacity for carbon sequestration, as compared with the Applicant's Preferred Alternative.

4.7.4.3.3 Terrace Alternatives

The impacts of each terrace alternative on air quality would be similar to those described above for the alternatives without terraces. Wetland creation in the Barataria Basin during the 50-year analysis period would be greater under each of the alternative scenarios involving terraces as described in Section 4.6 Wetland Resources and Waters of the U.S. and therefore would provide greater capacity for carbon sequestration, as compared with alternatives without terraces. However, given the size of the incremental increase in wetland creation due to terraces, the incremental impact on carbon sequestration due to the presence of terraces would be negligible. Therefore, as compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on air quality as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives without terraces.

4.7.5 Summary of Potential Impacts

Table 4.7-3 summarizes the potential impacts on air quality for each alternative. Details are provided in Sections 4.7.2 through 4.7.4 above.

Table 4.7-3
Summary of Potential Impacts on Air Quality from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on air quality from construction of the Project would occur. • Future developments in the Project area could have some adverse impact on air quality. • Any future development would be required to comply with applicable local, state and federal air quality standards.
Operational Impacts	• The emissions associated with operations and maintenance of the Project would not occur. • Continued loss of wetlands in the Barataria Basin would release methane and CO_2 trapped in plant biomass and marsh sediments, contributing to increased atmospheric GHGs.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Minor, direct, temporary, adverse impacts on air quality would occur during construction of the Project due to emissions from combustion-powered equipment. • Minor to moderate, direct temporary, adverse impacts on air quality due to emissions from fugitive dust, including during operation of the on-site concrete manufacturing plant.
Operational Impacts	• Negligible impacts on air quality due to operations and maintenance would occur over the 50-year analysis period during active maintenance activities (including dredging, vegetation maintenance, and operation of back-up generators at the diversion structure). • Minor, indirect, permanent, beneficial impacts on carbon sequestration and atmospheric GHG concentrations due to wetland creation and restoration within the Barataria Basin. • Negligible impacts on train-induced air emissions from combustion-powered engines due to trains traversing the proposed railroad bridge and the extension of the track termination point.
50,000 cfs Alternative	
Construction Impacts	• Minor, direct, temporary, adverse impacts on air quality would occur during construction of the Project due to emissions from combustion-powered equipment. • Minor to moderate, direct, temporary, adverse impacts on air quality due to emissions from fugitive dust, including during operation of the on-site concrete manufacturing plant.
Operational Impacts	• Negligible impacts on air quality due to operations and maintenance would occur over the 50-year analysis period during active maintenance activities (including dredging, vegetation maintenance, and operation of back-up generators at the diversion structure). • Minor, indirect, permanent, beneficial impacts on carbon sequestration and atmospheric GHG concentrations due to wetland creation and restoration within the Barataria Basin. • Negligible impacts on train-induced air emissions from combustion-powered engines due to trains traversing the proposed railroad bridge and the extension of the track termination point.

Table 4.7-3
Summary of Potential Impacts on Air Quality from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
150,000 cfs Alternative	
Construction Impacts	• Minor, direct, temporary, adverse impacts on air quality would occur during construction of the Project due to emissions from combustion-powered equipment. • Minor to moderate, direct, temporary, adverse impacts on air quality due to emissions from fugitive dust, including during operation of the on-site concrete manufacturing plant.
Operational Impacts	• Negligible impacts on air quality due to operations and maintenance would occur over the 50-year analysis period during active maintenance activities (including dredging, vegetation maintenance, and operation of back-up generators at the diversion structure). • Minor, indirect, permanent, beneficial impacts on carbon sequestration and atmospheric GHG concentrations due to wetland creation and restoration within the Barataria Basin. • Negligible impacts on train-induced air emissions from combustion-powered engines due to trains traversing the proposed railroad bridge and the extension of the track termination point.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, the three terrace alternatives would have substantially similar construction impacts on air quality as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Incremental impacts on air quality from operation of construction equipment for terracing would be negligible as compared to the alternatives without terraces.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar operational impacts on air quality as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Incremental impact on carbon sequestration due to the presence of terraces would be negligible as compared to the alternatives without terraces.

4.8 NOISE

4.8.1 Area of Potential Impacts

Construction activities within the Project construction footprint would include clearing and grading associated with site preparation; materials and equipment delivery; and installation of the diversion complex structures and cofferdams cells (for example, pile driving). The most prevalent noise-generating equipment and activity during construction of the Project is anticipated to be pile driving, although internal combustion engines associated with general construction equipment and dredging would also produce sound that would be perceptible in the vicinity of the site. The various types of construction activities proposed for construction of the Project and associated noise levels are described below.

Operation of the Project would produce noise from activation of the diversion components, such as opening and closing gates; water flow through the diversion; use of a back-up generator for electricity; and ongoing maintenance activities, such as dredging and mowing of vegetation.

4.8.1.1 Airborne Sound

The area of potential impacts for the evaluation of construction impacts on ambient, airborne sound includes the immediate vicinity (within 0.5-mile) of the construction footprint because construction activities would be highly localized and sound attenuates with increasing distance from the source. NSAs such as residences near the construction footprint have the greatest potential to be affected by construction and operational noise; the NSAs nearest to each proposed Project feature are identified in Chapter 3, Section 3.8 Noise, Table 3.8-3 and Figure 4.8-1 below. Operational noise impacts would be limited to the immediate vicinity (within 0.5-mile) of the diversion complex, and would include any necessary maintenance dredging or vegetation maintenance activities such as mowing.

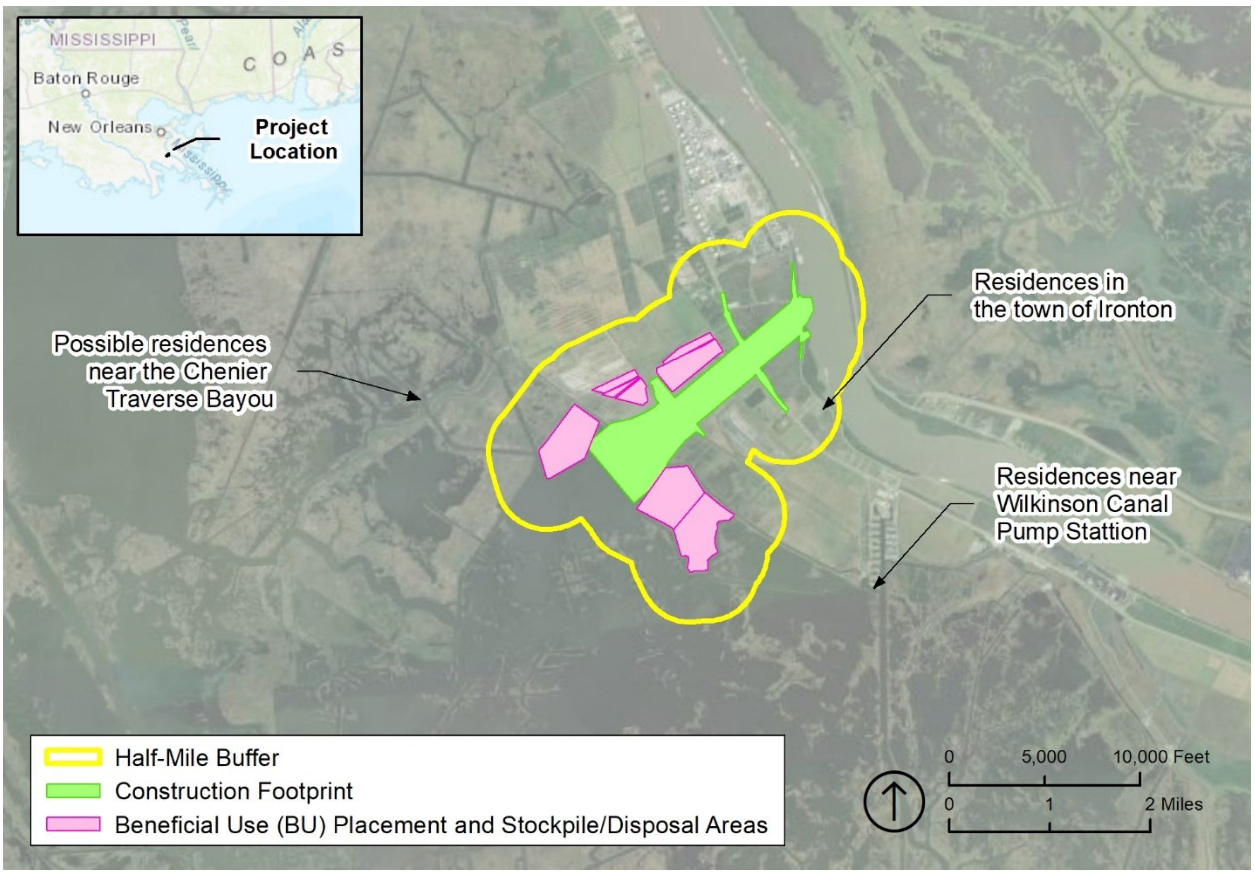


Figure 4.8-1. Locations of Noise Sensitive Areas near Project Features.

4.8.1.2 Underwater Sound

The area of potential impacts for the evaluation of construction and operation impacts on ambient, underwater sound levels and the marine and aquatic species that may be affected by noise are defined as the ZOIs; these are the areas in which noise would exceed a threshold protective of marine and aquatic species. ZOIs were determined as applicable for marine mammals, sea turtles, and fish using estimated noise levels for pile driving and dredging, and these ZOIs are described for each of these resources in their respective sections (see Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species). The only source of operational noise within the basin would be periodic maintenance dredging, if needed; therefore, operational noise impacts would be limited to the immediate vicinity (within 0.5-mile) of any necessary maintenance dredging.

4.8.2 Guidelines for Noise Impact Determinations

Impact intensities for noise are based on the definitions provided in Section 4.1 and the following noise-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on resources exposed to noise would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[61]
- minor: increased noise could attract attention, but its contribution to the soundscape would be localized and unlikely to affect current user activities, aquatic species, or wildlife;
- moderate: increased noise would attract attention and contribute to the soundscape including in local areas and those adjacent to the action, but would not dominate. User activities, aquatic species, or wildlife could be affected; and
- major: increased noise would attract attention and dominate the soundscape over widespread areas. Noise levels would eliminate or discourage user activities or result in injury to aquatic species or wildlife.

4.8.3 Construction Impacts

4.8.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The ambient sound levels would be expected to continue as described in Chapter 3, Section 3.8.3 during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area may be developed for industrial or commercial purposes that would likely have some adverse effect on noise levels in the area. However, it would be speculative to guess what exactly those future

[61] The term "negligible" will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

developments might be (see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with local noise ordinances and federal guidelines.

4.8.3.2 Applicant's Preferred Alternative

4.8.3.2.1 Impacts Related to Airborne Sound

Temporary, direct, minor to moderate, adverse noise impacts would occur during construction of the Project. The potential significance of construction-related noise impacts are defined by comparing the estimated Project-related noise levels to the applicable FHWA noise analysis standards defined in Chapter 3, Table 3.8-2 in Noise. Because the nearest NSAs to the Project are residences, construction noise exceeding 67 dBA L_{eq} could result in annoyance.

Internal combustion engines associated with general construction equipment and dredging would produce sound that would be perceptible in the vicinity of the Project facilities. Pile driving would also generate noise and is anticipated to be the loudest single activity during construction of the Project.

Noise from construction activities varies greatly depending on the type and model of construction equipment, the operations being performed, and the overall condition of the equipment. Construction of the Project facilities would occur in several phases over a 5-year period, and the construction equipment necessary for each stage of construction would differ. Construction equipment would be operated intermittently over that period as needed.

During construction, sound levels would temporarily increase above the existing ambient sound levels presented in Chapter 3, Section 3.8.3.1 in Noise in the immediate vicinity (within 0.5-mile) of each work area, resulting in adverse impacts ranging from minor to moderate. Impacts would be greatest near the diversion complex and adjacent auxiliary structures, where pile driving is planned. Work within the Barataria Basin would be limited to driving wooden piles for navigation and a boat pier, installation of sheet piles and H-piles to support the outfall structure, dredging for the barge access routes and the outfall transition feature, and dredging and material deposition in the beneficial use placement areas. Because noise in these areas would be limited to vessel activity for dredging and placement, which could occur intermittently over the estimated 5-year timeframe for construction, adverse noise impacts from Project-related activities on nearby NSAs would be temporary and minor.

Internal combustion engines in construction equipment would be the primary source of airborne noise over the full construction period; these equipment types would include excavators, trucks, loaders, dozers, rollers, scrapers, graders, cranes, barges, drill rigs, and pile drivers. Table 4.8-1 provides typical sound levels associated with some of the types of equipment (including pile drivers) that would be used during construction of the Project.

Table 4.8-1
A-weighted (dBA)[a] Sound Levels of Typical Construction Equipment and Modeled Attenuation at Various Distances[b]

Noise Source	Distance from Source				
	50 feet	100 feet	200 feet	500 feet	1,000 feet
Auger drill rig	84	78	72	64	58
Backhoe	78	72	66	58	52
Clam shovel	87	81	75	67	61
Compactor (ground)	80	74	68	60	54
Concrete manufacturing plant	83	77	71	63	57
Crane	81	75	69	61	55
Dozer	82	76	70	62	56
Dump truck	76	70	64	56	50
Excavator	81	75	69	61	55
Front-end loader	79	73	67	59	53
Generator	81	75	69	61	55
Grader	85	79	73	65	59
Impact pile driver	101	95	89	81	75
Vibratory pile driver	101	95	89	81	75
Roller	80	74	68	60	54
Truck (pickup)	75	69	63	55	49
Truck (flat-bed)	74	68	62	54	48

Source: FHWA 2006

[a] Decibels are the units of measurement used to quantify the intensity of noise. To account for the human ear's sensitivity to low-level noises, the decibel values are corrected to weighted values known as decibels on the A-weighted scale (dBA). The A-weighted scale is used because human hearing is less sensitive to low and high frequencies than mid-range frequencies.

[b] The dBA at 50 feet is a measured or estimated noise level. The 100- to 1,000-foot sound levels are conservative modeled estimates assuming no attenuation other than by distance.

Pile driving would be required for installation of piles at the diversion complex, and as shown in Table 4.8-1, is likely to be the greatest single noise source during Project construction. Pile driving would be conducted using both impact and vibratory hammers; impact hammers produce impulsive (short, intense) sound, while vibratory hammers produce continuous sound while in use. Vibratory pile driving would be used to install sheet piles for the cofferdam cells intermittently over a period of up to 18 months on the river side of the MR&T Levee. Once the cofferdam is in place, impact and vibratory pile-driving methods would be used to install round and square steel and concrete pipe piles for the diversion gates, intake system, and transition walls intermittently over an additional 12 months. Vibratory pile driving would be used to install sheet piles for the cutoff wall of the diversion complex to prevent scour. The sheet piles would be driven to a depth of up to 100 feet. Finally, vibratory pile driving would be used to install sheet and H-pilings to form a system of braced sheet-pile walls at the outfall. Sheet piles would be driven to a depth of either 20 or 58 feet below grade, while the H-pile braces would be driven to either 40 or 100 feet.

The USEPA has published estimated L_{eq} for typical construction activities; these levels conservatively assume that all construction equipment required for a given activity are operating concurrently and that sound is not attenuated by ground absorption, vegetation, or on-site structures (USEPA 1971). Table 4.8-2 presents these USEPA-estimated construction noise levels, and estimates the sound levels for each construction stage at the NSAs nearest to the diversion complex based on attenuation over the approximate distance from the Project feature boundary to the nearest NSA.

Table 4.8-2
Noise Levels Associated with Outdoor Construction and Estimated Impacts on NSAs

Activity	Noise Level (dBA)	
	L_{eq} at 50 feet	L_{eq} at Residences in Ironton, Louisiana (0.5 mile from the Diversion Complex)[c]
Ground clearing[a]	84	50
Excavation and grading[a]	88	54
Foundations[a]	88	54
Structural work[a]	79	45
Finishing and cleanup[a]	84	50
Pile driving[b]	101	67

a USEPA 1971; Leq sound levels at 50 feet presented here were estimated for the construction of public works roads and highways, sewers, and trenches, assuming an ambient sound level of about 50 dBA.
b FHWA 2006
c Noise levels were estimated based on the distance from the NSA to the approximate boundary of the diversion complex. The estimated noise level is a conservative modeled estimate assuming no attenuation other than by distance.

The nearest NSAs from the diversion complex include residences in the town of Ironton, which are approximately 0.5 mile from the Project footprint where construction would occur. Construction noise is expected to attenuate to levels that meet the recommended hourly L_{eq} for residential land (67 dBA) during construction of the diversion complex and related auxiliary facilities (including pile driving) as shown in Table 4.8-2.

Noise would also be generated by vessels used for construction of the Project, including tugs, scows, and barges used to transport construction materials and equipment. A small dredge would be used within access channels to facilitate access for construction. Airborne noise from these would likely be consistent with other vessel activity in the Project vicinity, such as barges and other commercial vessels traveling along the Mississippi River and navigational channels in the Barataria Basin; therefore, impacts would be negligible.

To further minimize the impacts of construction on nearby NSAs, the Applicant would limit construction to daytime hours, to the extent practicable, with construction activities occurring predominantly during the day, typically between 7:00 a.m. and 7:00 p.m., Monday through Friday. Equipment would be maintained in good working order, using manufacturer-installed mufflers, and would only be operated when necessary.

4.8.3.2.2 Impacts Related to Underwater Sound

The Project has the potential to produce underwater sound from construction activities including pile driving, dredging, and the transit of Project-related vessels. Pile driving would include both impact pile driving and vibratory pile driving. Dredging would occur in the Mississippi River as well as in the Barataria Basin. Additional detail is provided in Chapter 2.

Underwater sound generated in the Mississippi River has the potential to impact freshwater species of fish. Within the Barataria Basin, species potentially exposed to elevated underwater sound include marine mammals, marine and estuarine fish, and sea turtles. Project activities that may cause underwater sound are listed in Table 4.8-3, including source levels and the anticipated duration of the noise-producing activity. The impacts of these source levels on species are discussed further in their respective sections (see Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species).

Table 4.8-3
Estimated Sound Levels from Underwater Noise Sources

Pile-driving Activity or Effect Level	Sound Exposure Level (SEL) (dB re 1 μPa2s)	Root Mean Square Sound Level (dB RMS) (dB re 1 μPA)	Peak Sound Level (dB re 1 μPA)	Duration of Activity per Day (hours)/Strikes per Pile	Total Duration
Vibratory pile driving[a]	165	165	182	8 to 12 hours/NA	up to 4 months (basin) or 10 months (river)
Impact pile driving (steel piles)[b]	180	190	208	8 to 12 hours/ 280-500	1 to 2 months (river only)
Impact pile driving (timber piles)[c]	160	170	180	20	5 days (basin only)
Dredging[d]	--	180	185	24 hours	12 months (river and basin)
Vessel operations[e]	--	175	175	As needed	As needed

-- = Not available.

[a] Source level for the vibratory hammer was obtained from NMFS (2020e) for a 24-inch sheet pile installed in 49 feet of water at a source distance of 33 feet. Vibratory pile driving of H-piles in the Barataria Basin is also proposed, but is estimated to produce a lower peak sound level than the sheet-pile installation.

[b] Source level for the impact hammer was obtained from Caltrans (2015) and NMFS (2020e) for a 36-inch steel pipe pile installed in less than 16 feet of water at a source distance of 33 feet.

[c] Source level for the timber piles was obtained from WSDOT (2019) and NMFS (2020e) for a 24-inch sheet pile installed in 2 to 4 feet of water at a source distance of 33 feet. Pressed installation of additional timber piles would also occur over 1 to 2 months, but would result in negligible noise levels.

[d] The specific method of dredging has not yet been determined. Therefore, dredging source levels for multiple options are estimated based on literature review, with the referenced value being the upper source level produced by a cutterhead dredger at a distance of 3.3 feet (CEDA 2011).

[e] Vessel sound levels vary based on location, speed, and vessel type. The referenced value was produced by a dredge vessel transiting at speeds of 10 to 14 knots, at a source distance of 3.3 feet (de Jong et al. 2010).

4.8.3.3 Other Action Alternatives

All other action alternatives, including terrace alternatives, would have a similar construction footprint and use the same construction methods as that of the Applicant's Preferred Alternative. Any additional impacts from airborne noise during operation of construction equipment for terracing would be negligible. As such, the direct and indirect impacts of the construction of all other action alternatives from airborne sound would be similar to those described above for the Applicant's Preferred Alternative. However, construction timeframes for the 150,000 cfs alternatives would be longer by several months and for the 50,000 cfs alternatives would be shorter by several months as compared to the Applicant's Preferred Alternative. As such, the duration of potential temporary impacts on NSAs exposed to airborne noise would be slightly longer for the 150,000 cfs alternatives and slightly shorter for the 50,000 cfs alternatives. Impacts on marine mammals, marine and estuarine fish, and sea turtles from underwater sounds generated during construction are described in their respective sections (see Section

4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species).

4.8.4 Operational Impacts

4.8.4.1 No Action Alternative

Under the No Action Alternative, the long-term impacts described for operation of the action alternatives would not occur. It is predictable that over the next 50 years, the area may be modified by other projects, and that those projects may result in changes to sound levels. Ongoing activities, such as maintenance dredging and vessel traffic in nearby navigational channels, would continue to produce underwater sound.

4.8.4.2 Applicant's Preferred Alternative

During operation of the Project, airborne impacts on ambient sound levels would be limited to those generated by the intermittent operation of the diversion's gates, water flow through the diversion, and use of a back-up generator. There would also be intermittent disturbance from ongoing maintenance activities (such as dredging and mowing of vegetation). Direct impacts would also result from operation of the proposed railroad bridge and extension of the track termination point.

4.8.4.2.1 Impacts Related to Airborne Sound

Intermittent but permanent, direct, adverse noise impacts due to operations and maintenance would occur over the 50-year analysis period; however, these impacts would be negligible to minor, mainly occurring during active maintenance activities, diversion gate operation, and water flow through the diversion. These operational activities would have increased noise levels that could attract attention but would be localized and unlikely to affect the NSAs because of the distance (approximately 0.5 mile) to the diversion complex. Estimated Project-related operational noise levels at the nearest NSAs are compared with the USEPA outdoor noise guideline level of 55 dBA L_{dn} (see Chapter 3, Section 3.8.2 in Noise). If Project-related operational noise impacts exceed the 55 dBA L_{dn} noise level or result in a sound increase of 10 dB or more (perceived as a doubling of sound), significant impacts on nearby NSAs could occur. These significance thresholds are more protective than the Plaquemines and Jefferson Parish noise ordinances described in Chapter 3, Section 3.8.2 in Noise, which are not addressed further.

If needed, CPRA would conduct maintenance dredging of the conveyance channel and the outfall transition feature to ensure that the appropriate water depths are maintained to allow the Project to function as designed (see Section 4.4 Surface Water and Coastal Processes). Maintenance dredging would also be conducted within federally maintained navigational channels (the Barataria Bay Waterway, GIWW, and Bayou Lafourche) as needed. Mowing and other vegetation maintenance would be conducted in vegetated areas at the permanent diversion complex right-of-way. These activities would occur intermittently and would be consistent with other periodic vegetation maintenance activities in the Project area, such as the mowing of the existing

Mississippi River Levee, roadside vegetation, and lawns on developed land. Sound from the use of a tractor to mow is estimated to be 70 dBA at a distance of 100 feet. The noise generated during these activities would be intermittent and negligible during active maintenance and is not expected to impact nearby NSAs due to the distance from the proposed Project.

In addition to the direct Project impacts described above, once construction of the proposed NOGC railroad modifications is complete, permanent, direct, and adverse impacts from train-induced noise are expected due to trains traversing the proposed railroad bridge and the extension of the track termination point to be 600 feet closer to Ironton. However, given the short distance of additional track, impacts would be negligible. See Section 4.22 Land-Based Transportation for additional detail regarding railroad impacts.

4.8.4.2.2 Impacts Related to Underwater Sound

The underwater noise generated during maintenance dredging would be similar to the levels described above for construction of the proposed Project (see Table 4.8-3). However, periodic, individual maintenance dredging events would be conducted in the outfall area as needed (based on sedimentation rates within the outfall transition feature and federally maintained navigational channels) and would require a much shorter timeframe than the dredging that would be conducted to construct the Project. Impacts on marine mammals, marine and estuarine fish, and sea turtles from underwater sounds generated during operation are further described in their respective sections (see Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species).

4.8.4.3 Other Action Alternatives

4.8.4.3.1 50,000 cfs Alternative

The direct and indirect impacts of the operation of the 50,000 cfs alternative on NSAs impacted by airborne sound would be similar to those described above for the Applicant’s Preferred Alternative. Airborne noise impacts would be intermittent, permanent and negligible to minor, mainly occurring during active maintenance activities, diversion gate operation, and water flow through the diversion. Underwater noise impacts would be limited to infrequent episodes of active maintenance dredging, as described for the Applicant’s Preferred Alternative, and impacts on marine mammals, marine and estuarine fish, and sea turtles from underwater sounds generated during construction are described in their respective sections (see Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species).

4.8.4.3.2 150,000 cfs Alternative

The direct and indirect impacts of the operation of the 150,000 cfs alternative on NSAs impacted by airborne sound would be similar to those described above for the Applicant’s Preferred Alternative. Airborne noise impacts would be intermittent, permanent and negligible to minor, mainly occurring during active maintenance activities, diversion gate operation, and water flow through the diversion. Underwater noise impacts would be limited to infrequent episodes of active maintenance dredging, as described for the Applicant's Preferred Alternative, and impacts on marine mammals, marine and estuarine fish, and sea turtles from underwater sounds generated during construction are described in their respective sections (see Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species).

4.8.4.3.3 Terrace Alternatives

The direct and indirect impacts of all three terrace alternatives from airborne and underwater sound would be similar to those described above for the flow capacity alternatives without terraces. Airborne noise impacts would be intermittent, permanent and negligible to minor, mainly occurring during active maintenance activities, diversion gate operation, and water flow through the diversion as compared to the No Action Alternative. There would be no incremental change in noise levels due to the presence of the terraces.

4.8.5 Summary of Potential Impacts

Table 4.8-4 summarizes the potential impacts on resources exposed to noise for each alternative. Details are provided in Sections 4.8.2 through 4.8.4 above.

Table 4.8-4
Summary of Potential Impacts on Resources Exposed to Noise from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on noise levels from construction of the Project would occur. • Future developments in the Project area could have some adverse impact on noise levels. • Any future development would be required to comply with applicable noise ordinances.
Operational Impacts	• The noise associated with operations and maintenance of the Project would not occur. • Any future development in the Project area could result in changes to ambient sound levels in the Project area.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Minor to moderate, direct, temporary, adverse airborne noise impacts would occur during construction of the Project due to operation of combustion-powered construction equipment and pile driving. • Maximum projected airborne sound levels at the nearest residence would be 67 dBA during construction at the nearest NSA. • Impacts on marine and aquatic species due to underwater noise from pile driving, dredging, and vessel traffic.[a]
Operational Impacts	• Negligible airborne noise impacts due to operations and maintenance during active maintenance activities, diversion gate operation, and water flow through the diversion.

Table 4.8-4 Summary of Potential Impacts on Resources Exposed to Noise from Each Alternative	
Impact Type	**Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)**
	• Impacts on marine and aquatic species due to noise from maintenance dredging would be intermittent and limited to maintenance dredging activities.[a] • Negligible train-induced noise impacts due to trains traversing the proposed railroad bridge and the extension of the track termination point.
50,000 cfs Alternative	
Construction Impacts[a]	• Minor to moderate, direct, temporary, adverse airborne noise impacts would occur during construction of the Project due to operation of combustion-powered construction equipment and pile driving. • Maximum projected airborne sound levels at the nearest residence would be 67 dBA during construction at the nearest NSA. • Impacts on marine and aquatic species due to underwater noise from pile driving, dredging, and vessel traffic.[a]
Operational Impacts	• Negligible airborne noise impacts due to operations and maintenance during active maintenance activities, diversion gate operation, and water flow through the diversion. • Impacts on marine and aquatic species due to noise from maintenance dredging would be intermittent and limited to maintenance dredging activities.[a] • Negligible train-induced noise impacts due to trains traversing the proposed railroad bridge and the extension of the track termination point.
150,000 cfs Alternative	
Construction Impacts	• Minor to moderate, direct, temporary, adverse airborne noise impacts would occur during construction of the Project due to operation of combustion-powered construction equipment and pile driving. • Maximum projected airborne sound levels at the nearest residence would be 67 dBA during construction at the nearest NSA. • Impacts on marine and aquatic species due to underwater noise from pile driving, dredging, and vessel traffic.[a]
Operational Impacts	• Negligible airborne noise impacts due to operations and maintenance during active maintenance activities, diversion gate operation, and water flow through the diversion. • Impacts on marine and aquatic species due to noise from maintenance dredging would be intermittent and limited to maintenance dredging activities.[a] • Negligible train-induced noise impacts due to trains traversing the proposed railroad bridge and the extension of the track termination point.
Terrace Alternatives	
Construction Impacts[a]	• As compared to the No Action Alternative, all three terrace alternatives would have the substantially similar construction impacts on NSAs exposed to airborne noise as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts from airborne noise due to the construction of terraces would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar operational impacts from airborne and underwater noise as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • There would be no incremental change in airborne or underwater noise level due to the presence of the terraces.
[a] Impacts on marine mammals, marine and estuarine fish, and sea turtles from underwater sounds generated during construction and operation are described in their respective sections (see Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species)	

4.9 TERRESTRIAL WILDLIFE AND HABITAT

4.9.1 Area of Potential Impacts

The area of potential impacts for the evaluation of impacts on terrestrial wildlife (those that use upland or a combination of upland and wetland habitats) and terrestrial vegetation communities (those that include fully upland vegetative species) varies by Project phase. Impacts on fully aquatic species are discussed in Section 4.10, Aquatic Resources and a full discussion on wetland impacts is included in Section 4.6, Wetland Resources and Waters of the U.S.

Impacts from construction would occur within, and in close proximity to, the footprint of each individual Project component developed during construction (for example, the diversion complex, laydown yards, access roads, dredged material disposal areas). Land clearing for these Project components would result in direct impacts on terrestrial and wetland habitat, as well as to the species that use them. Indirect impacts would occur in a larger area or at a later point in time that would be dependent on the specific activity being conducted. For example, noise associated with construction would extend beyond the footprint of the Project components, to the distance at which noise attenuates back to ambient conditions (within about 0.5-mile; see Section 4.8 Noise).

Impacts from operations would similarly have direct and indirect impacts. Direct impacts from placement of the Project structures would occur from the conversion of habitat, which would initially occur during the construction period, but would persist for the 50-year analysis period. Direct and indirect impacts would also occur from the movement of sediments and water from the Mississippi River to the Barataria Basin, increasing the availability of wetland habitat over time, which could alter the populations of wetland-dependent terrestrial species throughout the basin. Therefore, the area of potential impacts during operations includes the entire Project area, as defined in Section 4.1.

4.9.2 Guidelines for Terrestrial Wildlife and Habitat Impact Determinations

Impact intensities for terrestrial wildlife and habitat are based on the definitions provided in Section 4.1 and the following resource-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on terrestrial wildlife and habitat would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[62]

[62] The term “negligible” will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

- minor: impacts on native vegetation may be detectable, but would not alter natural conditions and would be limited to localized areas. Infrequent disturbance to individual plants would be expected, but would not impact local or range-wide population stability. Infrequent or insignificant one-time disturbance to locally suitable habitat would occur, but sufficient habitat would remain functional at both the local and regional scales to maintain the viability of the species. Opportunity for increased spread of nonnative plant species would be detectable but temporary and localized and would not displace native species populations and distributions. Impacts on native wildlife species, their habitats, or the natural processes sustaining them would be detectable, but localized, and would not measurably alter natural conditions. Infrequent responses to disturbance by some individuals would be expected, but without interference to feeding, reproduction, resting, migrating, or other factors impacting population levels. Small changes to local population numbers, population structure, and other demographic factors would occur. Sufficient habitat would remain functional at both the local and range-wide scales to maintain the viability of the species. Opportunity for increased spread of nonnative wildlife species would be detectable but temporary and localized, and these species would not displace native species populations and distributions;

- moderate: impacts on native vegetation would be measurable but limited to local and adjacent areas. Occasional disturbance to individual plants would be expected. These disturbances would impact local populations but would not be expected to impact regional population stability. Some impacts might occur in key habitats, but sufficient local habitat would retain function to maintain the viability of the species both locally and throughout its range. Opportunity for increased spread of nonnative plant species would be detectable and limited to local and adjacent areas, but would only result in temporary changes to native species population and distributions. Impacts on native wildlife species, their habitats, or the natural processes sustaining them would be measurable but limited to local and adjacent areas. Occasional responses to disturbance by some individuals would be expected, with some adverse impacts on feeding, reproduction, resting, migrating, or other factors impacting local population levels. Some impacts might occur in key habitats. However, sufficient population numbers or habitat would retain function to maintain the viability of the species both locally and throughout its range. Opportunity for increased spread of nonnative wildlife species would be detectable and limited to local and adjacent areas, but would only result in temporary changes to native species population and distributions; and

- major: impacts on native vegetation would be measurable and widespread, including loss or growth of vegetation, as well as a change in the composition of an existing vegetation community. Frequent disturbances of individual plants would be expected, with impacts on both local and regional population levels. These disturbances would impact range-wide population stability. Some impacts might occur in key habitats, and habitat impacts would adversely impact the viability of the species both locally and throughout its range. Actions would result in the widespread increase of nonnative plant species, resulting in broad and permanent impacts on native species populations and distributions. Impacts on native wildlife species, their habitats, or the natural processes sustaining them would be detectable and widespread. Frequent responses to disturbance by some individuals would be expected, with impacts on feeding, reproduction, migrating, or other factors resulting in a decrease in both local and range-wide population levels and habitat type. Impacts would occur during critical periods of reproduction or in key habitats and would result in direct mortality or loss of habitat that might impact the viability of a species. Local population numbers, population structure, and other demographic factors might experience large changes or declines. Actions would result in the widespread increase of nonnative wildlife species resulting in broad and permanent impacts on native species populations and distributions.

4.9.3 Construction Impacts

4.9.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The general character of terrestrial wildlife and vegetation in the Project area would continue as described in Chapter 3, Section 3.9 Terrestrial Wildlife and Habitat, and the ongoing impacts on these resources are expected to continue. Only limited impacts on terrestrial wildlife and vegetation in the Project area are expected during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that may have some adverse impact on terrestrial wildlife and vegetation. However, it would be speculative to project what exactly those future developments might be (see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal standards.

4.9.3.2 Applicant's Preferred Alternative

4.9.3.2.1 Vegetation

Overall construction impacts on upland vegetation in the construction area and adjoining areas would include temporary to permanent, minor (detectable but localized) to moderate (measurable in local and adjacent locations), adverse impacts. As shown in Chapter 3, Table 3.9-1 in the Terrestrial Wildlife and Habitat section, upland vegetation communities in the Barataria Basin generally include agriculture/crop/ grassland (agricultural land), coastal dune grassland/shrub thicket, barrier island live oak forest, and live oak natural levee forest. Although each of these communities occurs in the Barataria Basin, the predominant terrestrial communities within the construction footprint of the Project would be non-specific forested lands (including uplands and wetlands), as well as agricultural uplands and wetlands (see Section 4.16 Recreation and Tourism, Table 4.16-1 and Figure 4.16-1 and Section 4.6 Wetlands and Waters of the U.S., Figure 4.6-1). Impacts on wetland vegetation are discussed in Section 4.6.

There is a relatively large forested upland area, a portion of which would be within the proposed diversion complex footprint (about 154.9 acres; between the MR&T Levee and LA 23). According to CPRA's wetland delineations, the area appears to be seasonally flooded but well drained, such that most areas are classified as uplands, containing smaller areas of forested wetlands (bottomland hardwoods). Although live oak was identified as a dominant tree species at one location, other dominating overstory species typical of a live oak natural levee forest (for example, water oak, American elm) were not present. Forested vegetation would not be allowed to re-establish in this area after construction, resulting in the forested areas being converted to developed land (within the footprint of the diversion structure) or maintained as turf grass (in areas cleared for construction but not encumbered by the diversion structure); therefore, impacts on forested vegetation would be direct, permanent, and adverse, but minor to moderate.

Between LA 23 and the NOV-NFL Levee, the construction footprint includes pasture/grassland areas as well as drainage ditches that have been excavated for past agricultural practices. The pasture includes primarily Bermuda grass (*Cynodon dactylon*) that transitions to wetland vegetation closer to the basin. Permanent or temporary, minor to moderate, direct, adverse impacts on agricultural land would occur within the construction footprint as the habitat is converted to either developed land (permanent) or restored to turf grass (temporary).

In addition to direct clearing of forest and grasses within the construction footprint, adjacent vegetation communities could be indirectly impacted by erosion, sedimentation, stormwater runoff, and minor spills of fuels or other hazardous materials during and temporarily following construction. To minimize the potential for these impacts to occur, CPRA would implement preventative plans (for example, a SWPPP and SPCC Plan). Erosion control measures implemented as part of the SWPPP would include:

- limiting construction traffic to access roads to minimize disruption of natural drainage patterns;
- constructing silt fences and sediment traps, such as hay bales, at stormwater drainage locations;
- using grading methods to avoid concentrated flows;
- redirecting stormwater runoff into temporary sediment basins or vegetated swales; and

- seeding or mulching exposed soils.

Given the extent of cleared vegetation and implementation of these plans and mitigation measures, adverse impacts on agricultural and forested lands adjacent to the construction area as a result of the Project would be direct and indirect, minor to moderate, and permanent; however, these localized impacts would be negligible at the basin-scale.

4.9.3.2.2 Terrestrial Wildlife

As described in Chapter 3, Section 3.9.3 in Terrestrial Wildlife and Habitat, terrestrial wildlife, including birds, reptiles, amphibians, and mammals are those that either fully use terrestrial (upland) habitat, a mixture of terrestrial and wetland habitat, or wetland habitat above the water. Select species and the habitats that they use are included in Chapter 3, Table 3.9-2. Impacts on terrestrial species associated with construction of the Project would generally include displacement, stress, and direct mortality of some individuals. The degree of impact would depend upon the type, relative quantity and quality of habitat impacted, the timing of clearing and construction activities, and the rate at which the area returns from disturbance to preconstruction conditions, if at all. Therefore, impacts on terrestrial wildlife are discussed by habitat type, including the following types: upland forest (live oak natural levee forest), agricultural land, and wet pasture/marsh/bottomland hardwoods (generally referred to as wetlands). As shorelines along the barrier islands and the barrier islands themselves are not anticipated to be impacted by construction of the Project, barrier island-associated habitats, and species use of these habitats, are not discussed further.

4.9.3.2.2.1 Upland (Live Oak Natural Levee) Forest

Overall impacts on upland forest habitat and associated wildlife in the area of impacts for construction would include permanent, minor (detectable but localized) to moderate (measurable in local and adjacent locations), direct and indirect, adverse impacts, as described below; however, these impacts would likely be negligible to wildlife populations at a basin-wide level. The area directly impacted by the diversion structure and auxiliary features is predominantly in agricultural use for production of hay or as pasture land; however, as shown in Section 4.18 Land Use and Land Cover, Figure 4.18-1, a 324-acre forested/shrub patch would be bisected by the diversion structure resulting in direct and permanent impacts on 154.9 acres of upland forested land within the construction footprint (as well as about 27.1 acres of which is forested wetland/bottomland hardwood). Wildlife using this habitat (such as deer and bobcat, see Chapter 3, Section 3.9 Terrestrial Wildlife and Habitat, Table 3.9-2) would be directly displaced and would be indirectly impacted within remaining portions of the bisected forested patch, as well as additional areas immediately adjacent, as described below.

Direct impacts on upland forest and associated species would be permanent as the cleared trees would not be allowed to re-establish during the 50-year analysis period of the Project. Clearing of vegetation would reduce suitable cover, nesting, and foraging habitat for some wildlife species using upland forest. Mobile wildlife species, such as birds and terrestrial mammals, may relocate to similar habitats nearby when construction activities commence. However, smaller, less mobile wildlife (for example, most reptiles and amphibians) could be inadvertently injured or killed by construction activities. The permanent reduction in available habitat would likely reduce the size of some local populations given the limited forest habitat in the immediate vicinity (within 0.5-mile) of the Project footprint, albeit marginally given the range and abundance of many of the impacted species within and even beyond the larger Project area.

Indirect, minor to moderate, adverse impacts on upland forest and associated species would occur in areas immediately adjacent to construction activities. Minor impacts may temporarily occur where increased noise and lighting may deter wildlife from using available adjacent habitat. Construction would occur in several phases over an approximately 5-year period, such that impacts would be prolonged and would overlap the migratory or breeding seasons for multiple species. Moderate long-term and permanent adverse impacts would also occur adjacent to cleared forested areas due to the relative scarcity of forested lands in the immediate vicinity (within 0.5-mile) of the Project's construction footprint. Moderate impacts are more likely to occur on non-avian species as they disperse into remaining forested areas along the west bank of the Mississippi River, resulting in increased inter- and intra-specific competition in those forested blocks, possibly decreased reproduction success of individuals, and lower population sizes overall as a result of decreased habitat availability. Minor impacts are more likely to occur on birds as they can more readily move to forested lands on either side of the river, causing less competitive pressure within the immediate Project vicinity.

4.9.3.2.2.2 Agricultural Land

Overall impacts on agricultural habitat and associated wildlife (such as doves and rat snakes, see Chapter 3, Table 3.9-2) in the area of impacts for construction would include temporary to permanent, minor, adverse impacts, as described below; however, these impacts would likely be negligible to wildlife populations at a basin-wide level. About 463 acres of upland agricultural land would be directly impacted by construction activities, all of which would revert to turf grass or be permanently converted to a developed state through the placement of the Project structures. Although many species use agricultural habitats for foraging and migration, the vegetation identified within the construction footprint (primarily Bermuda grass) is not considered high-value wildlife habitat. Further, a review of aerial imagery indicates that similar habitat is prevalent in the immediate vicinity (within 0.5-mile) of the Project. Therefore, direct impacts on wildlife species from clearing agricultural lands is anticipated to be minor and permanent within the construction footprint. Indirect impacts on the habitat and species would be similar to those discussed above for upland forest habitat and associated species, including movement of species away from areas of increased noise, light, and human disturbance in adjacent agricultural habitat, causing increased intra- and inter-species competition. However, as previously noted, similar habitat is prevalent in the immediate vicinity (within 0.5-mile) of the construction footprint;

therefore, these indirect impacts on species utilizing adjacent habitat are anticipated to be temporary and minor.

4.9.3.2.2.3 Wetlands (Wet Pasture/Marsh/Bottomland Hardwoods)

Overall impacts on wetland habitat and associated wildlife (such as alligators and muskrats, see Chapter 3, Table 3.9-2 in Terrestrial Wildlife and Habitat) in the area of impacts for construction would include temporary to permanent, minor to moderate, adverse and beneficial impacts, as described below. About 204.2 acres of wetlands would be directly and adversely impacted by construction activities, including permanent conversion to a developed state through placement of the Project structures, and excluding the beneficial use areas addressed further below (see Section 4.6 Wetlands and Waters of the U.S., Table 4.6-1). Clearing of wetland vegetation would reduce suitable cover, nesting, and foraging habitat for wildlife species using wetlands.

Permanent, minor impacts would occur on species utilizing herbaceous (wet pasture and marsh) wetland areas cleared during construction (173.9 acres), as areas not converted to permanent Project features would likely not return to herbaceous wetland following construction. Permanent, minor impacts would occur on species utilizing forested and scrub/shrub wetlands in the construction footprint (30.3 acres) as this habitat would not be restored after construction.

Indirect impacts on wetland habitat and species would be similar to those discussed above for upland forest habitat and associated species, including movement of species away from areas of increased noise, light, and human disturbance, causing increased intra- and inter-species competition. These impacts would be minor in the wet pasture wetlands, as similar habitat is prevalent in the immediate vicinity (within 0.5-mile) of the construction footprint. Impacts on forested wetlands and associated species would be moderate and similar to those discussed above for upland forest, given the limited acreage of similar habitat in the immediate vicinity (within 0.5-mile). Construction would occur in several phases over an approximately 5-year period, such that impacts would be prolonged and would overlap the migratory or breeding seasons for multiple species. Moderate impacts are more likely to occur on non-avian species as they disperse into remaining forested areas along the west bank of the Mississippi River, resulting in increased inter- and intra-specific competition in those forested blocks, possibly decreased reproduction success of individuals, and lower population sizes overall as a result of decreased habitat availability. Minor impacts are more likely to occur on birds as they can more readily move to adjacent blocks on either side of the river.

As noted in Chapter 3, Section 3.9.3 in Terrestrial Wildlife and Habitat, there is a colonial waterbird rookery in the immediate outfall area, about 900 feet from the outfall transition feature’s eastern boundary, which was identified as active in 2014. The species utilizing this rookery may include little blue and tricolored herons, as well as great, snowy, and cattle egrets. The USFWS – Louisiana Ecological Services Office and the LDWF generally make the recommendation to restrict construction activities outside of a species-specific nesting period, or if that is not practicable, to restrict construction activities within 1,000 feet of the rookery during the nesting season (USFWS 2017h, LDWF 2017o). As this rookery may not be active at the time of construction, and because new rookeries may become established prior to construction, CPRA, at the request of LDWF, would conduct preconstruction surveys during the nesting season (but no more than 2 weeks prior to construction) to identify any active rookeries within the vicinity of the Project construction footprint. Further, CPRA would provide the survey results to LDWF to determine if mitigation measures are warranted for the protection of any rookeries identified. CPRA would adhere to LDWF's letter recommendations. Bald eagles may also use the forested areas within the construction footprint of the Project; this species is discussed further in Section 4.12.2 in Threatened and Endangered Species given its special status under the Bald and Golden Eagle Protection Act (16 USC. 668-668c).

In addition to the overall purpose of the Project, which includes restoration of marshes within the Barataria Basin, CPRA proposes to establish three beneficial use areas within the immediate outfall area. Dredged/excavated materials would be hydraulically pumped to three beneficial use areas for the creation and enhancement of wetlands. The total combined footprint of the beneficial use areas would be 467 acres, most of which would be within currently open water areas and within the tidal frame. A total of approximately 2.0 mcy of excavated material would be repurposed to create 375 acres of emergent marsh and nourish 92 acres of existing marsh. This conversion of open water to mudflat, and later to marsh, would result in a permanent, moderate, beneficial impact on bird species that use wetland habitats, such as waterfowl, shorebirds, and wading birds. Impacts of the beneficial use areas are further discussed in Section 4.6 Wetland Resources and Waters of the U.S.

4.9.3.2.3 Terrestrial Invasive Species

4.9.3.2.3.1 Terrestrial Invasive Plants

Construction of the Project could result in short-term, indirect, minor, adverse impacts on terrestrial wildlife habitat due to the potential introduction or spread of invasive plants. Removal of existing vegetation and disturbance of soils during construction would create conditions conducive to the establishment and spread of invasive species. Invasive plant species identified during wetland surveys that already occur in the construction area include Chinese tallow and Chinese privet *(Ligustrum sinense)*, which were identified in multiple locations within the forested uplands. To minimize the potential spread of invasive species, CPRA would seed and hydromulch bare upland soils after construction as part of its SWPPP. Aquatic invasive species impacts are discussed in Section 4.10 Aquatic Resources; wetland invasive species impacts are discussed in Section 4.6 Wetland Resources and Waters of the U.S.

4.9.3.2.3.2 Terrestrial Invasive Animals

Smaller invasive animal species present within the Project construction footprint, such as the cane toad and greenhouse frog, would likely be injured or killed during vegetation clearing and dredging/excavation of the diversion complex. Any larger invasive species, such as birds (for example, European starling, Eurasian collared dove, and rock pigeon), nutria, or feral hogs utilizing the terrestrial habitats in the construction footprint would be displaced to adjacent areas, potentially causing further competition for those habitats by native wildlife. Given that most invasive species thrive in disturbed habitats, these populations may increase. However, given the relatively small footprint of the disturbance related to construction, and the likely presence of these terrestrial invasive animals in adjacent habitat already, the impacts are likely to be minor.

4.9.3.3 Other Action Alternatives

As compared with the Applicant's Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition feature would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes, but the overall construction footprint of all action alternatives would be similar. Additionally, construction timeframes for the 150,000 cfs alternatives would be longer by several months and for the 50,000 cfs alternatives would be shorter by several months as compared to the Applicant's Preferred Alternative. As such, the duration of potential temporary impacts from construction activities would be longer or shorter, respectively, than the Applicant's Preferred Alternative. In addition, the relatively wider or narrower intake and conveyance channels associated with the 150,000 cfs and 50,000 cfs alternatives, respectively, could result in more or less fill material available for placement in the beneficial use areas as compared with the Applicant's Preferred Alternative, resulting in a relatively larger or smaller area of permanent, beneficial impacts on wetlands (and the wildlife that use them) in the beneficial use areas.

Three of the action alternatives propose the construction of terraces in the immediate outfall area. The terraces would be constructed in an area predominated by open water; however, some areas of existing wetlands would be disturbed by the placement of materials to construct the terraces. The incremental impact of the terraces would be negligible as compared to the alternatives without terraces. Therefore, as compared to the No Action Alternative, construction of the three terrace alternatives would have the same impacts on terrestrial wildlife species that also use wetlands, like waterfowl and alligators as the non-terrace alternatives.

4.9.4 Operational Impacts

4.9.4.1 No Action Alternative

The No Action Alternative would not result in the wetland creation associated with the action alternatives, nor would existing wetlands be sustained and nourished in the same manner as expected with the action alternatives. The trend of increasing salinity and wetland loss in the Barataria Basin would continue (see Chapter 3, Section 3.6.1 Wetlands and Waters of the U.S.). Shifts in salinity would reduce the overall diversity of the Barataria Basin, as species reliant on fresh and intermediate marsh would have fewer acres of available habitat, including, but not limited to, alligators and many species of waterfowl (see below). Continued loss of wetlands (including emergent marsh and freshwater swamp) in the Barataria Basin via conversion to open water, which would occur under the No Action Alternative, would decrease the habitat available for terrestrial species that use wetlands, such as waterfowl, and wading and colonial waterbirds, as well as for those species that use both wetland and upland habitats for breeding, foraging, and migration (see Chapter 3, Section 3.9 Terrestrial Wildlife and Habitat, Table 3.9-2), resulting in major, permanent, adverse, direct and indirect impacts on terrestrial wildlife. Further, the continued loss of wetlands would decrease protection of freshwater swamp in the Upper Barataria Basin and upland habitats throughout the basin; as wetlands are lost or degraded, these swamp and inshore habitats would be subjected to higher pressures from storm surges and overwash, particularly in inshore areas that lack risk reduction structures such as levees, resulting in minor to moderate, adverse, and short-term to permanent impacts on swamp and terrestrial vegetation.

Evaluation of potential impacts on select species from the No Action Alternative (and other action alternatives, as discussed further below) also takes into account a set of HSIs, which consider the value of combined habitat characteristics (by polygon), such as vegetation cover and salinity, on four species selected by the LA TIG to represent area wildlife (see Figure 4.9-1 and Table 4.9-1). The HIS scores show modeled habitat suitability (scored between 0 and 1, with 1 being the most suitable) and provide useful information to assist in assessing Project impacts; however, these models do not account for all habitat characteristics. For example, the HIS models may identify high-value habitat that is inaccessible due to physical and/or environmental barriers, or may identify a habitat as low quality that is actually highly used because of high prey densities or low predator densities. The HIS models for the selected terrestrial species are discussed further in Appendix M.

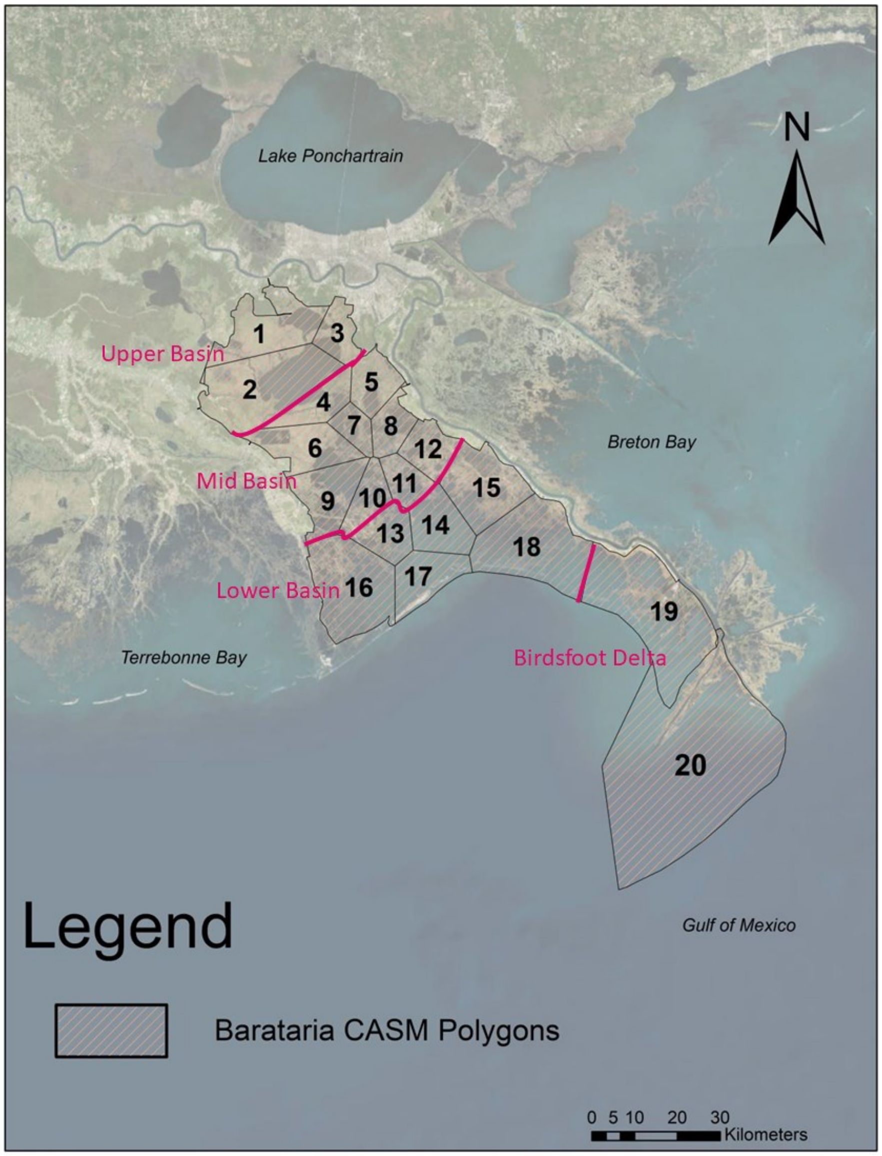


Figure 4.9-1. Barataria Basin Spatial Polygons Identified by Number and Grouped for the Upper (1-3), Mid (4-12), and Lower Basin (13-18) Regions of the Estuary with the Birdfoot Delta (19, 20). Figure adapted from Carruthers et al. 2019, and previously developed for the purpose of the Comprehensive Aquatic Systems Model (CASM) modeling for the Mississippi River Delta Management Study. The polygons were aggregated into four geographic regions (that is, Upper Barataria Basin [3 polygons], Mid-Barataria Basin [9 polygons], Lower Barataria Basin [6 polygons], and Birdfoot Delta [2 polygons]) to further facilitate characterization of the HIS results.

Table 4.9-1
Summary of HIS Results for Modeled Species Under the No Action Alternative

Species	Model Factors[a,b]	2020 HIS Range	2070 HIS Range[c]	Range of Change by Polygon	Identified Trend Over 50 Modeled Years	Predominant Reason for Change
Green-winged teal	DV fresh marsh), OW (35-75%), D (4-7 in)	0.15 to 0.83	0.05 to 0.59	-0.10 to -0.61	Habitat suitability decreased in all polygons over time (to <0.27), with only polygons 1 and 2 maintaining relatively suitable habitat (HIS = 0.46 and 0.59) by the year 2070.	Increased water depth, decreased marsh vegetation
Mottled duck	DV fresh marsh), PL (32-70%), D (4-12 in), S (<9)	0.17 to 0.87	0.03 to 0.75	-0.05 to -0.57	Habitat suitability decreased in all polygons over time (to <0.39), with only polygons 1 and 2 maintaining relatively suitable habitat (HIS = 0.66 and 0.75) by the year 2070.	Increased water depth, decreased land/marsh availability
Gadwall	DV (intermediate marsh), OW (>70%), D (9-11 in)	0.06 to 0.28	0.05 to 0.30	-0.10 to 0.07	Habitat suitability did not change substantially over time (+/- 0.10) and is projected to be and remain relatively unsuitable across time.	Increased water depth, but likely tradeoff between decreasing wetland coverage and increasing open water
Alligator	OW (20-40%), D (about 6 in), DV (intermediate marsh), E (interspersed), S (<10)	0.00 to 0.83	0.00 to 0.45	-0.69 to 0.12	The relatively suitable habitat (HIS >0.54) present in 2020 in polygons 1-10, 12, 15, and 19 decreases substantially (0.20-0.69) over time. All but polygon 2 (0.45) are below 0.4 by 2070.	Increased water depth, decreased marsh and edge habitat

Sources: Leberg 2017a, b, c; Waddle 2017; McInnis et al. 2020

[a] DV = dominant emergent vegetation and associated open water, OW = proportion of open water, D = mean water depth, PL = proportion land (emergent vegetation), S = salinity (in ppt), and E = edge habitat. Although general model factors may be similar or the same between species, the specific factors included in the model differ between species to account for habitat preferences and changes in seasonal habitat use.

[b] Although these species of waterfowl can be found in habitats outside of the optimal habitat parameters, the more significant the difference, the less likely it is that they would occur in that environment.

[c] The gadwall HSI model accounts for habitat changes through year 2060.

The general decrease in habitat suitability throughout the Barataria Basin for the three modeled dabbling ducks (those that dip their heads underwater to forage for food, as opposed to diving ducks, which fully submerge to forage) would be impacted predominantly by the increasing water depth, as well as the decreasing availability of land and emergent marsh from sea-level rise over time (see Table 4.9-1). Behney

(2020), and references therein, report that dabbling ducks focus their feeding in areas where they can reach the substrate and that they decrease feeding by 10 percent for each 4.2-inch increase in water depth. As depicted in the Section 4.4 Surface Water and Coastal Processes, Figure 4.4-13, increasing water depths under the No Action Alternative are projected to exceed the preferred depths for each of these species (max of 14.2 inches for the gadwall; Leberg 2017a, b, c) by 2040 at the representative stations. Further, although waterfowl eat aquatic insects, snails, and crustaceans, they feed predominantly on marsh vegetation and SAV (Fontenot and DeMay 2018), requiring various amounts of marsh and open water to obtain their preferred food sources. As described in Section 4.6.5.1 in Wetlands and Waters of the U.S., approximately 298,000 acres (80.4 percent) of wetlands would be lost in the Barataria Basin by 2070 under the No Action Alternative; these losses would likely result in decreased foraging efficiency and concentrations of ducks in remaining wetlands, increasing competition for food. The decrease in habitat over time would result in major, permanent, direct and indirect, adverse impacts on the green-winged teal (*Anas carolinensis*) and mottled duck as they would expend higher amounts of energy to survive and thrive in sub-optimal habitats. Impacts on gadwall would also be adverse and permanent, but likely negligible to minor given the minimal changes projected for that species throughout the Project area and across decades; the limited projected changes may be related to the increase in open water that is concurrent with the decrease in marsh habitat.

Habitat suitability for the alligator projected under the No Action Alternative in 2020 is more variable than that projected for the waterfowl, with relatively suitable habitat (HSI greater than 0.5) present in polygons 1 through 10, 12, 15, and 19, much of which is maintained for the first few decades but begins to decrease as sea-level rise and marsh loss begins to impact the mid and upper basins (see Section 4.6 Wetland Resources and Waters of the U.S., Figures 4.6-2 through 4.6-7). In all but two polygons (polygons 16 and 18), HSI scores for alligator decrease over time, with all polygons having scores of less than 0.5 by 2070. Although mature males, non-breeding females, and sub-adults tend to stay in deepwater habitats, they will bask on land to raise their body temperatures. After mating, females will build nests in interior marshes, and young may stay near their nest for a couple of years (LDWF 2020c). As coastal marshes make up the vast majority of alligator habitat in Louisiana (LDWF 2020c, Gabrey 2010), the projected general decrease in habitat suitability throughout the Project area over time would result in major, permanent, direct and indirect, adverse impacts on alligators as they would expend higher amounts of energy to survive and thrive in sub-optimal habitats.

4.9.4.2 Applicant's Preferred Alternative

4.9.4.2.1 Vegetation

Although the Project is proposed to divert sediment and water into the Barataria Basin, land accretion is not expected to reach levels that would impact upland vegetation communities; therefore, any adverse or beneficial impacts on upland vegetation through land accretion would be negligible. Although upland vegetation may be present within the existing upland/beneficial use areas within the immediate outfall area, these vegetated ridges are anticipated to channel the water and sediment introduced through the diversion complex but are not anticipated to be substantially impacted by it. At the same time, the Project is anticipated to reduce the continued loss of wetlands. Gains associated with the proposed Project would primarily be within the delta formation area where marsh vegetation predominates (see Section 4.2 Geology and Soils, Figures 4.2-2 through 4.2-4), and would not be expected to cause the direct establishment or spread of tree species. However, upland vegetation (including vegetated ridges) in the outfall area would experience continued or increased protection from storm surge and overwash as existing wetlands are protected and/or new wetlands are established, which would result in permanent, moderate, beneficial impacts on upland vegetation in the outfall area. Wetlands created over time by the Caernarvon Diversion have been subject to tree plantings in an attempt to establish cypress swamps, with some success (see Appendix U).

4.9.4.2.2 Terrestrial Wildlife

4.9.4.2.2.1 Upland (Live Oak Natural Levee) Forest

Operation of the Project would have permanent, negligible to minor, adverse impacts on terrestrial wildlife from increases in operational lighting and noise, which could disturb wildlife in adjacent habitats, impact migratory birds, and impede the movement of small mammals and other animals from crossing the diversion complex. Operational lighting is anticipated to be minimal given the relatively low profile of the diversion structure and the limited number of workers that would be present. CPRA has developed mitigation measures that would reduce night time visibility of the aboveground facilities, including light reduction techniques such as limiting the amount of outdoor lighting installed, dimming lights at night, and directing light downward.

Operational noise would be limited to periodic dredging (if needed), vegetation mowing, and diversion operations, mainly opening/closing of the diversion gates and the attendant sounds of water moving from the river to the basin. Periodic dredging and vegetation mowing are not anticipated to produce prolonged periods of noise. In-water noise from periodic dredging, if needed, would be less perceptible to those animals that occur predominantly on land. Noise from diversion operations, including gate opening/closing and water transfer from the river to the basin, would result in negligible to minor, adverse, and permanent impacts on terrestrial wildlife, depending on the rate of flow within the conveyance channel and discharge into the basin. Airborne noise is discussed in Section 4.8 Noise.

The diversion complex would span the terrestrial habitats between the west bank of the Mississippi River and the Barataria Basin. Given the width and depth of the conveyance channel, which would contain flowing water throughout operations, it is likely that movement of terrestrial (non-avian) species across the structure would be impeded or curtailed. As open transit between up- and down-river areas along the west bank would be restricted, animals may increasingly use the existing road corridor as a travel corridor, potentially resulting in increased mortality. This mortality could have a permanent, though minor, adverse impact on these terrestrial populations.

4.9.4.2.2.2 Agricultural Land

Operation of the Project would have permanent, minor, adverse impacts on the species that use agricultural lands. These impacts would be similar to those listed above for upland forest and include permanent, but minor, adverse impacts from increases in operational lighting, noise, and restriction of movement across the conveyance channel for non-avian species.

4.9.4.2.2.3 Wetlands (Wet Pasture/Marsh/Bottomland Hardwoods)

Operation of the Project would have short-term to permanent, minor to major, adverse and beneficial impacts on wetlands in the Barataria Basin and the species that use them, whereas operation of the Project would have permanent, moderate, adverse impacts on wetlands in the birdfoot delta and the species that use them. Impacts on bottomland hardwood and wet pasture species would be similar to the impacts discussed for forested upland and agricultural land-associated species, respectively. As discussed in Section 4.6 Wetland Resources and Waters of the U.S., the Applicant's Preferred Alternative would result in fewer wetland losses than the No Action Alternative in the Barataria Basin, but more wetland losses in the birdfoot delta. The long-term impacts of emergent marsh creation/maintenance in the basin from operation of the Project would be moderate and beneficial for those species that use both terrestrial and emergent wetland habitats. Specifically, waterfowl would substantially benefit from restoration and maintenance of fresh and intermediate marshes, as many species (including the mottled duck and gadwall) have seen previous population declines that are at least partially attributed to wetland loss and degradation (Hartke 2013, Fontenot and DeMay 2018). Further, Yaukey (2018) assessed bird distribution among marsh types in southeast Louisiana and observed the most avian species per site visit at fresh-intermediate marsh, followed by brackish and saline marsh. Therefore, freshwater marsh created and sustained by the Project would be expected to provide habitat for a diverse assemblage of migratory and resident birds. In addition, early and ongoing land accretion in the outfall area would create mudflats that could be used by multiple species (such as shorebirds) prior to the establishment of marsh vegetation. Although multiple species could use these mudflats, they would be particularly beneficial to female mottled ducks and their broods, which require wetlands with short emergent vegetation and mudflats that the ducklings can rest on (Hartke 2013). Conversely, the loss of wetlands in the birdfoot delta could impact terrestrial species that utilize marsh habitat.

Plant species diversity, and therefore habitat importance to waterfowl, increases with a decrease in salinity, such that fresh marshes are considered to be the most valuable marsh to most dabbling waterfowl, followed by intermediate and brackish marsh (GCJV 2002). As operations continue and the fresher marshes are re-established or maintained near the outfall, it is likely that many waterfowl populations, some colonial waterbird species, and other species that prefer fewer saline habitats (for example, alligators) would increase in the outfall area.

The anticipated benefits of increased marsh in the outfall area are supported by HSI models for the select species in coastal Louisiana. Habitat suitability nearest to the diversion structure (polygons 8 and 12) generally increases for ducks, with the HSI scores for the green-winged teal and mottled duck increasing by between 0.31 and 0.46 by 2070 (see Table 4.9-2), resulting in moderate, permanent, direct and indirect beneficial impacts on these species. These increased scores are likely based on the presence of land/emergent marsh, and shallower depths in areas of land accretion. Similar increases in habitat suitability scores in the outfall area are not projected for the gadwall, likely due to the decrease in open water areas that would be concurrent with the projected wetland gains; impacts on this species from habitat changes would likely be negligible. As wetland losses and increasing depths continue in other portions of the Project area, habitat suitability for the modeled ducks outside of the outfall area generally decreases or remains similar (+/- 0.1) to the No Action Alternative over time and space. As previously discussed, the HSI models are not inclusive of all factors that impact the modeled species. For example, SAV biomass is expected to increase in areas outside of the outfall area (see Section 4.10.4.1 in Aquatic Resources), which could increase available foraging habitat for ducks over that described by the HSIs. Further, although the gadwall is projected to have low habitat suitability for both the No Action Alternative and Applicant's Preferred Alternative, it is identified as one of the most prevalent wintering waterfowl species along the Louisiana coastline (Remsen et al. 2019), indicating that additional factors impact its habitat use.

Similar to the No Action Alternative, relatively suitable habitat for the alligator is projected to be present in the upper and upper-mid basin in 2020, and generally declines over time from continual impacts from sea-level rise and marsh loss reaching further north. Polygons 6, 7, 9, 10, 14, 17, 19, and 20 show relatively small changes from the No Action Alternative over time (less than 0.1; see Table 4.9-2). However, increases in habitat suitability compared to the No Action Alternative are larger (greater than 0.1 to 0.36) closer to the diversion structure (polygons 8, 11, and 12) in later decades, likely in response to changes in wetland vegetation. There are also gains (up to 0.40) in habitat suitability in the northern portion of the lower basin (polygons 13, 15, and 16) during the first few decades of operation, likely in response to the decreasing salinities, which are later partially counteracted by sea-level rise. Although most polygons would have low to moderate habitat suitability for alligators by 2070 (0.00 to 0.49), the retention of suitable habitat near the diversion structure (polygon 8, HSI = 0.76) would result in minor, permanent, beneficial, direct and indirect impacts on alligator populations in the Project area as compared to the No Action Alternative. Further, although alligator nests are subject to flooding events, females generally select nest sites in June or July, such that diversion flows would be already high or decreasing in a typical water year, thereby limiting the potential for nest flooding.

Table 4.9-2
HSI Scores for No Action Alternatives for Select Species and Polygons and Comparison of Operational Alternatives to the No Action Alternative

	Polygon[a]	2020	2030	2040	2050	2060	2070
Green-wing Teal							
No Action Alternative	5	0.80	0.77	0.69	0.54	0.34	0.19
	7	0.64	0.62	0.47	0.41	0.34	0.27
	8	0.59	0.56	0.49	0.40	0.32	0.27
	11	0.63	0.46	0.38	0.22	0.13	0.11
	12	0.58	0.51	0.36	0.26	0.13	0.11
	15	0.70	0.68	0.55	0.34	0.19	0.14
50,000 cfs – No Action	5	-0.01	-0.02	-0.05	-0.01	0.00	0.04
	7	0.00	-0.01	0.08	0.07	0.06	0.05
	8	0.09	0.13	0.21	0.35	0.40	0.44
	11	-0.09	0.08	0.00	-0.02	-0.01	0.00
	12	0.08	0.12	0.22	0.16	0.29	0.19
	15	-0.10	-0.10	-0.08	0.01	-0.02	0.02
75,000 cfs – No Action	5	-0.01	-0.03	-0.07	0.00	0.01	0.04
	7	0.00	-0.01	0.08	0.07	0.06	0.05
	8	0.09	0.13	0.22	0.37	0.43	0.46
	11	0.01	0.08	0.01	0.00	0.01	0.01
	12	0.07	0.13	0.27	0.37	0.43	0.31
	15	-0.10	-0.10	-0.09	-0.04	-0.02	-0.01
150,000 cfs – No Action	5	-0.02	-0.07	-0.12	0.05	0.13	0.17
	7	0.00	-0.02	0.07	0.10	0.10	0.10
	8	0.07	0.15	0.23	0.41	0.49	0.54
	11	0.00	0.12	0.11	0.18	0.16	0.14
	12	0.05	0.15	0.31	0.48	0.61	0.50
	15	-0.10	-0.11	-0.10	-0.05	-0.01	0.00
Mottled Duck							
No Action Alternative	5	0.87	0.86	0.84	0.69	0.48	0.30
	7	0.68	0.66	0.57	0.52	0.45	0.39
	8	0.72	0.66	0.60	0.52	0.43	0.37
	11	0.60	0.57	0.45	0.32	0.20	0.10
	12	0.70	0.61	0.50	0.34	0.24	0.13
	16	0.38	0.47	0.33	0.27	0.23	0.14

Table 4.9-2
HSI Scores for No Action Alternatives for Select Species and Polygons and Comparison of Operational Alternatives to the No Action Alternative

	Polygon[a]	2020	2030	2040	2050	2060	2070
50,000 cfs – No Action	5	0.00	0.00	-0.01	0.00	0.00	0.04
	7	0.00	0.00	0.06	0.05	0.05	0.04
	8	0.06	0.13	0.22	0.31	0.39	0.43
	11	0.03	0.07	0.08	0.04	0.03	0.01
	12	0.05	0.10	0.20	0.22	0.31	0.30
	16	0.12	0.00	0.10	0.07	0.01	0.01
75,000 cfs – No Action	5	0.00	-0.01	-0.02	0.00	0.01	0.05
	7	0.00	0.00	0.06	0.05	0.05	0.04
	8	0.06	0.14	0.22	0.33	0.41	0.45
	11	0.09	0.07	0.10	0.06	0.06	0.08
	12	0.05	0.13	0.24	0.38	0.43	0.43
	16	0.12	0.00	0.10	0.07	0.01	0.01
150,000 cfs – No Action	5	0.00	-0.03	-0.05	0.03	0.10	0.18
	7	0.00	0.01	0.07	0.08	0.10	0.11
	8	0.05	0.14	0.23	0.34	0.45	0.50
	11	0.09	0.10	0.18	0.22	0.24	0.28
	12	0.03	0.16	0.29	0.49	0.60	0.62
	16	0.12	0.02	0.12	0.07	0.02	0.02
Gadwall							
No Action Alternative	8	0.27	0.26	0.25	0.24	0.21	NA[b]
	9	0.22	0.22	0.22	0.21	0.19	NA[b]
	10	0.22	0.22	0.23	0.19	0.17	NA[b]
	11	0.20	0.25	0.19	0.17	0.13	NA[b]
	12	0.28	0.27	0.26	0.18	0.18	NA[b]
	16	0.10	0.16	0.10	0.09	0.13	NA[b]
50,000 cfs – No Action	8	-0.04	-0.02	0.00	0.02	0.05	NA[b]
	9	0.00	-0.03	-0.03	-0.03	-0.02	NA[b]
	10	0.00	-0.02	-0.02	0.05	0.05	NA[b]
	11	0.05	-0.02	0.02	0.05	0.04	NA[b]
	12	-0.04	-0.03	-0.01	0.10	0.05	NA[b]
	16	0.07	0.00	0.07	0.07	0.00	NA[b]
75,000 cfs – No Action	8	-0.04	-0.01	0.00	0.03	0.06	NA[b]
	9	0.00	-0.02	-0.03	-0.03	-0.02	NA[b]
	10	0.00	-0.02	-0.02	0.05	0.05	NA[b]
	11	0.02	-0.02	0.03	0.07	0.06	NA[b]
	12	-0.04	-0.02	-0.01	0.08	0.07	NA[b]

Table 4.9-2
HSI Scores for No Action Alternatives for Select Species and Polygons and Comparison of Operational Alternatives to the No Action Alternative

	Polygon[a]	2020	2030	2040	2050	2060	2070
	16	0.07	0.00	0.08	0.07	0.00	NA[b]
150,000 cfs – No Action	8	-0.03	-0.01	0.01	0.03	0.07	NA[b]
	9	-0.03	-0.02	-0.03	-0.03	-0.02	NA[b]
	10	-0.03	-0.02	-0.02	0.03	0.03	NA[b]
	11	0.03	-0.02	0.04	0.10	0.12	NA[b]
	12	-0.04	-0.02	-0.01	0.09	0.10	NA[b]
	16	0.07	0.05	0.12	0.07	0.03	NA[b]
Alligator							
No Action Alternative	8	0.83	0.77	0.68	0.58	0.47	0.39
	11	0.48	0.49	0.31	0.17	0.00	0.00
	12	0.69	0.61	0.45	0.24	0.15	0.00
	13	0.40	0.38	0.32	0.24	0.15	0.00
	15	0.56	0.55	0.44	0.28	0.18	0.12
	16	0.00	0.29	0.00	0.00	0.11	0.07
50,000 cfs – No Action	8	-0.06	0.00	0.10	0.24	0.29	0.32
	11	0.13	-0.01	0.06	0.08	0.13	0.00
	12	-0.04	0.00	0.11	0.26	0.24	0.36
	13	0.13	0.12	0.12	0.11	0.07	0.00
	15	0.19	0.16	0.14	0.04	0.06	0.03
	16	0.38	0.10	0.31	0.23	0.04	0.03
75,000 cfs – No Action	8	-0.07	0.00	0.13	0.27	0.36	0.36
	11	0.09	-0.01	0.07	0.09	0.14	0.11
	12	-0.05	0.02	0.16	0.34	0.35	0.49
	13	0.13	0.12	0.12	0.11	0.06	0.00
	15	0.20	0.16	0.14	0.11	0.06	0.07
	16	0.40	0.10	0.32	0.24	0.04	0.03
150,000 cfs – No Action	8	-0.11	0.01	0.15	0.35	0.43	0.53
	11	0.08	0.01	0.13	0.26	0.33	0.30
	12	-0.10	0.03	0.26	0.51	0.57	0.75
	13	0.14	0.12	0.12	0.12	0.06	0.10
	15	0.20	0.15	0.13	0.11	0.07	0.06
	16	0.42	0.19	0.40	0.25	0.08	0.05

[a] Selected polygons included the 6 polygons for each species with the most change when compared to the No Action Alternative.
[b] The year 2070 was not modeled for the gadwall.

Although the highest concentration of other reptiles and amphibians in the Barataria Basin occurs along natural ridges and levees, the second highest concentration is in areas adjacent to fresh and intermediate marshes. Most species of these herpetofauna are carnivorous or omnivorous and feed on smaller terrestrial and aquatic animals (Conner and Day 1987). Reduced habitat loss from the slowing of saltwater intrusion would result in permanent, major, beneficial impacts on these animals, but may have short- to long-term, minor, detrimental impacts on individuals in the immediate outfall area as initial freshwater input (flooding) modifies both the wetland vegetation coverage and diversity (see Section 4.6 Wetland Resources and Waters of the U.S.) and the localized food web. Conversely, there may be permanent, moderate to major adverse impacts on species that predominantly use higher salinity areas, such as the diamondback terrapin, as initial freshwater flows impact the species and then decrease their available habitat within the basin. Small mammals using wetland habitat, such as the swamp rabbit (common in all habitats except salt marsh), raccoon and mink (found throughout the basin), and muskrat (most common in brackish marsh), would likely experience similar impacts (Conner and Day 1987). Because outflow from the diversion structure would be constant upon commencement of operation (with flows of at least 5,000 cfs occurring year round), the fresher salinity regime in the immediate outfall area, as well as the vegetation regimes and food web, would likely achieve a new equilibrium within the first couple of years, at which point adverse impacts on most species would cease and the beneficial impacts would be realized.

4.9.4.2.3 Terrestrial Invasive Species

4.9.4.2.3.1 Terrestrial Invasive Plants

Operation of the Project would have a negligible impact on the spread of invasive plants in upland vegetation within the construction footprint, but could have a permanent, minor, adverse indirect impact on upland vegetation throughout the Barataria Basin. As discussed above (see Section 4.9.3.1), CPRA would seed and hydromulch bare ground disturbed during construction. Once the Project is operational, no new ground clearing would occur, although vegetation maintenance activities would occur at the diversion complex permanent right-of-way. Operation of the Project would therefore have a negligible impact on the spread of invasive plants in upland areas in the diversion complex right-of-way; however, diversion flows could potentially introduce or expand the seed source of invasive plant species such as Chinese tallow and privet, which could cause a minor increase the establishment of these invasive plants in upland areas such as interior ridges or spoil banks.

4.9.4.2.3.2 Terrestrial Invasive Animals

Operation of the Project would have permanent, minor, indirect, and adverse impacts on wildlife habitat from the potential spread of invasive animals. As discussed above (see Section 4.9.3.1), invasive species, such as birds, nutria, or feral hogs utilizing the terrestrial habitats would be permanently displaced from the operational footprint and would disperse into adjacent areas, potentially causing additional competition for those habitats with native wildlife. Although feral hogs do occur in wetland habitat, their populations are greatest in forested habitat, which would not be established by operation of the Project (LSU Ag Center 2018b). Although feral hogs have been noted to damage levee systems, and projected increases in water levels in portions of the mid/southern basin and outside the federal levee system (see Section 4.4.4.2.2.2 in Surface Water and Coastal Processes) may result in less habitat in these areas, the forested lands (including wetlands) that are preferred by feral hogs are predominantly located in areas where increased water levels are not expected (see Figures 3.6-1 and 3.18-1 in Chapter 3); therefore, increased water levels from the diversion are not expected to appreciably increase feral hog use of and damage to levees in the proposed Project area.

The anticipated Project-related land accretion and vegetation establishment could lead to population increases in nutria, which would be detrimental to the establishment rate of new vegetated wetlands. However, with the protocols being implemented to decrease the expansion of nutria (see Chapter 3, Section 3.9.4 in Terrestrial Wildlife and Habitat), its spread is anticipated to be limited to minor levels.

4.9.4.3 Other Action Alternatives

During operations, each alternative is expected to result in variable land gains that would create additional wetland habitat to support wildlife. These wetland gains would benefit wildlife that are dependent on wetland vegetation, as well as wildlife that use both wetland and upland habitats, although the degree would vary. A summary of the changes in wetland area in the Barataria Basin is presented in Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-3, and is summarized for each alternative below. Table 4.9-2 shows the HSI scores for select polygons under the No Action Alternative, along with the absolute difference in HSI score between the No Action Alternative and the 50,000 cfs Alternative, the Applicant's Preferred Alternative (75,000 cfs), and the 150,000 cfs Alternative. A comparison of the action alternatives' operational impacts on terrestrial wildlife is summarized below. No changes in impacts on fully terrestrial wildlife (those species that do not use wetlands) or upland wildlife habitat is anticipated between the other action alternatives and, as such, the discussions below focus on the change in emergent wetlands from the No Action Alternative and how those changes may result in differences on wildlife.

4.9.4.3.1 50,000 cfs Alternative

Operation of the 50,000 cfs Alternative would result in an increase of about 9,240 acres of total vegetated wetland area within the Barataria Basin over the No Action Alternative in year 2070 (see Section 4.6 Wetlands and Waters of the U.S., Table 4.6-4), resulting in direct and indirect, minor to major, beneficial, and permanent impacts on wetland creation, and the wildlife that use wetlands as habitat. Conversely, the birdfoot delta would experience an additional projected loss of 2,721 acres of wetland cover by 2070 when compared with the No Action Alternative (see Section 4.6 Wetlands and Waters of the U.S., Figures 4.6-15 and 4.6-18), representing moderate, permanent, adverse impacts.

Modeled impacts on the habitat suitability of green-winged teals, mottled ducks, and alligators would be similar to that described for the Applicant's Preferred Alternative, although the increases in habitat suitability would be slightly less pronounced, resulting in moderate, permanent, direct and indirect beneficial impacts on these species compared to the No Action Alternative. Impacts on the gadwall are projected to be negligible due to the slight changes in habitat suitability in the Project area.

4.9.4.3.2 150,000 cfs Alternative

Operation of the 150,000 cfs Alternative would result in an increase of about 25,800 acres of total vegetated wetland area within the Barataria Basin over the No Action Alternative in year 2070 (see Section 4.6 Wetlands and Waters of the U.S., Table 4.6-4), resulting in direct and indirect, minor to major, beneficial, and permanent impacts on wetland creation, and the wildlife that use wetlands as habitat. Conversely, the birdfoot delta would experience an additional projected loss of 2,698 acres of wetland cover by 2070 when compared with the No Action Alternative (see Section 4.6, Figures 4.6-15 and 4.6-18), representing moderate, permanent, adverse impacts.

Modeled impacts on the habitat suitability of green-winged teals, mottled ducks, and alligators would be similar to that described for the Applicant's Preferred Alternative, although the increases in habitat suitability would be slightly more pronounced. The additional gains for these species are most pronounced in polygon 12, where habitat suitability projected in 2070 would be higher than that projected in 2020 for the No Action Alternative, and substantially higher than that predicted for the No Action Alternative in 2070 (see Table 4.9-2). These additional gains in habitat suitability would likely result in moderate to major, permanent, beneficial, direct and indirect impacts on the green-winged teal, mottled duck, and alligator given the additional high-value habitat projected to be present in polygon 12. Although habitat suitability for the gadwall also increases incrementally, the impacts on the gadwall are projected to be negligible due to the relatively low overall habitat suitability in the Project area.

4.9.4.3.3 Terrace Alternatives

As discussed in Section 4.6.5.1 Wetlands and Waters of the U.S. and Table 4.6-3, the terrace alternatives would result in an increase in wetland acreages compared to the alternatives without terraces; for example, an additional 443 acres would be created in the Barataria Basin under the 75,000 cfs + Terraces alternative as compared to the Applicant's Preferred Alternative. However, these incremental changes in wetland acreages would not result in appreciable changes to wildlife or wildlife habitat. Therefore, as compared to the No Action Alternative, impacts from each of the three terrace alternatives would be the same as the impacts of each alternative of the same capacity without terraces.

4.9.5 Summary of Potential Impacts

Table 4.9-3 summarizes the potential impacts on terrestrial wildlife and vegetation for each alternative. Details are provided in Sections 4.9.1 through 4.9.4 above.

Table 4.9-3
Summary of Potential Impacts on Terrestrial Wildlife and Habitat from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on terrestrial wildlife or vegetation from construction of the Project would occur.
Operational Impacts	• Major, permanent, adverse, direct and indirect impacts on terrestrial wildlife due to the continued loss or conversion of wetlands in the Barataria Basin and birdfoot delta. • Minor to moderate, short-term to permanent, adverse impacts on upland vegetation due to decreased presence of wetlands and storm surge protection. • Major, permanent, direct and indirect, adverse impacts on modeled species (green-winged teal, mottled duck, and alligator) from a projected decrease in habitat suitability; negligible to minor permanent, direct and indirect, adverse impact on gadwall from changes in habitat suitability.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Minor to moderate, temporary to permanent, adverse, direct and indirect impacts on upland vegetation due to clearing associated with Project construction. • Negligible to moderate, temporary to permanent, direct and indirect, adverse impacts on wildlife from habitat clearing and construction disturbance. • Minor, short-term, indirect, and adverse impacts on wildlife from the potential spread of invasive plants and animals.
Operational Impacts	• Permanent, moderate, beneficial impacts on upland vegetation from increased wetlands and related protection from overwash. • Negligible to minor, permanent, direct and indirect, adverse impacts on terrestrial species from operational noise and lighting, and potential impacts on migration/ movement. • Minor to major, permanent, direct and indirect, beneficial and adverse impacts on wildlife using wetland habitat from the creation of about 12,700 acres of wetland in the basin by year 2070. • Moderate, permanent, adverse impacts on wildlife in the birdfoot delta through the loss of wetlands by year 2070. • Minor to moderate, permanent, direct and indirect, beneficial impacts on green-winged teal, mottled duck, and alligators from increased habitat suitability in the immediate outfall area; negligible impacts on the gadwall due to overall low habitat suitability in the Project area. • Major, permanent, direct and indirect, beneficial impacts on reptiles and amphibians from curtailed saltwater intrusion, but short- to long-term, minor, adverse impacts in the immediate outfall area at initial start-up of the Project. • Moderate to major, permanent, direct and indirect, adverse impacts on species that predominantly use higher salinity marsh. • Negligible to minor, permanent, indirect, and adverse impacts on upland vegetation from the potential spread of invasive plants and animals. • Minor, permanent, indirect, adverse impacts on wildlife and wildlife habitat from the potential spread of invasive plants and animals.

Table 4.9-3
Summary of Potential Impacts on Terrestrial Wildlife and Habitat from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
50,000 cfs Alternative	
Construction Impacts	• Minor to moderate, temporary to permanent, adverse, direct and indirect impacts on upland vegetation due to clearing associated with Project construction. • Minor to moderate, temporary to permanent, direct and indirect, adverse impacts on wildlife from habitat clearing and construction disturbance. • Minor, short-term, indirect, and adverse impacts on wildlife from the potential spread of invasive plants and animals.
Operational Impacts	• Negligible to moderate, permanent, direct and indirect, adverse impacts on upland vegetation and wildlife from habitat conversion and operational activities. • Major, permanent, direct and indirect, beneficial impacts on reptiles and amphibians from curtailed saltwater intrusion, but short- to long-term, minor, adverse impacts in the immediate outfall area at initial start-up of the Project. • Minor to major, permanent, direct and indirect, beneficial impacts on wildlife using wetland habitat from the creation of about 9,240 acres of wetland in the basin by year 2070. • Moderate, permanent, adverse impacts on wildlife in the birdfoot delta through the loss of 2,721 acres of wetlands by year 2070. • Moderate, permanent, direct and indirect, beneficial impacts on green-winged teal, mottled duck, and alligators from increased habitat suitability in the immediate outfall area; negligible impacts on the gadwall due to overall low habitat suitability in the Project area. Negligible, short-term, indirect, and adverse impacts on upland vegetation from the potential spread of invasive plants and animals.
150,000 cfs Alternative	
Construction Impacts	• Minor to moderate, temporary to permanent, adverse, direct and indirect impacts on upland vegetation due to clearing associated with Project construction. • Minor to moderate, temporary to permanent, direct and indirect, adverse impacts on wildlife from habitat clearing and construction disturbance. • Minor, short-term, indirect, and adverse impacts on wildlife from the potential spread of invasive plants and animals.
Operational Impacts	• Negligible to moderate, permanent, direct and indirect, adverse impacts on upland vegetation and wildlife from habitat conversion and operational activities. • Minor to major, permanent, direct and indirect, beneficial impacts on reptiles and amphibians from curtailed saltwater intrusion, but short- to long-term, minor, adverse impacts in the immediate outfall area at initial start-up of the Project. • Minor to major, permanent, direct and indirect, beneficial impacts on wildlife using wetland habitat from the creation of about 25,800 acres of wetland in the basin by year 2070. • Moderate, permanent, adverse impacts on wildlife in the birdfoot delta through the loss of 2,698 acres of wetlands by year 2070. • Moderate to major, permanent, direct and indirect, beneficial impacts on green-winged teal, mottled duck, and alligators from increased habitat suitability in the immediate outfall area; negligible impacts on the gadwall due to overall low habitat suitability in the Project area.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, construction of the three terrace alternatives would have substantially similar impacts on terrestrial wildlife species and habitat as the corresponding flow capacity alternatives without terraces listed above. • Any additional impacts on terrestrial wildlife and habitat due to the construction of terraces would be negligible.

Table 4.9-3
Summary of Potential Impacts on Terrestrial Wildlife and Habitat from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• As compared to the No Action Alternative, impacts from each of the three terrace alternatives would be substantially similar to the impacts anticipated under the corresponding flow capacity alternatives without terraces listed above. • The incremental addition of wetland acreage in the Project area due to the presence of terraces would not result in appreciable differences to wildlife and wildlife habitat as compared to the corresponding flow capacity alternatives without terraces.

4.10 AQUATIC RESOURCES

4.10.1 Area of Potential Impacts

Direct impacts on aquatic resources during construction would occur within estuarine or fresh water overlapping active construction or beneficial use areas. Indirect impacts (that is, those that occur later in time or that are farther removed from Project-related activities) would occur in a larger area that would be dependent on the specific pathway for impacts. For example, benthic habitat would be directly affected (altered or removed) by dredging within the aquatic portion of the construction footprint, whereas suspended sediments resulting from dredging would be transported with currents, indirectly affecting additional benthic habitat at locations outside of the construction footprint. Construction-related indirect impacts outside the construction footprint would generally be related to turbidity, sedimentation, and noise, and would extend to different distances based on sediment characteristics, currents, and factors affecting sound propagation.

During operations, direct impacts would occur from the presence of the diversion and auxiliary structures in estuarine and fresh water, as well as from the movement of water, nutrients, and sediment from the Mississippi River to the Barataria Basin. Direct impacts on aquatic resources would also occur if organisms are directly affected by the fresh water and sediment entering the basin, either beneficially or adversely. In general, direct impacts would be considered to be those that have immediate impacts on aquatic organisms, causing them to move away from, or into, an area (for example, salinity or temperature changes) or causing a physiological impact (for example, reduced fitness/growth rate/reproductive success). The area of direct impact would change each year, depending on the volume and duration of diverted water and sediment. Indirect impacts would occur on species within, and outside of, the outfall area as the habitat and food web dynamics change over time and fauna enter or leave the altered habitat over time; these impacts would likely extend across the entire Project area, including the Barataria Basin and the birdfoot delta.

4.10.2 Guidelines for Aquatic Resource Impact Determinations

Impact intensities for aquatic resources are based on the definitions provided in Section 4.1 and the following aquatic resource-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on aquatic resources would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: impacts could be detectable and localized but small. Disturbance of individual species could occur; however, there could be no change in the

diversity[63] or local populations of marine and estuarine species. Any disturbance could not interfere with key behaviors such as feeding and spawning. There could be no restriction of movements daily or seasonally. Opportunity for increased spread of nonnative species could be detectable but temporary and localized and these species could not displace native species populations and distributions;

- moderate: impacts could be readily apparent and result in a change in marine and estuarine species populations in local and adjacent areas. Areas being disturbed may display a change in species diversity; however, overall populations could not be altered. Some key behaviors could be affected but not to the extent that species viability is affected. Some movements could be restricted seasonally. Opportunity for increased spread of nonnative species could be detectable and limited to local and adjacent areas, but could only result in temporary impacts on native species population and distributions; and

- major: impacts could be readily apparent and could substantially change marine and estuarine species populations over a wide-scale area, possibly river-basin-wide. Disturbances could result in a decrease in fish species diversity and populations. The viability of some species could be affected. Species movements could be seasonally constrained or eliminated. Actions could result in the widespread increase of nonnative species resulting in broad and permanent impacts on native species populations and distributions.

4.10.3 Construction Impacts

4.10.3.1 Submerged Aquatic Vegetation

4.10.3.1.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from construction would occur. The Project area would continue to provide suitable habitat for SAV until or unless habitat characteristics were otherwise modified. Only limited impacts on SAV due to ongoing trends of sea-level rise are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the area, it is predictable that at some future point the area of the proposed diversion complex may be developed for industrial or commercial purposes that could have some impact on SAV. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development

[63] The measure of species richness (number of different species) and evenness (relative abundance of each species).

would be required to comply with applicable local, state, and federal environmental standards.

4.10.3.1.2 Applicant's Preferred Alternative

As discussed in Chapter 3, Section 3.10.2 Aquatic Vegetation in Aquatic Resources, 14 species of SAV have been identified within coastal areas of the northern Gulf of Mexico, including fresh, brackish, and marine species (Hillmann et al. 2016a). No seagrasses (for example, turtlegrass [*T. testudinum*]) are present in the Project area. Although SAV generally has high inter-annual variability, USGS analysis of remote sensing imagery collected between 2015 and 2018 indicates the likely presence of SAV within the open-water portion of the construction footprint, which would be directly affected by construction activities (see Figure 4.10-1). Because mapping of SAV distribution using such data is difficult given limited water clarity in the shallow coastal waters of Louisiana (DeMarco et al. 2018), the spatial coverage of SAV shown in Figure 4.10-1 is approximate, but considered a reasonable estimate. Based on average salinities in the vicinity of the diversion complex (see Chapter 3, Section 3.5 Surface Water and Sediment Quality, Figure 3.5-5), affected SAV within the construction footprint would be limited to species that are capable of growing in fresh to brackish environments of less than 10 ppt.

Depending on the specific action occurring, SAV may either be lost (removed or covered during Project installation) or would be adversely impacted by the turbidity and sedimentation caused by construction activities. For example, dredged material placement in proposed beneficial use areas would smother any SAV present. Construction of the outfall transition feature, an access route, and placement of riprap would also involve removal or replacement of SAV habitat. The SAV present within the beneficial use areas and outfall transition feature footprint is not currently known, so the acreage of this direct, permanent, and adverse impact on SAV cannot be estimated. However, because the above-referenced USGS analysis indicates the likely presence of SAV throughout open-water areas within the Project area, this direct impact is expected to be minor.

SAV could be adversely impacted by land- and water-based construction activities through soil erosion, sediment disturbance, and accidental spills. Soil erosion and sediment disruption would cause turbidity which, although temporary, reduces light penetration into the water column and therefore the depth at which primary productivity occurs. The resultant sedimentation could result in mounds of deposited sediment that are then prone to resuspension, extending impacts on light availability. Accidental spills of hazardous materials into the water could smother or contaminate SAV, and could also cause reduced light penetration into the water column (Handley, Altsman, and DeMay 2007).

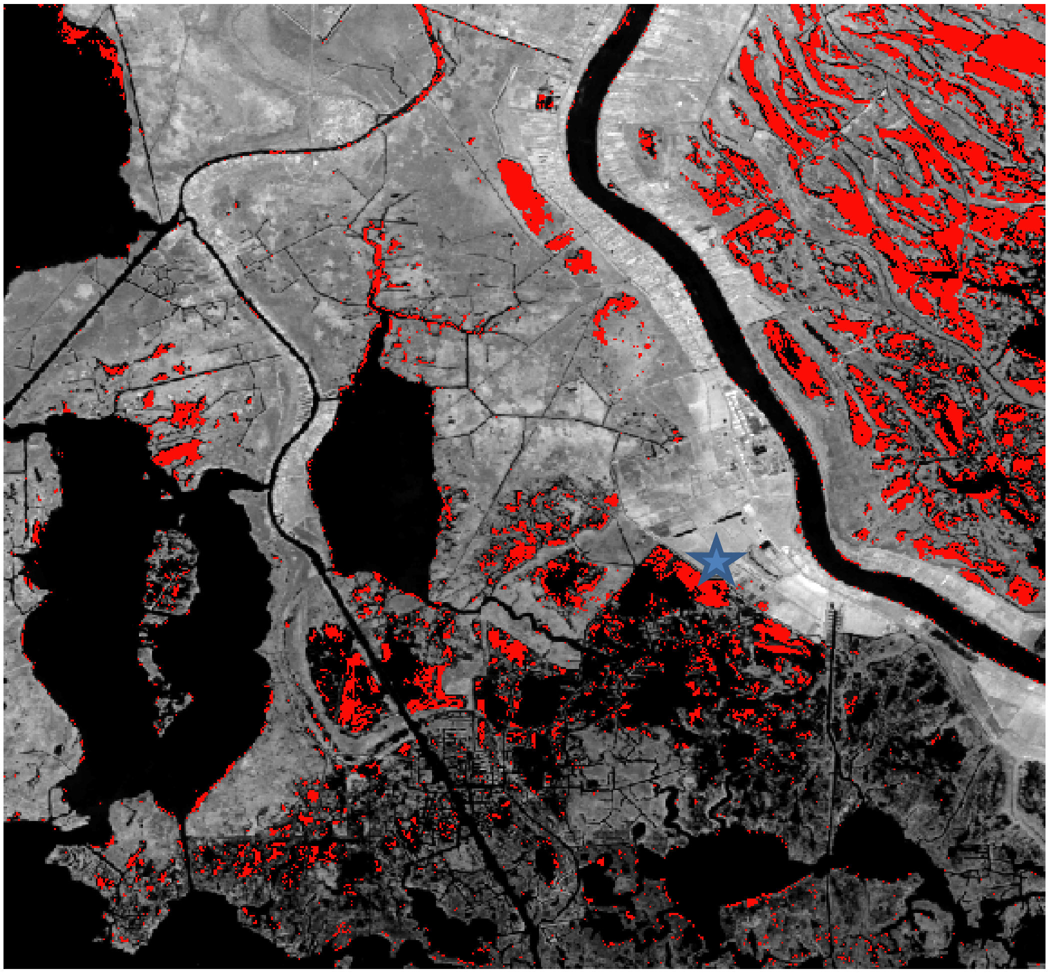


Figure 4.10-1. Estimated SAV Coverage in the Project Outfall Area Based on Analysis of Remotely Sensed Aerial Data. Areas in red are identified as containing SAV in this layer during the 2015 to 2018 observation period. The blue star indicates the general location of the diversion structure.

The amount of time that sediment remains suspended depends on local currents and sediment grain sizes, with larger grain sizes (for example, gravel, sands) resettling relatively quickly and smaller grain sizes (for example, silts and clays) traveling farther before settling; sediments in the mid-basin have been identified as predominantly smaller grain-sized particles (silt and clay; see Chapter 3, Section 3.2.1.2 Existing Conditions in Geology and Soils). SAV closest to areas of excavation or sediment placement would be most affected by turbidity and sedimentation, with impacts decreasing with increasing distance from these activities as the sediments settle out. To minimize impacts on SAV from turbidity and contamination during construction, CPRA would adhere to Project-specific preventative plans (SPCC Plan and SWPPP), and contain runoff and discharge of pollutants with containment dikes or other means of erosion and pollution control both on land and in water construction zones. See Section 4.5 Surface Water and Sediment Quality for further discussion about potential Project impacts on water quality.

Overall, given the limited timeframe for construction and the small portion of SAV habitat within the construction footprint, direct and indirect impacts on SAV during construction would be temporary to permanent, minor, and adverse.

4.10.3.1.3 Other Alternatives

Direct and indirect impacts on SAV due to the construction of the other five action alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion structure would have the same proposed features. Although the width of the conveyance channel bottom and intake channel would be narrower for the 50,000 cfs Alternative (164 and 93 feet wide, respectively) and wider for the 150,000 cfs Alternative (630 and 300 feet wide, respectively) as compared to the Applicant's Preferred Alternative (300 and 194 feet wide, respectively), there would be a similar overall construction footprint between the different capacity alternatives, and therefore would have similar direct and indirect impacts on SAV during construction as the Applicant's Preferred Alternative, which would be temporary to permanent, minor, and adverse.

Three of the action alternatives propose the construction of terraces, which would build up specific areas adjacent to the diversion to an elevation of +4.8 feet (see Figure 2.8-1 in Chapter 2). Dredging for the material to build the terraces would take place immediately adjacent to the terraces, resulting in turbidity and sedimentation, as discussed above for the Applicant's Preferred Alternative. Placement of this dredged material would smother existing SAV, if present within the 80- to 90-acre footprint of the terraces and adjacent dredged areas, and would preclude the growth of SAV under the terrace footprints after construction is complete. Potential longer-term benefits of terraces for promoting SAV growth between the terrace structures are discussed in Section 4.10.4.1. Impacts on SAV from terraces would be minor, temporary to permanent, and adverse given the expected area of suspended solids and excavated materials placement.

4.10.3.2 Benthic Resources

Benthic resources of the Barataria Basin described in this section include benthic algae, infauna (live in the sediment), and epifauna (live on top of the sediment). Section 4.10.3.4 identifies impacts on larger aquatic fauna, including benthic macrofauna such as penaeid shrimp and blue crab.

4.10.3.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from construction would occur. In consideration of current and planned developments in the area, it is predictable that at some future point, the area of the proposed diversion complex may be developed for industrial or commercial purposes that may affect benthic resources in aquatic environments. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal environmental standards.

4.10.3.2.2 Applicant's Preferred Alternative

As discussed in Chapter 3, Section 3.10.3 Benthic Resources in Aquatic Resources, benthic resources include infauna, epifauna, and algae. Most benthic infauna live in the top 3.9 inches of the seabed and must maintain some connection to the sediment/water interface for ventilation and feeding (Miller at al. 2002). Increases in sedimentation and turbidity can decrease available sunlight (limiting the production or growth of algae, macrophytes, and natural vegetation), transfer contaminants to new environments, bury benthic infauna and epifauna, cause detrimental impacts on suspension feeders, and/or cause sediment hypoxia or anoxia (if diffusion of oxygen through sediments by tube-builders is precluded) (Miller et al. 2002, TCEP 2019).

Following sedimentation events, benthic community recovery can occur by planktonic larval recruitment (taking weeks to years), lateral migration of juveniles/adults from adjacent areas (taking days to weeks), or vertical migration through the deposited materials (Bolam 2011). The potential depth of vertical migration varies by species and sediment composition but has been identified at as little as 2.4 inches for certain polychaetes to as much as 11.8 inches in general for burrowing polychaetes, amphipods, and mollusks (Wilber et al. 2008, Bolam 2011). General benthic succession indicates that after impact to a benthic community, opportunistic pioneering (Stage I) species such as tube-dwelling polychaetes and small bivalves colonize surficial sediments in relatively high abundance but low diversity. Stage I species are later replaced by Stage II species, which are larger, longer-lived, and deeper-burrowing species. And finally, the Stage III assemblage comprises a more diverse but less abundant group of larger taxa (Wilber et al. 2008).

Construction of the diversion structure and dredging/dredge placement activities would affect approximately 682 acres of open water, most of which would be in the estuarine environment. Direct impacts on benthic resources would occur as a result of the removal or disturbance of benthic habitat. This includes about 375 acres of benthic habitat that would be modified by the placement of dredged/excavated materials in beneficial use sites, which would raise the elevation from shallow waters to a target elevation of +2.0 feet. About 243 acres of emergent wetlands would also be affected during construction (including 69 acres in the beneficial use areas; see Table 4.6-1). Any non- or less-mobile biological resources in the footprint of the diversion structure or beneficial use areas would be lost during construction and the habitat removed or altered for the analysis period, constituting a direct, permanent, and adverse, but minor impact given the abundance of benthic habitat available in the Project area. Disturbed benthic communities adjacent to the diversion structure that would be affected by dredging or dredge placement would generally be expected to return to background levels within 3 months to 2.5 years following construction, resulting in direct, moderate (readily apparent but localized) and adverse, short-term impacts as recolonization occurs (Brooks et al. 2004, Wilber et al. 2008). Mobile organisms displaced during construction would be expected to return following construction, resulting in a direct, temporary, adverse, and negligible impact on these species. However, as discussed in Section 4.10.4.2, those areas that are affected by operation of the diversion would be subject to continual impacts and the habitats and species assemblages may shift to communities adapted to the new abiotic and biotic conditions and not return to preconstruction community structure.

Construction of the diversion complex would result in an increase in turbidity and sedimentation adjacent to the construction footprint; however, this impact is expected to be localized and limited to the time of construction activity. Accidental spills into the Barataria Basin during land-based construction could also have an adverse impact on benthic resources. As discussed above for SAV, benthos closest to areas of excavation or sediment placement would be most affected by turbidity and sedimentation, but impacts would decrease with increasing distance from construction as the sediments settle out, covering only a small area relative to the total habitat available. To minimize impacts on benthic resources from turbidity and contamination during construction, CPRA would adhere to a Project-specific SPCC Plan and SWPPP, and contain runoff and discharge of pollutants with containment dikes. See Section 4.5 Surface Water and Sediment Quality for further discussion about potential Project impacts on water quality. Overall, the increased turbidity and sedimentation is considered a direct, short-term and negligible impact given the abundance of locally available soft bottom and water column habitat.

4.10.3.2.3 Other Alternatives

Direct and indirect impacts on the benthic community due to construction of the other five action alternatives would be similar to those described above because there would be a similar overall construction footprint of the diversion structures between the alternatives; however, alternatives that include terrace construction would have a slightly greater spatial extent of impacts. Three of the action alternatives propose the construction of terraces in specific areas adjacent to the diversion to an elevation of +4.8 feet, which would require the dredging of borrow material from the areas immediately adjacent to each terrace footprint. This dredging would disturb benthic communities adjacent to the terraces through direct removal, which would generally be expected to return to background levels within the 3 months to 2.5 years following construction, resulting in moderate and adverse, but short-term direct impacts. However, as described above for the Applicant’s Preferred Alternative and in Section 4.10.4.2, these areas of direct removal would be subject to continual impacts throughout the Project life, and the habitats and species assemblages may shift to communities adapted to the new abiotic and biotic conditions and not return to preconstruction community structure.

Mobile organisms that are displaced during construction are expected to return following construction, resulting in a temporary, adverse, and negligible direct impact on these species. Placement of this dredged material would cover existing benthos, likely resulting in the loss of the benthic community in the footprint of the terraces and impacts associated with turbidity and sedimentation immediately adjacent to the terraces, resulting in a short-term to permanent, moderate and adverse direct and indirect impacts. However, benefits from marsh creation may be realized over time during Project operation (see Section 4.10.4.4).

4.10.3.3 Essential Fish Habitat

4.10.3.3.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from construction would occur. Sea-level rise would continue to reduce the amount of emergent marsh habitat in the Project area during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes could have some impact on EFH. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal environmental standards.

4.10.3.3.2 Applicant's Preferred Alternative

EFH consultation is required for federal actions that may adversely impact EFH, which includes all types of aquatic habitat, as described in Chapter 3. Adverse impacts on EFH are defined as any reduction in quantity or quality of EFH and may include direct or indirect physical, chemical, or biological alterations of the water or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. In parallel with the preparation of this EIS, consultation with the NMFS Southeast Regional Office, Habitat Conservation Division in accordance with the MSFCMA is being undertaken to assess potential impacts on EFH.

Estuarine waters in the Project area include EFH for life stages of eight managed species as shown in Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-2. The areas of EFH in the construction area are emergent marsh, SAV, and water column, with a larger component of soft bottom habitat used by managed species. Activities with the potential to impact EFH for these managed groups during construction include direct dredging/excavation, placement of riprap and dredged sediments, and permanent removal, of approximately 925 acres of habitat, of which most would be benthic (soft bottom) habitat with interspersed SAV and emergent marsh. Dredging would result in indirect, temporary impacts on EFH and managed species through increased turbidity and sedimentation, which would likely displace mobile species and possibly bury benthic infaunal or epifaunal organisms that are prey for many managed species. The three beneficial use sites in the immediate outfall area for the placement of excess dredged/excavated materials would result in a target marsh elevation of +2.0 feet MLLW; if this elevation is achieved, fauna would lose direct access to the aquatic habitat (EFH); however, benefits from marsh creation may be realized over time during

Project operation (see Section 4.10.4.4). Other indirect impacts on EFH would include soil erosion and accidental spills into the Barataria Basin during land-based construction. Actions would be taken to avoid, minimize, or contain potential contaminants and erosion during construction, including adhering to a Project-specific SPCC Plan and SWPPP. See Section 4.5 Surface Water and Sediment Quality for further discussion about potential Project impacts on water quality. Overall, construction of the Project would result in temporary to permanent, negligible to minor, adverse, direct and indirect impacts on EFH and the species and life stages of managed species that use EFH through the alteration of habitat and the mortality or displacement of individuals.

4.10.3.3.3 Other Alternatives

Direct and indirect impacts on EFH due to the construction of the other five action alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion structure would have a similar overall construction footprint. However, three of the action alternatives propose the construction of terraces, which would build up specific areas adjacent to the diversion to an elevation of +4.8 feet and, combined with the adjacent excavated areas, would have a footprint of approximately 80 to 90 acres, which would result in the initial smothering of SAV and benthic resources present in the footprint of the terraces. Potential longer-term benefits of terraces for promoting SAV and emergent marsh growth are discussed in Section 4.10.4.1. Overall, construction of the action alternatives would result in temporary to permanent, negligible to minor, adverse, direct and indirect impacts on EFH, similar to the Applicant's Preferred Alternative, with the terraced alternatives having a slightly greater impact due to the additional 80 to 90 acres of dredging and dredge placement.

4.10.3.4 Aquatic Fauna and General Habitat

4.10.3.4.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from construction would occur. Only limited impacts on fauna and habitat due to ongoing trends of sea-level rise and marsh loss are expected during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have some impact on aquatic fauna. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal environmental standards.

4.10.3.4.2 Applicant's Preferred Alternative

Impacts on fauna during construction would likely be caused by disturbance of habitats/organisms, increased turbidity and sedimentation, entrapment within construction areas, loss of overwater shading structure, and noise from pile driving. Impacts on threatened and endangered aquatic species are discussed in Section 4.12 Threatened and Endangered Species.

Direct disturbance on fauna would occur within the 925 acres of open water and emergent herbaceous wetlands in the construction footprint for the diversion complex and associated features (see Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-1). Fauna in these areas would be temporarily displaced (if mobile) from the construction area or lost (if non- or less-mobile) within the construction footprint as dredging and structural placement occurs. In addition to the diversion structure, and as discussed in Section 4.2 Geology and Soils, three beneficial use sites would be used in the estuarine immediate outfall area for the placement of excess dredged/excavated materials from construction of the diversion structure, resulting in a target marsh elevation of +2.0 feet MLLW; if this elevation is achieved, fauna would lose direct access to the aquatic habitat; however, benefits from marsh creation may be realized over time during Project operation (see Section 4.10.4.4). Based on the lack of oyster leases and the relatively unsuitable habitat within the construction footprint (see Figures 4.10-6 and 4.10-15 [year 2020]), oysters are not anticipated to occur within the construction footprint.

As discussed in Section 4.5 Surface Water and Sediment Quality, temporary, minor or moderate, and adverse construction impacts on water quality would result from the resuspension of fine sediments into the water column from in-water activities at the diversion structure, placement of materials in the beneficial use areas, or runoff of sediment from adjacent work zones, resulting in increased turbidity and TSS. Increases in turbidity and TSS, which would occur throughout in-water construction activities, would result in minor (due to the localized area of impact), temporary, and adverse indirect impacts on fauna through a variety of avenues, including, but not limited to, reduction of available DO, reduction in swimming performance, physical abrasion (including gill trauma), and increase in water temperature (Kjelland et al. 2015). Changes within the water column could also result in temporary disruption of predator-prey interactions. Further, disturbance of existing habitats could allow for the invasion or expansion of aquatic invasive species; these potential impacts are discussed in Section 4.10.3.5.

Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) within the construction footprint and its vicinity, which could migrate into adjacent aquatic habitat, causing adverse, but temporary and negligible indirect impacts on fauna. Actions would be taken to avoid, minimize, or contain potential contaminants and erosion during construction, including adhering to a Project-specific SPCC Plan and SWPPP. See Section 4.5 Surface Water and Sediment Quality for further discussion about potential Project impacts on water quality.

Entrapment of aquatic fauna could occur if they are enclosed within areas of construction without an escape route; however, the diversion structure would predominantly be excavated over terrestrial habitat, where aquatic fauna do not occur. A portion of the Mississippi River would initially be enclosed by a cofferdam, and subsequently dewatered to allow construction “in-the-dry.” Fauna entrapped within the dewatered area would be lost and the habitat removed for the duration of cofferdam use (about 3.5 years), resulting in a minor, adverse, direct, and short-term impact.

Removal of vegetation overhanging aquatic areas would reduce habitat shading, increasing the sunlight and temperature in previously shaded areas, and can allow for increased erosion and pollution into a waterway (Stark et al. 2000, Cunningham et al. 2016). Loss of streambank vegetation also coincides with the loss of food and structure for aquatic species (Cunningham et al. 2016). Although a forested riparian strip is present on the river side of the proposed diversion site, tree-clearing would be limited to an area about 0.4-mile-long and 50- to 250-feet-wide (about 6.6 acres); given the width and length of the Mississippi River, loss of this riparian strip is anticipated to result in an indirect, permanent, adverse, but minor, impact on fauna from habitat shading, loss of food, and loss of structure.

Sound can have both physical and behavioral impacts on fish. Fish produce and use sounds in a variety of behaviors, including reproduction, protection of territory, and aggression, and are able to detect a range of frequencies (Hastings and Popper 2005). Studies have shown that the sound waves from pile driving may result in injury or trauma to fish and other animals with gas filled cavities, such as swim bladders, lungs, sinuses, and hearing structures, and may result in mortality (Popper and Hastings 2009, Hastings and Popper 2005). Other impacts of exposure to continuous and impulsive sounds may include damage to the ear, startle responses, avoidance, or lack of responsiveness to biologically relevant sounds due to masking (Hastings and Popper 2005). The literature on acoustic impacts on fish is scant; however, NMFS does often adopt the dual thresholds for which injury could occur: 206 dB PK or 187 dB cumulative sound exposure level (SEL_{cum}) for fishes 2 grams or larger or 183 dB SEL_{cum} for fishes smaller than 2 grams; these values are identified for sturgeon and salmon but are also used as a proxy for fish species in general. Sub-injury or adverse behavioral responses could occur when fish are exposed to sound levels at or exceeding 150 dB re 1µPa RMS (NMFS 2018b) (see Table 4.10-1).

Table 4.10-1
Acoustic Thresholds for Fish[a]

Pile-Driving Activity or Effect Level	Cumulative Sound Exposure Level (SEL_{cum}) (dB re 1 μPa^2s)	Root Mean Square Sound Level (dB RMS) (dB re 1 μPA)	PK (flat) (dB re 1 μPA)[b]
Injury Onset (all sizes)	--	--	206
Injury Onset (≥2 grams)	187	--	--
Injury Onset (<2 grams)	183	--	--
Behavioral Effects	--	150	--

Source: NMFS 2020e

[a] Effects thresholds for fishes were identified for sturgeon and salmon but are also used as a proxy for fish species in general (NMFS 2020e).

[b] The script "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The script associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (low-, mid-, and high-frequency cetaceans; phocid pinnipeds; and otariid pinnipeds) and the recommended accumulation period is 24 hours.

Underwater noise would be generated during pile driving, dredging, and vessel use associated with the Project that could affect riverine and marine fishes. By using a practical spreading transmission loss constant (15logR) to account for noise attenuation, a ZOI (the area in which sound levels exceed a threshold) was identified for anticipated in-water activities on fish. Table 4.10-2 identifies the distance at which applicable sound levels from these activities would attenuate to the effects levels described in Table 4.10-1.

As shown in Table 4.10-2, noise-producing construction activities would exceed the threshold for adverse behavioral effects up to 705 feet from the source, but would not exceed the injury threshold for a significant distance; therefore, impacts on fish in the Barataria Basin from noise would be minor, indirect, adverse, and temporary. Impact pile driving in the Mississippi River may result in behavioral effects up to 15,230 feet (2.9 miles) from the source, with injury potentially occurring to fish within 3,281 feet; therefore, impacts on fish from produced noise in the Mississippi River would be direct and indirect, adverse, and temporary, and minor to moderate during in-river construction.

Table 4.10-2
Estimated Zone of Influence from Underwater Sounds for Fish

Activity and Effect Level	Zone of Influence for Impulsive Sounds (ft)[a]		
	Cumulative Sound Exposure Level (SEL) (dB re 1 μPa²s)	Root Mean Square Sound Level (dB RMS) (dB re 1 μPA)	Peak Sound Level (dB re 1 μPA)
30- or 36-Inch Steel Pile, Impact Hammer (River Side Only)			
Injury Onset (all sizes)	--	--	46
Injury Onset (≥2 grams)	3,281	--	--
Injury Onset (<2 grams)	3,281	--	--
Behavioral Effects	--	15,230[b]	--
12-Inch Timber Pile, Impact Hammer (Basin Side Only)			
Injury Onset (all sizes)	--	--	0.0
Injury Onset (≥2 grams)	6.6	--	--
Injury Onset (<2 grams)	9.8	--	--
Behavioral Effects	--	705	--

Source: NMFS 2020e
Notes:
NA = Not applicable. Source levels represented in Table 4.8-4 do not exceed a given threshold and therefore no ZOI exists.
-- = Acoustic thresholds are not identified for this sound measurement.
a Values calculated using the Greater Atlantic Regional Fisheries Office (GARFO) acoustics tool with the Practical Spreading Loss Model for sound attenuation (NMFS 2019c). Dredging, vibratory pile driving (in the Mississippi River only), and vessel noise may exceed behavioral threshold levels for fish, but would result in lower ZOIs than those presented for impact pile driving (328, 328, and 152 feet, respectively, as calculated using the Practical Spreading Loss Model equation identified in the GARFO acoustics tool).
b This is a conservative estimate of the ZOI as it does not account for the absorption of sound by wetlands and other landforms between the noise-producing activity and other areas of the basin.

4.10.3.4.3 Other Alternatives

Direct and indirect impacts on fauna from the construction of other alternatives would be similar to those discussed for the Applicant's Preferred Alternative, resulting in minor, adverse, and temporary to permanent direct and indirect impacts from increased turbidity and sedimentation, habitat removal, decreased water quality, potential entrapment, the removal of overhanging (shading) vegetation, and underwater noise.

Although the construction footprint for each alternative's diversion structure would be similar, placement of this dredged material for terrace construction would temporarily or permanently remove submerged habitat, likely resulting in the loss of non- or less-mobile species in the footprint of the terraces and adjacent beneficial use areas, as well as the temporary displacement of mobile species and an increase in turbidity and sedimentation immediately adjacent to the terraces. Although the terrace alternatives would result in increased turbidity and sedimentation compared to the non-terraced alternatives, the spatial scale of the impacts from construction of the terraces (80 to 90 acres) would be localized as compared to the wider spatial scale of impacts associated with construction of other Project features. Therefore, the additional impacts associated with construction of the terraces would not be expected to result in a difference in overall impacts on fauna. Therefore, impacts of each terraced alternative would also be direct and indirect, minor, adverse, and temporary to permanent. Potential longer-term benefits of terraces for fauna are discussed in Section 4.10.4.4.

4.10.3.5 Aquatic Invasive Species

4.10.3.5.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from construction would occur. As discussed in detail in Chapter 3, Section 3.10.6 Aquatic Invasive Species in Aquatic Resources, Louisiana has more introduced aquatic plants (32) than any state except Florida (45 species) and has nearly twice the average number of introduced aquatic plants per state (Kravitz et al. 2005). Under the No Action Alternative, the expansion of these would continue at the present rate without intervention during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse impact on aquatic resources. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal environmental standards. Although the rate of that expansion cannot be predicted, the State of Louisiana's Wildlife Action Plan indicates that "…the rate at which invasive species spread is frequently faster than the rate at which these removal techniques can be implemented" (Holcomb et al. 2015).

4.10.3.5.2 Applicant's Preferred Alternative

4.10.3.5.2.1 <u>Aquatic Invasive Plants</u>

The Applicant's Preferred Alternative would have both direct and indirect impacts on aquatic invasive plant species within the Project construction footprint. Under the Applicant's Preferred Alternative, aquatic invasive plant species (see Section 3.10.6.1 Aquatic Invasive Plants in Aquatic Resources), as well as desirable native species, would likely be removed from 925 acres of aquatic habitat within the construction footprint during dredging and placement of riprap for the outfall transition feature and construction access route. These activities would include removal of vegetated areas (creation of open-water habitats) and disturbance of existing soft bottom habitats. Initial disturbance and removal of habitat would result in a beneficial, temporary, and negligible impact as invasive species are removed from the construction footprint. Invasive species such as Roseau cane, giant Salvinia, water hyacinth, and alligator weed are among those present in the basin, as described in Chapter 3, and would be removed along with other vegetation.

After the initial disturbance, unpopulated open water and soft bottom habitat created or disturbed in the outfall area of the proposed Project would likely be initially colonized by both invasive aquatic plant species and desirable native species. However, invasive species are typically prolific, establish under disturbed conditions, and often have a greater capacity to acquire nutrients in new habitats (Kravitz et al. 2005). Therefore, invasive species may outcompete native species due to the stress imposed by sediment, hydrology, and water quality disturbances. Ecological recovery of native species is likely to be more successful in habitats where disturbance is limited and few invasive species are present (Prior et al. 2018). Stormwater runoff from the Project construction site could result in nutrients, sediments, and contaminants extending beyond the immediate Project construction footprint and into adjacent aquatic habitats, adversely impacting native aquatic plants and allowing the expansion of invasive species that outcompete native species. To minimize the potential for stormwater runoff during construction, CPRA would implement its SWPPP, which includes measures to direct stormwater to temporary sediment basins or vegetated swales, minimizing the extent of contaminants and nutrients that enter estuarine waters.

Overall, impacts from construction are anticipated to be minor or moderate (readily apparent but localized), adverse, and temporary to permanent as native and nonnative species re-establish in disturbed areas and the distribution or dominance of the species assemblage changes. Impacts on the Mississippi River are anticipated to be temporary to permanent and adverse, but minor given CPRA’s implementation of its SWPPP and the general restriction of aquatic vegetation to the riverbank and adjacent wetland habitats. Aquatic invasive wetland plants are discussed in Section 4.6.5.2 Wetland Invasive Plants in Wetland Resources and Waters of the U.S.

4.10.3.5.2.2 Aquatic Invasive Animals

The Applicant’s Preferred Alternative would have both direct and indirect impacts on invasive aquatic animal species within the Project construction footprint. Aquatic invasive animals reported in the Barataria Basin include mollusks, at least one crustacean species, and numerous invasive fish species (see Chapter 3, Section 3.10.6.2 Aquatic Invasive Animals in Aquatic Resources). Elimination of invasive aquatic animals would occur through the direct loss of habitat and replacement of some existing habitat with Project infrastructure. Invasive, as well as native species, would be removed from the construction footprint, especially those that are less-mobile (for example, apple snails). However, the benefits of the initial disturbance and removal of habitat would be temporary and negligible since disturbance is anticipated to benefit invasive species at the expense of native species less tolerant of the disturbance.

The created open-water habitat in the immediate outfall area and dredged access route would create habitat suitable for invasive aquatic fauna, while potentially precluding or inhibiting the re-establishment of native aquatic fauna due to the limited competitive ability of native species under such disturbed conditions. Species from nearby areas may expand into and colonize the outfall area by simply moving into the area and the reintroduction of Mississippi River water (back into the Barataria Basin) can also increase the introduction and establishment of invasive species (Kravitz et al.

2005). Exotic species such as Asian tiger mosquito, Asian clam, zebra mussel, giant apple snail, and several species of carp are established in the Lower Mississippi River basin, including the Barataria Basin (Kravitz et al. 2005) and the Asian clam is the most widespread nonnative, invasive bivalve in North America (McMahon 1999). Native freshwater bivalves are especially vulnerable to disturbance and competition from nonnative species: 25 percent were listed as federally endangered as early as the 1990s (Williams et al. 1993). Open water and sediments in the outfall area could support the Asian clam. Zebra mussels could become established, precluding native mussels, but also potentially improving water quality by filtering nutrients. Giant apple snails could also invade or expand in areas indirectly affected by construction, reducing aquatic plant cover and available habitat for native fish. If standing water develops in the Project construction footprint, both during and after construction, it could be colonized by the invasive Asian tiger mosquito.

Invasive fish species such as carps may also become established in the construction area. The State Management Plan for Aquatic Invasive Species in Louisiana identifies several established finfish that may spread via aquatic pathways. Established finfish in the region include Rio Grande cichlid (*Cichlasoma cyanoguttatum*), common carp, grass carp, silver carp, and bighead carp. While typically found in open water, many of these fish use freshwater marshes and coastal wetlands as nursery or forage habitat and could travel and disperse through the access route dredged during construction, consuming native mollusks that support native fish, turtles, and birds. For example, the Rio Grande cichlid poses a threat to native aquatic vegetation and possibly commercially valuable species such as shrimp and may harbor parasites or diseases that can harm native fish. Recent collections indicate the normally freshwater species has expanded into areas with low salinities of at least 5 ppt (LDWF 2017i). Several carp species may also threaten native species. For example, the common carp is typically a freshwater fish but is tolerant of brackish waters in its native range and has expanded into estuarine habitats adjacent to the Gulf of Mexico, where temperatures are suitable. The common carp is omnivorous, disturbs vegetated bottom habitat, and consumes fish eggs and larvae. It is also tolerant of wastewater and agricultural runoff and distributed throughout Louisiana.

Overall, impacts on aquatic invasive animals from construction in the Barataria Basin are anticipated to be minor to moderate, adverse, and temporary, although the potential exists for a permanent, moderate change in the distribution or dominance of native and nonnative species assemblage to re-establish in disturbed areas and continue to be a problem for the State of Louisiana. Impacts on the Mississippi River are anticipated to be temporary and adverse, but negligible given the small reduction of available habitat through placement of the diversion structure and the general nature of recovery of soft bottom habitats.

4.10.3.5.3 Other Alternatives

Overall impacts from invasive species expansion/invasion from the other alternatives would be similar to those discussed for the Applicant's Preferred Alternative, resulting in minor to moderate (readily apparent but localized), adverse, and temporary to permanent impacts from aquatic invasive plants and animals in the Barataria Basin. Impacts from aquatic invasive plants in the Mississippi River are anticipated to be temporary to permanent and adverse, but minor; impacts from aquatic invasive animals would be temporary and adverse, but negligible given the small reduction of available habitat through placement of the diversion structure and the general nature of recovery of soft bottom habitats.

4.10.4 Operational Impacts

4.10.4.1 Submerged Aquatic Vegetation

4.10.4.1.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no direct impacts on SAV from diversion operations would occur; however, indirect impacts, namely shifts in SAV presence and assemblage due to changing environmental conditions, would nonetheless occur. The Delft3D Basinwide Model results indicate that under the No Action Alternative, land loss in the Project area (both within the Barataria Basin and the birdfoot delta) would continue, resulting in the projected conversion of over 330,000 acres of emergent wetlands and other above-water landforms to shallow-water areas between year 2020 and 2070 (see Section 4.2.3.2.2.1 in Geology and Soils for more information about land loss projections under the No Action Alternative). Increases in water depth may allow SAV to become established in newly submerged areas, but may also result in some currently suitable areas becoming less suitable for SAV (or specific SAV species) as water depth, salinity, wave action, and turbidity increase. The No Action Alternative is projected to result in higher mean winter salinity due to sea-level rise and higher wave action due to the ongoing loss of wetlands over time, both of which influence SAV species assemblages and occurrence. As salinity and exposure in a given location increase, the likelihood of occurrence of SAV is expected to decrease (DeMarco et al. 2018). Thus, the No Action Alternative would have indirect, moderate (minor degree of decrease but spatially widespread), permanent, and adverse impacts on SAV, particularly after 2050, when sea-level rise is projected to cause the greatest increases in water levels and salinity in the basin.

4.10.4.1.2 Applicant’s Preferred Alternative

As discussed in Section 4.5 Surface Water and Sediment Quality, the Delft3D Basinwide Model projects that the Applicant’s Preferred Alternative would cause permanent, minor to moderate changes to salinity (primarily decreasing salinity) in the Barataria Basin during Project operations. The model projects that by the year 2070, average maximum monthly salinities would be consistently lower than those under the No Action Alternative throughout the Project area, with the exception of the area near the birdfoot delta, which would slightly increase in salinity over time due to projected sea-level rise increases and subsidence rates, which are incorporated into the Delft3D Basinwide Model setup (see Section 4.1 Approach to Evaluation of Environmental Consequences for more information about the Delft3D Basinwide Model), as well as projected morphological changes (water elevation and bottom elevation changes) due to the proposed Project (see Section 4.4.4.2 in Surface Water and Coastal Processes). Major (readily apparent and widespread) impacts on salinity (primarily decreasing salinity) are projected to occur closer to and downstream of the proposed diversion structure. Project-induced decreases in salinity are projected to be more moderate (detectable and localized) in the northern and western portions of the outfall area. In the southern portion of the basin, Project-induced decreases in salinity are projected to be minor (barely detectable and localized) during the dry winter months and more moderate during the wet spring months when the diversion gates would be open (operating above the 5,000 cfs base flow). Details regarding projected salinity impacts are provided in Section 4.5.5.1 in Surface Water and Sediment Quality.

Hillmann et al. (2016b) indicated that fresher marshes of the Barataria Basin, on average, had higher species richness and biomass of SAV when compared to intermediate, brackish, and saline sites; saline sites had the lowest species richness and biomass of SAV. Therefore, the decrease in average salinity in the basin may result in increased biomass of SAV over time, when compared to the No Action Alternative. Conversely, the increase in salinity projected in the birdfoot delta may result in a decrease of SAV biomass over time within the birdfoot delta; however, this decrease is similar to that projected under the No Action Alternative. Further, although emergency operation of existing diversions (for example, in response to the DWH oil spill) and hurricanes have resulted in declines in SAV from immediate and extreme decreases or increases, respectively, of salinity, regular operation of the Davis Pond Freshwater Diversion resulted in increases in SAV biomass (see Chapter 3, Section 3.10.2.1 Submerged Aquatic Vegetation in Aquatic Resources). Similarly, newly created mudflats near the outfall of Mardi Gras Pass have been colonized by SAV (Henkel et al. 2018; see Appendix U). These examples demonstrate that regular operation of the proposed Project, which would result in prolonged freshwater input, would likely lead to similar increases in SAV biomass over time. Because cooler Mississippi River water is also diverted through Davis Pond and Mardi Gras Pass, both of which have had observed establishment of SAV during certain periods (LDWF 2015c, Henkel et al. 2018), the decrease in water temperature resulting from the proposed Project is also not anticipated to adversely affect SAV over the long term. As described in Section 4.6.5.1 Wetland Types and Extent in Wetland Resources and Waters of the U.S., operation of the proposed Project would likely result in a decrease in freshwater throughput from the Davis Pond Freshwater Diversion into the northern basin; however, given the continued (albeit decreased) input of fresh water and nutrients from the Davis Pond Freshwater Diversion, and the projected decrease in salinity across the Barataria Basin, including the northern basin, from the proposed Project, impacts on SAV biomass in the northern basin would be negligible.

In addition to SAV biomass, the SAV species assemblage would also be likely to change as abiotic habitat variables change. Operation of the proposed Project would likely result in increased habitat suitability for SAV species in the Barataria Basin that thrive in or tolerate less saline water, while decreasing the habitat suitability of those that are adapted to more saline waters. Only three of the 14 species identified in Hillmann et al. (2016a) occurred across all salinity gradients, and SAV is generally thought to be restricted to waters about 4 to 6.5 feet deep or less (LDWF 2019d, DeMarco et al. 2018). DeMarco et al. (2018) identifies SAV species assemblages by salinity gradient. Species identified within Louisiana estuaries during the study included (asterisk added to dominant species):

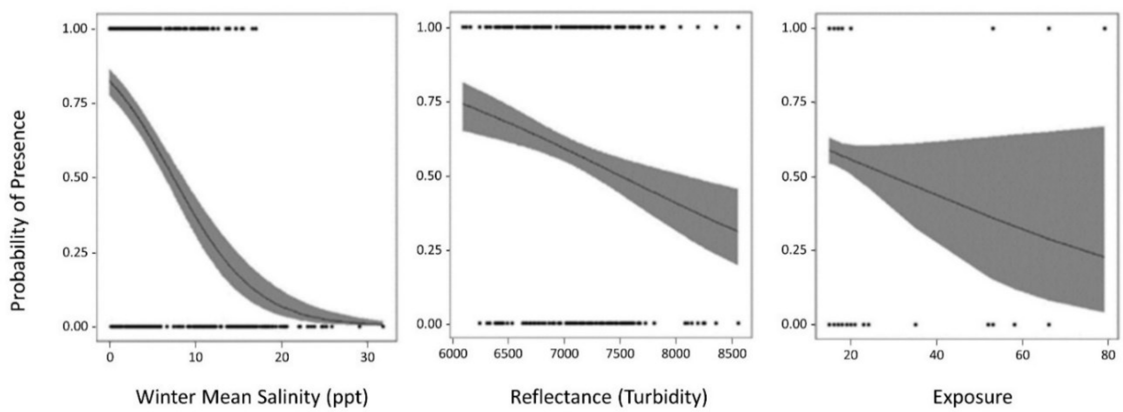
- Fresh marsh (0 to 3 ppt): hydrilla*, hornwort* (*Ceratopyllum demersum*), cabomba (*Cabomba caroliniana*), and floating invasive species such as water hyacinth and Salvinia.

- Intermediate marsh (3.1 to 10.0 ppt): wild celery, southern water nymph (*Najas guadalupensis*), horned pondweed (*Zannichellia palustris*), and hornwort*.

- Brackish marsh (10.1 to 20.0 ppt): Eurasian watermilfoil*, widgeon grass (*Ruppia maritima*).

- Saline marsh (20.1 ppt and above): widgeon grass.

In this same study, which included waterbodies no more than 6.6 feet (2 meters) deep during the period of observation, DeMarco et al. (2018) identified three habitat variables as significant predictors of SAV presence and absence, including winter salinity, turbidity (affecting light availability), and exposure (physical wind/wave disturbance). The strong response of SAV occurrence to winter salinity is likely related to species-specific adaptations of the dominant species (as noted above) that overwinter in the benthos as roots, tubers, or winter buds and regenerate vegetatively; this adaptation provides a competitive advantage over species that grow from seed once the growing season begins. Figure 4.10-2 depicts contour plots for the impact of significant predictors on the likelihood of SAV presence in the spatial likelihood occurrence (SLOO) model in DeMarco et al. (2018). Each inset identifies one of the three predictors versus the probability of presence; the steepness of the slope represents the strength of the parameter impact on SAV presence and the gray area is the uncertainty surrounding each parameter's ability to influence SAV presence based on 95 percent confidence intervals.



Source: Figure 2.2 in DeMarco et al. (2018).

Figure 4.10-2. Contour Plots for Predictors of SAV Occurrence.

Because winter salinity (November 15 through February 14) appears to have the greatest influence over SAV presence in the Project area, changes in average winter salinity over time were assessed to approximate how the SAV assemblages may change over time. As shown in Figure 4.10-3 and Table 4.10-3, the projected shift in salinity shows an overall increase in winter salinity throughout the Project area over time for both the Applicant's Preferred Alternative and the No Action Alternative. However, the Applicant's Preferred Alternative is projected to result in a winter salinity regime that would provide significantly more habitat conducive to the growth of freshwater and intermediate SAV species when compared to the No Action Alternative, while decreasing the acreage conducive to the growth of brackish and saline SAV species.

As discussed above, turbidity is also a predictor of SAV presence, and increased turbidity near the diversion, when operating above base flow, may decrease the potential for SAV growth in the outfall area. However, the larger areas of fresher water are anticipated to result in a higher biomass of SAV over time compared to the No Action Alternative. Further, the Applicant's Preferred Alternative would result in lowered wave action near areas of created or maintained wetlands, which would result in a more conducive environment for SAV growth over time (DeMarco et al. 2018).

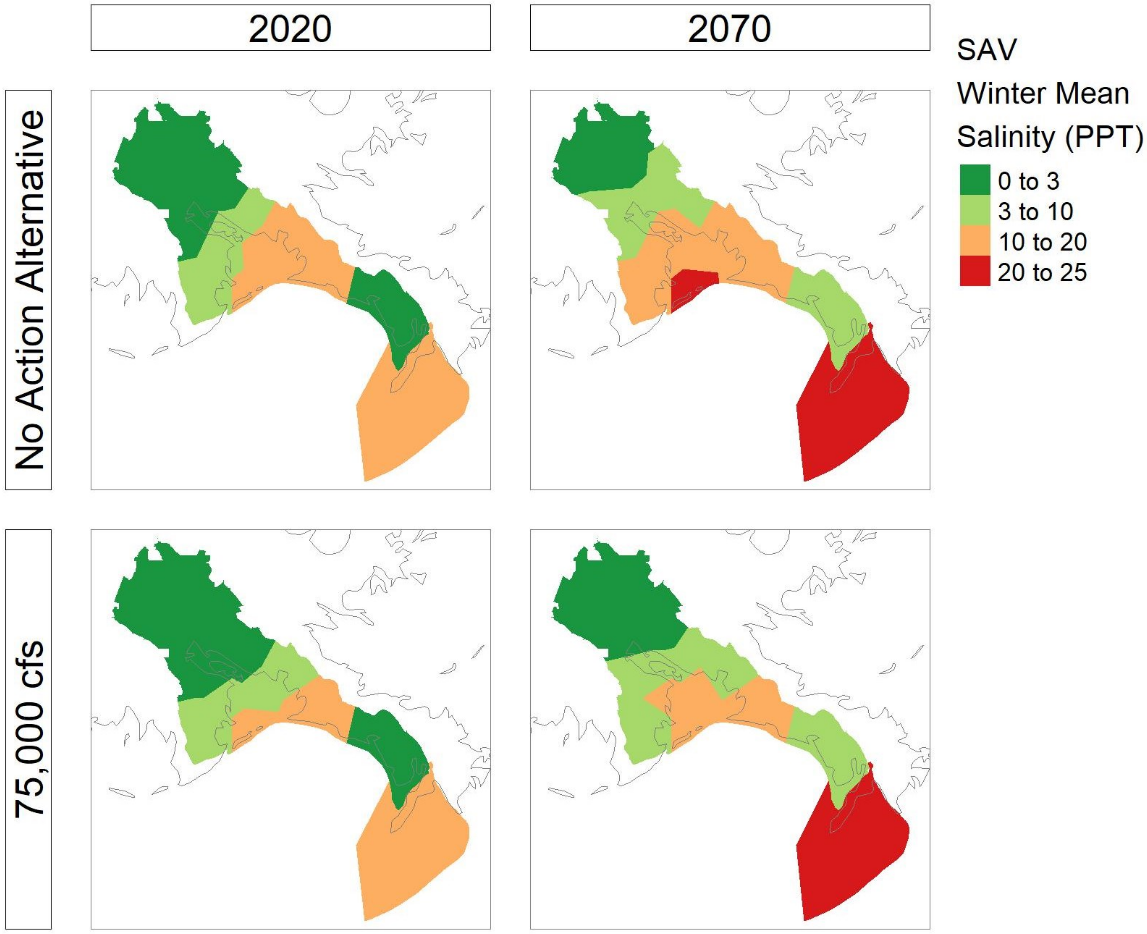


Figure 4.10-3. Changes in Monthly Mean Winter Salinity Regimes Over Time for the No Action Alternative and Applicant's Preferred Alternative.

Table 4.10-3 Change in Winter Salinity Regime Over Time				
Action Alternative	**Salinity Regime**			
	Fresh (0 to 3 ppt)	**Intermediate (3 to 10 ppt)**	**Brackish (10 to 20 ppt)**	**Saline (>20 ppt)**
2020				
No Action Alternative (acres)	547,366	207,917	613,323	0
Applicant's Preferred Alternative (acres)	629,998	235,213	503,395	0
Difference (acres)	82,631	27,296	-109,927	0
2070				
No Action Alternative (acres)	229,658	348,849	391,198	398,902
Applicant's Preferred Alternative (acres)	355,733	434,575	222,516	355,781
Difference (acres)	126,076	85,726	-168,681	-43,121

The sediment diversion may function to not only build new land but also to increase the elevation of existing marshes or sediment beds (Carle et al. 2015). As described for the Wax Lake Outlet following the 2011 Mississippi River flood, the largest changes in vegetation occurred at low elevations where sediment accretion resulted in decreased water depths and the subsequent conversion of fully submerged species to floating-leaved or emergent species (Carle et al. 2015). Similarly, for Mardi Gras Pass, depositional sediments resulted in mudflats which, once created, appear to have colonized with SAV within 2 years (Henkel et al. 2018; see Appendix U). However, floating-leaved invasive species, such as water hyacinth and Salvinia, may replace native species and cover large areas of open water, reduce the oxygen available to native species, and/or support invasive animals such as apple snails, thereby reducing the habitat value to native fish and wildlife, as described further in Section 4.10.4.6.

Overall, the proposed Project would likely initially result in a temporary, adverse, major, indirect impact on SAV in the basin from a relatively quick change in salinity (see Table 4.10-3), which may result in die-offs of species intolerant of the new salinity regime early in the Project life. However, major, permanent, indirect beneficial impacts are anticipated for the overall coverage and biomass of SAV in the basin once salinity regimes stabilize and new freshwater or intermediate communities become established; these longer-term increases are anticipated to offset the initial adverse impacts. As the birdfoot delta would become deeper and more saline over time, its suitability for SAV would likely decrease, resulting in a permanent, adverse, and indirect, but negligible impact compared to the No Action Alternative.

4.10.4.1.3 Other Alternatives

As discussed in Section 4.5 Surface Water and Sediment Quality, neither the 50,000 cfs nor the 150,000 cfs Project flow alternatives appear to have a consistent or large enough impact on salinities compared to the Applicant's Preferred Alternative to create clear differences in SAV occurrence. Maximum and minimum average monthly salinities (see Section 4.5 Surface Water and Sediment Quality, Table 4.5-2), show little relative difference between the Applicant's Preferred Alternative and the 50,000 cfs or

150,000 cfs Alternative, such that all alternatives would maintain additional acreages of fresher waters compared to the No Action Alternative. Turbidity and sedimentation are anticipated to decrease (50,000 cfs Alternatives) or increase (150,000 cfs Alternatives) based on the total outflow of a given alternative, as compared to the Applicant's Preferred Alternative. The increased turbidity and decreased salinity would initially result in temporary, adverse, major, indirect impact on SAV in the basin from a relatively quick change in salinity in the first year (see Table 4.10-3), which may result in die-offs of species intolerant of the new salinity regime early in the Project life, but would be followed by major, permanent, indirect beneficial impacts in the overall coverage and biomass of SAV in the basin once the salinity regimes stabilize. As the birdfoot delta would generally become deeper and more saline at similar rates over time under the Applicant's Preferred Alternative and the other action alternatives, the suitability for SAV would similarly decrease under the other action alternatives, resulting in a permanent, adverse, and indirect, but negligible impact compared to the No Action Alternative.

While terracing was not found to directly affect salinities, terraces are believed to create conditions favorable to more SAV cover when compared to the non-terraced alternatives. Field studies have found that marsh terraces in Louisiana promote the occurrence of SAV and increased SAV biomass compared to unterraced shallow marsh ponds, suggesting that the terrace alternatives may have a beneficial impact on SAV (Cannaday 2006, Brasher 2015). The terracing reduces fetch across the water surface, resulting in reduced wave action, erosion, and turbidity, and therefore greater opportunities for SAV establishment. Terraced ponds had more than three times the biomass of SAV when compared to unterraced ponds in one study (Cannaday 2006). Others have found that terracing improves habitat for fisheries and waterbirds (Rozas et al. 2005, O'Connell and Nyman 2011). La Peyre et al. (2007) attributed greater numbers of marsh-SAV oriented nekton species in terraced sites, due in part to the greater SAV biomass found in terraced ponds, and the increased marsh habitat created by the terraces themselves. Therefore, each terracing alternative would result in additional indirect, permanent, minor (due to limited terrace acreage) benefits to SAV and associated nekton.

4.10.4.2 Benthic Resources

Benthic resources of the Barataria Basin described in this section include benthic algae, infauna (live in the sediment), and epifauna (live on top of the sediment). Commercially important benthic macroinvertebrates, including brown and white shrimp, blue crab, and oysters, are discussed in Section 4.10.5.

4.10.4.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed, and therefore no impacts on benthic resources from operations would occur. As previously discussed, ongoing changes associated with sea-level rise in the Barataria Basin and birdfoot delta (for example, land loss and increases in salinity and water depth) would continue over time. These habitat changes would result in concurrent changes to the benthic community as it adapts to changing conditions. For example, the Delft3D Basinwide Model results indicate that under the No Action Alternative, and as noted in Section 4.2.3.2.2.1 in Geology and Soils, land loss in the Project area would continue, resulting in the projected conversion of over 330,000 acres of emergent wetlands and other above-water landforms to shallow water between year 2020 and 2070. Further, Conner and Day (1987) indicate that numerical abundance of benthic organisms was highest in freshwater habitats, decreasing with increasing salinity. As infauna and epifauna have been noted to occur in higher densities within and immediately adjacent to marsh habitats (see Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-1), ongoing marsh loss, as well as increasing salinities, would likely cause a permanent, major, adverse, indirect impact to the overall benthic biomass.

4.10.4.2.2 Applicant's Preferred Alternative

As described in Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-1, lower trophic-level benthic species are generally more diverse, with higher densities, in and adjacent to vegetated areas. Within the Barataria Basin, lower trophic-level benthic species have been noted as being more abundant in freshwater habitats than more saline habitats (Philomena 1983), although studies in other estuaries show the opposite trend (Van Diggelen and Montagna 2016). Multiple additional factors have been identified as controlling the structure and diversity of the benthic community, including sediment characteristics, water current, DO, and salinity (Conner and Day 1987, Gunter 1961, Junot et al. 1983). Studies have shown that there is a strong trophic link between infauna and nekton near the marsh edge that contributes to high fishery productivity in Gulf Coast marshes (Whaley and Minello 2002). A discussion of how impacts on the benthic community would impact the food web and how changes in food web productivity impact benthos is provided in Section 4.10.4.4.

As discussed throughout this EIS, each of these habitat characteristics would be modified by operation of the proposed Project. For example, although the overall presence of marsh in the Barataria Basin would decrease over time, wetland losses in the basin under the Applicant's Preferred Alternative are projected to be 12,700 acres (17.4 percent) less than the losses projected under the No Action Alternative, which would have a major, permanent, and beneficial impact on the benthic community. However, sediment characteristics, water levels, and currents would all be substantially affected by operation of the diversion structure. As discussed in Section 4.2.3.2.2.1 in Geology and Soils, diverted sediments from the Mississippi River, which would be retained and deposited within the outfall area, would initially be coarser and less consolidated than existing surface sediments (organic-rich marsh soils and finer silts and clays), with a larger sand fraction, greater bulk density, and lower organic content. Further, water levels and currents would be significantly impacted during operation of the diversion structure (see Section 4.4.4.2 in Surface Water and Coastal Processes). All of these factors would change the benthic habitat and could result in changes in the community assemblage, although not necessarily changes in overall productivity. For example, Cahoon et al. (1999) indicated that benthic microalgal biomass may be higher in sediments with larger grain sizes. Another study (Gaston et al. 1998) indicated that certain macrobenthic taxa are more abundant at estuarine stations with finer sediments but that sandy stations have higher species richness; changes in trophic group (for example, surface versus subsurface deposit feeders) due to sediment characteristics were less pronounced.

As described in Section 4.6 Wetland Resources and Waters of the U.S., although wetland losses in the Barataria Basin are projected to decrease as a result of the proposed Project, wetland losses in the birdfoot delta are projected to be greater, resulting in 2,900 acres (45.1 percent) fewer wetlands in 2070 when compared to the No Action Alternative. Only 3,500 acres (6.0 percent) of the wetlands present in the birdfoot delta in 2020 are projected to remain under the Applicant's Preferred Alternative in 2070 (compared with 6,400 acres or 10.9 percent under the No Action Alternative). This projected loss of almost 3,000 additional acres of wetlands (5.0 percent) would result in a moderate, permanent, and adverse impact on benthic resources in the birdfoot delta; however, the reduction in land loss in the Barataria Basin as compared to the No Action Alternative would result in major, permanent, and beneficial impacts on benthic resources.

As discussed in Section 4.5 Surface Water and Sediment Quality, the Delft3D Basinwide Model projects that the Applicant's Preferred Alternative would cause permanent, minor to moderate changes to salinity (primarily decreasing salinity) in the Barataria Basin during Project operations. In addition to the general trends over time, salinity would be variable throughout each year of operation. As shown in Figures 4.10-8 and 4.10-9 (see Section 4.10.4.4.2.6.1, Salinity and Temperature), salinity in the Barataria Basin varies naturally during the course of the year according to various environmental factors. However, the Applicant's Preferred Alternative is projected to cause parts of the Barataria Basin's salinity to be, or approach, 0 ppt during periods when the diversion is open (operating above the 5,000 cfs base flow), indicating that certain brackish or saline habitats would essentially be fresh during periods of each year; this impact is projected to be most pronounced in the outfall area and in the mid-basin (Stations HWQ-08, B. Waterway, Hackberry Bay, and B. Bay North GI in Figure 4.10-10). This suggests that benthic species not currently acclimated to fresher salinities may be lost and replaced over time by species capable of tolerating wider ranges of salinity.

A study of five Texas estuaries was conducted to determine how salinity variability affected diversity in the benthic community (Van Diggelen and Montagna 2016). The study included results from quarterly sampling of benthic infauna conducted over multiple years and compared the benthic community between four stations in each estuary, two of which (Stations A and B) were closest to the freshwater inflow and two of which (Stations C and D) were closest to the Gulf of Mexico. Every Station A within an estuary had a lower diversity than the same estuary's Station D. Further, a strong inverse relationship was identified between salinity variance and species diversity, with the marine-influenced station having less salinity variability and higher species diversity than the more freshwater-influenced stations; this relationship was found with and without consideration of an anomalous, hypersaline estuary (the Laguna Madre). Overall, the study demonstrated that pulsed freshwater inflow is a form of disturbance for benthic organisms that results in decreased benthic diversity (Van Diggelen and

Montagna 2016). Operation of the proposed Project is projected to decrease salinity variability at stations closest to the diversion structure (changing to year-round fresh conditions), but increase at mid-basin stations (causing periods of fresh conditions followed by a return to higher salinities upon diversion closure). As previously noted, relatively permanent changes in salinity would likely result in a shift in the benthic community over time, whereas stations with highly variable salinity may result in frequent disturbance and modification of the benthic community present at those locations, possibly resulting in localized decreases in diversity similar to that identified by Van Diggelen and Montagna (2016). For short-lived species, diversity may increase, with a freshwater community establishing during higher outflows and a more brackish community establishing during low outflow periods. This community structure could be representative of the natural communities, which typically exist in dynamic estuarine systems where river flow and flooding are not constrained by a levee system.

A study from the 1997 Bonnet Carré Spillway opening and subsequent freshwater input to Lake Pontchartrain indicated that infaunal macroinvertebrates were negatively affected by some combination of the decrease in salinity, increase in cyanobacterial blooms, and hypoxia/anoxia related to the influx of fresh water from the Mississippi River (Brammer et al. 2007). The infaunal community was assessed at five sites between November 1996 and November 1998, with Site 1 being closest to the spillway opening and Site 5 closest to the tidal passes. The researchers noted that an oligohaline community did persist through the period of spillway operation, but that taxa dominance and composition changed over time. Prior to the opening, the five sampling sites were dominated by gastropods (snails) (November 1996) or oligochaetes (aquatic worms) (March 1997). During the spillway opening, oligochaetes and gastropods increased (markedly at some locations), but polychaetes (bristle worms) markedly decreased. One month after the spillway's closure (June 1997), polychaetes and many other species were rare or absent. Later months identified changing taxa and dominance, as well as the return of polychaetes. By July 1997 (3 months after the spillway closure) the benthic community had begun to recover and values for diversity, abundance, and the number of taxa were not substantially different than pre-opening values. Table 4.10-4 shows dominant taxa and trends by station within the months before and after the spillway opening. While this study provides some insight into potential impacts associated with freshwater introduction, the comparability of aquatic community responses between Lake Pontchartrain and the Barataria Basin is limited given the different characteristics of these two estuarine systems, such as Lake Pontchartrain's limited interspersion of wetlands, lower natural salinity variability, and restricted tidal exchange.

Based on the changes in abiotic habitat characteristics that are anticipated during initial operation of the proposed Project, it is likely that adverse direct and indirect impacts on the benthic community would occur through the acute introduction of fresh water and sediment, likely resulting in the initial mortality of certain benthic species/groups in the outfall area and downstream of it. Over time, modified benthic communities would likely be found in impacted areas, with species assemblages dependent on sediment deposition, salinity regimes, vegetation coverage, sediment types, and water quality/currents; spatial and temporal variation in assemblages may be both intra-annual and inter-annual as the species assemblage changes in response to continuing operations and freshwater inputs, which is typical of a natural dynamic estuarine system.

<table>
<tr><th colspan="7">Table 4.10-4
Dominant Taxa and Trends Before, During, and After the 1997 Opening of the Bonnet Carré Spillway</th></tr>
<tr><th rowspan="2">Site</th><th colspan="6">Month</th></tr>
<tr><th>November 1996</th><th>March 1997</th><th>April 1997 (Spillway Open)</th><th>June 1997</th><th>July 1997</th><th>September 1997</th></tr>
<tr><td>1</td><td>Probythinella protera</td><td>P. protera</td><td>P. protera, Texadina sphinctostoma</td><td rowspan="4">P. protera, Rangia cuneata, oligochaetes, T. sphinctostoma (all other species rare or absent)</td><td>Chironomids</td><td>Chironomids, P. protera, R. cuneata; but with low densities</td></tr>
<tr><td>2/3</td><td>T. sphinctostoma</td><td>Oligochaetes</td><td>T. sphinctostoma, R. cuneata, oligochaetes</td><td>R. cuneata, Amphicteis floridus, chironomids, Congeria leucophaeta</td><td>A. floridus</td></tr>
<tr><td>4</td><td>P. protera</td><td>Oligochaetes</td><td>Oligochaetes (marked decrease in polychaetes)</td><td>R. cuneata, A. floridus, chironomids, C. leucophaeta</td><td>P. protera; Streblospio benedicti and Polydora websteri present for the first time since spillway closing</td></tr>
<tr><td>5</td><td>T. sphinctostoma</td><td>Oligochaetes</td><td>T. sphinctostoma (marked decrease in polychaetes)</td><td>Increases in taxa and abundance, including the density of polychaetes</td><td>A. floridus; S. benedicti and P. websteri present for the first time since spillway closing</td></tr>
<tr><td colspan="7">Source: Brammer et al. 2007</td></tr>
</table>

As discussed in Section 4.10.3.2, benthos in the immediate outfall area would be most affected by turbidity and sedimentation, but impacts would decrease with increasing distance from the diversion structure as the sediments settle out. Although impacts in the immediate outfall area would be moderate and adverse due to the amount of sediment projected to accumulate, the benthic communities further in the outfall area would be subjected to less sediment accumulation and therefore would be more likely to have successful vertical migration, resulting in a minor impact in areas further in the outfall area. Overall, the impact of sedimentation on the benthic community is expected to be direct, minor to moderate, permanent (recurring), and adverse.

Components of the benthic community, such as oysters and other bivalves, provide water quality benefits in the Project area by filtering nutrients, organic matter, and other suspended particles. Although the number of oysters, and, therefore, their water-filtering capacity, would decrease as a result of the proposed Project (see Section 4.10.4.5.1.11, Eastern Oysters), other filter-feeders more tolerant of lower salinities may increase, partially offsetting lost water-filtration capabilities. For example, the hooked mussel (*Ischadium recurvum*) competes with oysters in salinities of less than 10 ppt, and *Rangia cuneata* (a clam) are most abundant at salinities less than 10 ppt (Smithsonian Environmental Research Center 2022, Wong et al. 2010). In addition, as described in Chapter 3, Section 3.6, Wetland Resources and Waters of the U.S., wetlands improve water quality by removing organic and inorganic toxic materials, suspended sediments, and nutrients via plant uptake and sedimentation; the Project is projected to result in maximum wetland gain of 17,100 acres at year 2060 before dropping to 12,700 acres at year 2070 in the Barataria Basin (see Section 4.6.5.1.2.4 Land Accretion). The increase in wetlands, when compared to the No Action Alternative, would continue to provide water quality benefits.

The change in salinity regime and increased sedimentation in much of the Barataria Basin, as well as the increase in wetlands in the outfall area, are likely to result in ongoing (permanent), minor to moderate, direct effects on the benthic community assemblage. Although impacts from sedimentation would generally be adverse, salinity impacts could be adverse or beneficial depending on a given species' salinity tolerance. For example, a freshwater benthic community that becomes established in mid-basin during operation of the diversion may be negatively impacted in July when the diversion returns to base flow and salinity increases. Conversely, benthic communities more tolerant of less saline waters would likely be benefited in the immediate outfall area, where operation of the diversion would result in fresh or intermediate habitats year-round, and would be benefited in later years of diversion operation where marsh was created or maintained (allowing for higher benthic biomass) compared to the No Action Alternative. The impact of shifting benthic communities on the larger food web is discussed in Section 4.10.4.4.

4.10.4.2.3 Other Alternatives

The Delft3D Basinwide Model projects that in the Barataria Basin, when compared to the No Action Alternative, there would be about 9,200 acres (12.7 percent) more wetland acreage in 2070 for the 50,000 cfs Alternative, increasing incrementally across the alternatives and reaching a projected maximum increase in wetland acreage of about 26,400 acres (36.3 percent) for the 150,000 cfs + Terraces Alternative in 2070 (see Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-4), which would have a proportionally major, permanent, indirect, and beneficial impact on the benthic community in the basin. Wetland losses within the birdfoot delta would follow a different trend as diverted sediments from the Mississippi River are projected to result in a similar level of marsh loss in the birdfoot delta as the Applicant's Preferred Alternative (within about 500 acres or 1 percent of total wetland loss under the No Action Alternative). Although these moderate, permanent, indirect and adverse impacts on wetlands, and resulting impacts on benthic communities, would occur in the birdfoot delta, the maintenance and creation of wetlands in the upper and mid-portions of the Barataria Basin would result in a net major, permanent, indirect and beneficial impact on the fresh and intermediate benthic communities given the additional marsh edge habitat that would be present within these portions of the Project area.

Sedimentation and turbidity are anticipated to decrease (50,000 cfs Alternatives) or increase (150,000 cfs Alternatives) based on the total outflow of a given alternative when compared to the Applicant's Preferred Alternative (for detailed discussions of the differences in sedimentation and turbidity under each alternative, see Section 4.4 Surface Water and Coastal Processes and Section 4.5 Surface Water and Sediment Quality). As discussed in Section 4.5, however, these differences would not be expected to be substantially different such that they would substantially change the level of impact to benthic communities as compared to the Applicant's Preferred Alternative. Thom et al. (2004) suggest that terrace construction could alter substrates such that benthic communities may not be substantially present adjacent to terraces for several decades, which would indicate an associated long-term, minor (due to limited terrace acreage), indirect, adverse impact under the terrace alternatives. Furthermore, if the terraces successfully capture and retain sediment over time, recovered benthic communities could later be buried, resulting in a short-term to permanent (depending on the final elevation), minor, and adverse indirect impact.

As discussed for the Applicant's Preferred Alternative, the combination of other changing habitat characteristics from operation of the five other alternatives would likely result in ongoing (permanent) and minor to moderate indirect impacts on the benthic community as its structure and assemblage change in response to salinity regimes (including ongoing salinity variation), which would result in adverse impacts on assemblages that could not tolerate the changes, but beneficial impacts on those that could. The intensity of this impact to the benthic community would not differ between action alternatives.

4.10.4.3 Essential Fish Habitat

4.10.4.3.1 No Action Alternative

The increasing salinities and water depths anticipated to continue over time are projected to result in the conversion of nearly 350,000 acres of marsh habitat and other above-water landforms in the Barataria Basin and birdfoot delta to shallow-water areas between year 2020 and 2070, and may result in the decrease of SAV biomass as salinities increase (Hillmann et al. 2016b). These ongoing impacts in the Project area would reduce the extent of emergent marsh and SAV available to managed species, while increasing the amount of less-sensitive EFH, such as soft bottom and water column habitat, as the marsh recedes. All EFH types in the Project area, especially those located in the lower and mid-basin, would experience changes over time as a result of sea-level rise and saltwater encroachment, although encroachment would occur over time, allowing for managed species and their prey to potentially acclimate to the changes and expand or contract their range accordingly. Sea-level rise and saltwater encroachment would also likely allow for the continued northward movement of oyster beds into areas of optimal salinity (but possibly decreased water quality from pollution runoff from commercial activities and agricultural practices), while allowing for existing populations in southern portions of the basin to remain in the higher salinities that propagate growth but also increase susceptibility to disease and predation (La Peyre et al. 2009, VanSickle et al. 1976).

Although EFH would remain in the Project area with implementation of the No Action Alternative, the general shift of EFH away from vegetated types would result in major, permanent, direct and indirect, and adverse impacts on quantity and quality of EFH. Although the potential for increased oyster productivity in some areas of the basin may increase hard substrate/shell bottom habitat, marsh loss would increase open water and soft bottom habitat, which are not typically limiting to managed species and would therefore have limited benefit to managed species and their prey.

4.10.4.3.2 Applicant’s Preferred Alternative

As discussed in Chapter 3, Section 3.10.4 Essential Fish Habitat in Aquatic Resources, review of available data and technical assistance from NMFS identified EFH along the estuarine and nearshore coastal zones in the Project area for seven species managed under the GMFMC FMPs (white shrimp, brown shrimp, red drum, lane snapper, gray snapper, cobia, and king mackerel) and eight highly migratory species managed by NMFS (blacktip [*Carcharhinus limbatus*], bull, finetooth [*Carcharhinus isodon*], scalloped hammerhead [*Sphyrna lewini*], Atlantic sharpnose, and spinner [*Carcharhinus brevipinna*] sharks; sailfish; and Atlantic yellowfin tuna). Although the highly migratory species generally occur in nearshore or offshore open waters, marsh EFH is particularly important to many species for foraging and/or refuge habitat as both juveniles and adults, and oyster beds provide shelter, food, or spawning habitat for many sensitive species. Loss of EFH can adversely impact managed species (Plunket and LaPeyre 2005), while conversion of EFH from one type to another would have varying impacts on managed species depending on their use of the specific habitats. In parallel with the preparation of this EIS, consultation with the NMFS Southeast Regional Office, Habitat Conservation Division in accordance with the MSFCMA is being undertaken to assess potential impacts on EFH. A full assessment of impacts on EFH is included in Appendix N; a summary of these impacts is included below. On April 6, 2021, the NMFS Southeast Regional Office, Habitat Conservation Division concurred with the determinations identified in Appendix N and provided conservation recommendations for the Project that include monitoring and adaptive management of the Project and continued development of ecosystem modeling by CPRA and the LA TIG (see Appendix N3). On April 30, 2021, the USACE committed to providing a final, written response to NMFS’ conservation recommendations at least 10 days prior to issuance of the ROD for the Project; therefore, this consultation under the MSFCMA is ongoing.

4.10.4.3.2.1 <u>Habitat Impacts</u>

EFH for managed species anticipated to occur in the Barataria Basin includes: SAV; emergent marsh; soft bottom, oyster reef, and sand/shell habitats; and the water column (see Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-2). Impacts from the proposed Project are anticipated to result in increases in the overall coverage and biomass of SAV (see Section 4.10.4.1) and emergent marsh (see Section 4.10.4.2), although the increases are often related to conversion from higher to lower-salinity communities. Conversely, soft bottom would decrease (compared to the No Action Alternative) as marsh is established or maintained, and areas of sand/shell may decrease, converting to soft bottom due to burial from sedimentation (see Section 4.10.4.4.2.2, Applicant's Preferred Alternative, Substrates). Oyster reefs that experience reduced oyster productivity could likewise be impacted by increased sedimentation. Although changes in the amount of water column habitat would be negligible, changes in salinity, temperature, and nutrient levels would occur, and certain areas would be affected by changes in water flow, turbidity, and DO (see Section 4.10.4.4). Overall, the total amount of EFH in the Barataria Basin would not be lost, but may be converted from one type to another, and often from more ubiquitous habitats (for example, soft bottom, unvegetated water column) to those that may provide more value to managed species and their prey (for example, SAV and marsh).

EFH for managed species anticipated to occur in nearshore waters outside of the barrier island or the birdfoot delta would include the same habitat types and hard bottom (see Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-2). With the exception of marsh habitat in the birdfoot delta, the influence of the proposed diversion on these habitats would be negligible given the maintenance of water flow patterns and characteristics outside of the basin. As discussed in Section 4.10.4.2, about 3,000 acres of marsh (5.0 percent) would be converted to soft bottom habitat in the birdfoot delta over time.

Overall, the net amount of structured EFH would likely increase for the Applicant's Preferred Alternative, when compared to the No Action Alternative, given the extent of marsh being created/maintained and the decreasing salinity of the estuarine water column, which could allow for a higher biomass of SAV. Although there would likely be decreased availability in other structured EFH types (for example oyster reef), the overall change in EFH is expected to be major, beneficial, direct and indirect, and permanent.

4.10.4.3.2.2 Managed Species Impacts

Species-specific discussions for brown shrimp, white shrimp, and red drum are included in Section 4.10.4.5 that identify the impacts on all life stages of these species as they relate to changing habitat characteristics. Impacts on oyster reefs are discussed in more detail in Section 4.10.4.4.2.2 Substrates and Section 4.10.4.5.2.11 Eastern Oysters. Impacts on the coastal migratory pelagics, reef fish, and highly migratory species with designated EFH in the Project area are discussed below; all species are further discussed in Appendix N.

Two coastal migratory pelagic species, king mackerel and cobia, have designated EFH in the Project area. Although they are primarily associated with pelagic marine habitats, both species may use portions of the Project area and estuarine EFH is designated for younger life stages of cobia. King mackerel are most commonly found in coastal marine habitats with salinities greater than 32 ppt and are only rarely found in estuaries. Cobia are known to spawn in saline coastal bays and estuaries and larvae are commonly observed in estuarine habitats with salinities greater than 18.9 ppt (GMFMC 2016). Spawning in the Gulf of Mexico generally occurs from late summer to early fall (NMFS 2020), when the Project would most likely be operating at or near base flows and salinity in the lower basin would be similar to the No Action Alternative (see Figure 4.10-8). Therefore, although some changes in habitat would occur in Barataria Bay, the migratory and pelagic nature of these species, and in consideration of the timing of salinity changes in the lower basin, impacts on these two species from Project operation are anticipated to be negligible.

The two reef fish (gray and lane snappers) have EFH established in both estuarine and nearshore portions of the Project area (see Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-2). Gray snappers are tolerant of a broad range of salinity conditions making them relatively insensitive to the salinity effects of the Project. Based on a higher-salinity range, lane snapper are likely limited to the more marine habitats in Project area (lower basin, coastal passes, and nearshore environments). Changes in salinity may reduce the proportion of Barataria Basin that will be used by lane snapper as nursery areas although juveniles are most common in the late summer to early fall, when Project operations would have minimal impacts on salinity in the lower basin (see Figure 4.10-8). Further, the abundance and distribution of some prey species may change in response to changes in estuarine dynamics. As discussed in Section 4.10.4.5 (Key Species, Applicant's Preferred Alternative), this includes an anticipated decrease in brown shrimp, a preferred prey item (particularly for the gray snapper). Therefore, although salinity changes in the basin would not likely have a significant effect on the gray snapper, the projected decrease in brown shrimp may have an effect on the species. The lane snapper is likely less reliant on brown shrimp but may be more affected by changes in salinity. Overall, both species would likely experience a minor, indirect, adverse, and permanent impact from operation of the Project.

EFH for most highly migratory species occurs in offshore or nearshore waters, with EFH occurring on the seaward side of the barrier islands and the birdfoot delta (see Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-2). Two shark species have designated EFH in Barataria Bay, including the blacktip shark (juvenile and adult stages) and bull shark (all life stages). Four other shark species have designated EFH in the nearshore waters outside of Barataria Bay (spinner, scalloped hammerhead, finetooth, and sharpnose), but individuals may still use the Barataria Bay. Apart from bull sharks, these species tend to be found in salinities of 20 ppt or higher such that decreasing salinities from Project operations may reduce the area of Barataria Basin used by shark species. However, these shark species are likely to continue to use the Lower Barataria Basin in the vicinity of the barrier islands for feeding opportunities. In addition, the projected increase in emergent vegetation and SAV over time, compared to the No Action Alternative, may provide nursery habitat for bull sharks, which use low-salinity habitats. The sailfish and yellowfin tuna occur outside of the barrier islands and around the frontal edge of the Mississippi River plume, near the birdfoot delta, where impacts on water flow and salinity would be limited. Based on the predominant nearshore and offshore habitat use for these highly migratory species, the maintenance of higher salinities in the lower basin during most of the year, and the highly mobile nature of these species, habitat changes due to the Project are likely to have a negligible effect on these species.

4.10.4.3.3 Other Alternatives

Impacts on the water column and soft bottom EFH types from the other action alternatives generally show similar trends to the Applicant's Preferred Alternative for salinity, temperature, and turbidity and sedimentation, although the scale of these impacts are slightly less for the 50,000 cfs Alternatives and slightly more for the 150,000 cfs Alternatives. Similarly, impacts on SAV would not be different, although the terrace alternatives would result in additional indirect, permanent, minor (due to limited terrace acreage) benefits to SAV and marsh and associated species.

The Delft3D Basinwide Model projects that in the Barataria Basin, when compared to the No Action Alternative, there would be 9,200 acres (12.7 percent) more wetlands in 2070 for the 50,000 cfs Alternative, increasing incrementally across the alternatives and reaching a projected maximum increase in wetland acreage of 26,400 (36.3 percent) for the 150,000 cfs + Terraces Alternative in 2070 (see Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-4), which would have a proportionally major, permanent, indirect and beneficial impact on managed species that could use them. Conversely, wetlands would be lost in the birdfoot delta for all action alternatives, with a negligible difference in lost acreage compared to the Applicant's Preferred Alternative.

Impacts on hard substrates oyster reefs for the action alternatives would be similar to that described for the Applicant's Preferred Alternative. However, the 150,000 cfs Alternatives would result in slightly lower salinities over or near the Hackberry POSR and Barataria Bay POSG, which would likely result in further reduction of oyster propagation or lowered growth rates of oysters, respectively. Further, additional sediment would build up over time in the Little Lake POSG and low volumes of sediment are projected to settle on the Hackberry POSR. The lowered salinity and increased sedimentation in these public oyster grounds may result in a decrease in oyster propagation and burial of oyster reefs or dead shell habitat over time. Although the impacts of the 150,000 cfs Alternative would be greater than the other action alternatives, the overall impacts on hard substrates from any alternative would remain moderate, adverse or beneficial (in the case of decreased salinity in the Barataria Bay POSG), permanent, and indirect.

Although the action alternatives would have variable impacts on oyster reefs based on salinity, sedimentation, and location of the oyster grounds, all action alternatives would likely result in increased SAV due to lower salinities and a net increase of wetland acreage in the Project area. Overall, the net amount of structured EFH would likely increase for any action alternative, when compared to the No Action Alternative, which would result in major, beneficial, indirect, and permanent impacts on available EFH, but individually minor adverse impacts on the reef fish and negligible impacts on coastal migratory pelagic and highly migratory species present in the Project area. Impacts on remaining managed species (red drum, brown shrimp, and white shrimp) are discussed in Section 4.10.4.5 (Key Species).

4.10.4.4 General Impacts on Habitat and the Environment

Operational impacts on fauna that differentially depend on the Barataria Basin throughout the year as nursery, spawning, and foraging grounds are assessed in the following sections through multiple avenues. General impacts on fauna are assessed for each of multiple habitat characteristics that may be modified by the Project's operational alternatives, or the No Action Alternative, such as changes in oyster reefs or dead shell habitat through sedimentation, or changes in salinity through freshwater introduction. These assessments take into account the modeled projections (through the Delft3D Basinwide Model) of the change in habitat characteristics through year 2070; data from interdecadal periods (2030 through 2060) were reviewed as available and any notable differences are discussed below. The modeled projections are used in combination with literature- and field-based data to infer the potential impacts on fauna from operation, or lack thereof, of the proposed Project.

4.10.4.4.1 No Action Alternative

Under the No Action Alternative, ongoing changes in the Project area, such as relative sea-level rise and continuing coastal erosion within the Barataria Basin, would have accelerating impacts on salinity, marsh loss, and water levels over time, as projected by the results of the Delft3D Basinwide Model (see Section 4.2.3.2.1 in Geology and Soils).

4.10.4.4.1.1 <u>Water Flow and Tidal Transport</u>

As detailed in Section 4.4.4.2.2.2 in Surface Water and Coastal Processes, monthly water levels under the No Action Alternative would continue to trend upwards over the simulation period due to sea-level rise. Tides and wind-driven currents would continue to be the principal driver of circulation within the Barataria Basin. Existing circulation patterns would continue as discussed in Chapter 3, Section 3.4.2.4 Tides, Currents, and Flow in Surface Water and Coastal Processes. As relative sea level continues to increase, the existing tidal influence would extend farther northward into the basin, the daily tidal signal is projected to become stronger, and the overall tidal range is projected to be larger in 2070 as compared to 2020. This change over time would cause daily wetting and drying cycles from the tide to impact vegetation at locations farther north than existing conditions, which could alter primary productivity in existing wetlands, and increased water levels could cause prolonged inundation, leading to wetland loss and thus loss of faunal nursery habitat. This loss of habitat would have major, permanent, indirect and adverse impact on aquatic fauna.

Generally, sea-level rise with continued marsh loss would increase tidal influences and saltwater encroachment in the estuary, however some seasonal salinity changes would likely continue to occur during periods of high spring discharge from the Mississippi River. The overall process of larval recruitment, or transport, from marine habitats into and throughout the estuary would be expected to continue as general circulation patterns would not be expected to change; however, some localized changes in flow would occur over time as wetlands are lost.

4.10.4.4.1.2 Substrates

As discussed in Chapter 3, Section 3.10.5.1 Habitat Preferences and Environmental Requirements in Aquatic Resources, structured habitats such as oyster reefs or dead shell or SAV often have higher relative abundance of fauna when compared to soft bottoms as they can provide refuge and higher availability of food resources. Impacts on SAV are discussed in Section 4.10.4.1 and impacts on oysters are discussed in Section 4.10.4.5.

Sea-level rise and saltwater encroachment over time would continue under the No Action Alternative. These impacts would not likely affect the amount of hard substrate available, although live oysters may convert to dead shell habitat as salinity (and therefore predation and incidence of disease) increases.

4.10.4.4.1.3 Turbidity and Sedimentation

Sediment transport within the Barataria Basin would continue to be driven by storm events along with wind- and wave-induced resuspension, which may increase over time as emergent vegetation is lost (see Chapter 3, Section 3.4.2.5 Sediment Transport in Surface Water and Coastal Processes). The Delft3D Basinwide Model for the No Action Alternative projects that maximum average TSS concentrations would increase over time at all but one modeled station, while minimum average TSS concentrations would remain similar over the analysis period. The increase in maximums is likely related to increased salinity, which contributes to TSS. Details regarding TSS trends are available in Section 4.5.5.6 Total Suspended Solids in Surface Water and Sediment Quality.

4.10.4.4.1.4 Nutrient Loading

Under the No Action Alternative, the potential for increased contaminants and nutrients from freshwater inflows from the diversion into the basin, and associated impacts on aquatic resources as described for the Applicant's Preferred Alternative, would not occur.

4.10.4.4.1.5 Dissolved Oxygen

Under the No Action Alternative, current DO seasonal trends would continue, with lower DO levels during summer months throughout the basin; these trends shift by 1 or 2 months later in the year in the later modeled decades. In the birdfoot delta, DO is expected to continue the variable trends that reflect Mississippi River influence. The Delft3D Basinwide Model projects that average monthly DO concentrations stay relatively consistent through 2070 under the No Action Alternative.

4.10.4.4.1.6 Salinity and Temperature

Under the No Action Alternative, Project area salinity during the first decade of modeled conditions (2020 to 2030) is projected to be within the range of the existing monthly average salinities presented in Chapter 3, Section 3.5.2.2 Salinity in Surface Water and Sediment Quality. Average salinity in the Barataria Basin and birdfoot delta would continue to show seasonal variability, with the lowest salinities occurring in the spring and summer, and the highest salinities occurring in the fall and winter. These elevated winter salinities are projected to increase to different degrees throughout the basin, and extend farther north into the basin over the analysis period, most likely due to increased rates of sea-level rise projected by the Delft3D Basinwide Model from 2050 to 2070. This shift in salinity ranges would induce an indirect, moderate, and permanent impact on the Project area's existing faunal species assemblage as a whole, which would be beneficial or adverse to differing degrees for individual species depending on species' optimal salinity range. Details on the impact of salinity shifts under the No Action Alternative on individual key species are provided in Section 4.10.4.5. Shifts in the salinity regime, particularly between 2050 and 2070, could restrict the seasonal movements and result in changes to population distribution of some species as individuals avoid or become precluded from the portion of the Project area that has become too saline. The combination of salinity changes with other abiotic and biotic factors, such as wetland composition, results in ecosystem-level impacts as discussed below under Food Web and Ecological Interactions.

The Delft3D Basinwide Model results show the existing seasonal pattern, with maximum temperatures in the range of 86°F (30°C) in the summer and minimum temperatures in the range of 55.4°F (13°C) in the winter, projected to generally continue through 2070. The model projects that, over time, minimum and maximum water temperatures in the basin may show a slight increase (less than 1.8°F [1°C]) during the analysis period. This minimal increase in temperature would have a negligible, indirect impact on fauna, which would be beneficial or adverse depending on species optimal temperature ranges.

4.10.4.4.1.7 Emergent Vegetation

As described in detail in Section 4.6.5.1 Wetland Types and Extent in Wetland Resources and Waters of the U.S., the Delft3D Basinwide Model projected that, under the No Action Alternative, approximately 298,000 acres (80 percent) of existing marsh vegetation and other above-water landforms in the Barataria Basin would convert to shallow water between year 2020 and 2070, with the greatest percentage of freshwater and brackish losses (or conversion to more saline marsh) occurring near the end of the analysis period (2060 to 2070), when impacts from sea-level rise and subsidence would likely be greatest. While the largest proportion of marsh in the Project area is fresh at the beginning and end of the analysis period, the Delft3D Basinwide Model projects about a 172,500-acre (74 percent) loss or conversion of fresh marsh acreage between 2020 and 2070. The Delft3D Basinwide Model also projects about a 65,300-acre (92 percent) loss or conversion of brackish marsh, and a 60,500-acre (91 percent) loss of saline marsh acreage. Likewise, in the birdfoot delta, while the largest proportion of marsh in the Project area is fresh at the beginning and end of the analysis period, the Delft3D Basinwide Model projects about 39,200 acres (88 percent) of loss or conversion of fresh marsh acreage between 2020 and 2070, a 9,300-acre (90 percent) loss or conversion of brackish marsh, and a 4,000-acre (97 percent) loss of saline marsh acreage in this area. The loss of such a large percentage of the basin's marsh vegetation across all wetland types constitutes a major loss of faunal nursery habitat for aquatic species that utilize marsh in each salinity range. The loss of this habitat would have a major, permanent, indirect and adverse impact on fauna, particularly for species which require nursery habitat within brackish or saline conditions.

4.10.4.4.1.8 Food Web and Ecological Interactions

Rose et al. (2019) analyzed previously derived outputs from two food web modeling platforms for the Mississippi River Delta region, the CASM and the EwE model, as well as a suite of model-derived ecosystem indicators to illustrate the structure and energy flows of the Barataria Basin aquatic food web. This study indicated that (a) detritus plays a very important role in fueling the food web; (b) increased productivity in the spring is channeled up the food web through a relatively few pathways and species compared to the rest of the year; (c) energy flows up the food web but quickly dissipates within the first few trophic levels with a lot of consumers eating several of the lower trophic levels (plankton, algae, infauna) as well as small shrimps and crabs; (d) the Barataria Basin food web is relatively complicated and provides many potential pathways for energy to flow to consumers; and (e) because of the redundancy of pathways, the food web shows a high degree of resilience.

With increased salinity and water levels, and more open water in the Barataria Basin, a general shift in the existing estuarine species assemblages and relative abundance of fauna throughout the basin is expected. The system would likely shift over time to support more coastal and marine species (for example, snappers, mackerels) and away from more freshwater fauna (for example, bass, sunfish, catfish) with salinity encroachment continuing into the estuary. Unless the converted open waters remain shallow enough to support SAV establishment and growth in place of the lost marsh, the production of shrimp, crab, and estuarine fishes like minnows, killifish, pinfish, seatrout, croaker, and drum that rely on vegetated habitats in the estuary, particularly as juveniles, could decline (LaPeyre and Gordon 2012, Castellanos and Rozas 2001, Ault et al. 1998, Minello et al. 1989, Browder et al. 1989, Turner and Boesch 1988). In a system that would become predominantly open water and soft bottom habitat with a low amount of wetlands, the food web would likely become more plankton-based and less detrital-based. This would represent a reduction in net system energy flow, trophic diversity, and faunal diversity compared to the existing system. The system could therefore be less resilient compared to one with multiple trophic pathways and detrital subsidies.

This shift in species assemblage, reduced trophic diversity, and lost production would be a major, permanent and direct impact of the No Action Alternative. While such a shift in species assemblage and loss of trophic diversity would inherently benefit certain species while adversely impacting others, the shift is neither beneficial nor adverse from an ecosystem-level perspective; however, lost wetland habitat, detritus and benthic production, and estuarine-dependent species recruitment is a major adverse impact to primary and secondary production and food web energy cycling in the estuary.

4.10.4.4.2 Applicant's Preferred Alternative

4.10.4.4.2.1 Water Flow and Tidal Transport

As discussed in Section 4.4.4.2 in Surface Water and Coastal Processes, operational impacts of the Applicant's Preferred Alternative on existing currents and flow would be direct, permanent and minor to major (depending on distance from the immediate outfall area) due to widespread and readily apparent impacts on water flow velocity and direction when the proposed Project is operating above base flow (greater than 5,000 cfs and up to 75,000 cfs depending on flows in the river). Tides would not be altered, other than from overall impacts of higher water levels related to sea-level rise. It is likely that high currents during diversion openings could modify and potentially disrupt transport and settlement of larval and juvenile fish and invertebrates that would normally be carried to nursery habitats in the outfall area (Rose et al. 2014, citations therein). However, larval transport and retention is likely to be unaffected in the most western and southern regions of the basin, in areas where tidal flow is unaffected by diversion operation.

A previous study in the Barataria Bay characterized flow fields and their impact on larval transport and retention, with blue crab selected as the model species. The study determined that tides were the most important factor for larval inflow into the Barataria Bay, with wind altering the direction of advection in the Barataria Bay (but less so in more secluded bays like Hackberry Bay and Bay Batiste) (Schaefer 2001). Other factors noted in the study as affecting advection were coastal topography, bathymetry, and the location of larvae in relation to tidal passes at the start of an ebb tide (Schaefer 2001). Schaeffer (2001) and citations therein acknowledge that estuaries with substantial freshwater input generally have a net seaward flow at the surface and net upstream flow at depth, and indicate how larvae are flushed or retained in the estuary by moving up or down in the water column, respectively. Larval movement is not restricted to passive movement with tides and many larvae demonstrate active responses to currents as a strategy to avoid down-estuary displacement (Glas et al. 2017, Garrison and Morgan 1999, Boehlert and Mundy 1988, Hartman et al. 1987). These authors describe specific dispersal strategies in estuarine larvae to enhance up-estuary movement or avoid down-estuary movement, such as: vertical migration of larvae during incoming tide and absence in the water column on ebb tides; use of visual or tactile cues to orient larvae with respect to microhabitat type; and lateral positioning to increase the probability of being able to move into a suitable habitat when it is close.

Because Barataria Bay is relatively shallow, the flow field is considered to be vertically homogenous and depth regulation and vertical migration by larvae to maintain or change horizontal position during an ebb tide may be limited (Park 1998, Schaeffer 2001). Nevertheless, there are a number of habitat settings, including tidal passes, pockets of greater depths, channel margins, small areas in close proximity to and down-flow from landforms, and shallow vegetated areas, where this effect will be less impactful and larval recruitment will occur (Schaeffer 2001). Ultimately, the overall process of larval advection, or transport of larvae, from marine habitats into the estuary would generally be unaffected given the lack of change in the primary advection drivers (tidal currents and wind). The Delft3D Basinwide Model data using the representative hydrographs for the first (2020 to 2029) and fourth (2050 to 2059) decades project that tidal patterns at passes along the barrier islands would not change drastically during operation of the diversion, although the outflowing water is often projected to move at a slightly higher velocity compared to the No Action Alternative in the first decade (the fourth decade shows less of a consistent pattern in velocity changes). For example, the daily tide through Barataria Pass moves into Barataria Bay in a northwestern pattern, then reverses over the course of the day to flow in a southeastern pattern; although slight modifications in the tidal signal would occur (such as a sporadic day without northwestern flow), the general trend of daily northwest-to-southeast flow would remain during Project operations.

As depicted in Figure 4.10-4, modeled sites[64] further north in the basin show variable flow trends during operation of the diversion above base flow in the first decade of operations. Sites in the outfall area are often projected to show a change in flow patterns, including changes in tidal signals or single direction flow. For example, the Oaks Bayou Station, which shows an east/west tidal signal for the No Action Alternative, shows a predominantly westbound flow during Project operations above base flow, with eastbound flow only projected to occur on sporadic days and not at all during maximum flows. Sites further in the outfall area are projected to have roughly similar flow patterns to the No Action Alternative, although flow direction may be modified or reversed on some days, and velocity may change. For example, the Little Lake to Grand Bayou Station has similar east/west tidal oscillations for both the Applicant's Preferred Alternative and the No Action Alternative; however, for the Applicant's Preferred Alternative, velocity generally increases (eastbound) or decreases (westbound) compared to the No Action Alternative, possibly resulting in less saltwater and larvae being transported into Bay Dosgris. The impacts on flow (velocity and direction) are highly variable and generally change based on amount of discharge above baseflow with limited impacts at lower flows (for example, below 40,000 cfs) and increased impacts with higher discharge. As wetlands are lost over time, flow patterns change and impacts on flow direction decrease further afield (see Figure 4.10-5).

[64] The modeled stations were chosen to represent areas with the highest velocities (that is, those occurring mid-channel) with depth averaged flow, and are therefore considered conservative representations of velocity and flow at a given location.

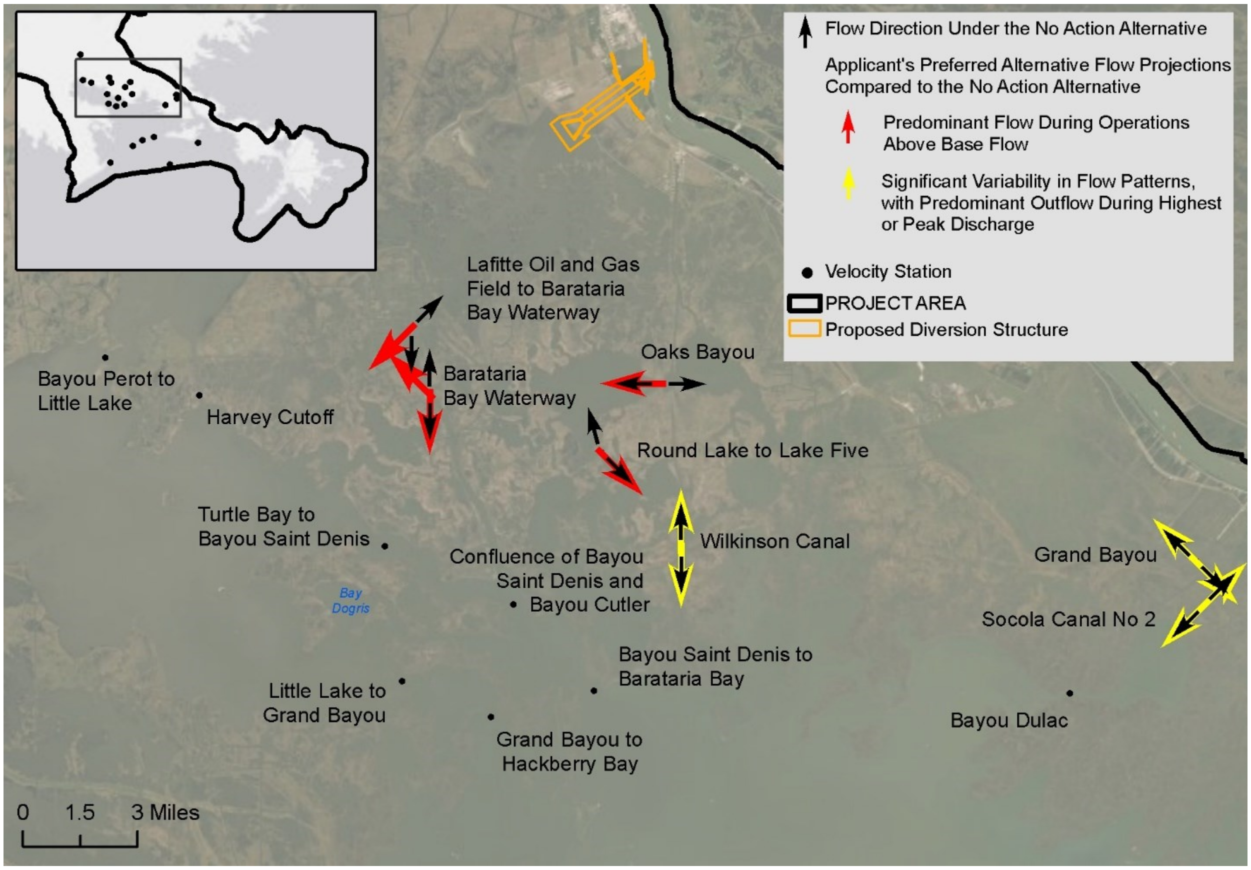


Figure 4.10-4. Changes in Water Flow Direction Between the No Action Alternative and the Applicant's Preferred Alternative During Diversion Operation Above Base Flow Between 2020 and 2029. Note: Where arrows are not depicted, flow direction between the No Action Alternative and the Applicant's Preferred Alternative are similar.

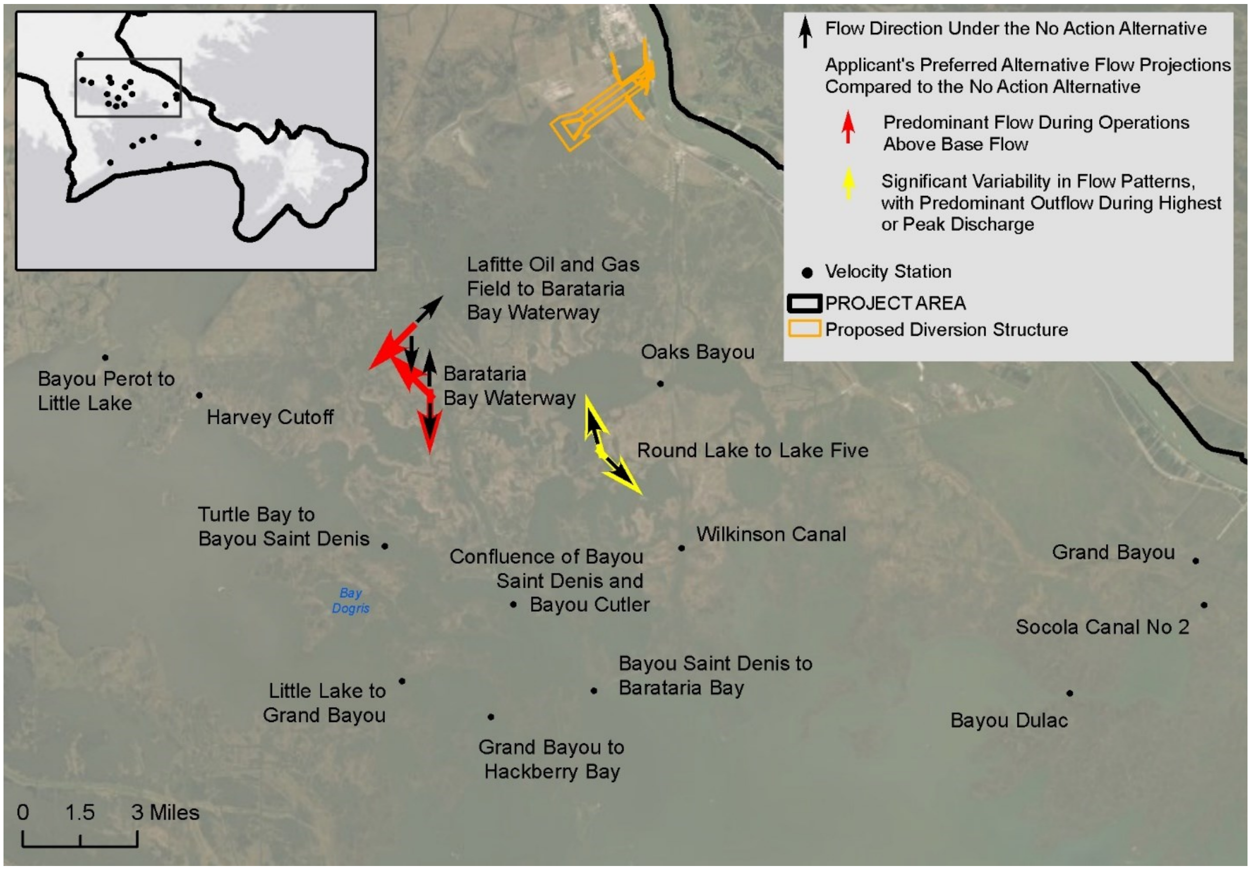


Figure 4.10-5. Changes in Water Flow Direction Between the No Action Alternative and the Applicant's Preferred Alternative During Diversion Operation Above Base Flow Between 2050 and 2059. Note: Where arrows are not depicted, flow direction between the No Action Alternative and the Applicant's Preferred Alternative are similar.

Depending on the timing and duration of larval influx, which varies by species (see Section 4.10.4.5 below) and the volume of discharge from the diversion, it is likely that larvae of some species would be restricted to differing degrees from advection into portions of the Barataria Basin, or that advection may be delayed and may occur in larger pulses when saltwater is able to push throughout the basin. Further, the changing currents in the outfall area of the proposed Project would also be likely to result in the modification of larval transport and juvenile settlement in and around the outfall area, with the impacts of high outflow decreasing with increasing distance from the immediate outfall area. However, as discussed above, recruitment could still occur in areas that are less affected by these flows (for example, tidal passes, channel margins, down-flow from landforms), even at stations where modeled flow directions are significant (see Figures 4.10-4 and 4.10-5). Similar instances of freshwater plumes possibly acting to restrict or preclude larval transport have been documented in previous studies, although juvenile catch rates in LDWF data were identified as recovering within 2 months, suggesting that sufficient larval transport and recruitment occurred in the system to offset impacts from the freshwater pulse (CPRA 2019b, Govoni 1997). The disruption of larval transport in the outfall area, and in certain areas of the Barataria Basin, could lead to larvae being precluded from settling in optimal habitats, transported to available suitable habitats outside the outfall area, or transported to unsuitable habitats; movement into less suitable habitats may result in reduced growth and increased mortality (Rose et al. 2014). These impacts would result in minor to major, permanent (recurring throughout the Project life), direct, and adverse impacts on faunal recruitment depending on the spatial and temporal overlap of high diversion flows (which can differ on an annual basis) and larval transport periods (which differ by species).

4.10.4.4.2.2 Substrates

As discussed in Chapter 3, Section 3.10.5.1 Habitat Preferences and Environmental Requirements in Aquatic Resources, structured habitats such as hard substrates (oyster reefs or dead shell) or SAV often have higher relative abundance of fauna when compared to soft bottoms as they can provide refuge and higher availability of food resources. Impacts on SAV are discussed in Section 4.10.4.1 and impacts on oysters are discussed in Section 4.10.4.5. POSG, POSR, and oyster leases, which are considered for purposes of this assessment to include areas of hard, structured substrate that provide high quality habitat for fauna, are predominantly outside the areas where projected changes in bed elevation from the diversion would occur. However, based on the Delft3D Basinwide Model, by 2070 the Applicant's Preferred Alternative is projected to result in about 4,778 acres of the Little Lake POSG receiving up to 10 inches of sediment (total over 50 years) associated with diversion of the Mississippi River (see Figure 4.10-6). Although Banks et al. (2016) has indicated a lack of data regarding the actual acreage of reef habitat within the Little Lake POSG, any hard substrate present within the 4,778 affected acres would likely be converted to soft or unconsolidated sediments over time. Similarly, hard substrate within the few oyster leases projected to be affected by sedimentation may be converted to soft bottom. However, any hard substrate present in unaffected areas of the Little Lake POSG and in other oyster leases would remain as habitat for fauna.

Oyster reefs provide the majority of hard substrate required by other sessile invertebrate species such as barnacles, bryozoans, tunicates, and anemones (LDWF 2021, Henderson and O'Neil 2003). In addition, the hooked mussel is another reef-associated benthic bivalve that can compete with oysters for settlement surfaces and food sources in salinities of less than 10 ppt (LDWF 2021). The influx of nutrients from the Mississippi River would be an overall benefit to the food web (see Section 4.10.4.4.2.8 Food Web and Ecological Interactions) and could stimulate the growth and/or population expansion of these organisms, potentially increasing, or assisting in the maintenance of, the structured habitat available for other species' use. However, given sedimentation of existing hard substrate, as discussed above, the potential growth of these species would likely result in a negligible benefit to the extent of structured habitat available for other species. Therefore, the indirect impacts from increased sedimentation on the Little Lake POSG and a small percentage of oyster leases, even considering potential benefits from the growth of other fouling organisms, would result in minor to moderate, permanent, and adverse impacts on hard substrates.

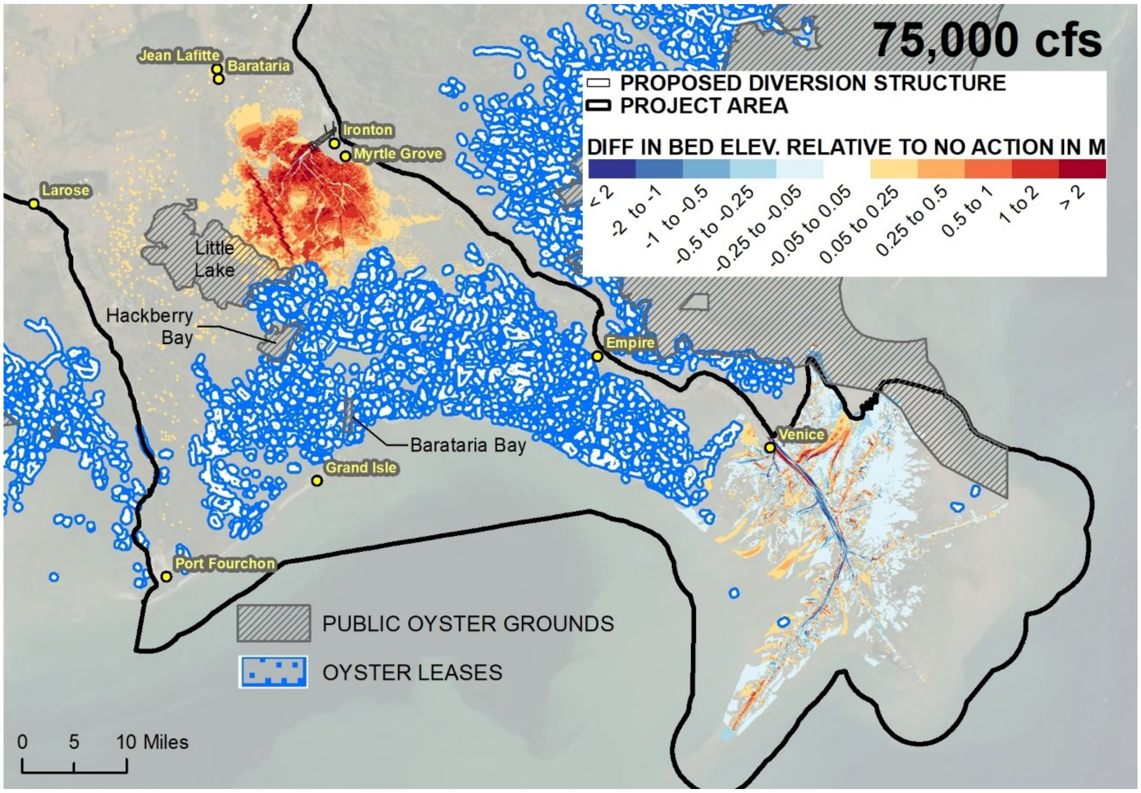


Figure 4.10-6. Bed Elevation Over Public Oyster Grounds from the Applicant's Preferred Alternative in 2070 as Compared to the No Action Alternative.

4.10.4.4.2.3 Turbidity and Sedimentation

Operation of the diversion would allow for the input of fresh water and sediment (including contaminants) into the Barataria Basin. The Delft3D Basinwide Model projects that the Applicant's Preferred Alternative would cause a permanent, minor to moderate increase in average TSS concentrations in the Barataria Basin during Project operations, with greater (moderate) increases in TSS concentration compared to the No Action Alternative near the diversion and central basin. The Applicant's Preferred Alternative is projected to cause a negligible difference in average TSS in the birdfoot delta. Additional details regarding TSS trends are provided in Section 4.5.5.6 in Surface Water and Sediment Quality, Total Suspended Solids). While TSS concentration is not a direct measurement of turbidity, it is an indication of the water clarity. It is also a potential indicator of suspended sediments in the water column that have the potential to settle out during sedimentation.

Previously constructed and operational diversions in the vicinity of the proposed Project have included pre- and/or post-diversion sampling that may indicate the potential impacts of introduced contaminants that could be expected from the proposed Project. The Caernarvon Diversion allows up to 8,000 cfs of fresh water and sediment to flow from the east bank of the Mississippi River, south of New Orleans, to the Breton Estuary. The Davis Pond Freshwater Diversion allows for up to 10,650 cfs of fresh water from the west bank of the Mississippi River into Lake Cataouatche, in the Upper Barataria Basin.

Fat-soluble contaminants are biomagnified through the food web, increasing exposure to higher trophic levels. For example, planktivorous fish would have less exposure to these contaminants than piscivorous fish. Fry and Chumchal (2012) studied mercury bioaccumulation in relation to Louisiana river diversions to test for unintended mercury contamination from floodplain restoration projects. The study determined that mercury concentrations in fish were about 1.7 times higher in areas with greater than 10 years of diversion inputs (in Breton Sound, near the Caernarvon Diversion) over background values. Shorter-term diversion inputs (2 to 3 years from Davis Pond) did not show strong mercury enrichment, leading the researchers to postulate that the longer-term diversion in Breton Sound allowed for increased epiphytic communities on SAV, which may act as mercury cycling hotspots.

In a separate study, USFWS monitoring results indicated that contaminant levels in the Caernarvon outfall area were not substantially different post-diversion compared to pre-diversion (LDWF 2010b). For the Davis Pond Freshwater Diversion, analyses of several contaminants in biota tissues showed lower levels 6 years post-diversion than in pre-diversion samples, and lower than in samples from the Mississippi River, and no gross abnormalities in skeletal, skin, or internal morphology were noted in collected fish (Jenkins et al. 2012). Although these studies imply negligible impacts on fauna from the influx of river contaminants, the substantially larger outflow of the proposed diversion may result in increased contaminant levels in biota.

Water quality analysis following freshwater diversion at Caernarvon found low impacts on water quality and a rapid assimilation of TSS, which remained elevated over short distances (Lane et al. 1999). However, the proposed diversion would be substantially larger and would result in substantially more sediments being released into the Barataria Basin. Section 4.4.3.2 in Surface Water and Coastal Processes indicates a major increase in bed elevation by 2070 within 10 miles of the diversion outlet, with minor to moderate changes extending further, but negligible impacts elsewhere in the basin (see Figure 4.10-6), which illustrates the likely spatial extent of increased turbidity and TSS in the Project area. However, these impacts would occur over time (see Section 4.4 Surface Water and Coastal Processes, Figure 4.4-3) such that impacts on fauna would occur over the course of the proposed Project. Increases in turbidity and TSS over time may result in reduction of available DO, reduction in swimming performance, and physical abrasion (including gill trauma) (Kjelland et al. 2015). Turbidity within the water column could also result in temporary disruption of predator-prey interactions. Based on the anticipated impacts on sediment resuspension in the water column, and the large outflows (and extension of sediment suspension time) associated with the proposed diversion, impacts on fauna from the Applicant’s Preferred Alternative would generally be direct and indirect, adverse, temporary during diversion openings (but permanently recurring throughout the analysis period), and negligible to moderate, with more moderate impacts occurring in the immediate outfall area and decreasing in intensity with distance from the diversion structure. As the Applicant’s Preferred Alternative is projected to cause a negligible difference in TSS in the birdfoot delta as compared to the No Action Alternative, no increased impacts on aquatic resources are anticipated in this area.

4.10.4.4.2.4 Nutrient Loading

As described in Chapter 3, Section 3.10, Aquatic Resources, shifts in species composition of phytoplankton communities are commonly attributed to changes in nutrient supply ratios, and primarily from nitrogen and phosphorus (Bricker 1999). Although the basin is not oligotrophic (lower in nutrients and primary productivity), Section 4.5.5 in Surface Water and Sediment Quality indicates that certain nutrients, such as total nitrogen and total phosphorus concentrations in the basin, would be elevated compared to the No Action Alternative, allowing for the increased primary productivity. Nixon and Buckley (2002) reviewed field experiments and observations of nutrient input into Scottish lochs, the Baltic Sea, and the North Sea, and determined that there are strong correlations between nutrient augmentation of primary production and the yield of fish and standing crop of benthic macrofauna (such as oysters) in phytoplankton-dominated marine ecosystems, where the input of inorganic fertilizers resulted in the “enhancement of benthos” and increased growth rates in fish. However, Nixon (2009) indicates that this increase in nutrients occurs in deeper systems (greater than or equal to 16.4 feet), whereas studies of shallower systems (3.3 feet deep coastal lagoon mesocosms) indicate a shift in primary producers, but not necessarily an increase in overall system production. As Barataria Bay has an average depth of 3.3 to 6.6 feet (Orlando et al. 1993, Turner et al. 2019), the overall increase in production may be limited.

Algal blooms, which can be beneficial or adverse depending on the size and species composition of the bloom, generally occur in late spring to early fall, following increased discharges from upstream snowmelt and surface runoff that allows for nutrient loading in the receiving system (Bargu et al. 2019, Riekenberg et al. 2015). For example, the diversion at Caernarvon is a major source of nutrients to the Breton Sound Estuary and phytoplankton blooms that occurred in the months following a period of diversion discharge suggested that nutrient loading may have been a contributing factor to the blooms (Day et al. 2009). A more recent study of diversion operations in the Breton Sound Estuary identified that changes in diversion flow, salinity, and specific nutrient concentrations caused shifts in the plankton community, with the highest abundance of potentially toxic genera occurring during the warmer, low-flow periods (Riekenberg et al. 2015). However, a review of currently available data acknowledges the scientific community’s lack of understanding regarding plankton community shifts under varying environmental conditions (Bargu et al. 2019).

The Delft3D Basinwide Model projects that the largest changes in monthly average chlorophyll A levels (a proxy for phytoplankton biomass) would occur closest to the diversion structure. For many of the closest stations, notable decreases in chlorophyll A levels are projected to occur in spring months (likely due to high turbidity limiting light availability for phytoplankton growth), followed by notable increases in chlorophyll A levels in the summer and early fall months (when the diversion is operating at or near the 5,000 cfs base flow and turbidity has decreased), indicating similar trends to those described by Day et al. (2009), above. However, increases in algal blooms are projected to occur earlier in the season (during operational months) at stations further from the diversion structure, where water clarity and residence times may be more conducive to algal growth during diversion operation above base flow. Notable changes in chlorophyll A concentrations are not projected to occur in the birdfoot delta as compared to the No Action Alternative.

Based on these lines of evidence, an increased potential (and frequency) of phytoplankton blooms would be likely within the Project area. Whether or not these blooms would become HABs cannot be definitively determined based on currently available knowledge, but if nutrient input from the proposed Project were to trigger HABs in the Barataria Basin, impacts on fauna would likely be adverse, minor to major, and temporary to short-term, depending on the size and intensity of the bloom, and resulting in death or sub-lethal impacts (for example reproductive health, behavioral impacts) on exposed individuals, as well as bioaccumulation of toxins up the food chain (CeNCOOS 2018).

Overall, although nutrient loading may result in beneficial impacts on the estuarine environment within the basin through an increase in primary productivity and available food sources, it may also result in detrimental impacts from potential increases in the size and frequency of HABs. Further, and as discussed below, increases in phytoplankton biomass may result in decreases in DO. Therefore, impacts on fauna from nutrient loading could result in indirect, minor to moderate (depending on an organisms' place in the food web), permanent, and beneficial impacts on fauna within the Barataria Basin through food web production, but may also result in direct and indirect, temporary (but recurring), minor to major, and adverse impacts on the estuarine community through the potential production of HABs and die-offs from phytoplankton blooms causing pockets of low DO. As the Applicant's Preferred Alternative is projected to cause a negligible change in nutrient loading in the birdfoot delta, no such impacts on aquatic resources from increased nutrient loading are anticipated in this area.

4.10.4.4.2.5 Dissolved Oxygen

As discussed in Chapter 3, Section 3.5.2.6 Dissolved Oxygen in Surface Water and Sediment Quality, DO changes in response to multiple factors, including temperature and the specific conductance of water, such that warmer and saltier waters often result in lower DO and cooler and lower salinities often result in higher DO. As discussed further below, much of the Barataria Basin is anticipated to have lower salinity and temperatures due to the diversion of cooler fresh water from the Mississippi River. In addition, biological processes, such as photosynthesis, ongoing biological processes, and algal blooms caused by nutrient loading may result in changes to DO concentrations.

The Delft3D Basinwide Model projects that chlorophyll A concentrations indicative of increased algal production would occur in spring and early summer within the basin and birdfoot delta, but that monthly mean DO would not decrease to hypoxic levels (2 to 3 mg/L or below) throughout the analysis period, with the lowest concentration projected to be 5.6 mg/L in the summer. However, as the Delft3D Basinwide Model projects monthly averages of depth-averaged DO only, sporadic pockets of low DO or low bottom-layer DO may nonetheless occur within the basin. Pockets of low DO would be most likely to occur during warmer months and at night, when respiration continues but photosynthesis is precluded by the lack of light. Some species avoid areas of low DO, even if hypoxic conditions are not met. For example, southern flounder avoid DO levels below 4 mg/L (Bell and Eggleston 2005, Eby and Crowder 2002), although they have also been observed to acclimate to DO levels below 4.5 mg/L (Taylor and Miller 2001).

Primary production stimulated from nutrient input would also result in organic matter accumulating at the sediment layer, where its decomposition could result in decreases in DO (Reed and Harrison 2016). Further, although fecal coliform (an indicator of the potential presence of pathogenic organisms) and enterococci are not harmful to fish and shellfish themselves (ADEM 2022), Project operations would increase these bacterial levels in the Barataria Basin (see Section 4.5.5.8 Fecal Coliform), which could result in increased oxygen demand and therefore lower DO levels (USEPA 2012). The impacts of fecal coliform on oyster propagation and harvest are discussed in Section 4.14.4.1.3 Eastern Oyster Fishery.

In areas where water layers are stratified (where salinity or temperature differences preclude mixing of upper and lower water boundaries), this DO draw-down could result in bottom-layer hypoxia or sub-optimal levels of bottom DO, which would not be evident in the Delft3D Basinwide Model projections. The Barataria Basin is generally considered to be well mixed given the wind, tides, and its shallow average depth (Turner et al. 2019); however, weak-to-moderate stratification does occasionally occur in deeper portions of Barataria Bay, such as the island passes and Barataria Waterway (Orlando et al. 1993).

Therefore, although sporadic and limited areas of low DO may occur, mainly in the summer months, no large or prolonged periods/layers of low DO are projected by the Delft3D Basinwide Model, nor anticipated based on the Barataria Basin's identification as a largely well-mixed estuary. Within any pockets of low DO that do form, mobile faunal species are likely to disperse as DO decreases, although mortality may occur in limited instances of larger or prolonged pockets, resulting in a temporary and negligible to minor, adverse, and indirect impact on those species. DO impacts on less or non-mobile benthic species are discussed in Section 4.10.4.2.

4.10.4.4.2.6 <u>Salinity and Temperature</u>

4.10.4.4.2.6.1 Salinity

As discussed in detail in Section 4.5 Surface Water and Sediment Quality, the Delft3D Basinwide Model projects that the Applicant's Preferred Alternative would cause permanent, minor to moderate changes to salinity (primarily decreasing salinity) in the Barataria Basin during Project operations. The model projects that minimum average monthly salinities would be consistently lower than those under the No Action Alternative, with the exception of the area near the birdfoot delta, which would slightly increase in salinity over time due to projected sea-level rise increases and subsidence rates, as well as Project-related morphological changes (water elevation and bottom elevation changes). In general, all portions of the basin are projected to experience lower minimum average monthly salinities throughout the analysis period while the diversion is operating above base flow, although salinities increase to No Action Alternative values after the diversion returns to base flow. In the first 3 decades of operations, minimum annual salinities are projected to occur in the northern and western basin during months that these areas would experience their maximum annual salinities under the No Action Alternative. In latter decades, the western area of the basin is projected to follow a seasonal pattern more similar to the No Action Alternative. Regardless of seasonal patterns, the northern and western portions of the basin are projected to experience lower minimum and maximum salinities than under the No Action Alternative, and to have less salinity variability (difference between minimum and maximum average monthly salinities) in the first 3 decades of Project operation.

In the central and southern portions of the basin, the seasonal pattern of minimum and maximum salinities is projected to remain similar to that under the No Action Alternative, but minimum and maximum salinities are projected to be lower over all decades in the central portion of the basin. Maximum salinities in this area are projected to increase over time, but would still remain lower than the maximum salinities projected under the No Action Alternative. Salinity variability is thus projected to increase slightly over time in the central basin as maximum salinities increase over time due to sea-level rise. In the southern portion of the basin, while minimum salinities are projected to be lower than that under the No Action Alternative in all decades, the maximum salinities are projected to remain similar to those under the No Action Alternative; thus, as maximum salinities rise over time due to sea-level rise, salinity variability would increase over time in this portion of the basin. To illustrate the projected spatial and temporal shifts in salinity, Table 4.10-5 provides the projected salinity ranges (maximum and minimum) for each decade at representative stations throughout the basin, as well as the months that each are projected to reach these maximum and minimum salinities.

As further illustration of intra-annual variability, Figures 4.10-7 and 4.10-8, respectively depict salinity changes at the Barataria Waterway Station (southwest of the diversion structure; see B. Waterway in Figure 4.10-9) and the southwestern station near Grand Isle (see B. Pass at GI in Figure 4.10-9). Salinity figures for the additional representative stations identified in Figure 4.10-9 are provided in Appendix N. The top charts in each figure below represent the projected salinities for the No Action Alternative and Applicant's Preferred Alternative over any given year in the identified decade (either 2020 through 2029 or 2070 through 2079 as depicted). The middle charts identify the difference in salinities between the No Action Alternative and Applicant's Preferred Alternative. The bottom charts identify the projected timing and volume of discharges for the diversion structure utilizing a representative hydrograph. Each figure identifies that, for both the No Action Alternative and the Applicant's Preferred Alternative, salinity in the basin varies naturally during the course of the year according to various environmental factors. However, the Applicant's Preferred Alternative is projected to decrease salinity to a greater degree when the diversion is operating above base flow. For example, once the diversion begins operating above base flow, the Barataria Waterway Station would reach or approach 0 ppt, indicating that certain intermediate habitats would essentially be fresh during periods of each year, and that some of these salinity regime shifts would be rapid (see Figure 4.10-7). Changes in salinity regimes during diversion openings at the southwestern station near Grand Isle (B. Pass at GI) (see Figure 4.10-8) are also projected with normally higher-salinity habitats decreasing to, in some cases, 0 ppt. However, the Barataria Waterway Station shows prolonged periods of decreased salinity, as opposed to the southwestern station near Grand Isle (B. Pass at GI), which is projected to have quickly oscillating peaks and drops in salinity.

Previous studies have investigated the impacts of salinity shifts on fish assemblages and biomass. For example, catch data for red drum and spotted seatrout within the area of influence of the Caernarvon freshwater diversion showed an increase in the catch of these species post-operation, including in areas with low salinity (LDNR 2003a, 2003b). Red drum were caught both below and above salinities of 5 ppt, while spotted seatrout were caught more frequently above 5 ppt. Furthermore, finfish biomass increased by 62 percent post-operation, though this increase could in part be due to increased presence of freshwater species (LDNR 2003a). In contrast, an analysis of fisheries-independent monitoring data showed no strong indication of changes in the CPUE or distribution of five fishery species in Breton Sound from the Caernarvon Diversion (Sable and Villarrubia 2011). Fishery-independent data collected to monitor the impacts of Davis Pond Freshwater Diversion found mixed results (Plitsch 2014). For example, the CPUE for red drum and spotted seatrout was variable, but relatively stable before and after the diversion opening. Since the diversion opening, the Plitsch (2014) report shows red drum CPUE increased steadily for gillnets and electrofishing, but decreased slightly in trammel nets and creel surveys. Similarly, there was an increase in spotted seatrout CPUE in gillnets and creel surveys, but a slight decrease in trammel nets and electrofishing. While studies regarding the Caernarvon and Davis Pond Freshwater Diversions offer insight into the possible impacts of freshwater introductions on aquatic fauna, the scale at which these diversions operate is much smaller than the flows anticipated under the Applicant's Preferred Alternative and thus the spatial extent of freshening is smaller than that of the Applicant's Preferred Alternative.

Table 4.10-5
Projected Salinity Ranges by Decade at Representative Stations with Applicant's Preferred Alternative

		Northern/Mid-Basin (CRMS 3985)		Station Nearest Diversion (CRMS 0276)		Central Station (CRMS 0224)		Western Station (Little L. Cutoff[a])		Southwestern, Barataria Pass near Grand Isle[b] (B. Pass at GI)	
		Salinity (ppt)	Months	Salinity (ppt)	Months	Salinity (ppt)	Months	Salinity (ppt)	Months	Salinity (ppt)	Months
2020	Min	0	Jan to Dec	0	Jan to Dec	0	Mar, May to Jul	0	Feb to Oct, Dec	3	May
	Max	0		0		7	Nov	1	Jan, Nov	22	Aug, Nov
2030	Min	0	Jan to Dec	0	Jan to Aug	0	Feb to Jul	0	Feb to Oct, Dec	2	May
	Max	0		1	Sep to Dec	8	Nov	1	Jan, Nov	21	Nov
2040	Min	0	Jan to Dec	0	Jan to Aug, Nov to Dec	0	Mar to May, Jul	0	Feb to Dec	3	Apr
	Max	0		1	Sep to Oct	5	Sep to Oct	1	Jan	23	Aug
2050	Min	0	Jan to Dec	0	Feb to Aug	0	Mar to Jul	0	Feb to Oct, Dec	2	May
	Max	0		3	Nov to Dec	10	Nov	2	Jan	24	Jan
2060	Min	0	Feb to Dec	0	Feb to Aug	0	Mar to Jun	0	Feb to Jul, Oct	2	May
	Max	1	January	4	Nov	11	Nov	3	Jan	25	Jan
2070	Min	0	Mar to Oct	0	Feb to Jul	0	Mar to Jun	0	Mar to Jun	4	Apr to May
	Max	1	Jan to Feb, Nov to Dec	7	Nov	16	Nov	6	Jan	28	Jan

[a] USGS 07380335
[b] USGS 073802516

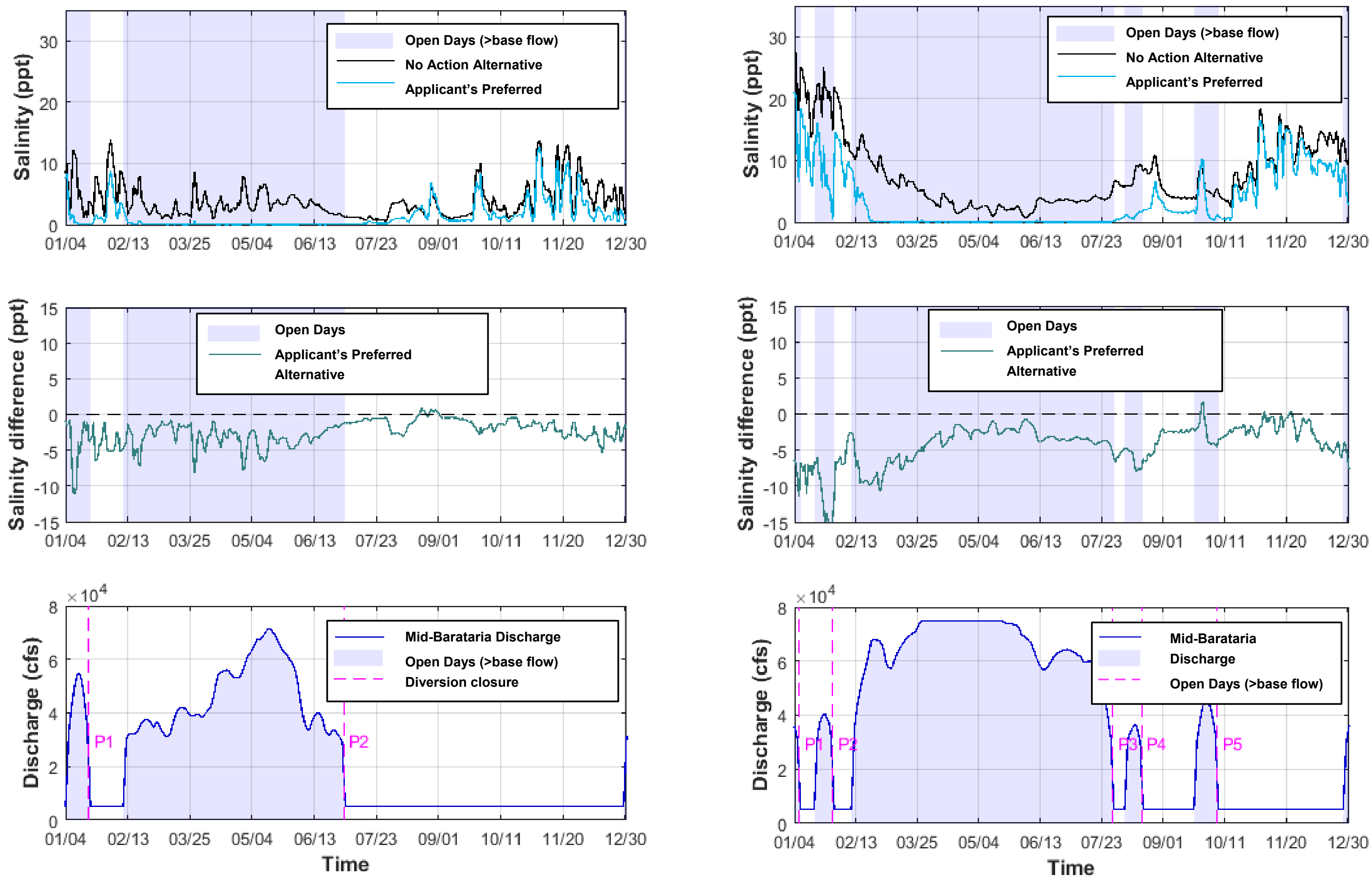


Figure 4.10-7. Projected Annual Variability in Salinity at the Barataria Waterway Station from 2020 to 2029 (left) and 2070 to 2079 (right). Note: P = pulse.

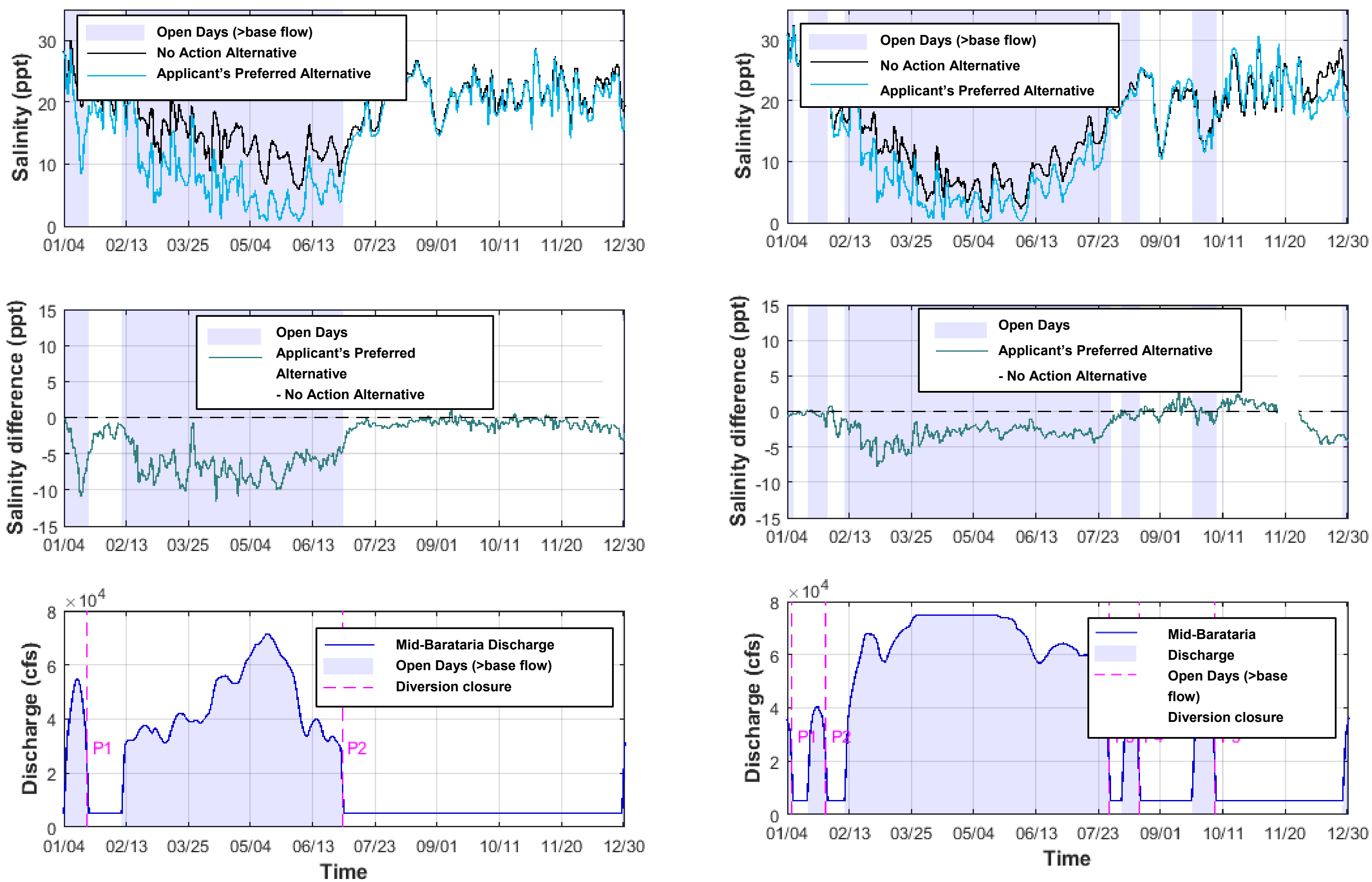


Figure 4.10-8. **Projected Annual Variability in Salinity at the Grand Isle Station from 2020 to 2029 (left) and 2070 to 2079 (right).**
Note: P = pulse.

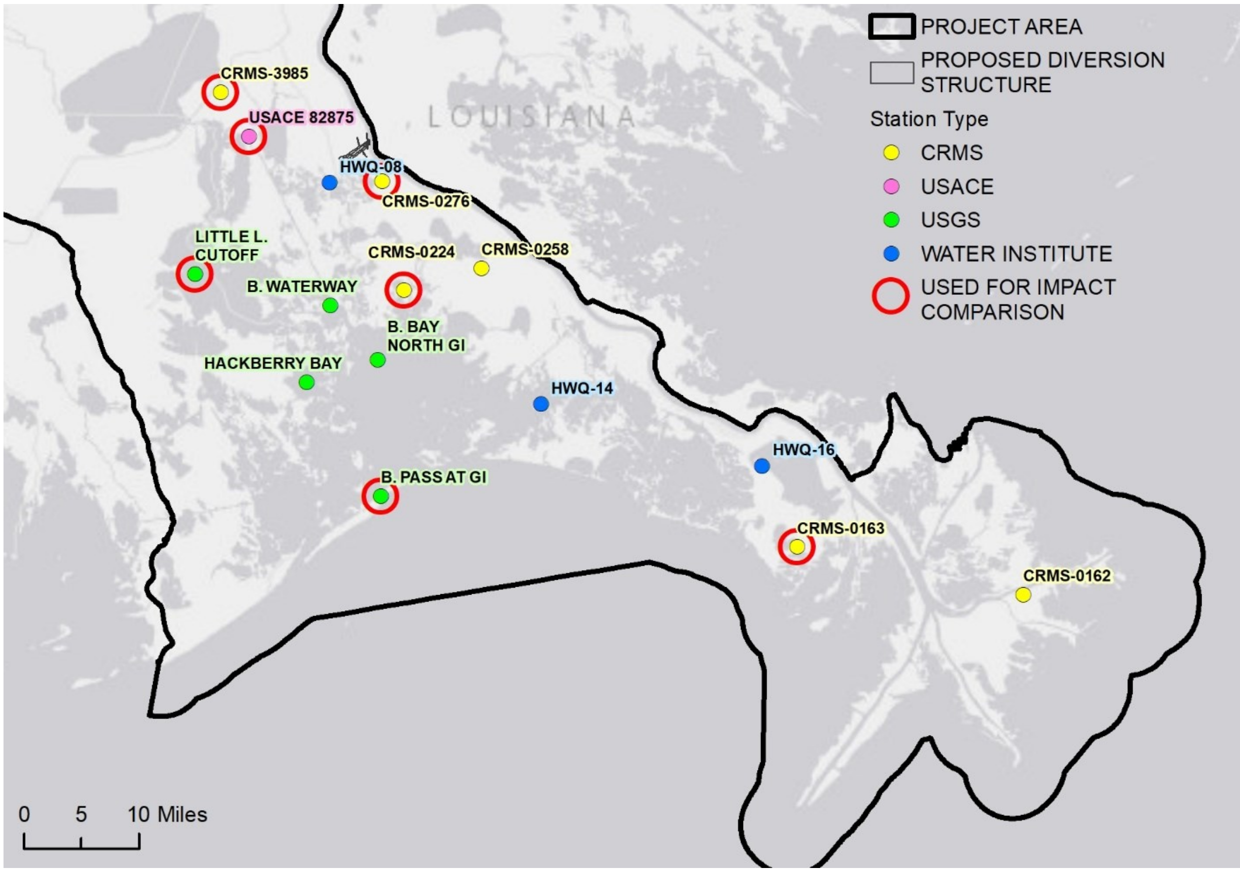


Figure 4.10-9. Stations for which Inter-annual Variability in Salinity Was Assessed. Note: Different stations were used in different assessments, depending on data availability.

A Vermilion Bay study provides insight into potential changes in populations due to episodic freshwater pulses, considered in a system that already receives annual freshwater flows lasting several months. The Vermilion-Cote Blanche Bay system, which has a similar faunal assemblage as the Barataria Basin, received large pulses of fresh water in mid-summer 2015, January 2016, August 2016, and August 2017 due to high discharge events from the Atchafalaya and Vermilion Rivers. Seine and trawl data collected between 2015 and 2017 indicated that while some species were temporarily displaced or had delayed recruitment, these impacts were short-term with catch levels returning to average levels over time (CPRA 2019b).

Since salinity in the Project area is projected by the Delft3D Basinwide Model to vary in a general gradient from north to south, instead of a uniformly lower-salinity regime, the resulting habitat and species assemblage may encompass a wide spectrum of species with varying salinity tolerances. Olsen (2019) notes that higher estuarine salinities are typically correlated with decreasing species diversity and fresher estuaries correlate with a more diverse and even species assemblage. As identified in Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-4, many species present within the Barataria Basin have optimum salinity ranges that include salinities down to 0 ppt, and tolerance ranges that infer a certain level of adaptability to salinity regime shifts. Estuarine species often use areas of very low salinity as predation refuge and can often adapt to salinity variability, including relatively rapid decreases in salinity (Bachman and Rand 2008), through osmoregulation or relocation, although both tactics require energy expenditure which could otherwise be used for growth. Therefore, these species (or species life stages) are not expected to be notably negatively affected by altered salinity regimes and major, permanent, and beneficial impacts on species with lower-salinity preferences may occur as saltwater intrusion into the Barataria Basin is curtailed. Species for which altered salinities are outside of the optimal range (for example, brown shrimp) may experience moderate, adverse, and permanent impacts associated with areas projected to experience significant drops in salinity while the diversion complex is operating above the 5,000 cfs base flow. However, as suggested by de Mutsert et al. (2012), this is expected to result in a movement of species to more suitable habitats (such as towards Grand Isle). Shifts in the salinity regime, particularly between 2050 and 2070, could restrict the seasonal movements and result in changes to population distribution of some species as individuals avoid or become precluded from the portion of the Project area that has become too fresh. It should be noted, however, that species distribution and abundance may be influenced by salinity, but are ultimately driven by a more complex interaction of abiotic and biotic factors. As noted by Olsen (2019), organisms are directly impacted by physical drivers such as salinity, but are also directly and indirectly affected by the interaction of salinity on other ecosystem features such as competition and predation. These ecosystem-level impacts are discussed in more detail later in this section and Section 4.10.4.5 provides examples of how salinity shifts may impact species of varied salinity tolerances.

4.10.4.4.2.6.2 Temperature

Operation of the proposed Project would result in decreases in temperature, which the Delft3D Basinwide Model projects would be most pronounced in the colder months and at locations in the immediate outfall area. The changes in projected temperature were assessed across all decades for all stations in Figure 4.10-9, with the exception of Station B. Bay nr Gr Terre, where temperature data was not projected. The largest anticipated change in average monthly temperature, as compared to the No Action Alternative, would decrease by about 11.9°F (6.6°C), which may result in changes in bioenergetics and avoidance of the immediate outfall area (and other colder areas) by fauna. Changes in temperatures would be most apparent mid-basin (including Stations HWQ-08, the station nearest the diversion [CRMS 0276]; see Figure 4.10-9), where average monthly temperatures are often projected to decrease more than 5.4°F (3°C) compared to the No Action Alternative, between December and April initially, and into May during the last two decades of operation. Similar, but sporadic, decreases in temperatures are also projected in winter and spring for stations further afield (B. Waterway, USACE 82875, and B. Bay North GI), depending on the representative hydrograph. Although the change in average monthly temperature would be relatively gradual, the initial release of colder river water into Barataria Bay during January and February (the projected startup of higher operational flows) would also result in acute exposure of fauna to waters that are up to 11.9°F (6.6°C) colder on a daily scale than temperatures present in the immediate outfall area at the time of opening (see Chapter 3, Section 3.5 Surface Water and Sediment Quality, Table 3.5-4). Projected temperature changes in the birdfoot delta are restricted to minor fluctuations (between -0.4 and 0.4°F [-0.2 and 0.2°C]), with the exception of the last decade of operation, when temperatures rise slightly compared to the No Action Alternative (range of 0.0 to 3.6°F [0.0 to 2.0°C]).

As an example of acute exposure impacts, a study investigating the impacts of temperature on different size classes of spotted seatrout determined that signs of stress occurred at temperatures of 43.3°F (6.3°C) for juvenile and small adults, with signs of lost equilibrium first displayed at 41.9°F (5.5°C) for all size classes (McDonald et al. 2010) However, prior studies and reports also indicated that thermal stress mortality occurred at maintained temperatures of less than or equal to 45.0°F (7.2°C) for longer than 24 hours and, conversely, that live specimens were obtained from temperatures as low as 37.4°F (3°C). The conflicting reports may be related to size and acclimation period to colder waters (McDonald et al. 2010, citations therein). Although different species likely have varying thermal tolerances, the Delft3D Basinwide Model projects that monthly average temperatures would generally remain above the stress and mortality levels noted by McDonald et al. (2010), with decreases below 45.0°F (7.2°C) only occurring in January and February in the immediate outfall area (that is, Station HWQ-08 and the station nearest the diversion [CRMS 0276]).

Although temperature differentials would quickly decrease as the inflowing river waters mix into the bay, and the impacts of the colder waters would decrease with distance from the diversion structure, the potential for faunal stress and mortality from acute temperature changes may increase during initial opening of the diversion each year, while decreased average monthly temperatures could cause changes in bioenergetics and avoidance of the outfall area, during the winter. The overall direct and indirect impacts of decreased average temperatures and acute temperature changes on faunal populations at these discrete locations and time periods would likely be direct or indirect, minor to moderate, and adverse, and annually recurring and therefore permanent throughout the analysis period.

4.10.4.4.2.7 Emergent Vegetation

As described in Section 4.2.3.2 in Geology and Soils, the Applicant's Preferred Alternative would introduce large volumes of sediment into the Barataria Basin over the 50-year analysis period of the Project (years 2020 to 2070). These additions are projected to increase sediment bed elevations in the outfall area and result in the net creation of about 12,700 acres of wetland (17.4 percent) by modeled year 2070, compared to the No Action Alternative. Over the course of Project operations, brackish and saline marsh would be lost at a higher rate than the No Action Alternative, while fresh/intermediate marshes would be created/maintained at a higher rate, resulting in a peak maintenance/creation of about 17,000 more acres (12.3 percent) than under the No Action Alternative in modeled year 2060 (see Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-4). By 2070, the Project area is projected to contain more fresh/intermediate marsh, less brackish marsh, and approximately the same amount of saline marsh as the No Action Alternative within the Barataria Basin. By 2070, greater overall wetland loss is projected within the birdfoot delta as compared to the No Action Alternative (about 3,000 acres, or 45 percent, more land loss). As described in Section

4.6 Wetland Resources and Waters of the U.S., freshwater vegetation is projected to form in the outfall area under the Applicant's Preferred Alternative, whereas that vegetative biomass would be lost under the No Action Alternative.

As discussed in Chapter 3, Section 3.10 Aquatic Resources, wetlands are extremely important to many estuarine and marine species, providing important edge habitat for fish and invertebrates with respect to feeding, reproduction, and refuge (Peterson and Turner 1994, Castellanos and Rozas 2001). In the Atchafalaya River Delta, emerging wetlands resulting from river diversions resulted in the recovery of fish nursery capacity (Thompson and Deegan 1983) and a much greater density of nekton in vegetated areas of freshwater tidal wetlands when compared to unvegetated areas. Although the freshwater wetlands projected to be created and maintained in the outfall area may not be directly suitable for use by certain species (for example, brown shrimp), these wetlands would still provide benefits associated with water quality improvement and concentration of the benthic community, as well as nursery habitat benefits for species and life stages more tolerant of low salinity. Conversely, the net decrease in brackish marsh would result in an adverse, minor to moderate, permanent, and direct impact on species which utilize such habitat. Overall, the increase in net vegetation coverage within the Project area (in spite of the moderate loss of wetlands in the birdfoot delta) would result in a major, permanent, direct, beneficial impact on freshwater fauna such as bass, catfish, and sunfish, as well as estuarine species that could access and use those wetlands, such as red drum and Gulf menhaden. In addition, the increase in freshwater marsh would likely have indirect beneficial impacts on estuarine species by allowing for the export of increased primary production, detritus, and prey resources to other areas of the basin that would support the local food web (see below). As detailed in Section 4.10.4.5, the impacts of increased vegetative cover on specific faunal populations would likely be minor to moderate (depending on the species), direct and indirect, beneficial, and permanent.

4.10.4.4.2.8 Food Web and Ecological Interactions

As discussed under the No Action Alternative, because a large part of the Barataria Basin food web uses detritus (dead organic matter) as an energy source, there exists a temporary energy reserve in the system that is somewhat independent of primary production and is therefore less sensitive to light limitation, nutrient ratios, and other factors impacted by operation of the Applicant's Preferred Alternative that may limit primary production (Rose et al. 2019). This potential buffer suggests that there may be some stability in the production rate of detritivorous species and their predators during temporary increases in system turbidity (which may occur in the outfall area during operation above base flow) that may limit phytobenthos or phytoplankton (live organic matter) production. The amount of energy in the system from detritivory, or detritus consumption, suggests that detritus plays a substantial role in supporting fish and fisheries in the Barataria Basin and that the food web has multiple pathways of moving fresh (chlorophyll) and recycled (detritus) organic matter through the food web. Therefore, the detritus-based food web should provide some resilience to overall system production, and it is likely that plankton-based consumption would be incorporated back into the food web when light conditions are not limiting in regions of the estuary. Responses in the food web to diversion operations would likely range from negligible to minor in relation to energy cycling and overall production as detrital energy sources may compensate for turbidity driven loss of phytobenthos or phytoplankton in the outfall area.

Rose et al. (2019) also suggested that spring inputs of fresh water and nutrients into Barataria Bay from the Mississippi River would stimulate primary and secondary production in the spring and summer. Higher than average nutrient inputs would likely contribute to seasonal increases in high biomass, low trophic-level species such as shrimps and crabs, and small planktivorous fish species such as bay anchovy and Gulf menhaden. These species groups are important to inshore fisheries and serve an important ecological role, as they facilitate energy transfer to higher trophic-level predators. Environmental changes, such as the changes in the supply of nutrients projected under the Applicant's Preferred Alternative (see Section 4.10.4.4, Nutrient Loading), therefore have the potential to alter the seasonal production of these high-biomass, low trophic-level consumer groups.

In contrast, the study indicated that biomass within the Barataria Basin food web is lower in the higher trophic levels, and predatory fish abundance is unlikely to be food limited (Rose et al. 2019). Therefore, numerous and redundant food web connections may reduce the impact of severe food limitation for predators even if important prey groups are disturbed or eliminated since many of the species are opportunistic, trophic generalists feeding on multiple prey types. Note that individual species or groups of similar species in the food web can still be affected (some being reduced), and that this resiliency depends on the type (where it impacts the food web and how), magnitude, duration, and repetitiveness of the disturbance. Overall, even if minor to moderate changes in the lower trophic-level biomass is caused by prolonged operation of the Applicant's Preferred Alternative due to changes in abiotic habitat characteristics discussed above (salinity, turbidity, water flow and tidal transport), a detectable response in a predator's response to these food web changes may not occur.

The negligible to minor impact from reduced primary productivity in the outfall area would be offset by increased primary production within the wider basin. Overall, the combination of adverse and beneficial impacts is anticipated to have permanent, moderate, beneficial impacts on energy flow to lower trophic-level consumers and permanent, negligible to minor, beneficial impacts on higher trophic-level predators.

4.10.4.4.3 Other Alternatives

4.10.4.4.3.1 <u>Water Flow and Tidal Transport</u>

As discussed in Section 4.4.3.1 in Surface Water and Coastal Processes, the other action alternatives would not have substantial differences from the Applicant's Preferred Alternative in terms of modifications to tides, currents, or flow in either the Mississippi River or the Barataria Basin, although the terraced alternatives could cause minor and localized changes to water currents within 0.5 mile of the terraces. However, similar to that described for the Applicant's Preferred Alternative, the other alternatives could result in localized changes in currents in the outfall area, or in tidal signal over-riding that results in adverse impacts on larval transport within a portion of the basin. While these localized changes are projected to be similar under the 50,000 cfs Alternative to the Applicant's Preferred Alternative, these changes would have a wider spatial extent under the 150,000 cfs Alternative, where the increased discharge rate would potentially disrupt larval transport over a wider projected portion of the immediate outfall area and adjacent areas (including Confluence of Bayou Saint Denis and Bayou Cutler, Little Lake to Grand Bayou, Grande Bayou to Hackberry Bay, and Bayou Dulac; see Figure 4.10-4), especially during periods of high flow (late April through early June). The disruption of larval transport could lead to larvae being transported to unsuitable habitats or precluded from settling in suitable habitats, which would result in minor to major, permanent (recurring throughout the analysis period), direct and adverse impact on faunal recruitment depending on the spatial and temporal overlap of high diversion flows (which can differ on an annual basis) and larval transport periods (which differ by species and is further described in Section 4.10.4.5).

4.10.4.4.3.2 Substrates

Impacts on hard substrates (oyster reefs and dead shell) for the other action alternatives would be similar to that described for the Applicant's Preferred Alternative. However, the 150,000 cfs Alternative would result in higher and more extensive volumes of sediment accruing over the public oyster grounds and oyster leases by 2070, with the eastern half the Little Lake POSG receiving at least 2 to 10 inches of sediment, and up to 6.6 feet (or more) of sediment in limited areas, over the 50-year analysis period, resulting in the burial of hard substrates and fewer potential benefits from the growth of other fouling organisms. With the 150,000 cfs Alternative, a portion of the Hackberry POSG would also receive sedimentation equating to 10 inches or less over the course of the proposed Project. Although the impacts of the 150,000 cfs Alternative would be greater than the other action alternatives, the overall impacts on hard substrates from any alternative would be moderate, adverse or beneficial (in the case of decreased salinity in the Barataria Bay POSG), permanent, and indirect. Impacts on SAV are discussed in Section 4.10.4.1 and impacts on oysters are discussed in Section 4.10.4.5.

4.10.4.4.3.3 Turbidity and Sedimentation

Sedimentation and turbidity are anticipated to decrease (50,000 cfs Alternatives) or increase (150,000 cfs Alternatives) within the basin based on the total outflow of a given alternative when compared to the Applicant's Preferred Alternative. Differences in sedimentation and turbidity between these alternatives and the Applicant's Preferred Alternative are expected to be negligible in the birdfoot delta (for detailed discussions of the differences in sedimentation and turbidity under each alternative, see Section 4.4 Surface Water and Coastal Processes and Section 4.5 Surface Water and Sediment Quality). As discussed in Section 4.5, however, these differences would not be expected to be so different such that they would substantially change the level of impact to benthic communities as compared to the Applicant's Preferred Alternative. Thom et al. (2004) suggest that terrace construction could alter substrates such that benthic communities may not be substantially present adjacent to terraces for several decades, which would indicate an associated long-term, minor (due to limited terrace acreage), indirect, adverse impact under the terrace alternatives. Furthermore, if the terraces successfully capture and retain sediment over time, recovered benthic communities could later be buried, resulting in a short-term to permanent (depending on the final elevation), minor, and adverse indirect impact. Impacts on the benthic community through turbidity and sedimentation would likely result in a negligible, long-term to permanent, adverse, and indirect impact on the fauna that prey on them given the extent of soft bottom and benthic habitat present in the Barataria Basin.

4.10.4.4.3.4 Nutrient Loading

As discussed under the Applicant's Preferred Alternative, the inflow of nutrients with fresh water would likely result in larger phytoplankton biomass that may contribute to increased fish biomass, resulting in major, permanent (ongoing throughout the analysis period), and beneficial impacts on fauna within the Barataria Basin. The inflowing nutrients would decrease (under the 50,000 cfs Alternatives) or increase (under the 150,000 cfs Alternatives) compared to the Applicant's Preferred Alternative. As the Applicant's Preferred Alternative would result in algal blooms, it is likely that more expansive algal blooms would occur with implementation of the 150,000 cfs Alternatives, which would also increase the chance of HABs. Although a triggered HAB could result in adverse, minor to major, and temporary to short-term impacts on fauna, depending on the size and intensity of the bloom, the nutrient input could also result in major, permanent (ongoing throughout the analysis period), and beneficial impacts on fauna within the Barataria Basin. As the 50,000 cfs Alternatives and 150,000 cfs Alternatives are projected to cause a negligible change in nutrient loading in the birdfoot delta, no such impacts on aquatic resources from increased nutrient loading are anticipated in this area.

4.10.4.4.3.5 Dissolved Oxygen

As described for the Applicant's Preferred Alternative, the Delft3D Basinwide Model for the other action alternatives projects that chlorophyll A concentrations indicative of algal blooms could occur in spring and early summer under the 50,000 cfs and 150,000 cfs Alternatives, but that monthly mean DO would not decrease to 4 mg/L or below throughout the analysis period. Project operations would also increase bacterial levels in the Barataria Basin (see Section 4.5.5.8 Fecal Coliform), which could result in increased oxygen demand and therefore lower DO levels (USEPA 2012). Although sporadic and limited areas of low DO may occur, mainly in the summer months when monthly averages are lowest, small and sporadic areas of low DO would likely result in a temporary and negligible to minor, adverse, and indirect impact on fauna.

4.10.4.4.3.6 Salinity and Temperature

4.10.4.4.3.6.1 Salinity

For the 50,000 cfs Alternative, representative hydrograph years show little change in salinity from the Applicant's Preferred Alternative in the first and last decades of operation although some of the western and southern stations show slightly higher salinities (Hackberry Bay, B. Pass at GI, B. Bay near Grand Terre), especially in 2070. For the 150,000 cfs Alternative, the hydrographs show further depression of salinities in the western and southern stations (those noted above and Station HWQ-14), with the most noticeable changes occurring in Hackberry Bay, where the salinity drops to essentially 0 during diversion opening (operating above the 5,000 cfs base flow), and B. Bay near Grand Terre, where there is a faster and greater decrease in salinity upon opening of the diversion, and a longer duration of salinity less than 5 ppt. Within the birdfoot delta, average monthly salinity is projected to show negligible differences between the 50,000 cfs Alternatives, Applicant's Preferred Alternative, and the 150,000 cfs Alternatives until the last modeled decade, when mean monthly salinity is projected to be lower under the 150,000 cfs Alternatives than under the Applicant's Preferred Alternative, although both would still have higher salinities than the No Action Alternative. As described for the Applicant's Preferred Alternative, some species present within the Barataria Basin have optimum salinity ranges that include salinities down to 0 ppt, and tolerance ranges that infer a certain level of adaptability to salinity regime shifts. Estuarine species can often adapt to salinity variability through osmoregulation or relocation, although both tactics require energy expenditure which could otherwise be used for growth. These species (or species life stages) are not expected to be notably negatively affected by altered salinity regimes and major, permanent, and beneficial impacts on species with lower-salinity preferences may occur as saltwater intrusion into the Barataria Basin is curtailed. Species for which altered salinities are outside of the optimal range (for example, brown shrimp) may experience moderate, adverse, and permanent impacts associated with areas projected to experience large drops in salinity while the diversion complex is open (operating above the 5,000 cfs base flow) or that freshen over time. Shifts in the salinity regime, particularly between 2050 and 2070, could restrict the seasonal movements and result in changes to population distribution of some species as individuals avoid or become precluded from the portion of the Project area that has become too fresh. It should be noted, however, that species distribution and abundance may be influenced by salinity, but are ultimately driven by a more complex interaction of abiotic factors (such as a change in bioenergetics as a species is exposed to sub-optimal conditions) and biotic factors. Section 4.10.4.5 provides examples of how salinity shifts may impact species of varied salinity tolerances.

4.10.4.4.3.6.2 Temperature

No substantial differences in temperature changes were projected between the Applicant's Preferred Alternative and the other action alternatives. Therefore, the overall direct impacts of decreased average temperatures and acute temperature changes on faunal populations would likely be direct and indirect, minor to moderate, and adverse, although permanent and recurring during the analysis period.

4.10.4.4.3.7 Emergent Vegetation

The Delft3D Basinwide Model projects that in the Barataria Basin, when compared to the No Action Alternative, there would be 9,200 more wetland acreage (12.7 percent) in 2070 for the 50,000 cfs Alternative, increasing incrementally across the alternatives and reaching a projected maximum increase in wetland acreage of 26,400 (36.3 percent) for the 150,000 cfs + Terraces Alternative in 2070 (see Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-4). Consistent with the Applicant's Preferred Alternative, these increases compared to the No Action Alternative would have proportionally major, permanent, indirect and beneficial impacts on aquatic fauna. Conversely, wetlands would be lost in the birdfoot delta for all action alternatives, with negligible difference in lost acreage as compared to the Applicant's Preferred Alternative; therefore, impacts on aquatic fauna in the birdfoot delta would be moderate, permanent, indirect, and adverse.

4.10.4.4.3.8 Food Web and Ecological Interactions

Under the Applicant's Preferred Alternative, Rose et al. (2019) was used to infer how the existing Barataria Basin food web (as modeled in de Mutsert et al. 2017 and Dynamic Solutions 2016) might be affected in the outfall area and basin-wide. The primary inferences are summarized here to support the stated impacts from other alternatives below.

The first inference taken from the food web modeling exercise was that if production of phytoplankton and phytobenthos are limited by light availability from turbidity, nutrient ratios, or reduced temperature, then detritus should offer a temporary energy reserve that could sustain consumption in the food web. The Delft3D Basinwide Model projected that primary production would be reduced in the proposed Project outfall area due to high flow and increased turbidity from February through June in most simulated decadal years. However, the detritus-based food web should provide some resilience to overall system production, and it is likely that plankton-based consumption would be incorporated back into the food web when light conditions are not limiting in the outfall area. The Delft3D Basinwide Model reflected this expected response, projecting primary production increases in the outfall area after diversion operations return to base flow. The 50,000 cfs and 150,000 cfs Alternatives would also have high turbidity that would limit primary productivity during high flows, and the detrital subsidy would also offer a temporary energy reserve to support the food web within the outfall area.

Spring and early summer operations of the diversion have the potential to show the largest responses in the food web. The changes in the abundance of phytoplankton, phytobenthos, and detrital or benthic export from the outfall area projected under the spring operational diversion flows could result in minor to moderate changes to high biomass prey species (for example, juvenile brown shrimp, crabs, and small forage fish) that feed upon the primary producer and lower trophic levels. In other regions of the Barataria Basin, an increase in primary production is projected during diversion operational flows above baseflow. A permanent, minor to moderate beneficial impact for high biomass consumer species such as shrimps, crabs, and small fish like anchovy and Gulf menhaden is expected to occur in the regions of the basin with increased primary production during and immediately following high operational flows.

The food web models also indicated that biomass within the Barataria Basin food web is lower in the higher trophic levels, and predatory fish abundance is unlikely to be food limited (Rose et al. 2019). Therefore, numerous and redundant food web connections could reduce the impact on higher trophic-level predatory species. Therefore, even if minor to moderate changes in the lower trophic-level consumer biomasses are detectable under prolonged and annually recurring operations of the diversion, it is likely that food web responses in the higher trophic-level predators such as bass, seatrout, and drums would be negligible.

Based on the above inferences, the 50,000 cfs Alternative would show similar or less food web impacts. Diversion discharge (flow) into the outfall area is reduced as compared to the Applicant’s Preferred Alternative, which would somewhat reduce the limiting impacts of turbidity in the outfall area, and also reduce the nutrient delivery that stimulates production in the rest of the basin.

Finally, the 50,000 cfs Alternative should have less of an overall impact on energy cycling in the food web and higher trophic-level biomass responses than the Applicant’s Preferred Alternative. That is, less fresh water and nutrients in the system should show less of a response in the food web. This conclusion is in relation to the inference that most of the biomass in the Barataria Basin food web is in the lower trophic levels, and the secondary and higher trophic-level consumers are typically generalist omnivores and carnivores, meaning that they should not be prey limited with changes in prey composition. The impacts on the lower trophic-level consumer species in high biomass such as shrimps, crabs, and small planktivorous fishes should be lower than that for the Applicant’s Preferred Alternative. The impacts would still be annually recurring and minor for these species.

The 150,000 cfs Alternative would likely show similar or more pronounced food web impacts on the Applicant’s Preferred Alternative. Diversion discharge (flow) into the outfall area is double that of the Applicant’s Preferred Alternative, which could reduce primary production in regions nearest but outside of the outfall area. Alternatively, the high-flow operations in the spring could provide nutrients to more regions of the estuary to increase primary production. Since the Delft3D Basinwide Model-generated chlorophyll A is already high under the Applicant’s Preferred Alternative, and the estuary is not nutrient-limited nor the food web consumer species prey limited, much of the phytoplankton and benthic algae could go unused by the food web to either be exported from the system or cause harmful blooms (see Section 4.10.4.4, Applicant’s Preferred Alternative, Nutrient Loading).

If the bottom-up impacts from an increase in phytoplankton, phytobenthos, and detritus under the 150,000 cfs Alternative compared to the Applicant's Preferred Alternative increase in duration and magnitude, then the changes in high biomass species could also be more detectable in the Barataria Basin. It would still be unlikely that the higher trophic-level predator species would show anything beyond minor impacts from the food web under the 150,000 cfs Alternative operational flows.

4.10.4.5 Key Species

Following the above synthesis of potential impacts on the general faunal habitat, the possible impacts on a set of key species are evaluated, putting into context the general assessments and how those generalized impacts may affect individual species that cover a range of different feeding guilds, habitat usage, and life histories. For the key species, the changes in water flow (velocity and direction), salinity, temperature, turbidity, sedimentation, nutrient input and primary productivity (for fueling the food web), amount of marsh vegetation, and bottom substrates, are potential impact-driving factors and are discussed to varying degrees.

The presence of low DO would also impact the key species, albeit in a more consistent manner than those drivers noted above. Periods of sustained low DO (less than 4 mg/l) would impair species growth or reproduction (for example, Breitburg 2002, Sable 2007, Thomas et al. 2007) and hypoxia (less than 2 to 3 mg/l) would cause mass mortality (for example, Diaz and Rosenberg 2008) for all of the key species discussed in the following sections. These low DO and hypoxic events, if they were to occur, would have similar impacts on all aquatic species growth and mortality if the species were exposed to low DO conditions for extended periods of time (for example, over days) (Sable 2007, Diaz and Rosenberg 2008). However, as discussed in Section 4.10.4.4, the Delft3D Basinwide Model-generated depth-averaged DO conditions and showed no low or hypoxic DO, and, therefore, the impact of low DO or hypoxic events is not further discussed for the individual key species.

In addition to the impacts on general faunal habitat discussed in Section 4.10.4.4, HSI models, which consider the value of combined habitat characteristics such as vegetation cover and temperature on the juvenile or sub-adult life stage of a key species, were utilized to further characterize potential impacts on key species. These HSI models assess near-term and future habitat characteristics projected by the Delft3D Basinwide Model. HSI scores show modeled habitat suitability, scored between 0 and 1, with a score of 0.0 indicating habitat that is unsuitable and a score of 1.0 being the most suitable habitat modeled for the species. The methodology for determining HSI scores for key species is discussed in detail in Appendix N.

To provide a clear understanding of the HSI results, HSI values by polygon (see Figure 4.10-10) and decade were mapped and tabularized. Although the maps provide visualization of change over time, the tables are useful in identifying smaller changes in HSI results by polygon and year. In addition, the HSI results by polygon were plotted against mean predictor variables (that is, seasonal salinity, temperature, chlorophyll A, and/or proportion of marsh to open water area) to show which variables drove the overall species HSI patterns and responses. These scatter plots communicate how and why the modeled fauna respond to changing conditions spatially and over time. The HSI polygon maps, tabularized data, and scatter plots for brown shrimp are provided in the discussion of that species as an example of how data were assessed for each of the modeled species (see Figure 4.10-11). Results from the remaining 10 species' HSIs are summarized in the impacts discussion for each species, and a full HSI analysis for each of the remaining 10 species, is included in Appendix N.

The value of the modeled HSIs is that they provide the basis for understanding species-habitat relationships, and they help to define habitats and habitat characteristics that are most important for a certain species or species life stage. However, it is important to note the limitations of the HSIs as applied to the proposed MBSD Project and why other studies of population-level impacts must be included in the analysis. It is also important to note that HSI models in general ignore population dynamics, assuming organisms can access and occupy all suitable habitat. Specifically, the HSI models in the Barataria Basin do not consider whether a site is accessible by the modeled life stage and may identify high value habitat that is inaccessible due to physical and/or environmental barriers, or sites that are relatively far from source populations. Alternatively, HSI models may identify a habitat as low quality yet species may occur there because of high prey densities or low predator densities. It is also worth noting that the HSIs do not account for trophic interactions (for example, interspecific competition and predator-prey dynamics). Nevertheless, HSIs provide useful information to assist in assessing Project impacts.

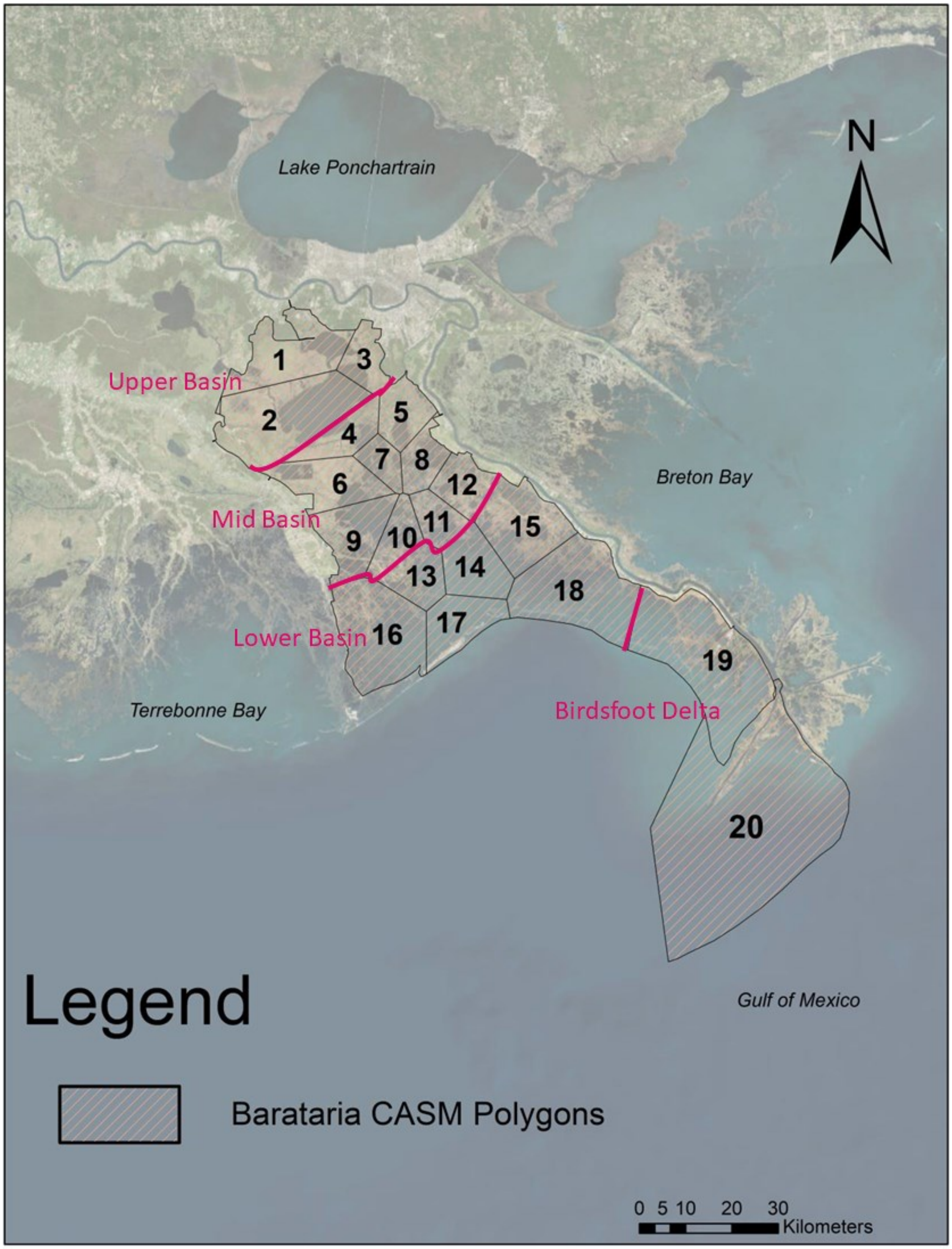
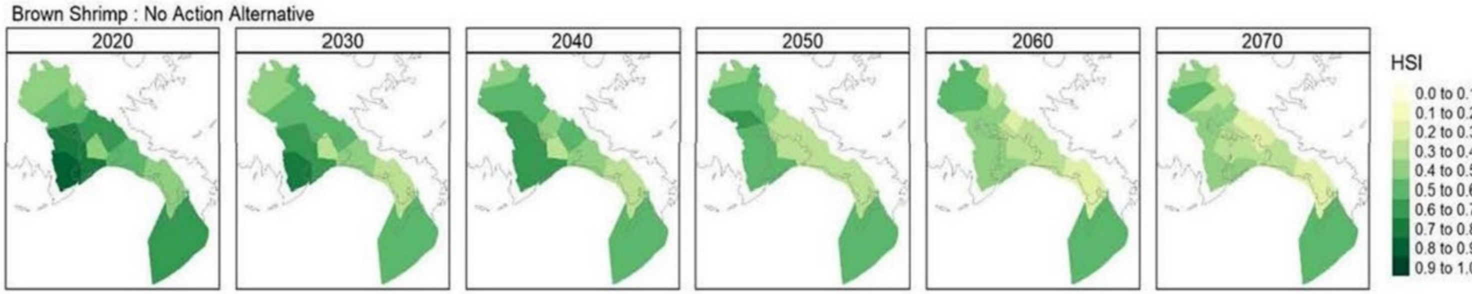


Figure 4.10-10. Barataria Basin Spatial Polygons Identified by Number and Grouped for the Upper (1 to 3), Mid (4 to 12), and Lower Basin (13 to 18) Regions of the Estuary with the Birdfoot Delta (19, 20). Figure adapted from Carruthers et al. 2019.

a



b

	Simulated Year					
Polygons	2020	2030	2040	2050	2060	2070
1	0.4597	0.4692	0.4749	0.4938	0.5143	0.4504
2	0.4788	0.4918	0.5024	0.5227	0.5341	0.5534
3	0.4866	0.5071	0.5204	0.5432	0.3760	0.3448
4	0.5157	0.5329	0.5502	0.5792	0.5185	0.3620
5	0.4922	0.5102	0.5267	0.4838	0.3768	0.3359
6	0.5975	0.5948	0.6190	0.6401	0.4981	0.4150
7	0.5579	0.5719	0.5554	0.5283	0.4621	0.4220
8	0.5831	0.5735	0.5513	0.4986	0.4165	0.4025
9	0.7713	0.6946	0.6605	0.5903	0.4616	0.4186
10	0.7236	0.6973	0.6790	0.5896	0.4158	0.3750
11	0.6812	0.5698	0.4809	0.3815	0.3190	0.3218
12	0.6568	0.5572	0.4652	0.3714	0.2999	0.2967
13	0.7213	0.6524	0.6294	0.5618	0.4112	0.3867
14	0.4641	0.3978	0.3945	0.3704	0.3285	0.3279
15	0.6676	0.5684	0.5331	0.3787	0.3009	0.2869
16	0.8536	0.7597	0.6992	0.5777	0.4592	0.4477
17	0.7010	0.6366	0.6267	0.5544	0.4864	0.4668
18	0.5906	0.4655	0.4562	0.3747	0.3318	0.3262
19	0.4430	0.3898	0.3586	0.3156	0.2967	0.2911
20	0.6168	0.5812	0.5685	0.5523	0.5373	0.5379

c

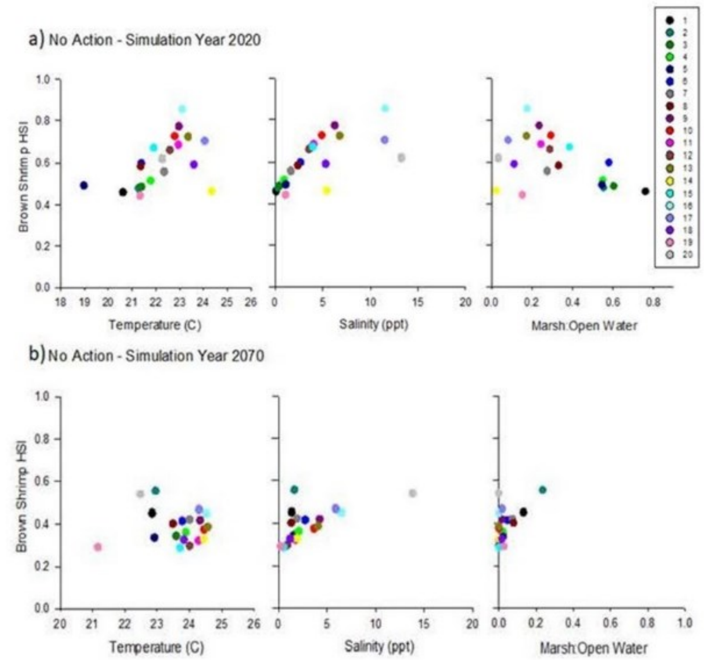


Figure 4.10-11. (a) HSI Polygon Maps, (b) Tabularized Data, and (c) Scatter Plots for Brown Shrimp in Relation to Spring Temperature, Salinity, and the Annual Proportion of Marsh to Open Water within each of the 20 Polygons for the No Action Alternative.

4.10.4.5.1 No Action Alternative

4.10.4.5.1.1 Brown Shrimp

The projected loss of approximately 80 percent of the marsh habitat in the Barataria Basin by the year 2070, as well as decreased SAV occurrence, would reduce the availability of brown shrimp juvenile habitat. The modeled HSI for brown shrimp early juvenile habitat suitability under the No Action Alternative ranges from about 0.44 to 0.85 (out of a score from 0 to 1) in year 2020, with highest suitability scores concentrated in the mid and lower polygons of the Barataria Basin (see Figure 4.10-11[a]). The largest reductions in the HSI scores are anticipated to occur over time in the polygons that had the highest starting suitability scores in 2020 (see polygons 9 to 17 in Figure 4.10-11[b]). By the end of the No Action Alternative simulation in 2070, the juvenile brown shrimp habitat suitability is projected to be reduced across most polygons (see Figure 4.10-11[a]), primarily because the proportion of vegetation to open water is reduced to below 0.20 (or 20 percent) (see Figure 4.10-11[c]).

While the continued northward movement of oysters and oyster beds into areas of optimal salinity may increase the availability of oyster reef and dead shell habitat for larger juvenile shrimp, this minor beneficial impact would not offset the major impact caused by the marsh loss and its associated impact on juvenile recruitment. The loss of marsh habitat would also indirectly cause a reduction in benthic biomass, impacting the availability of benthic prey for brown shrimp.

While salinity in the first decade of modeled conditions (2020 to 2030) is projected to be within the range of existing monthly average salinity concentrations throughout the basin, the maximum winter salinity would begin to increase and spring salinity decrease over time and to differing degrees throughout the basin, as detailed in Section 4.5.5.1 in Surface Water and Sediment Quality. Although the increased maximum annual salinity would not be expected to exceed the maximum salinity tolerance of brown shrimp life stages (post-larvae and juvenile) found within the basin (see Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-4), the minimum salinity would likely fall outside the suitable range of these life stages in portions of the basin during the time of year that they are most abundant in the basin. Habitat suitability in the brown shrimp HSI model is driven by salinity, with interacting and increasing temperature in the polygons (see Figure 4.10-11[c] – year 2020). The reduced juvenile brown shrimp habitat suitability with decreasing spring salinities (below 10 ppt) is also evident when examined over time within the scatter plots (see Figure 4.10-11[c]), indicating the significant impact that low salinities can exert on the HSI for early juvenile shrimp. The continued marsh loss over time appears to allow the high spring Mississippi River discharge to flow more freely into portions of the Barataria Basin because salinities are also reduced in these polygons (see Figure 4.10-11[c]). The intuitive response is an increase in salinity throughout the basin without the planned diversion, however the reduced salinity in the spring demonstrates the opposite impact and likely indicates the baseline driving force of the high Mississippi River flow with the Barataria Basin.

Indirect impacts on brown shrimp juveniles caused by marsh and SAV loss and reductions in spring salinity are expected to result in adverse impacts on the basin-wide brown shrimp population that would be only partially offset by potential increased oyster reef and dead shell habitat within a portion of the basin. The adverse impacts are expected to increase gradually over time, with the largest decreases in spring salinities and loss of marsh occurring in the last two decades of analysis. Overall, the combination of adverse and beneficial impacts is anticipated to have major, permanent, indirect, adverse impacts on the brown shrimp population in the Project area, with the largest decrease in abundance expected after 2050.

4.10.4.5.1.2 White Shrimp

As with brown shrimp, the projected loss of approximately 80 percent of the marsh habitat in the Barataria Basin, as well as decreased SAV occurrence, would reduce the availability of white shrimp juvenile habitat and indirectly cause a reduction in the availability of benthic prey for white shrimp. While juvenile white shrimp are known to utilize mud bottom and oyster reef habitat, smaller juveniles and post-larvae rely upon marsh and SAV as nursery habitat (Shervette et al. 2011, O’Connell et al. 2016b). While the continued northward movement of oysters and oyster beds into areas of optimal salinity may increase the availability of oyster reef and dead shell habitat, and increased marsh loss may increase availability of mud bottom habitat for larger juvenile shrimp, this minor beneficial impact would not offset the major impact caused by the marsh loss to post-larvae and early juveniles.

Changes in the salinity regime over time would have less of an impact on white shrimp than brown shrimp, as white shrimp post-larvae and juveniles are present in the basin later in the year than brown shrimp and would thus have less exposure to this salinity shift. Secondly, white shrimp are more tolerant of lower salinities (Sanchez-Rubio and Jennings 2015, Zein-Eldin and Renaud 1986), as they are known to migrate further into the less saline portions of the estuary and remain longer throughout the year than brown shrimp (O’Connell et al. 2016b).

As detailed in Appendix N, the HSI shows that by the end of the No Action Alternative simulation in 2070, the juvenile white shrimp habitat suitability is reduced basin-wide across all but one of the polygons in the northern basin, due primarily to the loss of marsh. The areas of the basin with the highest habitat suitability at the beginning of the analysis period are projected to have the lowest suitability by the end of the analysis period (see Figure 4.10-12).

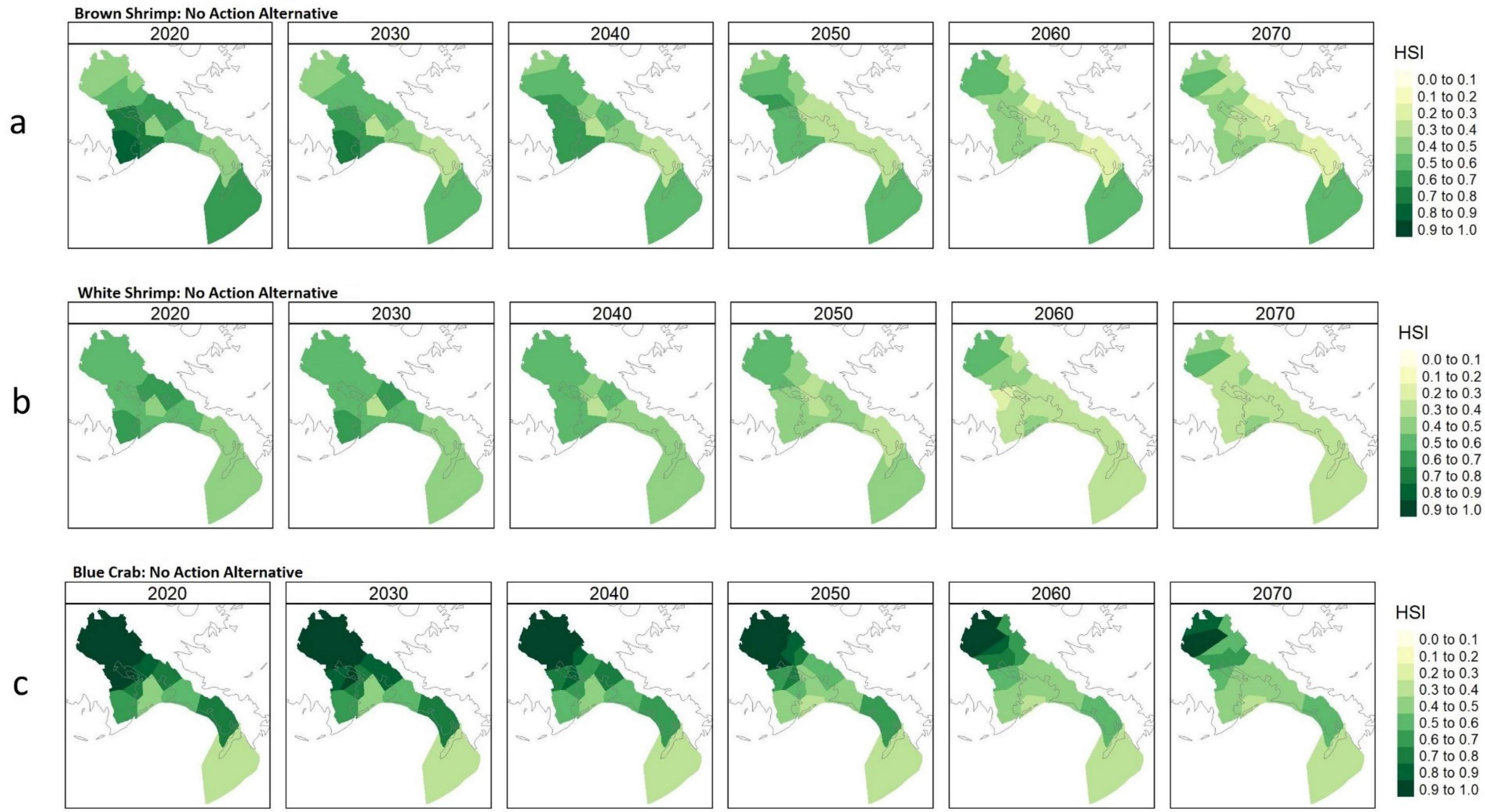


Figure 4.10-12. HSI Values for the No Action Alternative for (a) Brown Shrimp, (b) White Shrimp, and (c) Blue Crab through 2070. The darker shade signals more suitable habitat, while lighter shade signals less suitable habitat.

Indirect impacts on white shrimp juveniles caused by marsh and SAV loss are expected to result in adverse impacts on the basin-wide white shrimp population. Although white shrimp could use the increasing amount of mud habitat, and could use any new oyster reefs establishing in suitable habitats over time, these benefits would be minimal and would not offset the marsh loss. The adverse impacts are expected to increase gradually over time, with the largest loss of marsh occurring in the last two decades of analysis. Overall, the combination of adverse and beneficial impacts is anticipated to have major, permanent, indirect, adverse impacts on the white shrimp population in the Project area, with the largest decrease in abundance expected after 2050.

4.10.4.5.1.3 <u>Blue Crab</u>

As with brown and white shrimp, the projected loss of approximately 80 percent of the marsh habitat in the Barataria Basin, as well as decreased SAV occurrence, would reduce the availability of blue crab juvenile habitat and indirectly cause a reduction in the availability of benthic prey for blue crab. As blue crab are considered euryhaline (O'Connell et al. 2017), the increased winter salinity and decreased spring salinity projected to occur over time would not be expected to exceed the minimum and maximum salinity tolerance of the life stages found within the basin.

As detailed in Appendix N, the HSI shows that by the end of the No Action Alternative simulation in 2070, small juvenile blue crab habitat suitability is reduced basin-wide across all but one of the polygons in the northern basin due primarily to the loss of marsh. The areas of the basin with the highest habitat suitability at the beginning of the analysis period are projected to have some of the largest decreases in suitability by the end of the analysis period, with the exception of the northmost areas of the basin where some marsh remains. (see Figure 4.10-12). The habitat suitability score in some of the highest quality blue crab habitat is reduced by over 40 percent. However, even with this reduction in suitability, approximately half of the basin remains at or above an HSI score of 0.5.

The adverse impacts associated with marsh loss and SAV are expected to increase gradually over time, with the largest decrease in marsh habitat occurring after 2050. Overall, these adverse impacts are anticipated to have moderate, permanent, indirect, adverse impacts on the blue crab population in the Project area, resulting in a gradual decrease in abundance over time with largest decrease after 2050.

4.10.4.5.1.4 <u>Bay Anchovy</u>

Bay anchovy are a highly abundant species within the northern Gulf of Mexico due to the species' wide temperature and salinity tolerance and ability to utilize varied habitats (Pattillo et al. 1997). As a euryhaline species, the projected salinity shifts within the basin would be unlikely to impact bay anchovy.

While the species is commonly found in mud bottom shallow water and bays, juvenile bay anchovy can utilize marsh and SAV as feeding habitat and cover. While the loss of marsh and SAV would adversely impact juvenile bay anchovy, the species' ability to utilize varied habitats reduces the relative impact this loss of vegetation has on the species. Marsh conversion to shallow open water over time could be considered a benefit to the schooling species.

As bay anchovy feed primarily on zooplankton, food web disruptions related to marsh loss would have limited adverse impact on the species as compared to species such as shrimp which are largely benthic feeders. However, as marsh loss may allow high spring Mississippi River discharge to flow more freely into portions of the Barataria Basin, bay anchovy may potentially experience increased zooplankton productivity associated with the river discharge delivering nutrients and stimulating primary production in frontal zones in later decades (Adams et al. 2018).

As detailed in Appendix N, the HSI shows that the juvenile bay anchovy HSI values by polygon change very little over the decadal years, with some suitability scores slightly increasing and others slightly decreasing (see Figure 4.10-13). This supports the conclusion that while marsh loss is projected to be widespread throughout the basin over time, the impact on the species from this loss is limited.

Overall, the changes in habitat characteristics under the No Action Alternative are anticipated to have negligible, indirect impact to bay anchovy, with no measurable change in abundance over time.

4.10.4.5.1.5 Gulf Menhaden

Gulf menhaden are an abundant species in the northern Gulf of Mexico, with a heavy reliance on the estuaries of Louisiana for juvenile nursery habitat (Short et al. 2017). While early juveniles rely upon marsh vegetation and SAV for predator protection, larger juveniles migrate to open water within the estuary to form schools (Sable et al. 2017, Short et al. 2017). Because juveniles remain in the lower-salinity regions of the upper estuary, where marsh loss would be less pronounced until later in the analysis period, the adverse impact of marsh loss in the basin would be less for Gulf menhaden than species such as brown shrimp, which rely on more brackish and saline marshes.

As Gulf menhaden feed primarily on phytoplankton and resuspended benthic algae and detritus, food web disruptions related to marsh loss would have limited adverse impact on the species as compared to species such as shrimp which are largely benthic feeders. However, as marsh loss may allow high spring Mississippi River discharge to flow more freely into portions of the Barataria Basin, Gulf menhaden may potentially experience increased phytoplankton productivity and resuspension of benthic algae and detritus associated with the river discharge and mixing of the system in later decades (Adams et al. 2018).

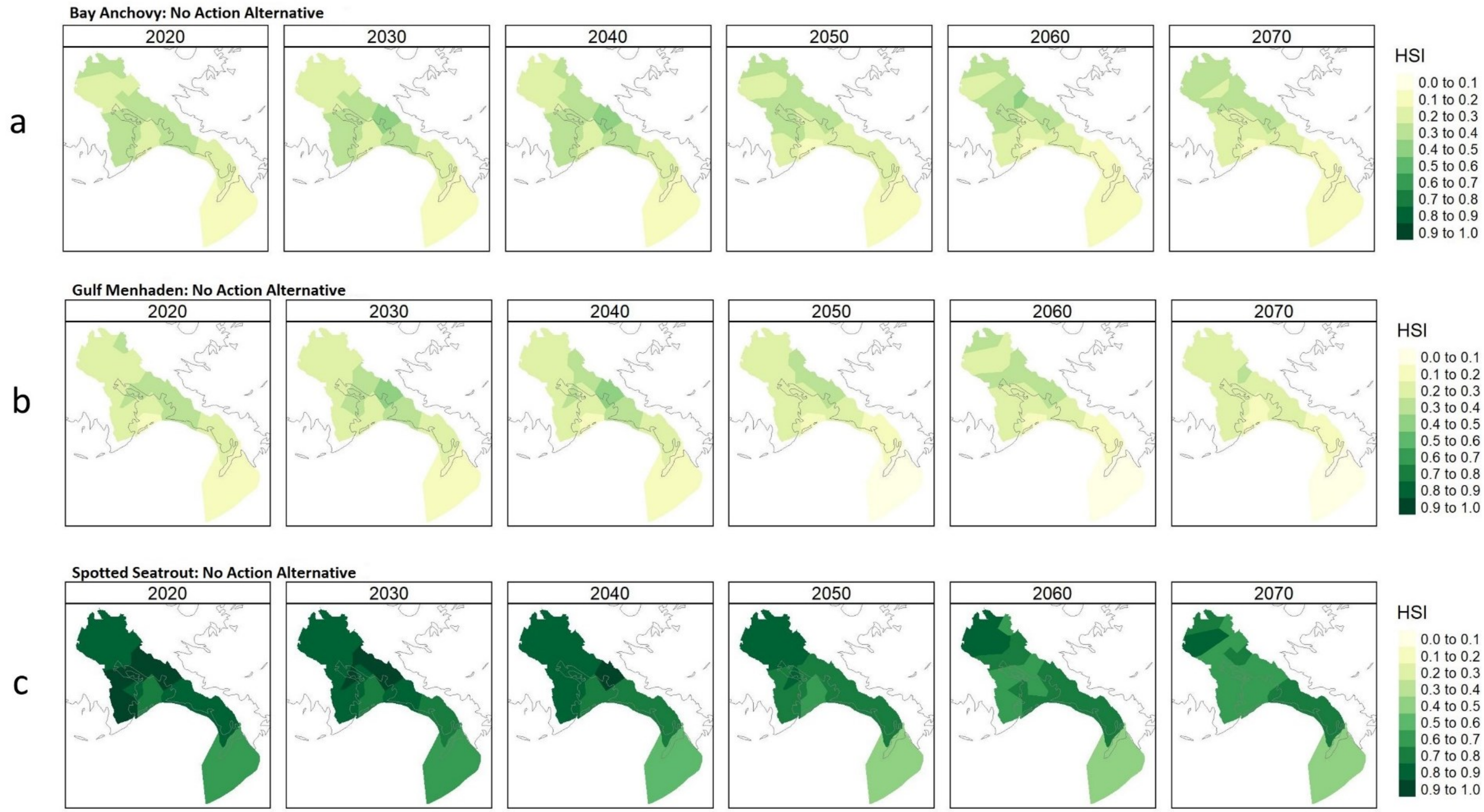


Figure 4.10-13. HSI Values for the No Action Alternative for (a) Bay Anchovy, (b) Gulf Menhaden, and (c) Spotted Seatrout through 2070. The darker shade signals more suitable habitat, while lighter shade signals less suitable habitat.

As detailed in Appendix N, the HSI shows that the juvenile Gulf menhaden HSI values by polygon change very little over the decadal years, with some suitability scores slightly increasing and others slightly decreasing (see Figure 4.10-13). This supports the conclusion that while marsh loss is projected to be widespread throughout the basin over time, the impact on the species from this loss is limited.

The increased winter salinity and decreased spring salinity projected to occur over time would not be expected to exceed the minimum and maximum salinity tolerance of the Gulf menhaden life stages found within the basin.

Overall, the changes in habitat characteristics under the No Action Alternative are anticipated to have negligible, indirect impact to Gulf menhaden, with no measurable change in abundance over time.

4.10.4.5.1.6 Red Drum

As with brown shrimp, the projected loss of approximately 80 percent of the marsh habitat in the Barataria Basin, as well as decreased SAV occurrence, would reduce the availability of red drum juvenile habitat and indirectly cause a reduction in the availability of benthic prey for the species. The early juvenile red drum prey upon benthic infauna and epifauna, small shrimps and crabs. The larger juvenile and adult red drum eat a variety of benthic prey and small fishes, but the shrimps, crabs, and smaller benthic feeding fishes are the major items of their diet. While juvenile red drum can utilize oyster reef as nursery habitat (Moulton et al. 2017), they seem to prefer vegetated habitats including marsh edge and SAV (Stunz et al. 2002). The continued northward movement of oysters and oyster beds into areas of optimal salinity may increase the availability of oyster reef and dead shell habitat over time; however, this minor beneficial impact would not offset the major impact caused by the marsh loss to juvenile red drum nor the moderate impact to the preferred benthic prey for the juvenile and adult red drum.

As larval, juvenile and adult red drum are euryhaline, the increased winter salinity and decreased spring salinity projected to occur over time would not be expected to exceed the minimum and maximum salinity tolerance of the red drum life stages found within the basin (Ward et al. 1980, Crocker 1981).

The red drum HSI's applicability to the Barataria Basin is limited and therefore was not relied upon to inform this impact analysis. The modeled HSI for red drum is geared more towards red drum larvae and early juveniles in more coastal temperate waters. It appears that it does not appropriately reflect the early juvenile abundance patterns within the Barataria Basin. Modeled values indicated very low habitat suitability within the basin, when it is known that juvenile red drum widely use the system as nursery grounds (Minello et al. 2003, Minello 1999).

Indirect impacts on red drum caused by marsh and SAV loss are expected to result in adverse impacts on the basin-wide red drum population that would be only partially offset by potential increased oyster reef habitat within a portion of the basin.

The adverse impacts are expected to increase gradually over time, with the largest loss of marsh occurring in the last two decades of analysis. Overall, the combination of adverse and beneficial impacts is anticipated to have minor, permanent, indirect, adverse impacts on the red drum population in the Project area, resulting in a slight decrease in abundance within the basin over time.

4.10.4.5.1.7 Spotted Seatrout

Spotted seatrout juveniles have shown a preference for structurally complex vegetated habits over non-vegetated bottoms (Neahr et al. 2010). As with brown shrimp, the projected loss of approximately 80 percent of the marsh habitat in the Barataria Basin, as well as decreased SAV occurrence, would reduce the availability of spotted seatrout early juvenile habitat as well as benthic prey availability for juvenile and adult seatrout. Like red drum, early juvenile spotted seatrout prey upon benthic infauna and epifauna, small shrimps, and crabs. The larger juvenile and adult seatrout eat a variety of benthic prey and small fishes like anchovy and menhaden, but the shrimps, crabs, and smaller benthic feeding fishes are the major items of their diet. Also similar to red drum, juvenile spotted seatrout can utilize oyster reef nursery habitat, but show a preference for marsh edge (Bortone 2002, Moulton et al. 2017, Sable et al. 2017). While the continued northward movement of oysters and oyster beds into areas of optimal salinity may increase the availability of oyster reef habitat, this minor beneficial impact would not offset the major impact caused by the marsh loss to early juvenile seatrout nor the impact to the preferred benthic prey for the juvenile and adult spotted seatrout.

As detailed in Appendix N, the HSI shows that by the end of the No Action Alternative simulation in 2070, habitat suitability for small juveniles is reduced basin-wide primarily due to the loss of marsh. The areas of the basin with the highest habitat suitability at the beginning of the analysis period are projected to experience the largest decrease in suitability by the end of the analysis period (see Figure 4.10-13); however, even the areas of the basin with the largest projected suitability decrease remain relatively suitable.

The increased winter salinity and decreased spring salinity projected to occur over time would not be expected to exceed the minimum and maximum salinity tolerance of the spotted seatrout life stages found within the basin (see Chapter 3, Section 3.10.5.1 in Aquatic Resources, Table 3.10-4).

Indirect impacts on spotted seatrout caused by marsh and SAV loss, and the loss of preferred benthic prey, are expected to result in adverse impacts on the basin-wide spotted seatrout population that would be only partially offset by potential increased oyster reef habitat within a portion of the basin. The adverse impacts are expected to increase gradually over time, with the largest loss of marsh occurring in the last two decades of analysis. Overall, the combination of adverse and beneficial impacts is anticipated to have minor, permanent, indirect, adverse impacts on the spotted seatrout population in the Project area, resulting in a slight decrease in abundance over time.

4.10.4.5.1.8 Atlantic Croaker

Similar to other estuarine species, Atlantic croaker utilize vegetated and marsh edge habitat as nursery grounds. Early larvae settle into shallow, lower-salinity benthic habitats (Rose et al. 2017), and early juveniles utilize this habitat type for benthic feeding and predator protection (Nye 2008). As with brown shrimp, the projected loss of marsh habitat in the Barataria Basin, as well as decreased SAV occurrence, would reduce the availability of Atlantic croaker early juvenile habitat and indirectly cause a reduction in the availability of benthic prey for the species. Juvenile and adult Atlantic croaker feed primarily on benthic epifauna like mussels, clams, and small oysters; infauna, such as worms; and smaller shrimps, crabs, and benthic fishes. However, older juveniles do not appear to require structural cover (Diaz and Onuf 1985), such that the loss of wetland habitat may have less of an adverse impact on Atlantic croaker than species which more heavily rely on marsh habitat. Additionally, juvenile and adult croaker are bottom-feeders that may benefit from worms and mollusks associated with muddy bottoms and potentially expanding oyster reef.

As Atlantic croaker are considered euryhaline, the increased winter salinity and decreased spring salinity projected to occur over time would not be expected to exceed the minimum and maximum salinity tolerance of the Atlantic croaker life stages found within the basin. However, adult Atlantic croaker are associated with mud bottom habitat that is shallow enough to support SAV growth (Odell et al. 2017), and juvenile croaker abundance in estuaries of the Gulf of Mexico has been positively correlated to shallow water (Diaz and Onuf 1985). Therefore, while the salinity shifts described in Section 4.5.5.1 Salinity in Surface Water and Sediment Quality would not be expected to impact Atlantic croaker, the increased water depths associated with sea-level rise would have an adverse impact on the species.

As detailed in Appendix N, the HSI shows that by the end of the No Action Alternative simulation in 2070, juvenile Atlantic croaker habitat suitability is reduced basin-wide primarily due to the increased water depth (see Figure 4.10-14). However, similar to spotted seatrout, even the areas of the basin with the largest Project projected suitability decrease remain relatively suitable.

The adverse impacts associated with marsh loss and increased water depth are expected to increase gradually over time. Overall, these adverse impacts are anticipated to have minor, permanent, indirect, adverse impacts on the Atlantic croaker population in the Project area, resulting in a slight decrease in abundance over time.

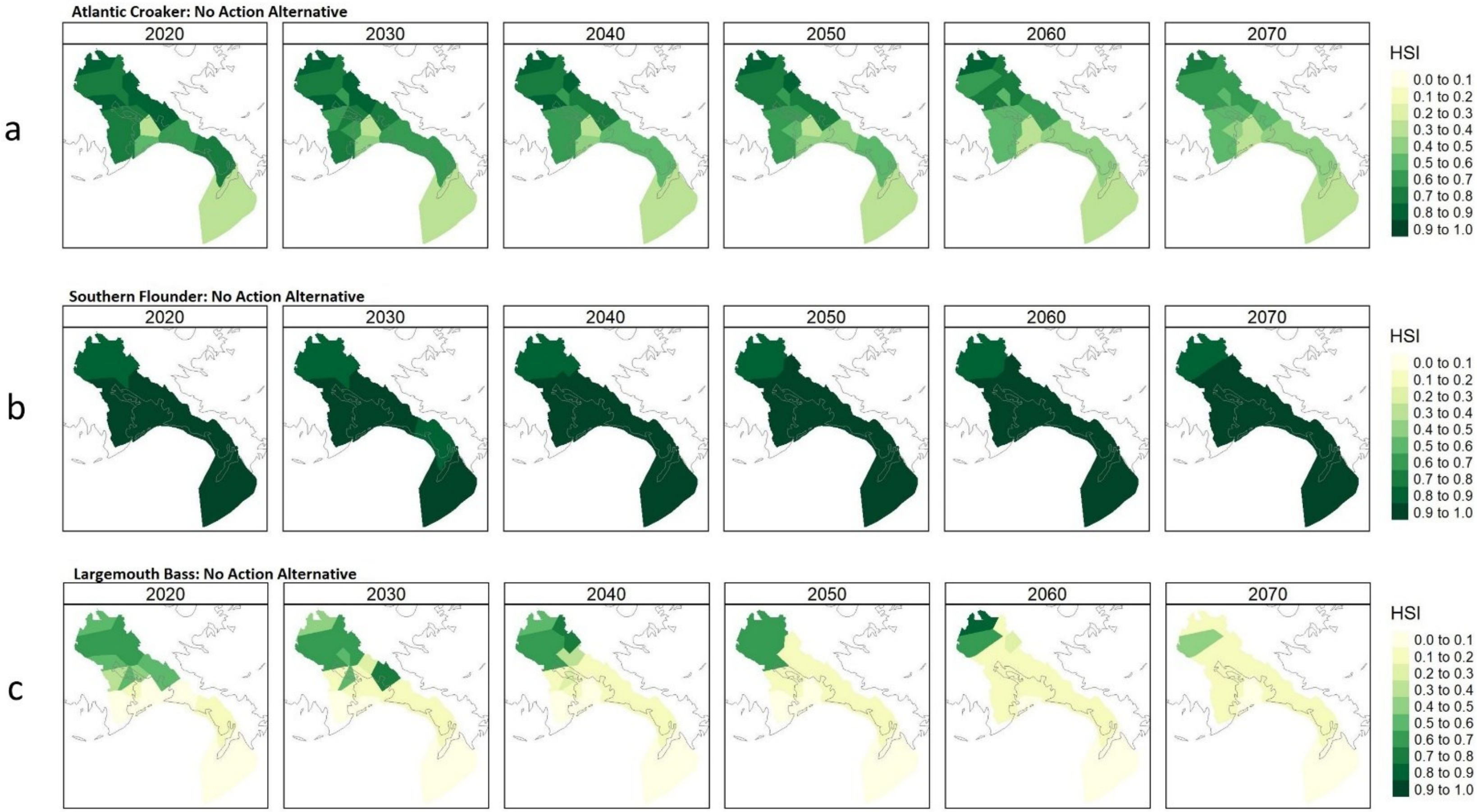


Figure 4.10-14. HSI Values for the No Action Alternative for (a) Atlantic Croaker, (b) Southern Flounder, and (c) Largemouth Bass through 2070. The darker shade signals more suitable habitat, while lighter shade signals less suitable habitat.

4.10.4.5.1.9 Southern Flounder

Juveniles and non-spawning adults are the only southern flounder life stages present in the Barataria Basin. While newly settled juveniles are associated with marsh edge and SAV in the upper estuary (Furey and Rooker 2013), larger juveniles and adult southern flounder are largely associated with non-vegetated muddy substrates. Newly settled juveniles would be more likely found in the lower-salinity regions of the basin where marsh loss would be less pronounced until later in the analysis period. Therefore, the adverse impact of marsh loss in the basin would be less for southern flounder than for species such as brown shrimp which rely on more brackish and saline marshes or species which more heavily rely on marsh habitat in general.

Southern flounder have a wide salinity tolerance range; studies have indicated that young juvenile flounder experience higher mortality in salinities below 5 ppt (Smith et al. 1999). As juvenile flounder migrate into the Barataria Basin from December through February (Allen and Baltz 1997, Glass et al. 2008, GSMFC 2000), increased minimum winter salinities may be beneficial to this life history stage. Because larger juvenile and adult flounder are more tolerant of salinities below 5 ppt, this benefit would have a negligible impact on the species.

Overall, the changes in habitat characteristics under the No Action Alternative are anticipated to have negligible impacts on southern flounder, with no measurable change in abundance over time.

4.10.4.5.1.10 Largemouth Bass

As with brown shrimp, the projected loss of marsh habitat in the Barataria Basin, as well as decreased SAV occurrence, would reduce the availability of juvenile bass habitat. Likewise, as largemouth bass are higher trophic-level predators feeding on various smaller fish, shrimp, and crabs, the decreased abundance of shrimp and crabs within the basin would adversely impact prey availability for the species.

Largemouth bass habitat is restricted to the upper reaches of the basin, largely due to the lower salinity in this portion of the estuary. Juveniles in particular have smaller range of salinity tolerance than adults, with adults preferring salinities below 5 ppt (Hijuelos et al. 2017a) and one study demonstrating increased mortality above 12 ppt (Meador and Kelso 1990). Increasing winter salinities would further restrict suitable habitat in the upper reaches of the basin.

As detailed in Appendix N, the HSI shows that largemouth bass (both juvenile and adult) suitable habitat is limited to the upper basin in 2020, and habitat suitability is reduced over time to the point that only a small portion of the originally suitable habitat still exists in 2070 (see Figure 4.10-14).

The adverse impacts associated with marsh loss and increased winter salinity is expected to increase gradually over time. Overall, the marsh loss and increased winter salinity are anticipated to have major, permanent, indirect, adverse impacts on the largemouth bass population in the Project area, resulting in a gradual but major decrease in largemouth bass abundance over time.

4.10.4.5.1.11 Eastern Oysters

Seasonal salinity ranges and fluctuations have important impacts on oysters, including impacts on spawning, gonad development, maturation and larval distribution, as well as influences on filtration and overall growth and predation rates (Hijuelos et al. 2017b and references therein). Research shows that oysters are less tolerant of lower salinities as temperatures reach the upper extreme (77 to 86°F [25 to 30°C]) of the species' optimal temperature range (Lowe et al. 2017, Rybovich et al. 2016, La Peyre et al. 2009). As detailed in Section 4.10.4.4, minimum and maximum water temperatures in the basin are projected to show a slight increase (less than 1.8°F [1°C]) during the 50-year analysis period. However, maximum winter salinity would increase and minimum spring salinity would decrease over time to differing degrees throughout the basin, as detailed in Section 4.5.5.1 Salinity in Surface Water and Sediment Quality and Appendix L.

Elevated winter salinities would extend further northward in the basin over time, most likely due to sea-level rise, allowing for limited northward expansion of oysters. However, increased salinities, particularly in the southernmost portion of the basin, could increase the risk of infection intensities of *Perkinsus marinus* (Lowe et al. 2017, Leonhardt et al. 2017), and predation (Banks et al. 2016, Van Sickle et al. 1976) as more of this portion of the basin would sustain prolonged periods above 15 ppt. Secondly, as marsh loss over time allows for high spring Mississippi River discharge to flow more freely into portions of the Barataria Basin, the suitability of habitat within central and eastern basin would decrease over time (see Appendix N), Figure 4.10-15.

Overall, the combination of adverse and beneficial impacts is anticipated to have major, permanent, indirect, adverse impacts on the oyster population in the Project area, with a gradual but major decrease in abundance over time with largest decrease after 2050.

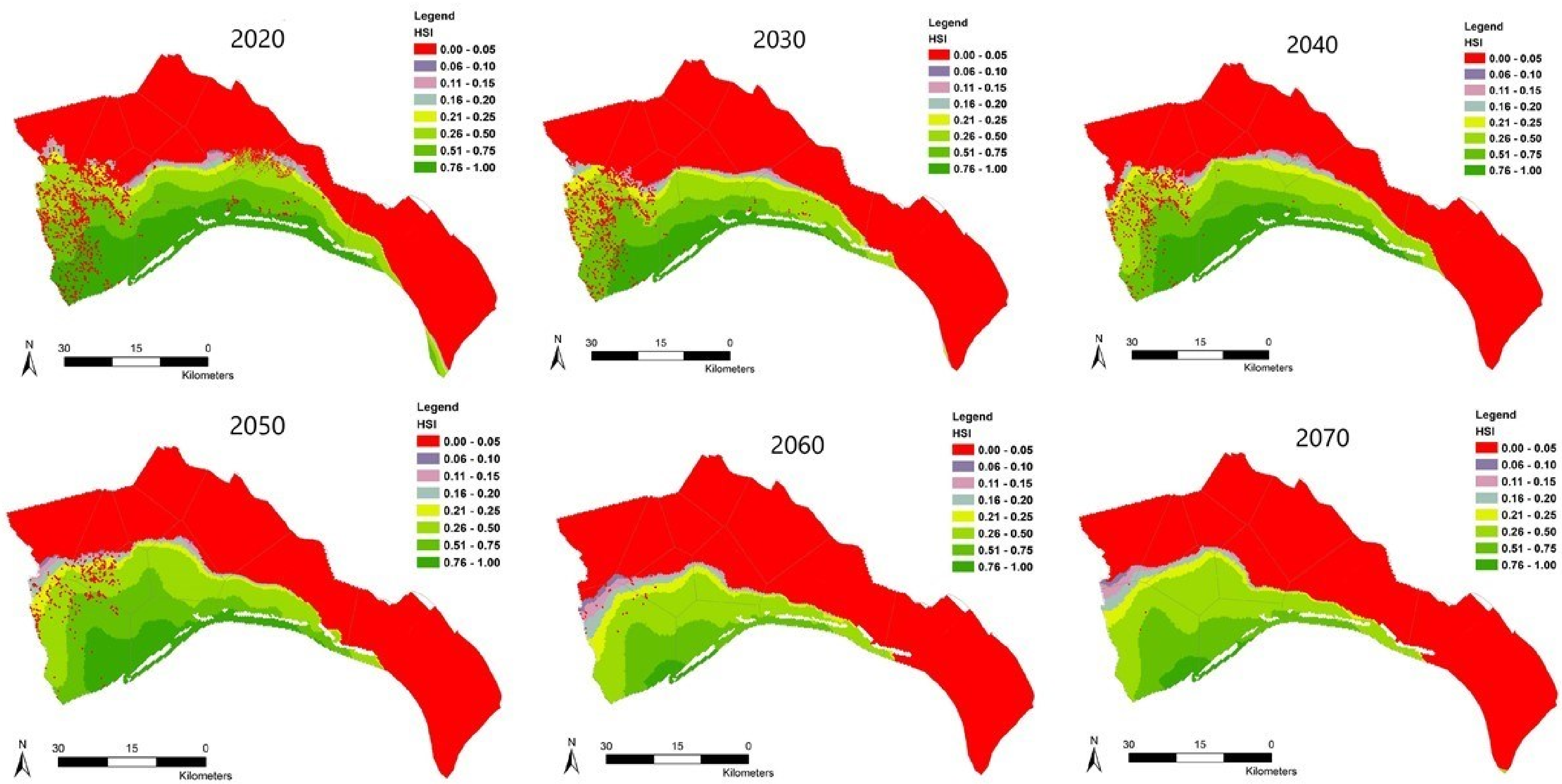


Figure 4.10-15. HSI Values for the No Action Alternative for Eastern Oyster through 2070.

4.10.4.5.2 Applicant's Preferred Alternative

Key species are addressed below in depth; however, a summary of the overall anticipated impact and the primary adverse and beneficial impact drivers are included in Table 4.10-6. This table highlights the primary drivers behind impacts on key species, while the following subsections provide detail regarding the spatial and temporal scale of these drivers as well as the degree to which they impact particular life stages of these key species.

Table 4.10-6
Summary of Key Species Impacts

Species	Impacts		
	Overall Impact[a]	Adverse Impact Drivers	Beneficial Impact Drivers
Brown shrimp	Major, adverse, direct and indirect, permanent impact to species with major decrease in abundance earlier in analysis period than No Action ; impact continues through the analysis period	Disruption of larval transport/juvenile settlement, decreased salinity	Increased marsh and primary production
White shrimp	Negligible to minor, beneficial, direct and indirect, permanent impact to species with potentially greater abundance than under No Action	Disruption of larval transport/juvenile settlement, decreased salinity	Increased marsh, SAV, and primary production
Blue crab	Negligible to minor, beneficial, direct and indirect, permanent impact to species with potentially greater abundance than under No Action	Disruption of mating, megalopae transport, early juvenile settlement	Increased marsh, SAV, and primary production
Bay anchovy	Minor, beneficial, direct and indirect, permanent impact to species with slightly greater abundance than under No Action	Disruption of larval transport	Increased marsh, SAV, and primary production
Gulf menhaden	Moderate, beneficial, direct and indirect, permanent impact to species with greater abundance than under No Action	Disruption of larval transport/juvenile settlement disruption	Increased low-salinity juvenile nursery habitat, increased prey biomass
Red drum	Moderate, beneficial, indirect permanent impact to species with greater abundance than under No Action	No significant adverse drivers	Increased marsh, SAV, and primary production
Spotted seatrout	Minor, adverse, direct and indirect permanent impact to species with a slightly lower abundance than under No Action	Disruption of larval transport, juvenile growth, and adult spawning activities	Increased marsh, SAV, and primary production
Atlantic croaker	Negligible, direct and indirect, permanent impact with no measurable basin-wide change in abundance over time as compared to No Action	Disruption of larval transport	Increased marsh, SAV, and primary production

Table 4.10-6
Summary of Key Species Impacts

Species	Impacts		
	Overall Impact[a]	Adverse Impact Drivers	Beneficial Impact Drivers
Southern flounder	Negligible to minor, adverse, direct and indirect, permanent impact to species with potentially lower abundance than under No Action	Disruption of larval transport, juvenile survival in low salinities	Increased marsh, SAV, and primary production
Largemouth bass	Moderate, beneficial, direct and indirect, permanent impact to species with greater abundance than under No Action	High flows in the outfall area	Increased low-salinity habitat, SAV, and prey
Eastern oyster	Major, adverse, direct and indirect, permanent impact to species with major decrease in abundance earlier in analysis period than No Action and continues over time	Reduced salinity	Reduced predation and disease
Freshwater fishes	Moderate, beneficial, direct and indirect, permanent impact to freshwater fish introduced into basin with greater abundance than under No Action	Not applicable[b]	Increased low-salinity habitat

a Impacts on key species include both direct and indirect impacts, depending on the specific impact driver.
b Adverse impacts on freshwater fishes would vary by species.

4.10.4.5.2.1 Brown Shrimp

The principal drivers of growth, survival, and perceived habitat preferences of brown shrimp life stages using the Barataria Estuary include salinity, temperature, presence of aquatic vegetation or habitat structure (for example, Minello and Rozas 2002, O'Connell et al. 2016a), food supply, and successful larval recruitment. Adult brown shrimp spawn outside of the estuary, and the earlier life stages (eggs and early larvae) occur offshore (see O'Connell et al. 2016a for review of life history). Therefore, these life stages are not anticipated to be directly or indirectly affected by operation of the Applicant's Preferred Alternative and impacts would be restricted to the post-larval, juvenile, and sub-adult life stages that occur in the estuary.

Brown shrimp post-larvae are carried into and migrate up the estuary from late January through June (O'Connell et al. 2016a). Brown shrimp post-larvae could be affected during transport into the outfall area through the majority of their larval transport period as the diversion outflows change flow direction and velocity within this region (see Section 4.10.4.4, Water Flow and Tidal Transport). The disruption of brown shrimp larval transport and retention would result in major, permanent, direct adverse impacts on the brown shrimp population. Major impacts are expected because high diversion flow during most years would overlap the majority of the brown shrimp larval transport period. While the annual duration of this impact (meaning the period of high flow during a given year) and spatial extent of this impact would vary depending on Mississippi River flows and the ongoing changes in wetland coverage, this impact would be annually recurring throughout the Project analysis period and would therefore be a permanent impact. Brown shrimp transport and retention is likely to be unaffected in the most western and southern regions of the basin, in areas where tidal flow is unaffected by diversion operation.

Post-larvae could also experience reduced growth and/or mortality if transported into low-salinity waters for extended periods of time. Changes in flow patterns could transport post-larvae into such areas, and if some post-larvae are able to migrate into the upper to mid-basin despite changes in flow patterns, these areas may not have suitable salinity for post-larval and juvenile survival. Saoud and Davis (2003) studied the 48-hour survival of post-larval brown shrimp into differing salinities when reared in salinities of 26 ppt. Survival of 13-day old post-larvae was between 0 and 5 percent when exposed to salinities of 8 ppt or below for 48 hours, and less than 44 percent when exposed to 12 ppt for 48 hours. Survival increased at lower salinities as the post-larval shrimp grew but remained relatively low with prolonged exposure to 1 to 2 ppt. At 4 ppt, post-larvae between 15 and 23 days old showed no substantial difference in mortality when compared to the control. As shown in Figure 4.10-7, prolonged salinities of 0 ppt would be present in the mid-basin during periods when the diversion is open (operating above the 5,000 cfs base flow). Thus, if post-larvae are transported or retained within fresh water over prolonged periods, the larval cohort could experience high mortality. Increased mortality events for shrimp post-larvae in the mid-estuary regions with prolonged fresh water would therefore result in moderate (due to spatial extent of reduced salinity), permanent (expected to occur most years), direct adverse impacts on the brown shrimp population.

Habitat suitability for juvenile brown shrimp, which is based on salinity, temperature, and the aerial proportion of marsh vegetation within the 20 polygons (see Figure 4.10-16) during their peak occurrence in the estuary from April through June (O'Connell et al. 2016a), is projected by the HSI model to be reduced by up to -0.3 in operational years 2020 through 2040 in the western region, and to a lesser extent (up to -0.2) across the lower to lower-mid estuary compared to the No Action Alternative. This reduction in suitability is primarily due to reduced salinity for the region. By 2060 and 2070, a minor decrease (between -0.2 and -0.1) in the suitability for juvenile brown shrimp remains in the mid to lower western area of the Barataria Basin compared to the No Action Alternative. These western polygons had the highest projected habitat suitability for juvenile brown shrimp in 2020 under the No Action Alternative (between 0.7 and 0.85, see Figure 4.10-12), but the suitability then decreased over time. In comparison to the No Action Alternative, the reduced suitability scores in the western polygons over time would result in the removal of the highest habitat suitability from this region early in the analysis period, such that the suitability in this region of the basin would be more similar to, and possibly even lower than, the current habitat suitability in other regions of the Barataria Basin. This decrease in habitat suitability would be major, permanent, direct, and adverse.

In contrast to the reductions in suitability for juvenile brown shrimp elsewhere in the estuary, a small increase in habitat suitability is projected to occur near the immediate outfall area (polygon 12) where marsh is maintained and even created under the Applicant's Preferred Alternative compared to the No Action Alternative (see Figure 4.10-17 for map of Marsh:Open Water), providing increased potential feeding and nursery habitat for juvenile shrimp. Maintenance of marsh within this region could result in minor, permanent, direct, beneficial impacts for the brown shrimp population if juveniles are able to settle within the marsh habitats. The impact of new and sustained marsh would be negligible to the overall population because this benefit would only be realized in those portions of the wetlands created/maintained in areas of favorable salinity and water flow for shrimp retention and settlement, as discussed above. Similarly, the increase in SAV biomass projected in fresher regions would be considered less suitable or sub-optimal for brown shrimp (salinity less than 10 ppt). As noted in Section 3.10.5.1.6, species can survive in sub-optimal conditions, although they may experience lower survival and growth rates outside of optimal conditions. For example, Herke et al. (1987) collected juvenile brown shrimp in salinities between 0.6 and 12.9 ppt in Louisiana marshes, with the highest number of juvenile shrimp collected in salinities between 2 and 3 ppt (that is, survival below optimal salinity) and with growth rates more driven by temperature. In another study, growth rates of juvenile shrimp were significantly lower at low salinities (2 and 4 ppt) when compared to growth rates at higher salinities (8 and 12 ppt), with the percentage of weight gain over 4 weeks increasing with salinity (33 percent at 2 ppt, 374 percent at 4 ppt, 614 percent at 8 ppt, and 689 percent at 12 ppt; Saoud and Davis 2003).

Whether or not juvenile brown shrimp could successfully reach, and grow well in, areas with sub-optimal salinities, the created or maintained marsh could nonetheless provide a minor, permanent, indirect benefit to the species as there are observed and modeled increases in prey biomass in shallow vegetated habitats compared to the No Action Alternative (see Dynamic Solutions 2016, see Section 4.6.4.1 in Wetland Resources and Waters of the U.S. and Section 4.10.3.1) which could be exported into portions of the estuary more suitable for juvenile shrimp settlement.

Brown shrimp are known to burrow in the sediment to avoid predation, although burrowing behaviors may be affected by multiple factors, such as shrimp size, sediment type, turbidity levels, and salinity (Minello 2016, Minello et al. 1987). In a study with over 20,000 observations of brown and white shrimp (Minello 2016), larger brown shrimp (mean of 95 millimeters) were recorded to burrow more often than smaller-sized shrimp and all brown shrimp were more likely to burrow in fine sand (89 percent of individuals burrowed) than coarse sand (22 percent) or finely crushed shell (8 percent). Brown shrimp also burrowed at the lowest rates at a salinity of 5, with significant differences between a salinity of 5 and the higher-salinity trials (25 and 40). Operation of the diversion would deliver both fine and coarse sediments to the outfall area, with coarser-grained sediments deposited near the outfall area. As discussed above, salinity in the outfall area would be low, constituting sub-optimal habitat for brown shrimp. Therefore, the potential for decreased burrowing activities due to the coarse-grained sediments would likely result in negligible impacts on brown shrimp.

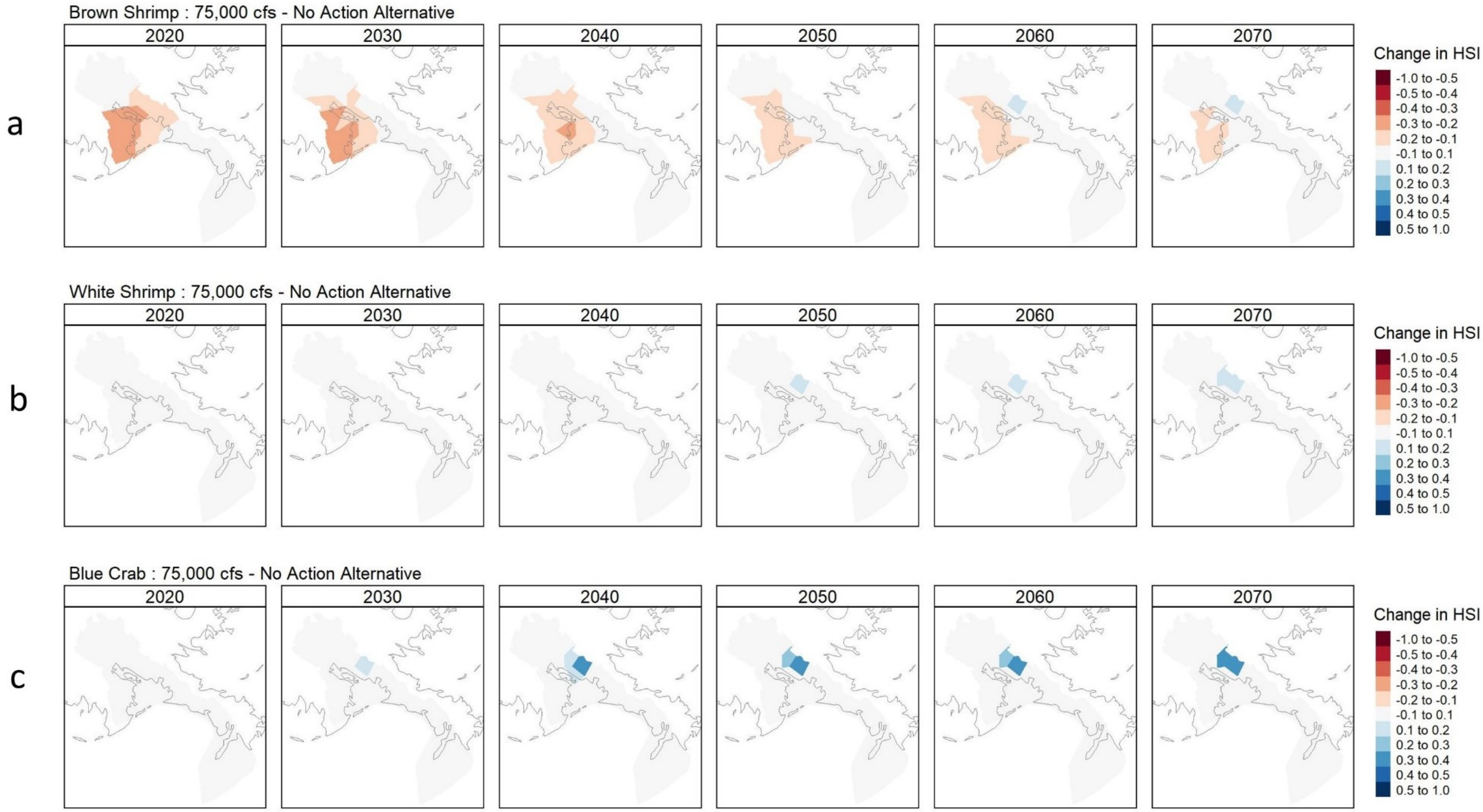


Figure 4.10-16. Difference in HSI for the 20 Polygons Over Time Compared to the No Action Alternative for (a) Brown Shrimp, (b) White Shrimp, and (c) Blue Crab. Red tones indicate a decrease in habitat suitability compared to the No Action Alternative, whereas blue tones indicate an increase.

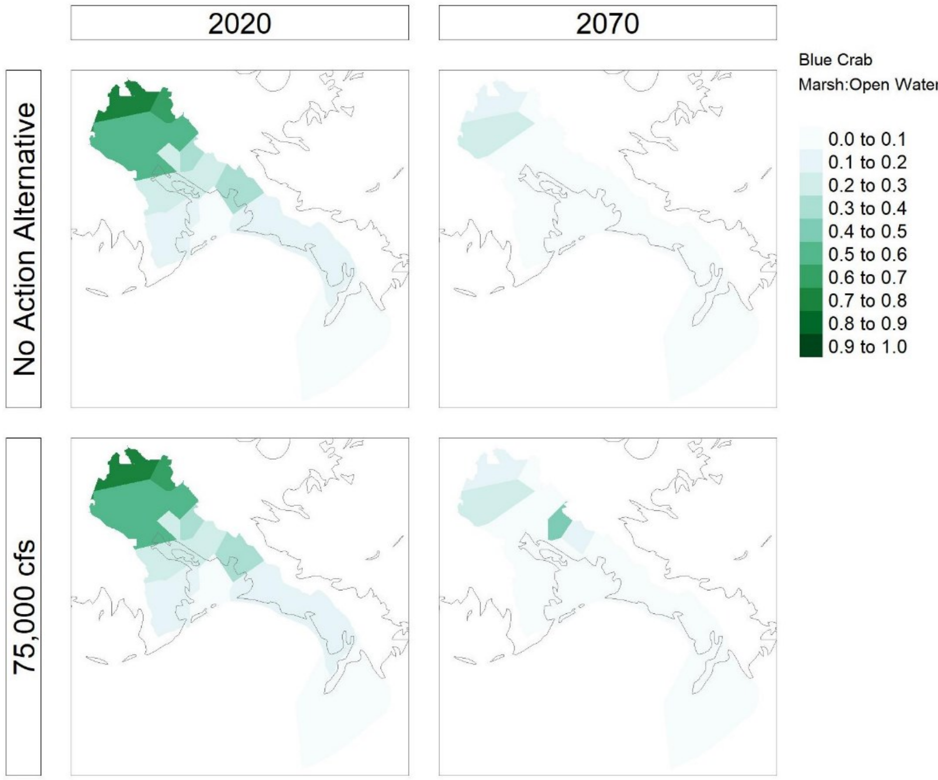


Figure 4.10-17. The Areal Proportion of Marsh to Open Water by Polygon for the No Action Alternative (top) and for the Applicant's Preferred Alternative (bottom) in Simulation Year 2020 and Year 2070.

Brown shrimp juveniles primarily consume detritus, phytobenthos, and benthic infauna such as polychaetes. If habitat changes result in impacts on the benthic portion of the food web, detritus should provide a temporary energy reserve for brown shrimp consumption and growth in regions affected by suspended sediments in the outfall area. Additionally, the increased primary production for many regions of the estuary following diversion releases could provide additional prey to benefit shrimp consumption and growth. The potential shifts and changes in prey biomass for juvenile brown shrimp would likely show indirect, moderate, permanent, and beneficial population-level impacts.

As discussed in Section 4.10.4.5 Eastern Oysters, the decreasing salinities projected as part of the proposed Project may increase oyster production in the lowermost portions of the Barataria Bay and the POSG if it helps to preclude marine predators and parasites like oyster drills (LaPeyre et al. 2009, LaPeyre et al. 2013), which may provide more suitable structural habitat for brown shrimp juveniles, resulting in minor, permanent, indirect beneficial impacts on juveniles. Larger juveniles and sub-adult brown shrimp (the surviving early juveniles that do find suitable habitat and grow up to move out of the shallow wetland habitats) would not likely experience substantial habitat impacts from operation of the proposed Project given their general outward migration through the lower basin over soft or sand/shell bottoms. Salinity in the Lower Barataria Basin may decrease below optimal levels in the spring and summer, when large juvenile brown shrimp would likely be present, but salinities are not expected to drop to 0 ppt for extended periods of time and large juvenile brown shrimp can tolerate low-salinity conditions.

Impacts on post-larval shrimp and consequent juvenile settlement in a portion of the basin, caused by the disruption of larval transport and reductions in spring salinity, are expected to result in adverse impacts on the basin-wide brown shrimp population that would be only partially offset by increased marsh habitat within the outfall area and increased primary production in areas of the basin. The adverse larval transport and salinity impacts, as well as the beneficial primary productivity impacts, are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to have major, permanent, direct and indirect, adverse impacts on the brown shrimp population level in the Project area. However, although a decrease in brown shrimp abundance is anticipated in the basin, the viability of the population is not anticipated to be affected.

4.10.4.5.2.2 White Shrimp

The principal drivers of growth, survival, and perceived habitat preferences of white shrimp life stages include temperature, salinity, presence of aquatic vegetation or habitat structure (for example, Minello and Rozas 2002, O'Connell et al. 2016b), food supply, and successful larval recruitment. Adult white shrimp spawn outside of the estuary, and the earlier life stages (eggs and early larvae) occur offshore (see O'Connell et al. 2016b for review of life history). Therefore, these life stages are not anticipated to be directly or indirectly affected by operation of the Applicant's Preferred Alternative and impacts would be restricted to the post-larval, juvenile, and sub-adult life stages that occur in the estuary.

White shrimp post-larvae entry to the estuaries lags the brown shrimp larvae by several months, with post-larvae being carried into and up the estuary from May through November with peaks in June and September. White shrimp post-larvae could be affected during transport into the outfall area and mid-estuary through early July (including the June peak) as the diversion outflows change flow direction and velocity within this region (see Section 4.10.4.4, Water Flow and Tidal Transport), with most of the impact on larval transport and juvenile settlement occurring in the outfall area. Diversion flows are typically anticipated to decrease to base flow by early July and therefore no impact on larval advection in the mid-estuary would be anticipated past that point, including the second peak of larval transport in September. As larval transport would generally not be precluded or disrupted for the majority of the larval transport period, the anticipated changes in tidal direction and flow are expected to have a minor, permanent, direct, adverse impact on early life stage success. This impact is anticipated to be minor because in most years, impacts would be expected during only a small portion (about 2 months) of the larval transport period and only one of the two larval transport peaks, and would mainly affect transport in the outfall area. While the annual duration and spatial extent of this impact would vary depending on Mississippi

River flows and the ongoing changes in wetland coverage, this impact would be annually recurring throughout the Project analysis period and would therefore be a permanent impact.

As shown in Figure 4.10-7 and Appendix N, prolonged salinities at or near 0 ppt are projected to be present in some portions of the Barataria Basin during periods when the diversion is open (operating above the 5,000 cfs base flow), with the spatial extent of reduced salinities expanding with increasing diversion flows. Post-larvae and juveniles could potentially experience increased energy requirements if transported by altered flow direction or velocity patterns into regions with extremely low salinities. However, white shrimp are generally considered more tolerant of low salinities than brown shrimp. Post-larval white shrimp have been collected in salinities from nearly 0 to 40 ppt (Patillo et al. 1997). While the minimum modeled optimal salinity for juvenile white shrimp is 5 ppt (see Chapter 3, Section 3.10 Aquatic Resources, Table 3.10-4), juvenile white shrimp have been documented as equally abundant in estuarine waters both below and above 5 ppt (O’Connell et al. 2017). Several studies also note the collection of post-larvae and juveniles in salinities lower than 5 ppt (Sanchez-Rubio and Jennings 2015, Zein-Eldin and Renaud 1986). Secondly, because the majority of the euryhaline post-larval and juvenile life stage occur when the diversion would typically be projected to operate at or near base flow, restricting salinity impacts on only a small portion of the overall annual larval recruitment and juvenile settlement period, this direct, adverse impact would be negligible on early life stage success. This negligible impact could occur for many or most years throughout the analysis period, and would therefore be a permanent impact.

Habitat suitability for juvenile white shrimp, as projected by the HSI model based on salinity, temperature, and the aerial proportion of marsh vegetation during their peak occurrence in the estuary from June through September (O’Connell et al. 2016b), is expected to change very little, if at all, compared to the No Action Alternative each decade (see Figure 4.10-12). Because the diversion would typically be projected to operate at or near base flow for the majority of the juvenile life stage, salinity reduction would also be expected to be limited during this timeframe. Beginning in 2050, a small increase in habitat suitability for juvenile white shrimp is projected in the immediate outfall area (HSI polygon 8), where marsh vegetation would eventually be created and maintained under the Applicant’s Preferred Alternative (see Figure 4.10-16), providing increased potential feeding and nursery habitat for juvenile shrimp. This increased habitat suitability would have a minor, permanent, direct, beneficial impact on white shrimp. The impact would be minor to the overall population since the benefits of the created and maintained marsh are projected to occur only in the outfall area of the estuary (localized), and only in the latter half of the analysis period. Additionally, this created or maintained marsh could provide an additional minor (detectable but slight), permanent, indirect beneficial impact on the species as increases in prey and nekton biomass in shallow vegetated habitats could be exported into portions of the estuary more suitable for juvenile shrimp settlement.

White shrimp juveniles primarily consume detritus, phytobenthos, and benthic infauna such as polychaetes. If habitat changes result in impacts on the benthic portion of the food web, detritus should provide a temporary energy reserve for white shrimp consumption and growth in regions affected by suspended sediments in the outfall area. Additionally, the increased primary production for many regions of the estuary following diversion releases could provide additional prey to benefit shrimp consumption and growth. The potential shifts and changes in prey biomass for juvenile and sub-adult white shrimp would likely show indirect, moderate, permanent, and beneficial population-level impacts. As discussed above for brown shrimp, white shrimp may burrow to avoid predation; however, they burrow at a much lower frequency than do brown shrimp (Minello 2016) and therefore any impact of changing sediment grain sizes in the outfall area would likely be negligible to their burrowing rates and potential.

Smaller white shrimp juveniles have been observed using vegetated habitats, followed by increasing sizes found in oyster beds, then non-vegetated bottoms; abundance was higher in oyster beds relative to non-vegetated bottoms, but no substantial difference in abundance was identified between vegetated and non-vegetated bottoms, nor between oyster beds and vegetated bottoms (Shervette et al. 2011). Early juvenile settlement in the marsh edge and shallow shoreline habitats is highest from about May through August, with LDWF typically closing the brown shrimp fishery in late June/early July when the catch of small juvenile white shrimp in the trawls increase and the managers want to ensure their successful recruitment to the fall white shrimp fishery (Bourgeois et al. 2015). White shrimp juveniles seem to move further up into the estuaries than brown shrimp, possibly because spawning takes place closer to the shore on the shallow shelf, and white shrimp may also remain in the estuary longer as sub-adults compared to the brown shrimp due to their tolerance of lower salinities (Pattillo et al. 1997, O’Connell et al. 2016b, Turner and Brody 1983). In a laboratory experiment, juvenile white shrimp (1.2 to 2.9 inches [30 to 75 millimeters] total length) collected from Galveston Bay, Texas, were able to move freely from salinities between 2 and 35 ppt in gently flowing water (Doerr et al. 2016). Over the course of seven trials, no notable pattern was identified in preferences between the salinity trials and the control, although white shrimp were more abundant than brown shrimp in lower (less than 18 ppt) salinities. The authors suggest that moderate variations in salinity do not drive the distribution of juvenile shrimp in estuaries and, in the case of freshwater diversions, that white shrimp may be more likely to remain in the estuary whereas brown shrimp may shift their distribution to higher-salinity regions of the estuary (Doerr et al. 2016). Therefore, the salinity shifts due to diversion operation would not be expected to impact the white shrimp juveniles. The increased SAV biomass anticipated to occur in freshwater areas would likely result in a minor, permanent, indirect, benefit to white shrimp.

Because wetland habitats throughout the basin are anticipated to decrease over time, even with implementation of the proposed Project, juvenile white shrimp may settle more frequently in other habitats, such as oyster reefs, and soft or sand/shell bottoms. Larger juveniles and sub-adult white shrimp would not likely experience substantial habitat impacts from operation of the proposed Project given their wide salinity tolerance and general outward movement to the lower estuary and nearshore shelf waters over soft or sand/shell bottoms.

Impacts on white shrimp are expected to be adverse in the outfall area due to disruption of larval transport, but these adverse impacts would be offset by beneficial impacts from new and sustained marsh vegetation in the outfall area and increased SAV and primary production in areas of the basin. The adverse larval transport and beneficial primary productivity impacts are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh would be realized later in the analysis period. Overall, the combination of these adverse and beneficial impacts is anticipated to have negligible to minor beneficial impacts on the white shrimp population level throughout the Project area.

4.10.4.5.2.3 Blue Crab

The principal drivers of growth, survival, and perceived habitat preferences of blue crab life stages include temperature, salinity, presence of aquatic vegetation or habitat structure (for example, Minello and Rozas 2002, O'Connell et al. 2016c), food supply, and successful larval recruitment. Turbidity in the outfall area was also considered as a mechanism of decreased mating potential.

Blue crabs spend most of their life cycle within the estuary. Adult males spend most of their time in low-salinity waters, while females move into lower-salinity regions of the estuary to molt and then to mate, typically during the spring and summer and peaking in March through May (O'Connell et al. 2017, Perry and Vanderkooy 2015); however, mating has also been identified later in the year (Perry and Vanderkooy 2015, Steele 1982). Blue crab reproduction is limited by the number and size of the males in the population (Rains et al. 2016). Although higher turbidity in the outfall area may result in minor impacts on mating during periods of high flows (from decreased visual cues for mate identification; Baldwin and Johnsen 2009), the impact would be negligible overall across the basin as many other regions, and periods of low flow, would have favorable conditions for female molting and mating with males.

After mating, females move to the deeper, higher-salinity estuarine waters nearer to the barrier islands, and offshore waters outside the barrier island areas, to spawn in June and July, typically about 2 months after mating (Gelpi et al. 2009, Perry and Vanderkooy 2015). Blue crab spawning in the lower estuary and on the shelf would likely not be affected by diversion operations as changes in flow and salinity would be minimal at these locations. After spawning, the females carry the eggs for approximately 2 weeks. The eggs hatch and the zoea larvae are then carried farther offshore. The planktonic zoea remain in offshore waters for up to 1 month before the offshore currents and the tides return the blue crab megalopae (late larval stages) back to the estuary. As these early life stages occur outside of the Project area, no impacts are anticipated to occur.

Blue crab megalopae are carried into and up the estuary, and settle as new juveniles (about 0.1 inch [2.5 millimeters] in carapace width) from late May through November (O' Connell et al. 2016b, Pattillo et al. 1997). Schaeffer (2001) found blue crab megalopae in areas with low and intermediate salinities; however, new juvenile settlement was greatest in the lower section of Barataria Bay (and in closer proximity to the tidal passes) with intermediate salinities. Settlement pulses were associated with southerly winds occurring for periods of at least 3 days. Although megalopae are capable of swimming up to 2 inches/second in still water and upstream against currents with flows of up to 1.9 inches/second (Luckenbach and Orth 1992), their ability to vertically move away from outflowing currents from the diversion would likely be limited to deeper areas (for example, tidal passes), where current stratification may occur. As transport of megalopae and settlement of new juveniles in the Barataria Basin is protracted, only the first 2 of the 7 months would be disrupted by high diversion flows in the outfall area and mid-estuary, with most of the impact on larval transport and juvenile settlement occurring in the outfall area. As larval transport would generally not be precluded or disrupted for the majority of the larval transport period, the anticipated changes in tidal direction and flow are expected to have a minor, permanent, direct, adverse impact on early life stage success in the outfall area. This impact is anticipated to be minor because in most years, impacts would be expected during only a small portion (about 2 months) of the larval transport period and would mainly affect transport in the outfall area. While the annual duration and spatial extent of this impact would vary depending on Mississippi River flows and the ongoing changes in wetland coverage, this impact would be annually recurring throughout the Project analysis period and would therefore be a permanent impact.

The HSI model for juvenile blue crab is based on salinity, temperature, and the aerial proportion of marsh vegetation during their peak occurrence in the estuary (January through March and August through December) (O'Connell et al. 2016c); habitat suitability is projected to change very little over space and time (see Figure 4.10-16). The largest changes in habitat suitability are projected increases of more than +0.3 by 2070 for polygons 8 and 12 (in the outfall area; see Figure 4.10-16) due to the creation and maintenance of marsh in that area (see Figure 4.10-17). This moderate increase in HSI scores brings the blue crab habitat suitability to above 0.8, which is considered highly suitable and near optimum for these polygons (see Carruthers et al. 2019 for polygon HSI scores by Alternative). The habitat suitability for juvenile blue crab in the rest of the Barataria Basin does not notably change over the simulated decadal years compared to the suitability under the No Action Alternative. Therefore, under the Applicant's Preferred Alternative, suitability for juvenile blue crabs remains relatively high throughout the rest of the basin with the same suitability gradient across polygons (ranging from about 0.3 to 0.96 by year 2070) as observed under the No Action Alternative (see Table 4.10-6).

Despite projected shifts in salinity under the Applicant's Preferred Alternative, the maintenance of marsh habitat in the outfall area, and thus increased habitat suitability for juvenile blue crab in a portion of the basin, results in a minor, indirect, permanent, beneficial impact on blue crabs. The impact would be minor to the overall population because the benefits of the created and maintained marsh are projected to occur only in the outfall area of the estuary and only later in the analysis period. In addition, as the salinity in the mid-basin decreases, an increase in SAV biomass is anticipated to establish over time (compared to the No Action Alternative; see Section 4.10.4.1). Early juveniles settling in SAV, or the new emergent marsh, as well as the later life stages of blue crab which utilize these habitats, would experience permanent, indirect, minor to moderate, beneficial impacts associated with the anticipated increase in wetland acreage and SAV biomass compared to the No Action Alternative.

Post-settlement growth and survival (Guillory et al. 1998) and high predation rates of juveniles after settlement (Heck et al. 2001) are important factors affecting blue crab populations in the estuary. Juvenile blue crabs are a favorite prey of the predator fishes across the salinity gradient including sea catfish, spotted seatrout, red drum, largemouth bass, catfish, Atlantic croaker, sheepshead, silver perch, snappers, and larger blue crabs. Changing salinity gradients could change the composition of the blue crab predators. However, the food web models indicated predator biomasses were low, with varied diets and multiple prey items; therefore, any shifts in predator composition with salinity gradients would be hard to detect and the impact on blue crab survival negligible.

Juvenile blue crab are generalist omnivores and consume detritus, phytobenthos, benthic infauna and small epifauna on the sediments and vegetation stems, and smaller crustaceans like caridean shrimp (see Food Web and Ecological Interactions). They would consume penaeid shrimps and cannibalize their own smaller-sized individuals as they grow larger. If habitat changes result in impacts on the benthic portion of the food web, detritus should provide a temporary energy reserve for blue crab consumption and growth in the outfall area during high-flow periods. Additionally, the increased primary production for many regions of the estuary following diversion releases could provide additional prey to benefit crab consumption and growth. The potential shifts and changes in prey biomass for blue crab would likely show indirect, moderate, permanent, and beneficial population-level impacts.

The adverse impacts associated with blue crab mating, megalopae transport, and early juvenile settlement in the outfall area would be offset by beneficial impacts from new and sustained marsh vegetation in the outfall area, and increased SAV and primary production throughout the basin. The adverse mating, transport, and settlement impacts, and beneficial bottom-up food web impacts from increased primary production, are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to have negligible to minor, beneficial, permanent, direct and indirect impacts on the blue crab population level in the Project area.

4.10.4.5.2.4 Bay Anchovy

The primary drivers of bay anchovy growth, survival, and perceived habitat preferences are zooplankton prey availability, temperature, salinity, presence of aquatic vegetation or habitat structure, and shallow waters for predation refuge (Houde and Zastrow 1991, Rilling and Houde 1999, Sable et al. 2016a and references therein for life history review). Potential impacts on larval recruitment from increased water flow were also considered.

Bay anchovy spend their entire life cycle within and around the estuary with spawning occurring in the deeper bay waters and inner continental shelf, possibly year-round, but peaking between May and October (Sable et al. 2016a, NMFS n.d.). Larvae migrate further up into the estuary (Jones et al. 1978, Sable et al. 2016a) to shallower and less saline reaches from May through October (Sable et al. 2016a). As larval transport is not expected to be precluded or disrupted by high diversion flows in the outfall area and mid-estuary for the majority of the larval transport period, the anticipated change in tidal direction and flow is expected to have a minor, permanent, direct, adverse impact on early life stage success in the outfall area. This impact is anticipated to be minor because in most years, impacts would be expected during only a small portion (about 2 months) of the larval transport period and would mainly affect transport in the outfall area. While the annual duration and spatial extent of this impact would vary depending on Mississippi River flows and the ongoing changes in wetland coverage, this impact would be annually recurring throughout the Project analysis period and would therefore be a permanent impact.

Habitat suitability for juvenile bay anchovy, as projected by the HSI model based on salinity, temperature, and the aerial proportion of marsh vegetation throughout the year (O’Connell et al. 2016c), shows no discernable difference in juvenile bay anchovy habitat suitability over space or time in the Barataria Basin for the Applicant’s Preferred Alternative compared to the No Action Alternative (see Figure 4.10-18) with the exception of a small increase in suitability in the outfall area in 2050 due to created and sustained marsh in this area. While the HSI model uses average annual salinity and temperature in calculating habitat suitability, which could dampen potential seasonal impacts, all life stages of bay anchovy are eurythermal (tolerant of a wide temperature range) and euryhaline (tolerant of a wide salinity range), and therefore any impacts on bay anchovy populations due to seasonal temperature or salinity changes would be negligible. The marsh vegetation created and maintained in the outfall area would provide increased potential feeding and cover habitat for juvenile bay anchovy. However, the impact would be minor to the overall population since the benefits of the created and maintained marsh are projected to occur only in the outfall area of the estuary, and occur later in the analysis period.

As the salinity in the mid-basin decreases, an increase in SAV biomass is anticipated (see Section 4.10.4.1). Early schooling juveniles utilizing low-salinity SAV or emergent marsh areas would experience minor to moderate, permanent, indirect, beneficial impacts associated with the anticipated increase in wetland acreage and SAV biomass compared to the No Action Alternative. Further, sediments accumulating in the outfall area over time would result in shallower water depths, providing bay anchovy with increased habitat for refuge.

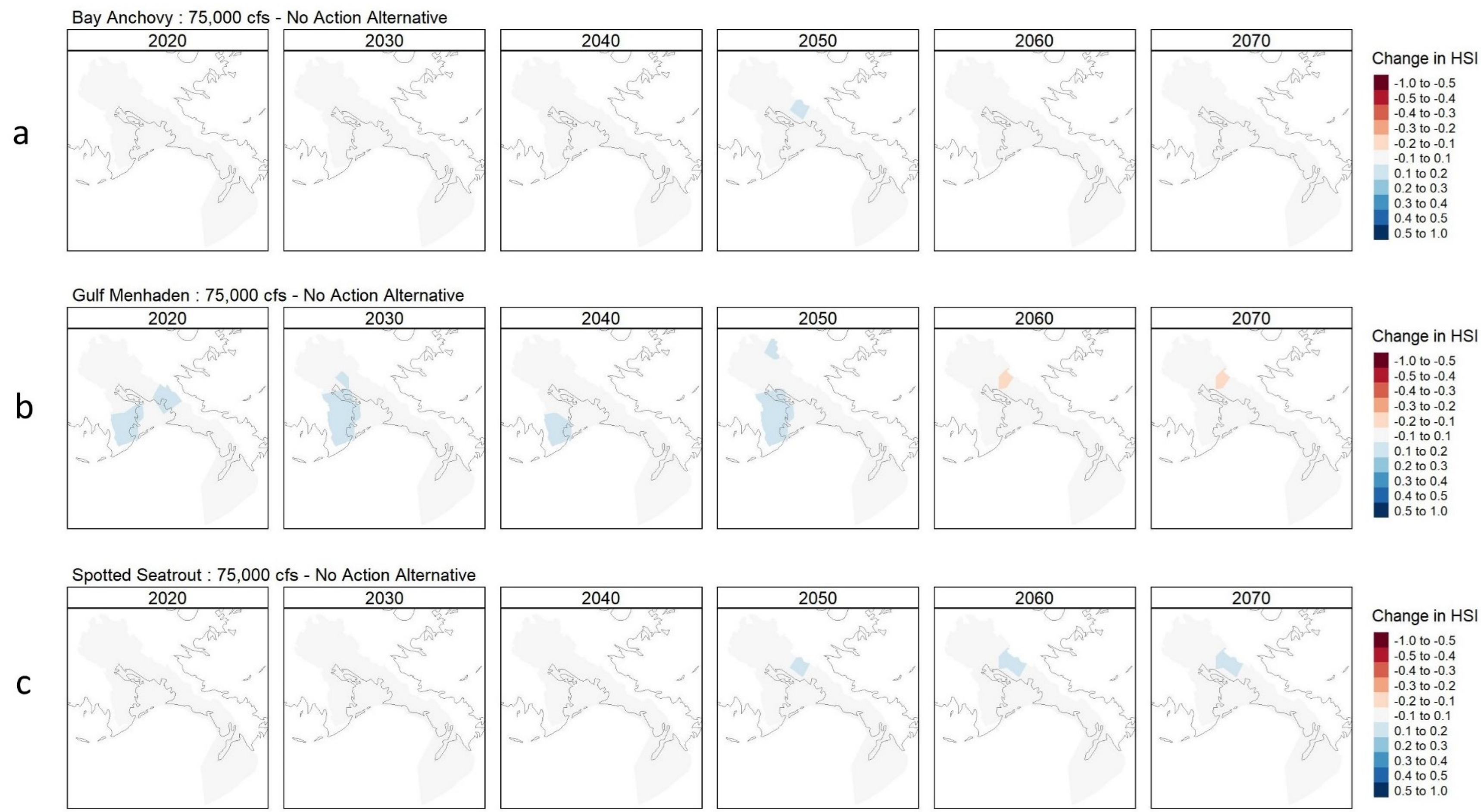


Figure 4.10-18. Difference in HSI for the 20 Polygons Over Time Compared to the No Action Alternative for (a) Bay Anchovy, (b) Gulf Menhaden, and (c) Spotted Seatrout. Red tones indicate a decrease in habitat suitability compared to the No Action Alternative, whereas blue tones indicate an increase**.**

Bay anchovy are a schooling forage fish species that prey predominantly upon zooplankton, and their abundance in estuaries is influenced by zooplankton presence (Houde and Zastrow 1991, Peebles et al. 1996, Peebles et al. 2007, Reid 1955, Rose et al. 1999). Bay anchovy feeding, and potentially growth and production, could be affected in the outfall area where increased turbidity would reduce the biomass of phytoplankton, and subsequently, of zooplankton. However, the increased primary production for many regions of the estuary following diversion releases could provide additional prey to benefit bay anchovy. The decrease in primary production in the outfall area would likely be offset by the increase in primary production in other areas of the basin, resulting in a net moderate, permanent, indirect, beneficial impact on bay anchovy.

The adverse impacts on bay anchovy associated with larval transport disruption in the outfall area would be offset by direct and indirect beneficial impacts from new and sustained marsh vegetation in the outfall area and increased primary production and SAV biomass in other regions of the basin. The impacts from larval transport (adverse) and primary production (beneficial) are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with increased SAV biomass, and new and sustained marsh would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to have minor, direct and indirect, permanent, and beneficial impacts on the bay anchovy population level in the Project area.

4.10.4.5.2.5 Gulf Menhaden

The primary drivers of Gulf menhaden growth, survival, and perceived habitat preferences are phytoplankton and phytobenthic prey availability, salinity, presence of aquatic vegetation or habitat structure for predation refuge (see Pattillo et al. 1997 and Sable et al. 2016b and references therein for life history and habitat requirements review). Potential impacts on larval recruitment from increased water flow were also considered.

All life stages of Gulf menhaden occur in the Barataria Basin except for spawning adults, eggs, and the early larvae that are found on the continental shelf (Christmas et al. 1982); these life stages would not be impacted by the diversion. Adults move inshore and up into the estuary and rivers during spring and summer, and then move on to the shelf to spawn in the fall through early spring (Deegan 1990). The Gulf menhaden yolk-sac larvae are carried from the shelf into the Barataria Basin by currents, and the feeding larvae continue to move up the estuary towards shallow freshwater reaches and river tributaries.

Gulf menhaden larvae are transported into and up the estuary from late October through May each year. Under the Applicant's Preferred Alternative, with high operational flows typically projected to overlap with the later portion of this larval transport period (from January through May; see Section 4.10.4.4, Water Flow and Tidal Transport), larval migration and juvenile settlement in the outfall area and mid-estuary would be disrupted. However, Gulf menhaden larvae exhibit some behavioral lateral movement in channels and in river mouths to avoid being displaced (Fore and Baxter 1972, Hartman et al. 1987) so it is possible that later season (strong swimming) larvae might be able to retain their positions to move up estuary and into shallow waters as juveniles. Therefore, although a large portion (about 5 months) of the later migration period would overlap with higher diversion flows, these flows would likely have a minor to moderate, direct, and adverse impact on early life stage success in the outfall area, depending on the size of the larvae as larger individuals may not be precluded from reaching marsh areas. While the annual duration and spatial extent of this impact would vary depending on Mississippi River flows and the ongoing changes in wetland coverage, this impact would be annually recurring throughout the Project analysis period and would therefore be a permanent impact.

Metamorphosis of juveniles occurs in the low-salinity waters in the upper estuary and around river mouths (Christmas et al. 1982). Juveniles remain in the upper reaches and shallow vegetated habitats of the estuary until they reach about 1.6 inches (40 millimeters) standard length. Although both the Applicant's Preferred Alternative and the No Action Alternative would have a net loss of marsh vegetation over the analysis period, more marsh vegetation would be created or maintained under the Applicant's Preferred Alternative, providing more potential feeding and nursery habitat over time when compared to the No Action Alternative. Further, as the salinity in the mid-basin decreases, an increase in SAV biomass is anticipated to establish (see Section 4.10.4.1). Early schooling juveniles utilizing SAV or emergent marsh would experience minor to moderate, permanent, indirect, beneficial impacts associated with the anticipated increase in wetland acreage and SAV biomass compared to the No Action Alternative.

Juveniles settling in and utilizing shallow vegetated habitats in the Project outfall area could be disrupted during high-flow operations from mid-February through May, although juvenile Gulf menhaden most often settle around freshwater reaches and river mouths so the species could be used to some higher flows (Christmas et al. 1982). Some level of displacement of juvenile Gulf menhaden within the Project outfall area and mid-estuary during these 3.5 months would result in direct, minor, permanent, and adverse impacts on the recruitment of juveniles. Minor, permanent, adverse impacts on juveniles would occur because they are present in Barataria Estuary year-round, so the larger portion of juvenile Gulf menhaden would not be affected by changes in water flow and direction during high-flow operations.

The juvenile Gulf menhaden HSI scores, predominately in the mid to lower western region of the Barataria Basin, increase slightly from about 0.1 to 0.2 compared to the No Action Alternative in simulated years 2020 through 2050, primarily due to increased chlorophyll A levels compared to the No Action Alternative. However, after 2050, the initial increases in habitat suitability compared to the No Action Alternative are lost and a subsequent decrease in habitat suitability is projected in polygon 8, in the outfall area compared to the No Action Alternative (see Figure 4.10-18). While the projected decrease in habitat suitability in polygon 8 is small (between -0.1 and -0.2), it would result in a minor, permanent, indirect, adverse impact on Gulf menhaden in the outfall area by the end of the analysis period. However, throughout the rest of the

Barataria Basin, lower salinities and increased phytoplankton prey (as discussed below) resulting from Project operations could provide better nursery habitat for juvenile Gulf menhaden. Therefore, it is expected that overall habitat suitability for juvenile Gulf menhaden would improve with the Applicant's Preferred Alternative. Improved nursery habitat for Gulf menhaden in the Barataria Basin outside of the Project outfall area would result in a direct, moderate, permanent, beneficial impact for juvenile Gulf menhaden. Late juveniles move down the estuary and into deeper bay waters where they would remain until spring and then move towards the upper reaches of the estuary again (Pattillo et al.1997 and references therein, Deegan 1990). Juvenile and adult Gulf menhaden are important in the Barataria Basin food web because they consume phytoplankton, as well as suspended phytobenthos and detritus in the water column (Deegan 1986, Olsen et al. 2014), and are prey to larger estuarine fish predators including seatrouts, drums, largemouth bass, and catfishes (Vaughan et al. 2007). If habitat changes result in impacts on the phytoplankton and benthic portions of the food web, detritus should provide a temporary energy reserve for Gulf menhaden consumption and growth in regions affected by suspended sediments in the Project outfall area. Additionally, the increased primary production for many regions of the estuary following diversion releases could provide additional prey to benefit Gulf menhaden consumption and growth. The potential shifts and changes in prey biomass for juvenile Gulf menhaden would likely show indirect, moderate, permanent, and beneficial population-level impacts.

The adverse impacts on larval migration and retention, as well as potential impacts on juvenile settlement in the Project outfall area would be offset by the increased juvenile nursery habitat and increased prey biomass for juvenile and adult Gulf menhaden consumption in many regions of the Barataria Basin. The adverse larval transport and beneficial primary productivity impacts are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to have moderate, direct and indirect, permanent, and beneficial impacts on the Gulf menhaden population level in the Project area.

4.10.4.5.2.6 Red Drum

The primary drivers of red drum growth, survival, and perceived habitat preferences are prey availability, temperature, salinity, and presence of aquatic vegetation or habitat structure for predation refuge (see Pattillo et al. 1997 and references therein for life history and habitat requirements review). Potential impacts on larval recruitment from increased water flow were also considered.

Red drum larvae, early juveniles (YOY before first birthday), immature and mature adult red drum occur in the Barataria Basin. Red drum spawning aggregations are found at deep barrier island passes and inlets, and around large structures on the shelf (Powers et al. 2012, Holt et al. 1985, Overstreet 1983). The eggs hatch in coastal waters and the young larvae are transported into the estuaries by currents. Therefore, spawning adults, eggs, and coastal larvae would not be affected by the proposed Project.

Following the general description of how larval transport can be affected in Section 4.10.4.4 (Applicant's Preferred Alternative, Water Flow and Tidal Transport), the red drum larvae should not be affected by the Applicant's Preferred Alternative operations. The timing of red drum larval entry and transport through the Barataria Basin occurs from August through December (Pattillo et al. 1997 and references therein), which would not typically be expected to overlap with the period of high-flow operations (January through early July; see Figure 4.10-7). Additionally, larval red drum are euryhaline, with similar growth and survival reported to occur from 1 to 50 ppt (Ward et al. 1980, Crocker 1981). Thus, the salinity shifts associated with the Applicant's Preferred Alternative should not affect early juvenile red drum growth and survival in the Barataria Basin.

Red drum early juveniles (YOY before first birthday) are estuarine-dependent and are commonly observed at salinities ranging from 0 to 50 ppt and water temperatures from 50 to 95°F (10 to 35°C; Pattillo et al. 1997 and references therein, GMFMC 2016). The growth and survival of early juvenile red drum are similar in fresh and salt water (Crocker 1981, Baltz et al. 1998, Stunz et al. 1999). Further, although optimal temperature ranges are higher, Anderson and Scharf (2014) indicate that mortality of juveniles from thermal stress occurred at temperatures of 41°F (5°C) or below; the Delft3D Basinwide Model does not project temperatures decreasing to this extent within the Project area.

Early juvenile red drum use shallow seagrass and marsh edge habitats for predation refuge from coastal predators, and increased foraging and growth afforded by high benthic prey density in these shallow vegetated habitats (Minello et al. 2003, Stunz et al. 1999, Baltz et al. 1998, Rooker et al. 1998, Rooker and Holt 1997, Perret et al. 1980). Red drum juveniles would also settle in oyster reefs within the estuary although seem to prefer vegetated habitats (Stunz et al. 2002, Moulton et al. 2017).

Although both the Applicant's Preferred Alternative and the No Action Alternative would have a net loss of marsh vegetation over the analysis period, more marsh vegetation would be created or maintained under the Applicant's Preferred Alternative, providing more potential feeding and nursery habitat over time when compared to the No Action Alternative, as long as the red drum that have settled within the outfall area are not flushed out or otherwise impaired by increased flow and turbidity during high diversion operations in the early spring. Further, as the salinity in the mid-basin decreases, an increase in SAV biomass is anticipated to establish (see Section 4.10.4.1). Therefore, the sustained and created marsh and increased SAV biomass anticipated under the Applicant's Preferred Alternative would likely have a moderate, permanent, indirect, and beneficial impact on red drum beginning later in the analysis period.

The red drum HSI was not used for impacts analysis because the HSI developed by Buckley (1984) for early life stages of red drum in temperate coastal waters of the

Atlantic does not appropriately reflect juvenile drum abundance patterns in the Barataria Basin. The predicted HSI scores were 0.0 in polygons when averaged salinity from August to November was below 10 ppt (see Carruthers et al. 2019, Buckley 1984). However, it is well established that red drum juveniles use the northern Gulf of Mexico estuaries extensively as nursery grounds (Minello et al. 2003, Minello 1999).

Sub-adult and adult red drum remain in the Barataria Basin year-round, or return after spawning, and would make cross-estuary movements apparently triggered by abrupt salinity changes from weather fronts or freshwater pulses, for foraging opportunities and also to find optimum thermal conditions (Sable et al. 2020, Moulton et al. 2017, Adams and Tremain 2000, Stunz et al. 2002). Red drum adults may move away from the outfall area to avoid higher flows, lower temperatures, salinities at the low end of their tolerance range, and increased turbidity during maximum operations. However red drum do forage in areas of higher flow or tidal exchange that provide increased prey concentrations (for example, Brogan 2010). These impacts from the Applicant's Preferred Alternative would be localized to the outfall area under maximum operations. Red drum are adept estuarine predators capable of long-range movements throughout the estuary, so these water quality and flow changes would be unlikely to cause an adverse, permanent, direct impact on adult red drum.

Evaluation of the LDWF fisheries-independent gill net and trammel net monitoring data for Breton Sound and the Barataria Basin have not identified changes in the annual basin-wide relative abundance of red drum linked to the Caernarvon or Davis Pond Freshwater Diversion operations, although the diversions are much smaller and the data collection is geared towards management rather than measuring species-habitat associations (for example, Plitsch 2014). However, when adult red drum catch in the gill and trammel net stations is considered by salinity there are clear patterns of increasing catch with decreasing salinity and seasonal temperature in the estuaries (unpublished LDWF data in Watkins et al. 2014).

All life stages of red drum are generalist omnivores that eat a variety of benthic and pelagic prey items depending on their size relative to the prey items (Scharf and Schlicht 2000). As discussed above, impacts on red drum prey biomass would not be affected by turbidity in the outfall area, based on the resilience of the food web and the ability of red drum prey to use detritus as a temporary energy reserve; however, as red drum are adept visual predators, they may avoid the outfall area during periods of high diversion outflow in favor of less turbulent areas where they can feed more efficiently. Further, the increased primary production for many regions of the estuary following diversion releases could benefit lower trophic-level prey and later contribute to red drum consumption and growth (see Section 4.10.4.4, Applicant's Preferred Alternative, Nutrient Loading). Although there would be moderate, permanent, and beneficial population-level impacts on individual prey species populations, red drum are currently not prey limited in the Barataria Basin (Rose et al. 2019) and therefore the benefit of increased prey would be indirect, negligible to minor, and permanent.

The new and sustained marsh vegetation in the Project outfall area, increased primary production, and increased prey and SAV biomass throughout the basin would have a beneficial impact on red drum. These benefits may result in a slight increase in species abundance over time. The beneficial primary productivity impacts are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh and SAV biomass would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to have moderate, permanent, indirect, and beneficial impacts on the red drum population level in the Project area.

4.10.4.5.2.7 Spotted Seatrout

The principal drivers on growth, survival, spawning, and perceived habitat preferences of spotted seatrout life stages using the Barataria Estuary include temperature, salinity, presence of aquatic vegetation or habitat structure as areas of reduced water flow and predation refuge, and food supply (for example, Ault et al. 1999, Sable et al. 2017). Potential impacts on larval recruitment from increased water flow were also considered.

Spotted seatrout generally spend their entire life cycle in their natal estuary and therefore all life stages are expected to be present in the basin. The spawning period for seatrout in Louisiana is generally from April through September or October in the lower bays and around barrier island passes with salinities between 20 and 37 ppt (Callihan et al. 2014, Nieland et al. 2002, Helser et al. 1993, Saucier and Baltz 1993). The species typically spawns multiple times over the course of the spawning season, with peaks in mid-summer (GSMFC 2001 and citations therein). The diversion duration and discharge rate would be expected to differ from year-to-year as Mississippi River flow conditions differ; in typical years the diversion would operate in late spring/early summer, such that some early season spawning could be delayed if salinities in the vicinity of the barrier islands remain below a suitable spawning range. As spawning peaks would generally occur during periods of lower diversion flows, eggs and larvae would largely be expected to experience favorable conditions as they move and settle around the basin. However, spotted seatrout produce eggs that are positively buoyant in their spawning salinity (that is, smaller eggs are produced in higher-salinity waters and larger eggs in lower-salinity waters) (Kucera et al. 2002). An unusually large freshwater input into a system would therefore cause eggs to sink, reducing the potential survival of the larvae (Holt and Holt 2003). Thus, eggs could experience a decreased rate of survival if spawned during high diversion flows and exposed to large decreases or fluctuations in salinity. However, these combined impacts would be considered minor as the species' spawning season typically lasts into the fall during lower diversion flows and therefore would potentially impact only a small portion of each recruitment class in the spring.

Larval spotted seatrout move up the estuary from the tidal passes through deeper channels to shallow vegetated nursery habitats within the Barataria Estuary, where they settle as juveniles. Spotted seatrout post-larvae could be affected during transport into the diversion outfall area and mid-estuary through early July as the diversion outflows change flow direction and velocity within this region (see Section 4.10.4.4, Water Flow and Tidal Transport). Diversion flows are typically anticipated to decrease to base flow by early July and therefore no impact on larval advection in the mid-estuary would be anticipated past that point, including the mid-summer peak in larval transport. As larval transport would generally not be precluded or disrupted for the majority of the larval transport period, the anticipated changes in tidal direction and flow is expected to have a minor, permanent, direct, adverse impact on early life stage success in the outfall area. This impact is anticipated to be minor because in most years, impacts would be expected during only a small portion (about 2 months) of the larval transport period and would mainly affect transport in the outfall area. While the annual duration and spatial extent of this impact would vary depending on Mississippi River flows and the ongoing changes in wetland coverage, this impact would be annually recurring throughout the Project analysis period and would therefore be a permanent impact.

Spotted seatrout juveniles in the Project area are typically found in shallow marsh edge, often in more saline conditions in the lower basin; however, as the optimal salinity range for this life stage is 5 to 20 ppt, juveniles are also found in lower-salinity areas if adequate marsh edge is present to provide protection from predators and ample food supply to smaller juveniles (Neahr et al. 2010, Sable et al. 2017, GSMFC 2001 and citations therein). Juveniles also tend to be found in marsh and SAV edge habitat in summer and fall months, during which the diversion would typically be operating at or near base flow. Juveniles utilizing SAV or emergent marsh would experience minor, permanent, indirect, and beneficial impacts on the overall population associated with the anticipated increase in wetland acreage and SAV biomass compared to the No Action Alternative (see Section 4.6.4.1 in Wetland Resources and Waters of the U.S. and Section 4.10.4.1). The impact would be minor to the overall population since the benefits of the created and maintained marsh are projected to occur only in the outfall area, and only in the latter half of the analysis period, and the increase in SAV biomass is anticipated to be highest in fresher areas that are outside of the optimal salinity range for the seatrout.

Juveniles are sometimes known to move into deeper water during the winter, which could coincide with sporadic winter pulses from the diversion (see Figures 4.10-7 and 4.10-9, and Appendix N). Although salinity may occasionally drop below optimal salinity for juveniles in the southern basin, the period of decreased salinity would be short (hours to a day or two) and juveniles should persist due to their wide salinity tolerance range, but growth rates could be minimally impacted due to increased osmoregulatory demands during short-term reductions or fluctuations in salinity. This potential short-term reduction in growth could have a negligible, direct impact on the species biomass.

The modeled juvenile spotted seatrout HSI scores do not substantially change compared to the No Action Alternative. The model considers mean salinity and temperature between the months of September through November, the peak period of occurrence for juvenile seatrout within the estuary, as well as percent coverage of vegetation (Sable et al. 2017, see Figure 4.10-18); the only changes of note are small increases between 0.1 and 0.2 in polygons 8 and 12 in the proposed Project outfall area in 2060 and 2070 due to marsh vegetation being maintained in this region compared to its loss under the No Action Alternative. The diversion would typically not be operating, other than base flow, during that time of year; therefore, no substantial change in HSI would be expected.

Spotted seatrout are higher trophic-level predators feeding on various smaller fish, shrimp, and crab. As discussed above, impacts on spotted seatrout prey biomass would not be affected by turbidity in the outfall area, based on the resilience of the food web and the ability of spotted seatrout prey to use detritus as a temporary energy reserve; however, as spotted seatrout are visual predators, they may avoid the outfall area during periods of high diversion outflow, even if salinities are favorable. Further, the increased primary production for many regions of the estuary following diversion releases could provide additional lower trophic-level prey to benefit spotted seatrout consumption and growth (see Section 4.10.4.4, Applicant's Preferred Alternative, Nutrient Loading). Although there would be moderate, permanent, and beneficial population-level impacts on individual prey species populations, spotted seatrout are not currently prey limited according to the food web modeling performed to support the EIS (Rose et al. 2019) and therefore the benefit of increased prey would be negligible to minor, indirect, and permanent.

Adult seatrout are typically found in areas of higher salinities in the southern portions of the estuary during spawning (Sable et al. 2017), which coincide with periods of higher salinity in this portion of the basin (see Figure 4.10-8). Secondly, Callihan (2011) showed that adult females tend to relocate to more suitable habitat zones during freshening events in western Louisiana, demonstrating an ability to spatially adapt to changing environmental conditions. This finding agrees with previous studies which indicated that salinity shifts can cause relocation and changes in spawning locations between years (Jannke 1971, Helser et al. 1993). Variable flow operations of the diversion in spring and early summer would reduce salinity in the lower bay from a range of about 10 to 20 ppt (No Action Alternative) to a range of about 5 to 10 ppt (see years 2020 to 2029 in Figure 4.10-8). Some shifts and relocation of spawning areas could occur during extended late spring-early summer freshening. The shifts or relocation of preferred spawning areas would be temporary for a given year as the protracted spawning season for seatrout extends through October, resulting in minor, temporary to permanent (recurring), direct, and adverse impacts over time.

The adverse impacts on spotted seatrout associated with larval transport disruption, juvenile growth, and adult spawning activities would be offset by beneficial impacts from new and sustained marsh vegetation around the Project outfall area, increased SAV biomass, and increased primary production throughout the basin. These adverse impacts and beneficial primary productivity impacts are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh, and increased SAV biomass, would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to result in minor, permanent, direct and indirect, adverse impacts on the spotted seatrout population level in the Project area.

4.10.4.5.2.8 Atlantic Croaker

The primary drivers of Atlantic croaker growth, survival, and perceived habitat preferences are benthic prey availability, temperature, salinity, and presence of aquatic vegetation or habitat structure for predation refuge and increased foraging by the early juveniles, which use the shallow marsh edge and SAV habitats as nursery grounds (Nye 2008, Pattillo et al. 1997 and references therein for life history and habitat requirements review). Potential impacts on larval recruitment from increased water flow were also considered.

Atlantic croaker larvae, early juveniles (YOY before first birthday), immature sub-adult and adult Atlantic croaker occur in the Barataria Basin. Atlantic croaker in the Gulf of Mexico spawn on the shelf from fall to early spring, with peaks in October/November and possibly January/February (Pattillo et al. 1997 and references therein, Cowan 1988, GSMFC 2017 and references therein). Eggs hatch in the coastal waters and larvae are transported into the estuaries by nearshore currents and tides between October and May, peaking in November and February, where they settle in low salinity, shallow vegetated habitats (Marotz 1984, Pattillo et al. 1997); Kupchik (2013) indicated that more than half the larvae collected during a 2-year study of larval recruitment occurred in November. Therefore, although larval migration in the outfall area and mid-estuary could be disrupted by higher January and February flows (see Figures 4.10-7 and 4.10-8), as well as occasional high flows in early winter (see Appendix N), earlier months of larval migration, including the November peak, would generally not be affected. Because the peak migration period would typically not overlap periods of highest diversion flows, changes in water flow and velocity in the outfall area would have a minor, direct, and adverse impact on early life stage success in the outfall area. While the annual duration and spatial extent of this impact would vary depending on Mississippi River flows and the ongoing changes in wetland coverage, this impact would be annually recurring throughout the Project analysis period and would therefore be a permanent impact.

Atlantic croaker life stages are euryhaline. Atlantic croaker eggs and larvae have been collected in coastal waters off Louisiana ranging in salinities from 15 to 35 ppt (Cowan and Shaw 1988). However, croaker eggs and larvae have been collected in other estuaries at salinities ranging from approximately 1 to 21 ppt (Ward et al. 1980). Atlantic croaker juveniles are collected in salinities ranging from 0 to 35 ppt (Pattillo et al. 1997 and references therein). Observed croaker abundance is highest at salinities less than or equal to 15 ppt in Louisiana and Texas (Ward et al. 1980). Juveniles appear to be more tolerant than adults to very low salinities (Gunter 1945); however, adults have been collected in fresh to marine waters as well (Ward et al. 1980). Within the estuarine life stages of Atlantic croaker, salinity does not directly affect growth (through osmoregulation-expended energy) (Nye 2008). Therefore, the Atlantic croaker life stages within the Barataria Basin should not be affected by shifts in salinity based on their physiological optimums and tolerances to salinity.

HSI modeled juvenile habitat suitability is driven by mean salinity from March through May (optimal salinity of less than or equal to 15 ppt) and mean annual water depth (optimal depths of less than or equal to 1.6 feet [0.5 meter]) (Carruthers et al. 2019). There are no HSI model projected changes to habitat suitability for juvenile Atlantic croaker under the Applicant's Preferred Alternative, with the exception of a small increase in suitability in the outfall area (see Figure 4.10-14[a]). This increase is projected by year 2060 and 2070 because the marsh was sustained and therefore mean water depth within the outfall area remained unchanged and at optimum levels for Atlantic croaker compared to the No Action Alternative.

Early juvenile Atlantic croaker abundance is highest in the vegetated and shallow shoreline habitats of Louisiana estuaries at salinities below 5 ppt (Baltz and Jones 2003, CPRA 2019b). Like other estuarine-dependent juveniles that use shallow wetlands of coastal Louisiana as nursery grounds, juvenile croaker concentrate in these habitats for consumption of benthic prey and higher growth (Nye 2008), and for reduced predation from larger predators such as southern flounder, blue catfish, largemouth bass, spotted seatrout, larger Atlantic croaker, red drum, and sheepshead (Levine 1980, Mercer 1987). Although the HSI indicates only a slight increase in habitat suitability in the outfall area, Atlantic croaker may also be benefited by the increase in SAV biomass in the larger basin area (see Section 4.10.4.1). Early juveniles utilizing the SAV or emergent marsh would experience minor to moderate, permanent, indirect, beneficial impacts associated with the anticipated increase in wetland acreage and SAV biomass compared to the No Action Alternative. As the juveniles grow larger, they move out of the shallow vegetated habitats and along non-vegetated creeks and channels of the estuary. After about 6 to 8 months in the estuary, adults migrate offshore in the fall for spawning (Pattillo et al. 1997 and references therein).

Juvenile and adult Atlantic croaker are benthic carnivores that prey on infauna such as polychaetes, small mollusks like clams and periwinkles, shrimps, crabs, and small benthic fish like gobies, minnows, and killifish. As discussed previously, impacts on Atlantic croaker prey biomass would not be affected by turbidity in the outfall area, based on the resilience of the food web and the ability of Atlantic croaker prey to use detritus as a temporary energy reserve. Additionally, impacts on benthic infaunal assemblages from salinity shifts (see Section 4.10.4.2) would have negligible impacts on Atlantic croaker, as the species is an opportunistic, trophic generalist feeding on multiple prey types. Further, the increased primary production for many regions of the estuary following diversion releases could provide additional lower trophic-level prey to benefit Atlantic croaker consumption and growth (see Section 4.10.4.4, Applicant's Preferred Alternative, Nutrient Loading). Although there would be moderate, permanent, and beneficial population-level impacts on individual prey species populations, Atlantic croaker are not prey limited and therefore the benefit of increased prey would be negligible to minor, indirect, and permanent.

Adverse impacts on the Atlantic croaker associated with larval transport disruption in the outfall area would be offset over time by beneficial impacts from new and sustained marsh vegetation in the outfall area, increased SAV biomass, and increased primary production throughout the basin. The adverse larval transport and beneficial primary productivity impacts are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh, and increased SAV biomass would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to have negligible impacts on the Atlantic croaker population level in the Project area.

4.10.4.5.2.9 Southern Flounder

The primary drivers of southern flounder growth, survival, and perceived habitat preferences are prey availability, temperature, and the presence of sandy and muddy substrates in shallow regions near marsh edge or SAV within the coastal estuaries of the northern Gulf of Mexico (Nanez-James et al. 2009, Pattillo et al. 1997 and references therein). Potential impacts on early life stage recruitment from increased water flow were also considered.

All but juveniles and non-spawning adults occur in offshore and nearshore waters. Adults spawn in deeper offshore waters from November through January, with peak spawning occurring off Louisiana's coast in December (Shepard 1986). Eggs and larvae occur in offshore and nearshore waters, and the juveniles move into the Barataria Basin from December through February (Allen and Baltz 1997, Glass et al. 2008, GSMFC 2000). Juveniles tend to move towards the low-salinity regions of the estuary and even up freshwater tributaries and rivers (Nanez-James et al. 2009), and adults migrate back into the estuaries from approximately February through May. The southern flounder life stages occurring in the Barataria Basin are eurythermal (reported range in occurrence of 35 to 86°F [2 to 30°C]) and euryhaline (range from 2 to 30 ppt), with temperature apparently having more of an impact than salinity on flounder consumption, growth, and cues for migrations in and out of the estuary (Peters 1971, Ward et al. 1980, Prentice 1989). However, laboratory studies of early juveniles (50 days old) showed low survivability (about 20 percent) after 72 hours in 0 ppt salinity (after acclimation); there was no difference in survivability in treatments with salinities between 5 and 30 ppt (Smith et al. 1999). Older juveniles (220 days old) did not experience mortality after a 2-week period in salinity treatments between 0 and 10 ppt (Smith et al. 1999).

Under the Applicant's Preferred Alternative, January and February flows are typically projected to overlap the tail end of the juvenile ingress and the beginning of the sub-adult migration down-estuary (see Figures 4.10-7 and 4.10-8). These near age-1 and age-1 flounder are strong swimmers and would not be affected by changes in flow direction from the diversion. However, as discussed above, early juvenile flounder coming through the lower estuary in January and February could experience reduced salinities, and mortality, during periods of high flow, which would have a minor, indirect, adverse, and permanent impact on early life stage success.

HSI modeled habitat suitability for juvenile southern flounder in the Barataria Basin did not appreciably change over space and time as compared to the No Action Alternative, except for a small reduction in decade 2040 in the outfall area (see Figure 4.10-19). The HSI modeled suitability was based on mean annual salinity and mean water temperature from May through August (Carruthers et al. 2019). The wide salinity optimum (approximately 5 to 20 ppt) and temperature optimum (68 to 95°F [20 to 35°C]) are in line with the ranges and apparent insensitivity of southern flounder to these conditions as reported in the literature (Pattillo et al. 1997 and references therein). No detectable change in juvenile flounder HSI values indicates that the salinity and temperature values remained at or near optimum suitability throughout the Barataria Basin for juvenile flounder over the entire simulated Project analysis period.

Juvenile and adult southern flounder are additionally affected by substrate, distance from vegetation, water depth, and DO (Dance and Rooker 2015, Furey et al. 2013, Furey and Rooker 2013, Nanez-James et al. 2009). There are observed differences in the selected zones and habitat characteristics of the estuary among newly settled juveniles, larger juveniles, and adult southern flounder (Nanez-James et al. 2009). Southern flounder generally prefer muddy substrates and are relatively abundant in areas where the substrate is composed of silt and clay sediments (GSMFC 2015 and references therein). However, newly settled juveniles are associated with shallow vegetated marsh edge and SAV habitats in the upper regions of the estuary furthest from tidal passes or inlets (Furey and Rooker 2013, Nanez-James et al. 2009). Additionally, the sustained and created marsh and increased SAV biomass under the Applicant’s Preferred Alternative would have a minor, permanent, indirect, and beneficial impact on early juveniles by providing additional nursery habitat. The juvenile southern flounder move to deeper non-vegetated bottoms as they grow in size. Adults tend to be found in the lower estuary closer to tidal passes or channels. Based on this upper to lower estuary zonation of southern flounder juveniles and adults in the Barataria Basin, it is expected that the Applicant’s Preferred Alternative would not affect larger juveniles and adults along non-vegetated bottoms in the mid and lower estuary and further from the Project outfall area.

Juvenile and adult southern flounder are ambush predators feeding primarily on shrimp, crabs, small fish like anchovy and Gulf menhaden, and other flounders as they grow larger (Overstreet and Heard 1982). As discussed previously, impacts on southern flounder prey biomass would not be affected by turbidity in the outfall area, based on the resilience of the food web and the ability of the benthic prey (like shrimps and crabs) to use detritus as a temporary energy reserve; however, as southern flounder are visual predators, they may avoid the outfall area during periods of high diversion outflow. Further, the increased primary production for many regions of the estuary following diversion releases could provide additional shrimp, crab, and small fish (prey) to benefit southern flounder consumption and growth. Although there would be moderate, permanent, and beneficial population-level impacts on individual prey species populations, southern flounder are not currently prey limited (Rose et al. 2019), eating a variety of prey items across fresh to marine waters, and therefore the benefit of increased prey would be indirect, negligible to minor, and permanent.

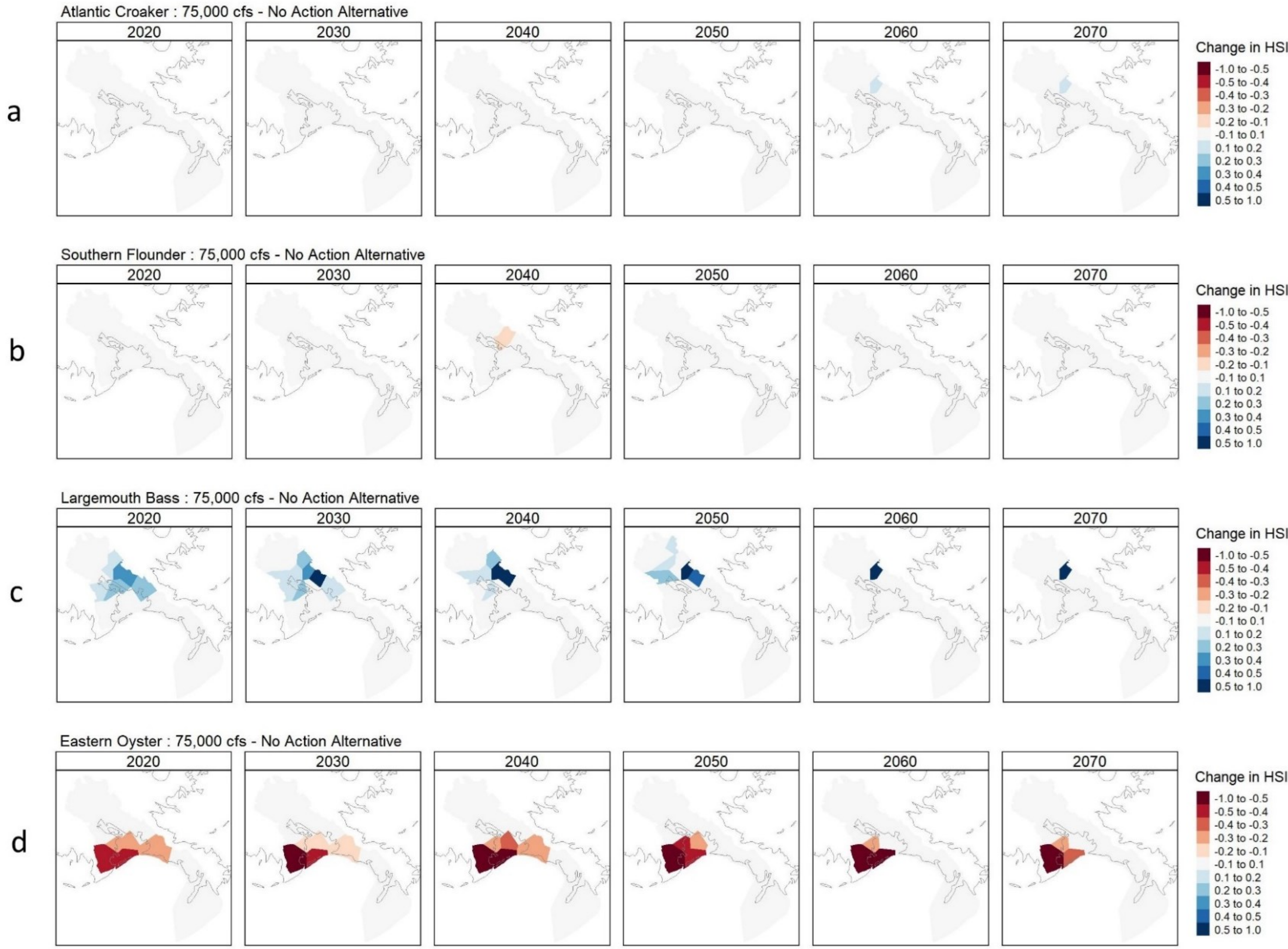


Figure 4.10-19. Difference in HSI for the 20 Polygons Over Time Compared to the No Action Alternative for (a) Atlantic Croaker, (b) Southern Flounder, (c) Largemouth Bass, and (d) Eastern Oyster. Red tones indicate a decrease in habitat suitability compared to the No Action Alternative, whereas blue tones indicate an increase.

The impacts on southern flounder associated with low-salinity impacts on early juveniles would be partially offset by beneficial impacts from new and sustained marsh vegetation in the Project outfall area, increased SAV biomass, and increased primary production throughout the basin. The adverse early juvenile salinity and beneficial primary productivity impacts are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh would be realized later in the analysis period. Overall, the combination of adverse and beneficial impacts is anticipated to have negligible to minor, direct and indirect, permanent, and adverse impacts on the southern flounder population level in the Project area.

4.10.4.5.2.10 Largemouth Bass

The primary drivers of largemouth bass growth, survival, and perceived habitat preferences are prey availability, temperature, salinity, and the presence of shallow marsh edge or SAV habitats within the Barataria Basin for early juveniles to feed on benthic prey and hide from larger estuarine predators (Hijuelos et al. 2017a and references therein for life history and habitat requirements). Potential impacts on larval retention from increased water flow were also considered.

All life stages of largemouth bass are present in the Barataria Basin, primarily in the upper basin north of the proposed diversion structure, preferring areas of low (less than 5 ppt) salinity, minimal turbidity, and proximal vegetative cover, although adults are adapted to a variety of habitat characteristics. Adult largemouth bass spawn in the Upper Barataria Basin, predominantly from February through April, and largemouth bass fry are present from April through June, with some fry still developing into early juveniles through July and August. Operation of the diversion during the spawning period is projected to result in decreases in water temperature (greater than or equal to 5.4°F [3°C]) nearest the diversion structure and out into the basin (see Section 4.10.4.4, Temperature), which could delay spawning activity at those locations until appropriate temperatures (greater than or equal to 61°F [16°C]) are reached; the Delft3D Basinwide Model projects that spawning temperatures would be delayed by about a month compared to the No Action Alternative. Decreased temperatures could also result in largemouth bass dispersal to (and competition with other bass for) warmer areas for spawning. Although temperatures would decrease in the outfall area during high flows, existing bass habitat further north in the estuary would not be substantially affected, indicating that spawning activities may experience minor to moderate, permanent (recurring), direct, adverse impacts from the potential spawning delay and population movements to warmer waters.

As all life stages of largemouth bass primarily occur north of the diversion structure, impacts on water flow and direction in the mid-estuary from high diversion flows would not be anticipated to measurably impact the species in the near term. However, as salinity in the mid-estuary decreases over time, largemouth bass would extend their range into areas further south, where outbound flows from the diversion structure may displace any fry present in the outfall area further south into the basin. Although individual fry may experience mortality if flushed to areas of unsuitable salinity or lack of cover (increased predation), these direct, adverse, and permanent (recurring) impacts would likely be negligible to minor to the overall population as many downstream areas would experience lower salinities during higher diversion flows.

The juvenile largemouth bass HSI scores increase in the middle estuary polygons under the Applicant's Preferred Alternative compared to the No Action Alternative for years 2020 through 2050 (see Figure 4.10-19). However, by 2070, the only remaining increase over the No Action Alternative occurs in polygon 8, albeit by more than +0.5 (see Figure 4.10-19). The high localized increase in habitat suitability for bass is due to sustained marsh vegetation at the outfall area by the end of the Project analysis period (see Figure 4.10-17). The increase in the middle estuary polygons from 2020 through 2050 are due to reduced salinities that are more optimal for the largemouth bass, as well as increased chlorophyll A concentrations which is a proxy in the HSI function for increased phytoplankton prey (and therefore bottom-up increases to largemouth bass prey). As further shown in Appendix N and Table 4.10-5, salinities would decrease to suitable levels for largemouth bass in much of the basin during diversion operation above base flow; however, the largemouth bass may migrate further up the estuary during periods of low flow, as salinities increase.

As discussed above (see Section 4.10.4.4, Emergent Vegetation), fresh/ intermediate marshes are projected to be created/maintained at a higher rate than the No Action Alternative during the analysis period, resulting in a peak of about 17,000 acres (12.3 percent greater than the No Action Alternative) in modeled year 2060, decreasing to about 12,700 acres (17.4 percent greater than the No Action Alternative) by 2070. The maintenance/creation of fresh/intermediate marshes (in the Project outfall area) and increased SAV biomass would result in moderate, permanent, indirect, beneficial impacts on not only the juveniles, but for all life stages of largemouth bass (Miranda and Pugh 1997).

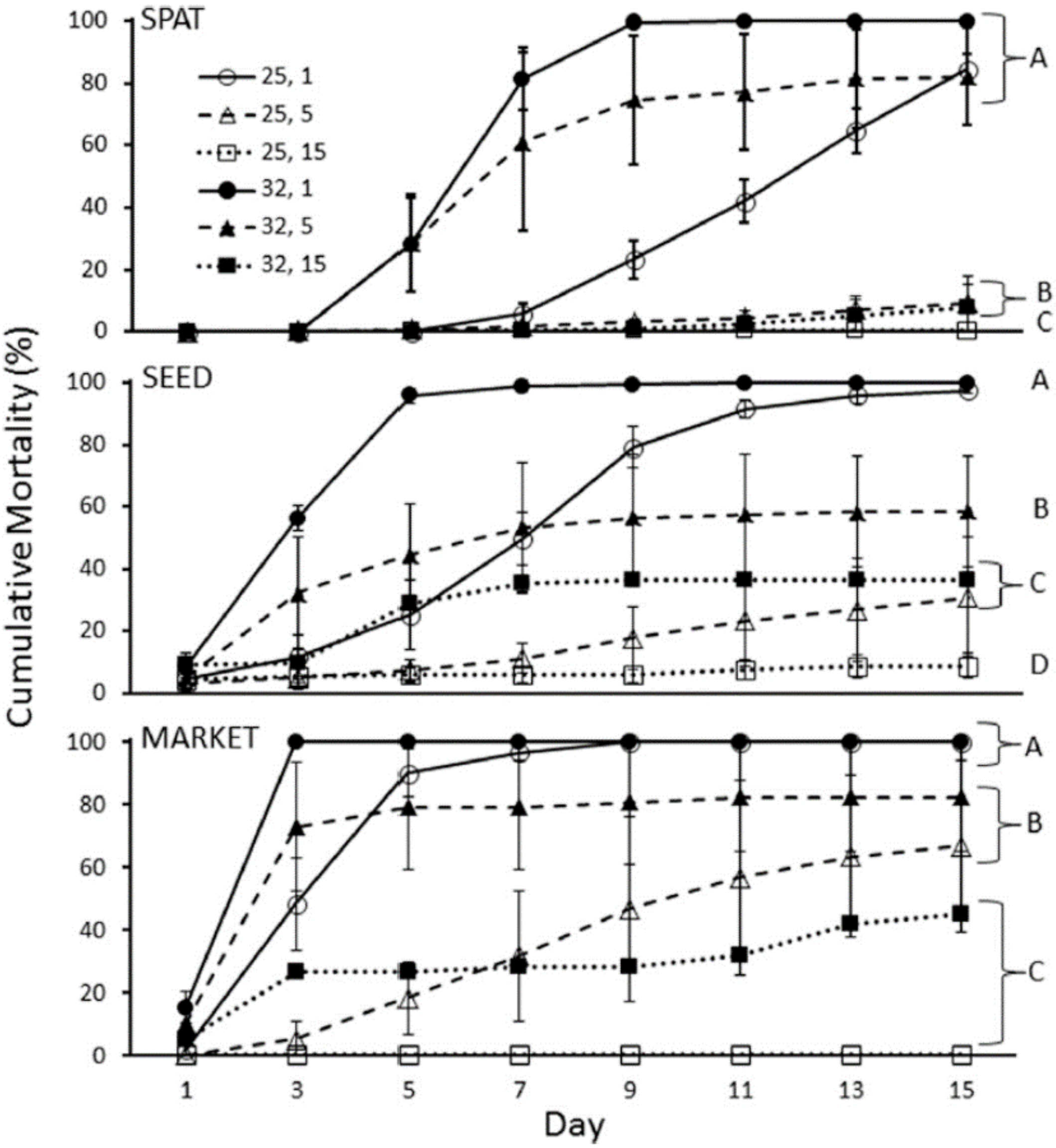
Largemouth bass are higher trophic-level predators feeding on various smaller fish, shrimp, crabs, and crayfish. As discussed previously, impacts on largemouth bass prey biomass would not be affected by turbidity in the outfall area, based on the resilience of the food web and the ability of largemouth bass prey such as shrimps and crabs to use detritus as a temporary energy reserve; however, as largemouth bass are visual predators (Boudreaux 2013, Hijuelos et al. 2017a and references therein), they are likely to avoid the outfall area during periods of high diversion outflow. Further, the increased primary production for many regions of the estuary, especially in regions with decreasing salinity, following diversion releases could provide additional lower trophic-level prey to benefit largemouth bass consumption and growth (see Section 4.10.4.4, Applicant's Preferred Alternative, Nutrient Loading). Although there would be moderate, permanent, and beneficial population-level impacts on individual prey species populations, largemouth bass are not currently prey limited (Rose et al. 2019) and therefore the benefit of increased prey would be indirect, negligible to minor, and permanent.

Overall, even though the recurring high-flow diversion operations in late winter through spring would likely deter use of the outfall area by largemouth bass, the extent of low-salinity areas with higher SAV and prey biomass in other regions of the Barataria Basin should provide a moderate, permanent, direct and indirect, and beneficial impact on the largemouth bass population. The impact is expected to be moderate because expanded low-salinity areas with higher SAV and prey could allow largemouth bass to expand their range and potentially outcompete other estuarine predatory fishes (Brown et al. 2009, Kazumi and Keita 2003). The benefits may result in a slight increase in species abundance over time.

4.10.4.5.2.11 Eastern Oysters

The principal drivers of growth, survival, and propagation for eastern oysters includes temperature, salinity, food supply, water circulation, and bottom character, with temperature and salinity being the main, and often interacting, drivers (Van Sickle et al. 1976, Lowe et al. 2017, Leonhardt et al. 2017, Rybovich et al. 2016). Although optimal growth parameters likely vary by stock, Lowe et al. (2017, and citations therein) identified optimal growth for Louisiana oysters (all size classes) as the combination of temperatures between 68 to 79.3°F (20.0 and 26.3°C) and salinities between 10.7 and 16.1 ppt. Combinations of temperature and salinity that include extreme values (that is, greater than 77 to 86°F (25 to 30°C) or less than 5 ppt) result in significant increases in mortality and decreases in growth (Lowe et al. 2017, Rybovich et al. 2016, La Peyre et al. 2009); however, oysters can survive extended periods of exposure to low salinity (less than 5 ppt) at lower temperatures (La Peyre et al. 2009, Leonhardt et al. 2017). La Peyre et al. (2009) indicated that adult oysters were able to survive when the daily mean salinity was below 5 ppt for 156 days (of the 210-day assessment period), of which 75 days had a salinity of less than 3 ppt, although growth was substantially slower than in areas with higher salinity. This corresponds with previous studies identifying oyster mortality being limited to prolonged (60 days) exposure to a salinity of less than 2 ppt (La Peyre et al. 2009, and references therein). Growth also decreases with longer exposure to waters greater than 15 ppt, with decreases in growth at this upper range being attributed to likely increases in infection intensities of *Perkinsus marinus* (Lowe et al. 2017, Leonhardt et al. 2017).

Rybovich et al. (2016) conducted laboratory and field studies to quantify the impacts of low salinity and high temperatures on the growth and survival of spat, seed, and market-sized oysters. Laboratory experiments included three salinity treatments (1, 5, and 15 ppt), each crossed with two temperature treatments (mean of 77 and 90°F [25 and 32°C]); oysters were placed directly into the treatment tanks after transport (that is, there was no acclimation time). As depicted in Figure 4.10-20, all life stages experienced significant mortality (about 80 percent or higher) with a salinity of 1 ppt, with mortality beginning after a short duration of exposure; associated field studies showed similar results for deployed seed and sack oysters. Spat and sack oysters also experienced mortalities of 80 percent or greater at 5 ppt and 90°F (32°C) after the 14-day trial. For remaining combinations, spat showed relatively low mortality (less than 20 percent) for combinations of 5 ppt/77°F (25°C), 15 ppt/77°F (25°C), and 15 ppt/92°F (32°C). Seed oysters experienced mortality of greater than 60 percent at 5 ppt/92°F (32°C), less than 40 percent at 5 ppt/77°F (25°C) and 15 ppt/90°F (32°C), and less than 20 percent at 15 ppt/77°F (25°C). Sack oysters showed 0 percent mortality at the 15 ppt/77°F (25°C) combination, but approximately 60 percent mortality at both the 5 ppt/77°F (25°C) and 15 ppt/90°F (32°C) combinations. The field study showed similar results (Rybovich et al. 2016).



Source: Rybovich et al. 2016.

Figure 4.10-20. Mean Cumulative Mortality (% +/- SD for All Tanks and Trials of Spat, Seed, and Market-sized Oysters Recorded Every Other Day). Letters at the end of lines denote statistically significant differences (P less than 0.05).

La Peyre et al. (2009) also indicated that significant drops in salinity over a short period of time (25 to 1 ppt over 24 hours, with the low salinity maintained for about 26 days) resulted in a 72 percent mortality of adult oysters, compared to a 31 percent mortality rate if the same decrease in salinity occurred over 1 week. In a parallel experiment, La Peyre et al. (2009) compared mortality rates in oysters when salinity dropped from 25 to 1 ppt or 25 to 5 ppt over 24 hours; mortality rates were 48 percent and 15 percent respectively (control was 12 percent). During the field component of this study, there was no significant difference in oyster mortality, which remained low (between 5 and 7.5 percent) across stations along a gradient of salinity regimes; however, although lower salinities were encountered, they were not maintained at less than 5 ppt over a 60-day period and the decrease in salinity was gradual when compared to the laboratory studies.

Mortality of oysters is also caused by disease and parasites. The primary disease-causing agent in Louisiana oysters is *Perkinsus marinus*, which thrives at salinities higher than 15 ppt and temperatures greater than 68°F (20°C); however, La Peyre et al. (2009) indicated that pulsed freshwater events could decrease infections in oysters even when temperatures exceeded 68°F (20°C) (Sehlinger 2018, citations therein; La Peyre et al. 2009). Specifically, La Peyre et al. (2009) indicated that a 2- to 3-week decrease in salinity to less than 5 ppt substantially decreased infection intensities in both field and laboratory studies. With respect to predation, Louisiana oysters experience higher mortality in salinities greater than 15 ppt, but the primary predator of Louisiana oysters (the oyster drill) cannot survive prolonged exposure to salinities below 10 ppt (Banks et al. 2016, Van Sickle et al. 1976).

Oyster reefs provide the majority of hard substrate required by other sessile invertebrate species such as barnacles, bryozoans, tunicates, and anemones. Fouling of oysters by overgrowth of these species could limit the ability of oyster larvae to attach to the available substrate (LDWF 2021). In addition, the hooked mussel is another reef-associated benthic bivalve and it can compete with oysters for settlement surfaces and food sources in salinities of less than 10 ppt. It is likely that competition for food impacts oyster growth rates, fecundity, and overall fitness (LDWF 2021). Although the influx of nutrients from the Mississippi River would be an overall, indirect benefit to the food web, including filter-feeding oysters (see Sections 4.10.4.4.2.4 Nutrient Loading and 4.10.4.4.2.8 Food Web and Ecological Interactions), the influx of nutrients could also stimulate the growth and/or population expansion of other organisms that could foul or compete with oysters.

As discussed in Section 4.10.4.4, the Delft3D Basinwide Model projected that by 2070, the Applicant's Preferred Alternative would result in about 4,778 acres of the Little Lake POSG receiving up to 10 inches of sediment associated with diversion of the Mississippi River (see Figure 4.10-6). Although 10 inches of sediment would smother oyster grounds if delivered in a short-term context, the projected 10 inches would be deposited over the course of 50 years (an average of 0.2 inches per year). LDWF has previously indicated that oysters can likely cope with gradual siltation, but Louisiana oyster fishermen have indicated that rapid siltation of 1 to 3 inches would cause high mortality (Sickle et al. 1976). Under optimal growth conditions for Louisiana oysters (60 to 97.3°F [20.0 to 26.3°C], 10.7 to 16.1 ppt), spat, seed, and sack oysters grow at a rate of 0.3, 0.2, or 0.06 inch per month, respectively, which would allow them to exceed projected deposition rates in the POSG (Lowe et al. 2017). However, as the Little Lake POSG is not productive currently, it is expected that sediment deposition may gradually cover existing suitable substrate.

Although portions of the Little Lake POSG would experience substantial sedimentation over time, the Delft3D Basinwide Model projects that in most existing public and private oyster areas (approximately 97 percent), sediment deposition would increase by less than 4 inches over the 50-year analysis period. Even so, while oysters may tolerate minimal increases in sediment deposition, high concentrations of sediment in the water column can reduce oyster feeding efficiency (Battista 1999), which could affect growth.

These studies indicate that acute and prolonged decreases in salinity, as well as extreme salinity (less than 5 ppt), temperature (greater than 77 to 86°F [25 to 30°C]), sedimentation, or combinations thereof, result in increased mortality and decreased growth rates in oysters. Conversely, maintained salinities of less than 10 ppt would be likely to decrease rates of disease and predation on Louisiana oysters.

Although the monthly average water temperature at many locations in the Barataria Basin and birdfoot delta are projected to approach or reach 86°F (30°C), those higher temperatures are only anticipated to be maintained in August when salinities are also projected to be at or near maximum, and no notable exceedances of 86°F (30°C) are anticipated. Although it is possible that temperatures above 86°F (30°C) would be maintained for a period of days during a given summer month, the diversion is typically projected to be closed (operating at the 5,000 cfs base flow) during late summer, such that salinities would generally increase above levels that would result in measurable mortalities from high temperature/low-salinity combinations.

However, operation of the diversion is expected to drastically affect salinity levels in the basin, with many stations in the mid-basin projected to approach or reach 0 ppt for an extended duration (up to 4 months; see Appendix N). As identified by Rybovich et al. (2016), these salinities would likely result in high mortalities of all size classes of oyster that may be present, although potentially at slightly lower rates than those reported in the study due to the more gradual decrease in salinity under the Applicant's Preferred Alternative; these decreases are generally variable over the course of weeks before dropping to and maintaining the lowest salinities. Oysters would be most adversely affected within POSG, POSR, or private leases at mid-basin locations, including areas near Station B. Bay North GI and to a lesser extent, Little L. Cutoff and Hackberry Bay. The Little Lake POSG is projected to change from very low salinity with intermittent salinity spikes, to salinities of around 0 or 1 throughout the year; although Little Lake has currently low productivity, operation of the proposed diversion would likely further restrict or preclude oyster growth.

The Hackberry Bay POSR is projected to typically experience salinities of less than 5 ppt from late winter/early spring through July in each decade of operation, but would otherwise maintain salinities greater than 5 ppt throughout the rest of the year. While the spatial extent and duration of these reduced salinities would vary depending on Mississippi River flows, there would likely be such reductions for multiple months each year. The low salinity would likely result in increased mortality and decreased growth of all size classes of oysters in Hackberry Bay, but may not preclude growth and survival. As a result of these impacts, the Hackberry Bay POSR may not consistently support commercially viable populations of oysters in the future. While larval availability may persist in waters with suitable conditions during operations, possibly through advection from fall spawning and recruitment from lower basin reefs, the compounded impact of multiple low recruitment years could substantially impact the oyster population in this POSR and areas experiencing similar conditions (for example, private leases in the same zone of influence). As discussed in Section 4.1 Approach to Evaluation of Environmental Consequences, the Delft3D Basinwide Model included assessment of both representative water years (water flow expected in a typical year) as well as water flow during years that experienced flood or drought conditions. The POSR, and similarly placed private leases, would have the largest losses during late spring flood flow years (as represented by the 2011 hydrograph) as salinities are further repressed, but there may be some recruitment in drier years (as represented by the 2006 hydrograph [low, multiple peak spring flow]), when salinities would remain relatively high in areas of the mid-basin; however, the potential for drier years cannot be depended on in terms of long-term viability of these areas. Over time, suitable substrate may be lost as shell disintegrates and other materials become buried. Cultch plants have regularly occurred in the Barataria Basin to create suitable habitats, however if there is no production of oysters then there would not be the financial incentive to replenish the substrate.

Low salinity also delays gonad development, spawning, and recruitment (Rybovich et al. 2016). Spawning generally occurs when salinities are higher than 10 ppt and water temperatures exceed 68°F (20°C), with two spawning events typically occurring in the spring (stimulated by rising temperatures) and fall (stimulated by falling temperatures) (Stanley and Sellers 1986). If there is a large reduction in salinity during the spawning season, spawning may not occur or larvae may not survive, thus reducing the recruitment potential within the various public oyster grounds. Salinity at all modeled stations (see Appendix N) is generally projected to be below the typical spawning salinity of 10 ppt in May, when temperatures at these stations are projected to reach 68°F (20°C); however, gonad development can occur at salinities greater than 6 ppt and oysters with ripe gonads have been known to spawn at a salinity of 5 ppt when exposed to low salinities (Van Sickle 1976). Although spring spawning may be affected (precluded or delayed), fall spawning (September and October) often occurs and may provide recruitment to oyster reefs in the Barataria Basin when the diversion is typically operating at base flow and salinity reductions outside of the outfall area (Station HWQ-08) are limited.

Operation of the diversion may also result in beneficial impacts on oysters in the lower basin (including the Barataria Bay POSG), where salinity is projected to generally remain above 5 ppt during operation above base flow (to allow growth and survival), but below 10 to 15 ppt, where predation and disease may be minimized. The Barataria Bay POSG is not currently suitable for oyster production due to the prevalence of disease and predation on oysters in this area. Stations potentially benefited by operation of the diversion include B. Bay near Grand Terre and B. Pass at GI. These two stations, although having depressed salinities during spring and early summer, would also be subjected to larger swings in salinity throughout the year, with low salinities present during operation of the diversion, but high salinities (about 10 to greater than 20 ppt) returning after diversion closure; this projected pattern is apparent across all decades of operation. As the post-closure salinity increases would be similar to existing patterns and values (albeit exacerbated) and would increase over a period of days or a week, measurable increases in mortality during this period are not expected. Once salinity at these stations increases above 10 ppt, increases in disease and predation may occur, but infection intensities may remain lower than would have otherwise been present had higher salinities been maintained. It is possible that areas near the barrier islands could be used as seed grounds and growing areas for adults when salinities are too low throughout the rest of the Barataria Basin, but this may require planting oysters after enhancing existing substrates to make them more suitable.

The eastern oyster HSI scores, which are based on mean spawning salinity (May to September), minimum monthly salinity, mean annual salinity, and the percent land cover, decrease in the lower estuary polygons over all simulated decadal years when compared to the No Action Alternative, with the largest reductions in the lower western region of the Barataria Basin (see Figure 4.10-19). These polygons, and polygon 20 at the south end of the birdfoot delta, were the only areas to have positive HSI scores above 0.0 in the Barataria Basin under the No Action Alternative by year 2070 (see Figure 4.10-15). However, under the Applicant's Preferred Alternative the suitability scores in this modeled lower western region are reduced to zero by 2070 and rendered unsuitable. Polygon 20 is the only one projected to remain suitable according to the oyster HSI used for this analysis. The large reduction in habitat suitability for the lower western region is primarily due to lower salinities in the spring and summer under the Applicant's Preferred Alternative compared to the No Action Alternative (see Appendix N).[65]

After review of the original HSI model, the LA TIG determined that the variation within the original 20 polygons could be quite large and critical to oysters, so a revised version of the eastern oyster HSI modeling was performed using a grid size of approximately 4-acre resolution to specifically address patterns of habitat changes for the sessile species. The revised HSI was run for each grid cell of the Delft3D Basinwide Model to provide finer spatial resolution, and to evaluate how suitability changes with different Mississippi River hydrographs (average hydrograph, spring flood flow conditions, and drought conditions). Similar to the first HSI analysis, projected changes in salinity from diversion operations were the primary driver in the modeled HSI results. Changes to salinity from the Applicant's Preferred Alternative are most noticeable during periods of higher diversion flow (typically January through June); however, even when the diversion is operating at base flow (5,000 cfs), it continues to influence salinity. According to the refined HSI model (see Figure 4.10-21), there would

[65] Note the oyster HSI summarized here and described in the appendix was the original model run by the Water Institute for the EIS. Some adjustments to the original HSI modeling analysis were performed when linking the Delft3D Basinwide Model spatial outputs with the HSI models for the Barataria Basin. The second analysis is described below. Additionally, improvements to the oyster HSI model structure and parameters are in progress for the 2023 Louisiana Coastal Master Plan Modeling, and include expanding the oyster spawning season beyond May/September to April/November in order to adequately cover the summer and fall spawning periods for oysters in coastal Louisiana.

be a notable reduction in suitable habitat in the Barataria Basin starting in the first 10 years of operation and continuing through subsequent time periods for adult oysters compared to the No Action Alternative. Reduced salinities as a result of diversion operation are projected to cause HSI values to decline and indicate that much of the mid- and lower basin would not be suitable for oysters. Habitat surrounding the barrier islands would remain suitable for oysters, even in years with late spring high flood flow conditions, but the total area is limited and may or may not currently have the appropriate substrate for oyster settlement. Under spring flood flow conditions, oysters located near the barrier islands would be outside of the primary impacts of freshwater input to the Barataria Basin from the diversion. The HSI model projections indicate that under drought conditions there would be less of a reduction in salinity throughout the Barataria Basin and more area of temporarily suitable habitat would be available for eastern oysters compared to wet years with late spring flood flow conditions. The areas of suitable habitat in drought years would include a larger portion of the Hackberry Bay POSR and all of the Barataria Bay POSG. Although, as previously indicated, the potential for drier years cannot be depended on in terms of long-term viability of areas experiencing prolonged and repeated periods of low salinity, seed oysters available from higher-salinity areas could be moved into the temporarily suitable habitat (during drier years), if suitable conditions are expected to persist long enough to allow for market-sized oysters to be harvested (which could be as little as a few months, depending on the size of the seed oysters). The economic viability of this option would depend on the level of confidence regarding forecast duration of drought conditions, the communication and coordination with fishers about the areas being opened for harvest, the accessibility and productivity of these areas, as well as market conditions.

Multiple lines of evidence indicate that adverse impacts on oysters would occur from the large decrease in salinity at multiple locations currently held in mid-basin POSG/POSR or private leases, although certain areas of the lower basin, including the Barataria Bay POSG, would possibly be benefited by the decrease in salinity over time. Overall, the decrease in suitability of two of the three Barataria Basin POSG/POSR and numerous private leases would represent a permanent, direct and indirect, adverse, and major impact on oysters from operation of the proposed diversion.

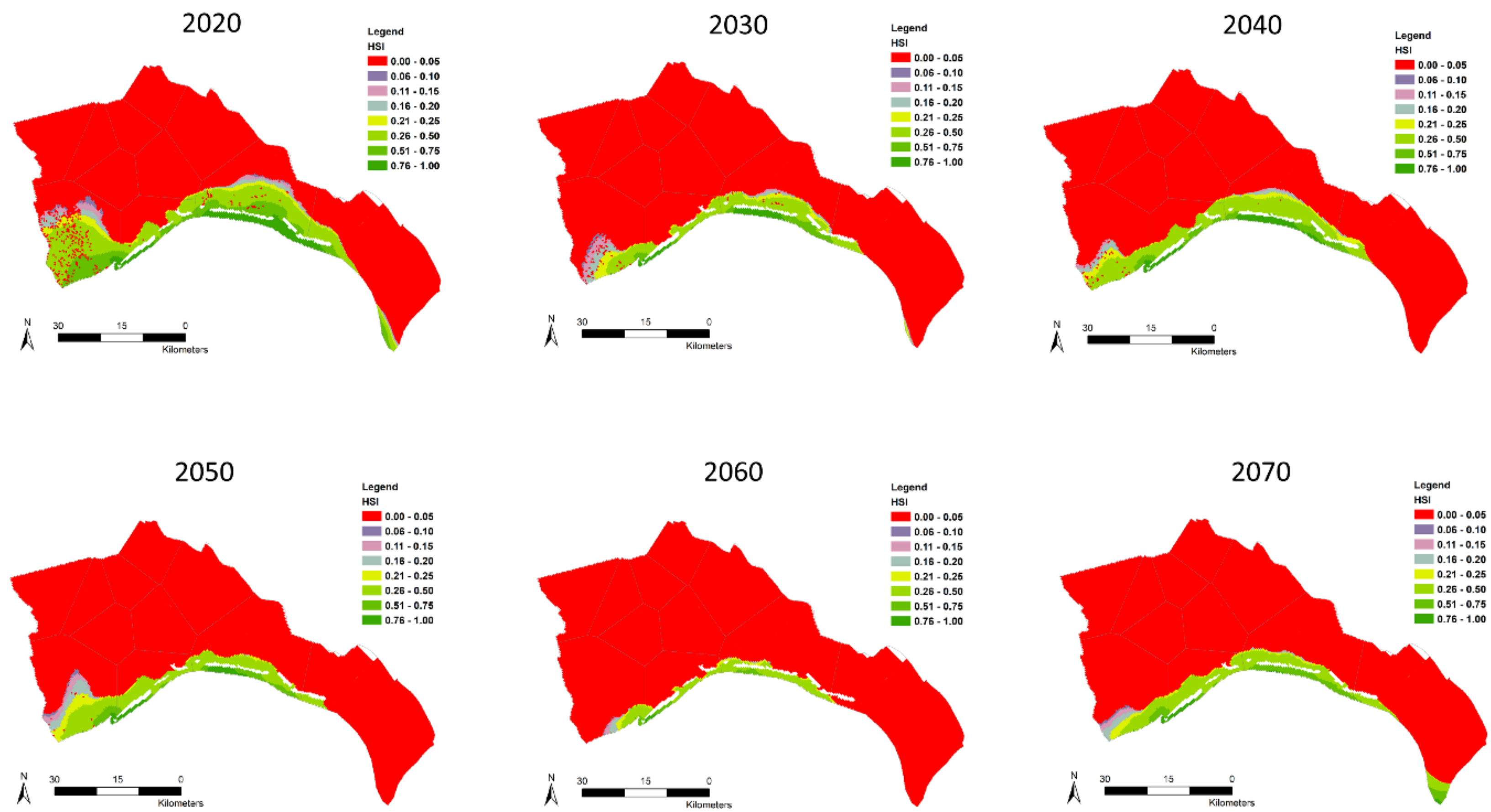


Figure 4.10-21. HSI Values for the Applicant's Preferred Alternative for Eastern Oyster through 2070.

4.10.4.5.2.12 Freshwater Fishes in the Lower Mississippi River

Freshwater fishes in the Lower Mississippi River, especially larvae or smaller juvenile fishes, may become entrained when the diversion is in operation and could be transported through the conveyance channel into the Barataria Basin. The Mississippi River has abundant populations of catfish, freshwater drum, striped bass, carps, and buffalo fish, many of which are already present in upper reaches of the Barataria Basin. These fish support recreational fisheries and grow to be quite large (LDWF 2019e), and can quickly grow in abundance, possibly outcompeting other species for prey species such as phytoplankton, zooplankton, mollusks, shrimps, crabs, and small fish. Alternatively, smaller riverine fishes coming through the diversion channel could become prey for larger estuarine predators such as red drum. Fish predators would use river plumes, tailwaters of dams or spillways, and channels or passes with high tidal exchange to feed on incoming (sometimes stunned) prey fish and invertebrates (De Robertis et al. 2005, Scharf and Schlicht 2000).

During operation of the Applicant's Preferred Alternative, the lowered salinities throughout the Barataria Basin could allow for introduced riverine fish to increase in abundance and thrive in the system. The introduction of additional large freshwater species into the system could cause a minor, permanent, adverse impact to current estuarine predator species in the Barataria Basin through increased competition for habitat and prey, primarily in areas of low or intermediate salinity that may be used by both freshwater and estuarine fishes for feeding. This impact would be minor because the current estuarine predators are not prey limited and the proposed Project would likely increase prey for estuarine predators. The spatial extent of the impact of introduced large predatory fish within the estuary would depend on the adaptive capabilities, reproductive capacity, and habitat preferences of the introduced species. Conversely, the diversion could also result in a minor to moderate, permanent, and beneficial impact on fish predators if the diversion delivers additional prey from the river to the estuary. The additional prey would benefit predators even if they are not currently prey limited. The benefit would likely be minor to moderate within the Project outfall area and nearby regions where coastal predators like drum and seatrout could feed on the incoming fish and invertebrates. A benefit to larger freshwater fish introduced from the river and the increased prey for larger predator fish is that commercial and recreational fisheries could have an increase in number and biomass of species within the basin. Overall, the proposed Project would have a moderate, beneficial, direct and indirect, permanent impact to freshwater fish introduced into the basin.

4.10.4.5.3 Other Alternatives

As discussed throughout Section 4.10, the other action alternatives generally do not result in substantial changes from that described in the Applicant's Preferred Alternative and therefore, impacts on the key species would be similar to those described above. The larger drivers of impacts on key species in the Barataria Basin include changes in salinity, temperature, SAV/marsh coverage, and water flow and tidal transport. Changes in salinity do not appear to be substantially influenced by either the variable flow or the presence of terraces, although salinities are projected to be slightly higher (50,000 cfs alternatives) or lower (150,000 cfs alternatives) when compared to the Applicant's Preferred Alternative, with differences most notable at the stations further afield from the outfall (see Section 4.5.5.1 Salinity in Surface Water and Sediment Quality). These differences would have incremental beneficial or adverse impacts on a given species, depending on their salinity tolerances. For example, decreased salinity is an impact driver for brown shrimp and oysters; therefore, impacts on these species may incrementally decrease under the 50,000 cfs alternatives and incrementally increase under the 150,000 alternatives.

Temperatures follow the same trends as the Applicant's Preferred Alternative, with minor differences (see Section 4.5.5.2 Water Temperature in Surface Water and Sediment Quality). As the changes in salinity for the other alternatives are not substantially different from the Applicant's Preferred Alternative, the biomass of SAV, which is expected to increase in freshwater areas, is also not anticipated to substantially change from the Applicant's Preferred Alternative (see Section 4.10.4.1).

Similarly, changes in marsh habitat and water flow from the 50,000 cfs Alternative is not anticipated to be substantially different than that described for the Applicant's Preferred Alternative. However, the 150,000 cfs Alternative would result in some notable differences from the Applicant's Preferred Alternative regarding the presence of marsh habitat and changes in water flow and tidal transport. The Applicant's Preferred Alternative would result in about 12,700 more acres of wetland (17.4 percent) within the basin in 2070 compared to the No Action Alternative, whereas the 150,000 cfs Alternative would result in 25,800 acres (35.4 percent) more than the No Action Alternative. The increase in wetlands created for the 150,000 cfs Alternative as well the terrace alternatives would result in incremental, beneficial impacts on those species that could use them. However, as with the Applicant's Proposed Alternative, the additional wetlands are anticipated to be created in the outfall area, restricting the created/maintained marsh to a relatively small portion of the basin and therefore, although resulting in an incremental benefit to the species, would not be expected to result in changes to the overall determinations for the key species, as identified above.

Delft3D Basinwide Model-projected water flow and velocity for the 150,000 cfs Alternative are projected to occur farther afield, with possible disruptions to larval transport occurring at additional stations (confluence of Bayou Saint Denis and Bayou Cutler, Little Lake to Grand Bayou, Grande Bayou to Hackberry Bay, and Bayou Dulac; see Figure 4.10-4) compared to the Applicant's Preferred Alternative, mostly during the periods of high flow (late April through early June). Additional incremental impacts would therefore occur on those key species that migrate up and into the estuary during high-flow periods, including the brown shrimp, white shrimp, blue crab, bay anchovy, Gulf menhaden, and spotted seatrout. Although larvae of these species may be precluded from entering and settling in these areas during the high-flow period, each species' larval transport period extends over a longer period than the typical high-flow period. As such, the incremental impacts associated with the further modification of flow patterns projected for the 150,000 cfs Alternative would not alter the overall determinations for the key species, as identified above. Although the terrace alternatives could cause minor and localized changes to water currents within 0.5 mile of the terraces, given the limited spatial extent of this additional impact, terraces would not alter the overall determinations for the key species, as identified above.

During operation, each alternative would have slightly different impacts associated with salinity and temperature changes, chlorophyll A concentrations resulting from changing light availability and nutrients, and marsh vegetation; however, as described above, these differences would not result in any substantial changes in the species-specific HSI polygon scores throughout the Barataria Basin over the 50-year Project analysis period. Table 4.10-7 shows the HSI scores under the No Action Alternative, along with the absolute difference in HSI score between the No Action Alternative and the 50,000 cfs Alternative, the Applicant’s Preferred Alternative (75,000 cfs), and the 150,000 cfs Alternative. Three species (brown shrimp, blue crab, largemouth bass) were selected to illustrate the small incremental changes that occur in the HSIs with increased operational flow based on changes in salinity, temperature, areal proportion of marsh to open water, and chlorophyll A concentration. Further, six select polygons (polygons 8, 9, 10, 11, 12, and 16) were used to illustrate the changes in HSI scores from the No Action Alternative. As shown in Figure 4.10-10, these polygons form a swath across the middle and lower estuary and tended to show the largest differences compared to the No Action Alternative. The suitability scores in polygons 8 and 12 often increased for species (for example, brown shrimp, blue crab, largemouth bass) for the Applicant’s Preferred Alternative because marsh vegetation was retained or increased. Suitability scores were also largely driven by chlorophyll A concentrations for the bass. In contrast, the species suitability scores in polygon 16 were sometimes reduced under the Applicant’s Preferred Alternative due to lowered salinity and interacting temperature (for example, brown shrimp). Table 4.10-7 shows HSI scores for brown shrimp, blue crab, and largemouth bass by six representative polygons for each decadal year for the No Action Alternative, and the absolute differences in HSI scores for the 50,000 cfs Alternative, the Applicant’s Preferred Alternative (75,000 cfs), and the 150,000 cfs Alternative as compared to the No Action Alternative for each year. Given the limited impact of terraces on salinity, temperature, areal proportion of marsh to open water, and chlorophyll A concentration, the terrace alternatives would be expected to have similar HSI scores as the non-terraced alternatives.

Table 4.10-7
HSI Scores for No Action Alternatives for Select Species and Polygons and Comparison of Operational Alternatives to the No Action Alternative

	Polygon	2020	2030	2040	2050	2060	2070
Brown Shrimp							
No Action Alternative	8	0.5831	0.5735	0.5513	0.4986	0.4165	0.4025
	9	0.7713	0.6946	0.6605	0.5903	0.4616	0.4186
	10	0.7236	0.6973	0.6790	0.5896	0.4158	0.3750
	11	0.6812	0.5698	0.4809	0.3815	0.3190	0.3218
	12	0.6568	0.5572	0.4652	0.3714	0.2999	0.2967
	16	0.8536	0.7597	0.6992	0.5777	0.4592	0.4477
50,000 cfs – No Action	8	-0.1295	-0.12189	-0.10149	-0.04692	0.036433	0.050472
	9	-0.1711	-0.1769	-0.17131	-0.1624	-0.10899	-0.09994
	10	-0.18254	-0.18305	-0.17741	-0.16597	-0.09197	-0.08753
	11	-0.20413	-0.13834	-0.11402	-0.08681	-0.05211	-0.0546
	12	-0.18744	-0.0913	-0.01753	0.024257	0.061088	0.038737
	16	-0.17771	-0.19226	-0.14731	-0.12001	-0.09259	-0.07645
75,000 cfs – No Action	8	-0.1293	-0.12273	-0.10451	-0.04862	0.034611	0.048195
	9	-0.20164	-0.2032	-0.19387	-0.18596	-0.12391	-0.11333
	10	-0.20302	-0.19785	-0.19112	-0.18135	-0.10208	-0.09774
	11	-0.21136	-0.14022	-0.113	-0.08838	-0.05517	-0.06077
	12	-0.19091	-0.09419	0.000952	0.077961	0.118377	0.101814
	16	-0.2211	-0.23338	-0.17762	-0.15753	-0.11717	-0.10151
150,000 cfs – No Action	8	-0.13045	-0.12366	-0.1072	-0.04984	0.033116	0.0457
	9	-0.25858	-0.23568	-0.22738	-0.21398	-0.13606	-0.1272
	10	-0.22676	-0.21532	-0.20826	-0.19019	-0.09956	-0.09861
	11	-0.21876	-0.12442	-0.06337	0.00098	0.008906	-0.01257
	12	-0.19535	-0.0996	-0.00803	0.084776	0.156231	0.158858
	16	-0.30471	-0.29583	-0.2347	-0.21885	-0.15278	-0.14737
Blue Crab							
No Action Alternative	8	0.9508	0.9449	0.8853	0.7691	0.6949	0.6448
	9	0.9162	0.8723	0.7978	0.6973	0.5645	0.5189
	10	0.9172	0.9149	0.8570	0.7012	0.5284	0.4455
	11	0.8679	0.7851	0.6426	0.4847	0.4504	0.4367
	12	0.8862	0.8259	0.6732	0.5254	0.4774	0.4617
	16	0.6885	0.6778	0.5953	0.4960	0.4434	0.4201
50,000 cfs – No Action	8	0.039831	0.042881	0.101513	0.214378	0.28794	0.329188
	9	0.018066	0.028055	0.031483	0.034958	0.070462	0.03627
	10	0.027458	0.041968	0.061307	0.054881	0.054157	0.042385
	11	0.072123	0.075985	0.084141	0.071113	0.05443	0.04324
	12	0.08512	0.135549	0.243095	0.26223	0.253836	0.198751
	16	0.032386	0.04465	0.056046	0.045066	0.040374	0.033689
75,000 cfs – No Action	8	0.039761	0.042484	0.101037	0.214535	0.288596	0.332657
	9	0.02103	0.031005	0.033871	0.038882	0.072483	0.038529
	10	0.030029	0.044574	0.065222	0.060665	0.058745	0.048167
	11	0.073317	0.083506	0.104266	0.088388	0.064644	0.056404

Table 4.10-7 HSI Scores for No Action Alternatives for Select Species and Polygons and Comparison of Operational Alternatives to the No Action Alternative							
	Polygon	2020	2030	2040	2050	2060	2070
	12	0.085726	0.135775	0.301169	0.393094	0.382198	0.34421
	16	0.036435	0.05302	0.067159	0.054581	0.046496	0.038356
150,000 cfs – No Action	8	0.040116	0.042248	0.100439	0.215502	0.290095	0.336141
	9	0.027529	0.035113	0.040994	0.044111	0.080386	0.047269
	10	0.035859	0.048234	0.078846	0.084115	0.094495	0.084387
	11	0.075724	0.131859	0.230138	0.289475	0.216356	0.181231
	12	0.086297	0.13597	0.302295	0.420866	0.473956	0.479179
	16	0.049497	0.065701	0.089119	0.06404	0.062964	0.055413
Largemouth Bass							
No Action Alternative	8	0.6493	0.6013	0.3320	0.1634	0.1967	0.1865
	9	0.3835	0.1719	0.1208	0.1277	0.1401	0.1433
	10	0.5689	0.5098	0.2956	0.1256	0.1456	0.1282
	11	0.4412	0.1321	0.1319	0.1288	0.1569	0.1413
	12	0.5775	0.2484	0.1484	0.1534	0.1857	0.1743
	16	0.0719	0.0933	0.0819	0.0891	0.1122	0.1010
50,000 cfs – No Action	8	0.376053	0.393654	0.633881	0.758642	0.699177	0.66622
	9	0.108501	0.092637	0.048582	0.066621	0.074864	0.059495
	10	0.216389	0.261711	0.169915	0.071068	0.065013	0.058209
	11	0.27589	0.076549	0.0763	0.06672	0.058173	0.054066
	12	0.420135	0.555779	0.354647	0.053511	0.03432	0.028054
	16	0.041251	0.047556	0.044721	0.043459	0.04917	0.039077
75,000 cfs – No Action	8	0.358187	0.349255	0.574947	0.687865	0.619374	0.655749
	9	0.130004	0.104979	0.054874	0.076839	0.082686	0.064644
	10	0.225369	0.265653	0.171945	0.072969	0.068085	0.060267
	11	0.236496	0.063821	0.069978	0.058149	0.049119	0.038341
	12	0.399143	0.660609	0.717147	0.477232	0.019147	0.009956
	16	0.050529	0.057592	0.053488	0.056653	0.061456	0.049492
150,000 cfs – No Action	8	0.334819	0.249821	0.471419	0.510574	0.447947	0.476089
	9	0.186502	0.129849	0.06437	0.089892	0.091133	0.077755
	10	0.24859	0.286498	0.22196	0.065345	0.06333	0.063429
	11	0.170482	0.371149	0.05629	0.035425	0.011863	0.018566
	12	0.341486	0.630633	0.820454	0.660832	0.600329	0.580063
	16	0.069027	0.074179	0.070879	0.072886	0.083421	0.07687

4.10.4.6 Aquatic Invasive Species

4.10.4.6.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from operations would occur. Existing aquatic invasive populations would be maintained or expand their range in accordance with current trends until or unless habitat characteristics were otherwise modified. For example, the ongoing trends of sea-level rise and saltwater intrusion may result in less suitable habitat for freshwater invasive species, which are more prevalent than marine invasive species in the Project area (see Chapter 3, Section 3.10.6 Aquatic Invasive Species in Aquatic Resources).

4.10.4.6.2 Applicant's Preferred Alternative

4.10.4.6.2.1 Aquatic Invasive Plants

Ecosystem restorations are particularly prone to invasion by undesirable species due to the scale of disturbance (D'Antonio and Meyerson 2002, DeMeester and Richter 2009). Water diversion projects that target wetland restoration in particular can result in habitat loss, pollutant conveyance, and further expansion of invasive species due to disturbance and hydrologic connectivity that increase the number and extent of dispersal routes for invasive species (Zhan et al. 2015, Kettenring and Adams 2011). Freshwater areas are also more susceptible to invasive species introduction and expansion due to relatively benign environmental conditions when compared with saline areas, where the general intolerance of salt by plants and reduced availability of fresh water for most animals results in a relatively low biodiversity.

Operation of the proposed Project would alter salinity regimes, vegetation, and sediment characteristics through direct disturbance of habitat and the introduction of river waters into the estuary. Therefore, the Applicant's Preferred Alternative would result in an increased potential for the introduction and expansion of invasive plant species into the Barataria Basin, but also expansion of existing invasive populations within the Barataria Basin as the native vegetation acclimates to altered conditions, if able.

A shift to freshwater conditions could result in a shift to freshwater species that would displace salt tolerant species such as sawgrass, bulrush, and cordgrass for habitat. While a shift to freshwater conditions would provide a greater amount of habitat for freshwater species, the change itself would create opportunities for invasive plant species to colonize and become established, by outcompeting native freshwater species. Some native species may be directly adversely impacted by increased water velocities or water depth during initial Project implementation. In addition, some invasive plant species, such as alligator weed and giant Salvinia, form floating or dense mats that could degrade habitat for other aquatic plants and animals and cause navigation difficulties, particularly in the slow-moving waters that provide their preferred habitat (Center for Bioenvironmental Research 2021). However, because the Project would divert water to the Barataria Basin, increasing water movement in the outfall area, thus the formation of mats of floating invasive plants would likely be restricted to areas north of the outfall, where salinity and water flow would be more similar to that of the No Action Alternative.

Although river diversions have the unintended consequence of increasing the potential for introduction and expansion of invasive species from the river into the wetlands (a minor to moderate, permanent, indirect impact on native aquatic plant species), the Louisiana Aquatic Invasive Species Task Force has determined that the benefits to native species as a result of restored flows to wetlands outweigh the adverse impacts of further expanding the ranges of invasive species (Kravitz et al. 2005). No substantial aquatic invasive plant impacts on the Lower Mississippi River and birdfoot delta are anticipated as a result of the diverted water and sediment, although salinities are projected to rise in the birdfoot delta in the last decade of operations.

4.10.4.6.2.2 Aquatic Invasive Animals

The Applicant's Preferred Alternative would result in increased introduction and expansion of invasive aquatic animals in the Project area, as identified in Chapter 3 Section 3.10.6 Aquatic Invasive Species in Aquatic Resources and as discussed above. The Rio Grande cichlid, common carp, grass carp, silver carp, and bighead carp are already established in the basin, as are zebra mussels and Asian clams (Kravitz et al. 2005), but the rate and extent of expansion would likely increase due to habitat disturbance and alterations, including decreased salinities that would allow expansion from areas further north in the Barataria Basin. The USACE, USFWS, and the LDWF all identify invasive species control as a priority although monitoring invasive species at diversion structures is very limited (Kravitz et al. 2005) and data quantifying potential distributions of aquatic animal species are unavailable.

Freshwater and sediment diversions from the Mississippi River provide potential pathways for invasive species dispersal into new waterways and more suitable habitat for freshwater animals, including invasive species. Competition with native species for resources would continue across the entire Barataria Basin, where the Delft3D Basinwide Model has projected that habitat changes would occur. Invasive fish species such as carp and cichlid, while typically found in open water, also use freshwater marshes and coastal wetlands as nursery or forage habitat and could travel with the flow of freshwater. Aggressive competition of bighead and silver carp with native filter feeder fish species for food and habitat, potentially disruptive of the entire food web, could occur over a large area (Wolfe et al. 2009). Larger and more extensive populations of grass carp could consume additional SAV and reduce available habitat for native fish species, while black carp could continue to forage on and threaten populations of native snails and mussels (Kravitz et al. 2005). Zebra mussels, Asian clams, and giant apple snails could also be expected to increase in distribution and abundance throughout the basin. Apple snails would reduce the amount of SAV for fish, while zebra mussels and Asian clams would gain habitat, with a corresponding loss in habitat for native species. Unlike the carp and apple snails, the Asian clam is tolerant of salinities up to 24 ppt and would therefore survive in nearly any slow-moving or still water in the Project area.

Overall, the altered nutrient, salinity, and other environmental gradients across the Barataria Basin under the Applicant's Preferred Alternative could result in the introduction, establishment, and expansion of nonnative species into the basin due to changing conditions and associated disturbance. While the shift to freshwater habitat alone would result in more habitat for freshwater species, nonnative species are typically better at exploiting new resources and would therefore displace many native species in the fresher habitats within the Project area. The impact of this introduction/expansion, although permanent and adverse, would likely result in indirect, moderate impacts on the diversity of species in the outfall. No impacts in the Lower Mississippi River basin or birdfoot delta are anticipated as a result of Applicant's Preferred Alternative with respect to invasive species.

4.10.4.6.3 Other Alternatives

As discussed in Section 4.5 Surface Water and Sediment Quality, neither the variable Project flow rates nor the presence of terraces appears to result in major differences in salinity, such that all alternatives would maintain additional acreages of fresher waters compared to the No Action Alternative. Sedimentation and turbidity are anticipated to decrease (50,000 cfs Alternatives) or increase (150,000 cfs Alternatives) relative to the Applicant's Preferred Alternative based on the total outflow of a given alternative but, each alternative would result in changes in habitats within the Barataria Basin. Therefore, each alternative would result in an adverse, moderate, and permanent impact from the potential introduction and/or expansion of aquatic invasive plants and animals into the Barataria Basin. No substantial aquatic invasive plant and animal impacts in the Lower Mississippi River and birdfoot delta are anticipated.

4.10.5 Summary of Potential Impacts

Table 4.10-8 summarizes the potential impacts on aquatic resources for each alternative. Details are provided in Sections 4.10.3 and 4.10.4 above.

Table 4.10-8
Summary of Potential Impacts on Aquatic Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts from construction of the Project would occur.
Operational Impacts	• SAV: Moderate, permanent, indirect, adverse impacts from increased salinity, water depth, wave action, and turbidity. • Benthic resources: Major, permanent, indirect, adverse impacts from ongoing marsh loss and increasing salinities. • EFH and managed species: Major, permanent, direct and indirect, adverse impacts from the loss of vegetated habitats. • Habitats and the Environment: o Major, permanent, indirect, adverse impacts on fauna from loss of marsh habitat. o Negligible, indirect impacts from temperature change, which could be adverse or beneficial depending on the species. o Moderate, permanent, indirect impacts from changes in salinity regime, which could be adverse or beneficial depending on the species. o Major, permanent, direct shift to the food web from reduced trophic diversity and lost production, which could be adverse or beneficial depending on the species. • Key species: All modeled HSI scores decrease over time with changing salinities and marsh loss. • Aquatic invasive plants and animals: No impact, but continued trend of invasive species expansion or maintenance.

Table 4.10-8
Summary of Potential Impacts on Aquatic Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• SAV: Minor, temporary to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • Benthic resources: Minor to moderate, short-term to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • EFH and managed species: Negligible to minor, temporary to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • Aquatic fauna and habitat: Negligible to minor, temporary, indirect, adverse impacts from increased turbidity/TSS and inadvertent spills. Minor, short-term to permanent, direct and indirect, adverse impact from entrapment (cofferdam) or loss of shading in the Mississippi River. Impacts on fish from produced noise in the Mississippi River would be direct and indirect, adverse, and temporary, and minor to moderate during in-river construction. • Aquatic invasive plants and animals: Minor to moderate, adverse, temporary to permanent impacts on the basin resulting from increased opportunities for establishment of invasive species.

Operational Impacts	• SAV: Major, temporary, indirect, adverse impact through the initial and immediate change in salinity in the Barataria Basin, followed by major, permanent, indirect, beneficial impacts from increased biomass based on decreased winter salinities. Negligible impacts in the birdfoot delta from increasing salinity.
	• Benthic resources: Minor to moderate, permanent, direct and indirect impacts in the Barataria Basin from changes in salinity regime (beneficial or adverse, depending on species), marsh creation (beneficial), and sedimentation (adverse). Moderate, permanent, and adverse impacts in the birdfoot delta from marsh loss.
	• EFH: Major, permanent, direct and indirect, beneficial changes from the potential conversion from less sensitive (soft bottoms) to higher value EFH types (SAV/marsh). Moderate, permanent, adverse impacts in the birdfoot delta from loss of marsh habitat.
	• Managed species: Negligible impacts on coastal migratory pelagics and highly migratory species due to predominant use of nearshore and offshore waters. Minor, adverse, indirect, and permanent impacts on reef fish from changes in prey species (gray snapper) or salinity and nursery habitat (lane snapper).
	• Habitats and the environment:
	    o Minor to major, permanent, direct, adverse impacts on fauna from changes in larval transport and recruitment patterns in the outfall area.
	    o Minor to moderate, permanent, indirect, adverse impact from sedimentation over hard substrates (oyster reef).
	    o Negligible to moderate, permanent, direct and indirect, adverse impacts on species from turbidity and sedimentation.
	    o Temporary to short-term, indirect, adverse impacts from nutrient loading capable of resulting in HABs (minor to major) or low DO (negligible to minor), but minor to moderate, permanent, indirect, benefits from increased food web production.
	    o Moderate, permanent, adverse, direct impacts on specific species that cannot tolerate areas of lower salinity, but major, permanent, direct, benefits on those that can.
	    o Minor to moderate, permanent, direct or indirect, adverse impacts on species from decreased temperatures at discrete locations.
	    o Minor to major, direct and indirect, permanent benefits on fauna using freshwater marsh or estuarine species that would benefit from indirect

Table 4.10-8 Summary of Potential Impacts on Aquatic Resources from Each Alternative	
Impact Type	**Impact Description (as Compared to No Action Alternative unless Otherwise Stated)**
	increases in the primary productivity from marsh presence. Direct, minor to moderate, permanent, adverse impacts on fauna that typically use more saline marsh. o Permanent, moderate, beneficial impacts on energy flow to lower trophic-level consumers and permanent, negligible to minor, beneficial impacts on higher trophic-level predators. o Negligible to minor, permanent, direct, and adverse impacts on the food web in the outfall area from turbidity and high flows, but negligible to moderate, permanent, beneficial impacts on increased primary production outside of the outfall area. • Key species: See Table 4.10-6. • Aquatic invasive plants and animals: Minor to moderate, permanent, indirect, adverse impact through changing conditions allowing the introduction and expansion of invasive species; no impact in the Mississippi River or birdfoot delta.
50,000 cfs Alternative	
Construction Impacts	• SAV: Minor, temporary to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • Benthic resources: Minor to moderate, short-term to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • EFH and managed species: Negligible to minor, temporary to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • Aquatic fauna and general habitat: Negligible to minor, temporary, indirect, adverse impacts from increased turbidity/TSS and inadvertent spills. Minor, short-term to permanent, direct and indirect, adverse impact from entrapment (cofferdam) or loss of shading in the Mississippi River. Impacts on fish from produced noise in the Mississippi River would be direct and indirect, adverse, and temporary, and minor to moderate during in-river construction. • Aquatic invasive plants and animals: Minor to moderate, adverse, temporary to permanent impacts on the basin resulting from increased opportunities for establishment of invasive species.
Operational Impacts	• SAV: Major, temporary, indirect, adverse impact through the initial and immediate change in salinity in the Barataria Basin, followed by major, permanent, indirect, beneficial impacts from increased biomass based on decreased winter salinities. Negligible impacts in the birdfoot delta from increasing salinity. • Benthic resources: Minor to moderate, permanent, direct and indirect impacts in the Barataria Basin from changes in salinity regime (beneficial or adverse, depending on species), marsh creation (beneficial), and sedimentation (adverse). Moderate, permanent, and adverse impacts in the birdfoot delta from marsh loss. • EFH: Major, permanent, direct and indirect, beneficial changes from the potential conversion from less sensitive (soft bottoms) to higher value EFH types (SAV/marsh). Moderate, permanent, adverse impacts in the birdfoot delta from loss of marsh habitat. • Managed species: Negligible impacts on coastal migratory pelagics and highly migratory species due to predominant use of nearshore and offshore waters. Minor, adverse, indirect, and permanent impacts on reef fish from changes in prey species (gray snapper) or salinity and nursery habitat (lane snapper). • Habitats and the environment: o Minor to major, permanent, direct, adverse impacts on fauna from changes in larval transport and recruitment patterns.

Table 4.10-8
Summary of Potential Impacts on Aquatic Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	○ Minor to moderate, permanent, indirect, adverse impact from sedimentation over hard substrates. ○ Negligible to moderate, permanent, direct and indirect, adverse impacts on species from turbidity and sedimentation. Negligible impact at the birdfoot delta. ○ Temporary to short-term, indirect, adverse impacts from nutrient loading capable of resulting in HABs (minor to major) or low DO (negligible to minor), but minor to moderate, permanent, indirect, benefits from increased food web production. ○ Moderate, permanent, adverse, direct impacts on specific species that cannot tolerate areas of lower salinity, but major, permanent, direct, benefits on those that can. ○ Minor to moderate, permanent, direct or indirect, adverse impacts on species from decreased temperatures at discrete locations. ○ Minor to major, direct and indirect, permanent benefits on fauna using freshwater marsh or estuarine species that would benefit from indirect increases in the primary productivity from marsh presence. Direct, minor to moderate, permanent, adverse impacts on fauna that typically use more saline marsh. ○ Major, permanent, direct shift to the food web from reduced trophic diversity and lost production, which could be adverse or beneficial depending on the species. ○ Negligible to minor, permanent, direct, and adverse impacts on the food web in the outfall area from turbidity and high flows, but negligible to moderate, permanent, beneficial impacts on increased primary production outside of the outfall area. • Key species: Generally consistent with Table 4.10-6, but with slight decreases in benefits due to smaller increases in marsh, slight decreases in adverse impacts from the smaller area of disrupted larval transport, and incremental changes in either beneficial or adverse impacts associated with the decreased area of salinity modification (depending on species preferences). • Aquatic invasive plants and animals: Minor to moderate, permanent, indirect, adverse impact in the Barataria Basin through changing conditions allowing the introduction and expansion of invasive species; no impact in the Mississippi River or birdfoot delta.
150,000 cfs Alternative	
Construction Impacts	• SAV: Minor, temporary to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • Benthic resources: Minor to moderate, short-term to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • EFH and managed species: Negligible to minor, temporary to permanent, direct and indirect, adverse impacts from structure placement, dredging, and turbidity/sedimentation. • Aquatic fauna and general habitat: Negligible to minor, temporary, indirect, adverse impacts from increased turbidity/TSS and inadvertent spills. Minor, short-term to permanent, direct and indirect, adverse impact from entrapment (cofferdam) or loss of shading in the Mississippi River. Impacts on fish from produced noise in the Mississippi River would be direct and indirect, adverse, and temporary, and minor to moderate during in-river construction. • Aquatic invasive plants and animals: Minor to moderate, adverse, temporary to permanent impacts on the basin resulting from increased opportunities for establishment of invasive species.

Table 4.10-8
Summary of Potential Impacts on Aquatic Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)

Operational Impacts	• SAV: Major, temporary, indirect, adverse impact through the initial and immediate change in salinity in the Barataria Basin, followed by major, permanent, indirect, beneficial impacts from increased biomass based on decreased winter salinities. Negligible impacts in the birdfoot delta from increasing salinity.
	• Benthic resources: Minor to moderate, permanent, direct and indirect impacts in the Barataria Basin from changes in salinity regime (beneficial or adverse, depending on species), marsh creation (beneficial), and sedimentation (adverse). Moderate, permanent, indirect, adverse impacts in the birdfoot delta from marsh loss.
	• EFH: Major, permanent, direct and indirect, beneficial changes from the potential conversion from less sensitive (soft bottoms) to higher value EFH types (SAV/marsh). Moderate, permanent, adverse impacts in the birdfoot delta from loss of marsh habitat.
	• Managed species: Negligible impacts on coastal migratory pelagics and highly migratory species due to predominant use of nearshore and offshore waters. Minor, adverse, indirect, and permanent impacts on reef fish from changes in prey species (gray snapper) or salinity and nursery habitat (lane snapper).
	• Habitats and the environment:
	    o Minor to major, permanent, direct, adverse impacts on fauna from changes in larval transport and recruitment patterns, which would occur over a slightly larger area than the Applicant's Preferred Alternative.
	    o Minor to moderate, permanent, indirect, adverse impact from sedimentation over hard substrates, which would be incrementally higher than the Applicant's Preferred Alternative.
	    o Negligible to moderate, permanent, direct and indirect, adverse impacts on species from turbidity and sedimentation.
	    o Temporary to short-term, indirect, adverse impacts from nutrient loading capable of resulting in HABs (minor to major) or low DO (negligible to minor), but minor to moderate, permanent, indirect, benefits from increased food web production.
	    o Moderate, permanent, adverse, direct impacts on specific species that cannot tolerate areas of lower salinity, but major, permanent, direct, benefits on those that can.
	    o Minor to moderate, permanent, direct or indirect, adverse impacts on species from decreased temperatures at discrete locations.
	    o Minor to major, direct and indirect, permanent benefits on fauna using freshwater marsh or estuarine species that would benefit from indirect increases in the primary productivity from marsh presence. Direct , minor to moderate, permanent, adverse impacts on fauna that typically use more saline marsh.
	    o Major, permanent, direct shift to the food web from reduced trophic diversity and lost production, which could be adverse or beneficial depending on the species.
	    o Negligible to minor, permanent, direct, and adverse impacts on the food web in the outfall area from turbidity and high flows, but negligible to moderate, permanent, beneficial impacts on increased primary production outside of the outfall area.
	• Key species: Generally consistent with Table 4.10-6, but with slight increases in benefits due to larger increases in marsh, slight increases in adverse impacts from the larger area of disrupted larval transport, and incremental changes in either beneficial or adverse impacts associated with the expanded area of salinity modification (depending on species preferences).

Table 4.10-8 Summary of Potential Impacts on Aquatic Resources from Each Alternative	
Impact Type	**Impact Description (as Compared to No Action Alternative unless Otherwise Stated)**
	• Aquatic invasive plants and animals: Minor to moderate, permanent, indirect, adverse impact in the Barataria Basin through changing conditions allowing the introduction and expansion of invasive species; no impact in the Mississippi River or birdfoot delta.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on aquatic resources as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on aquatic resources due to construction of the terraces would not change the overall determination of impacts listed above.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on aquatic resources as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on aquatic resources due to the presence of the terraces would not change the overall determination of impacts listed above.

4.11 MARINE MAMMALS

4.11.1 Area of Potential Impacts

As described in Chapter 3, Section 3.11 Marine Mammals, most northern Gulf of Mexico cetacean species are generally found in deeper waters outside of the Project area and therefore are not included in this impact analysis. Impacts on West Indian manatee are discussed in Section 4.12 Threatened and Endangered Species.

Impacts on marine mammals during construction would be limited to the BBES Stock boundaries (south of the central station [CRMS 0224]), and would generally be related to turbidity, noise, and vessel traffic.

During operations, direct impacts would affect dolphins within the BBES Stock boundaries due to the movement of fresh water, nutrients, and sediment from the Mississippi River into the Barataria Basin, which would result in physiological effects on exposed individuals. The area of direct impact would change each year, depending on the volume and duration of diverted water and sediment. Indirect impacts could occur as habitat, food web dynamics, and prey abundance/diversity/nutritional quality shift over time; and if BBES dolphins shift their movement patterns/distribution within the basin over time.

Other dolphin stocks are considered in this section, but the area of potential impacts is limited to the BBES boundary as these other stocks are largely found further from the outfall area, and therefore the magnitude of the impacts would likely be lower.

4.11.2 Guidelines for Marine Mammal Impact Determinations

Impact intensities for marine mammals are based on the definitions provided in the DWH PDARP (DWH NRDA Trustees 2016a) and Section 4.1, Approach to Evaluation of Environmental Consequences. They include the following marine mammal-specific indicators for the following impacts:

- No impact: there is no discernible or measurable impact;
- Negligible impact: the impact on marine mammals would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[66]
- Minor impact: impacts on marine mammals, their habitats, or the natural processes sustaining them could be detectable, but small and localized, and could not measurably alter natural conditions;
- Moderate impact: impacts on marine mammals, their habitats, or the natural processes sustaining them could be detectable and some alteration in the numbers of marine mammals or occasional responses to disturbance by some individuals could be expected, with some negative impacts on feeding, reproduction, resting, migrating, or other factors affecting local and adjacent population levels. Impacts could occur in key habitats, but sufficient population numbers or habitat could remain functional to maintain the viability of the species both locally and throughout their range; or
- Major impact: impacts on marine mammals, their habitats, or the natural processes sustaining them could be detectable, widespread, and permanent. Substantial impacts on the population numbers of marine mammals; or interference with their survival, growth, or reproduction could be expected. There could be impacts on key habitat, resulting in substantial reductions in species numbers.

4.11.3 Overview of Impact Analysis Approach

To determine the proposed Project's construction impacts on marine mammals in the northern Gulf of Mexico, the Applicant's descriptions of the proposed Project alternatives were compared to the best available literature to assess effects related to noise, vessel traffic, and decreased habitat and environment quality. To determine operational impacts on marine mammals from the proposed Project, (1) the best available literature and case studies were assessed to determine how multiple stressors, including habitat/ecological changes associated with each alternative, would lead to physiological, behavioral, and pathological responses in marine mammals; and (2) Delft3D Basinwide Model, information on marine mammal abundance and distributions, and a dose-response relationship between survival probability and

[66] The term "negligible" will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

prolonged low-salinity exposure was used to compare the intensity of impacts due to changes in salinity for each alternative across the BBES Stock of dolphins in the proposed Project area (see Figure 4.11-2). Figure 4.11-1 provides a summary of how these methods and various data sources were utilized to assess impacts.

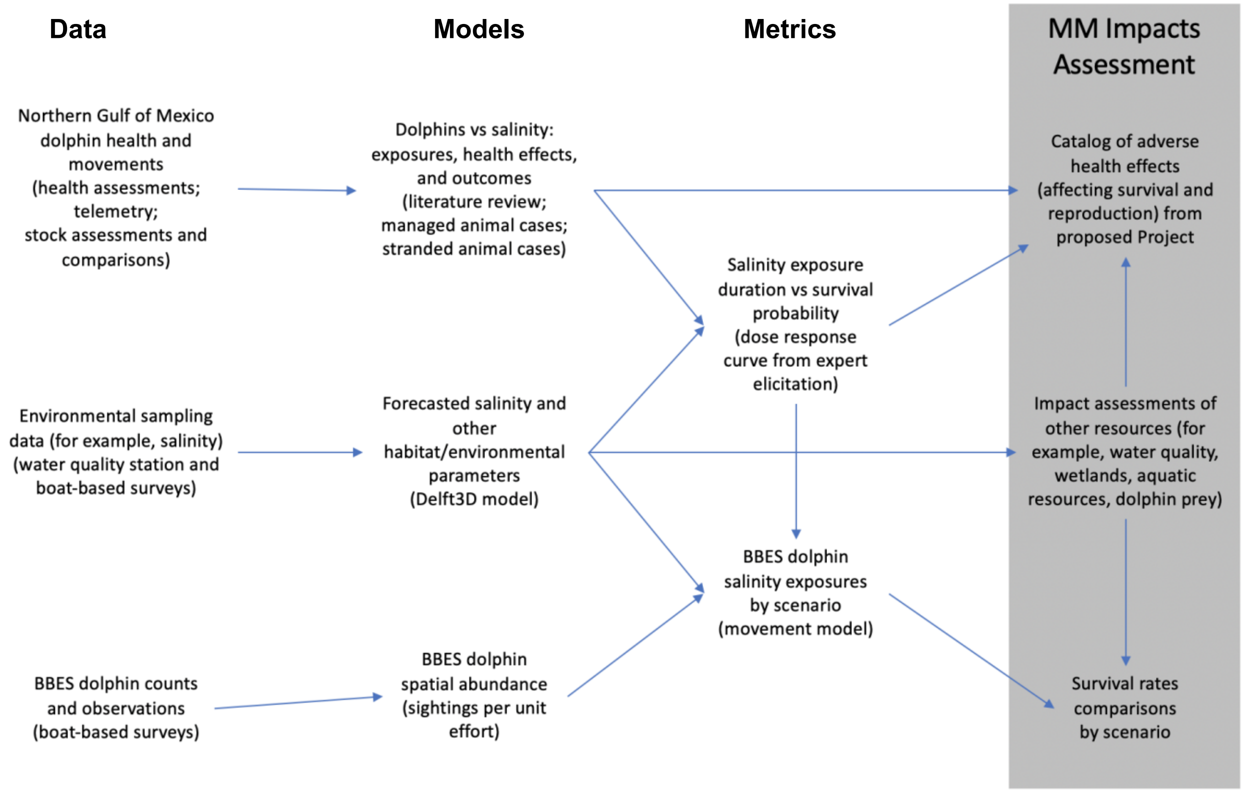


Figure 4.11-1. Approach to the Marine Mammal Impacts Assessment. Overview of data sources and the associated models and metrics used to assess the types and severity of impacts on marine mammals from the proposed Project.

The main sources of data included:

- Literature and case study review: marine mammal veterinarians and biologists conducted (1) a literature review on topics relevant to marine mammals and low salinity (for example, Rowley et al. 2018); (2) a review of case studies from live and dead stranded dolphins and observational studies (such as photo-identification studies) of dolphins in the southeastern United States that were exposed to low salinity, including summaries of their potential exposures, health effects, and outcomes (for example, https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2020-bottlenose-dolphin-unusual-mortality-event-along-northern); (3) a review of case studies from managed dolphins in human care that either spent time in low-salinity waters or were placed in low-salinity waters for veterinary procedures, including summaries of their exposures, health effects, and outcomes (McClain et al. 2020); and (4) a review of reports from capture-release health assessment studies of BBES dolphins, including veterinary health assessments and telemetry data (for example, Schwacke et al. 2014 and Smith et al. 2017).

- Delft3D Basinwide Model: as described in Section 4.1, Approach to Evaluation of Environmental Consequences, the Delft3D Basinwide Model was used to project hydrodynamics, sediment transport, water quality, and extent of emergent wetlands in the Barataria Basin associated with implementation of the proposed Project alternatives, including the No Action Alternative. More information can be found in Appendix E.

- BBES Stock survey and existing data from previous BBES Stock surveys: researchers conducted boat-based surveys of BBES dolphins and TTES dolphins using photo-identification and capture-mark-recapture techniques to assess abundance, density, and stock structure. Although these studies were not designed to answer questions specifically about the proposed Project, the data are useful for model inputs and characterizing the BBES Stock, including generating estimated densities of dolphins across continuous space and then in each stratum (using sightings per unit effort; Garrison et al. 2020).

- Dose-response relationship between survival and duration of exposure below a given salinity threshold: a formal expert elicitation defined dose-response curves to assess the relationship between (1) how many days dolphins can spend in waters less than 5 ppt salinity and (2) their associated survival probability (Booth and Thomas 2021).

- BBES dolphin movement analysis: biologists used a simulation of random dolphin movements to estimate the annual salinity exposure for simulated dolphins in various parts of the BBES Stock boundary under each alternative and hydrograph (Garrison et al. 2020).

- Survival rates and population trajectories: biologists compared the movement model results to the low salinity:survival probability dose-response curves to estimate annual survival rates for the BBES Stock under each alternative and hydrograph (Garrison et al. 2020). Researchers then used these annual survival rates in a BBES population model to estimate how the proposed Project may affect the stock's recovery from the effects of the DWH oil spill (Thomas et al. 2021, Thomas et al. 2022).

- Prey: a qualitative assessment is provided through a comparison of BBES dolphin stomach content analysis to the aquatic resource fish/invertebrate species analyzed in this EIS and reviewed available literature on the importance and impacts of prey to dolphin health.

- Wetlands: the analysis utilizes the wetland analysis in this EIS and available data and literature regarding dolphin habitat use and foraging strategies.

- Other non-salinity water quality (for example, HABs, contaminants, temperature): the analysis utilizes the water quality analysis in this EIS and available literature on exposure to various water quality parameters.

4.11.3.1 General Caveats to Impact Analysis Approach

Predicting future impacts comes with unavoidable uncertainty. There is still much to be learned about marine mammal behavior, physiology, and pathology; and the models used to forecast environmental conditions require assumptions and generalizations with different levels of confidence. Some of the important caveats to consider when reviewing these impact assessments include:

- Time/longitudinal aspects of Delft3D Basinwide Model hydrographs: As described in Section 4.1 Approach to Evaluation of Environmental Consequences, the Delft3D Basinwide Model outputs project environmental conditions into the future from 2020 to 2070. However, the model does not project changes over a continuous time period. This means that the Delft3D Basinwide Model results should not be evaluated in an absolute longitudinal fashion, but relative differences between or among decades can be useful. The Delft3D Basinwide Model also used alternative hydrographs to represent other scenarios (for example, low or high rainfall years); however, all of the analyses in this marine mammal section are based on the representative years for each decade.

- Retrospective salinity prediction bias: the Delft3D Basinwide Model has a spatial projection/validation bias associated with averaging salinity values over space and the boundary conditions assumed for the basin. However, the Delft3D Basinwide Model used observed data from water quality stations across the Barataria Basin to calibrate the model outputs and minimize the potential for retrospective biases (see Appendix E and Garrison et al. 2020). The significance of these biases on the comparison across alternatives would be minimal because the relative changes across alternatives should be the same. Garrison et al. 2020 conducted an analysis of the Delft3D Basinwide Model bias within the context of the BBES dolphin salinity effects modeling, and they identified a northern and southern cluster of water stations, each with a similar bias. Generally, the region with water stations north of the central station (CRMS 0224) had a bias of 0.717 ppt (standard deviation of 0.0889) and the region with water stations south of the central station (CRMS 0224) (where the majority of the BBES Stock area is found) had a bias of -2.316 ppt (standard deviation of 0.168).

- Future salinity prediction bias: the Delft3D Basinwide Model projects future conditions, which are inherently unknown, and the model's predictive capability for each of the alternatives is unknown. This overall bias and uncertainty represents the sum of many unknowns, including the future freshwater inflow, climate, sea-level rise, water flow, and other conditions (see Section 4.1, Approach to Evaluation of Environmental Consequences for more detailed discussion). The model does not account for variability associated with climate other than for one projected sea-level rise scenario. Alternative sea-level rise and climate scenarios could drive different model outputs. While a sensitivity run was conducted to investigate how a lower sea-level rise rate could impact model outputs, the uncertainty and bias associated with future projections cannot be quantified; however, assessments can avoid some of the inherent complications by comparing the proposed Project alternatives, with the assumption that the direction and magnitude of future projection bias will be similar in all scenarios. The estimates of future annual survival (Garrison et al. 2020) and future BBES population trajectories (Thomas et al. 2021, Thomas et al. 2022) are based on model results that rely on historic hydrography. If future river flows differ from the modeled hydrographs, then survival rates in a given year may be greater than or less than those modeled.

- Tidal variation and water column stratification: the Delft3D Basinwide Model uses daily averages of salinity to summarize across time and vertical averages of the water column to summarize across depth. Although the basin is generally a shallow system (approximately 2 meters on average), some locations are deeper (greater than 10 meters). Areas with deeper waters can become stratified so that the surface water is less saline than deep water. However, the impact on the marine mammal assessment should be minimal, as BBES dolphins move over large space and time scales relative to these hydrodynamic processes. In general, when considering dolphin behavior, this impact analysis assumes that the dolphins move up and down in the water column. These assumptions hold for both the literature/case studies and the dose-response curves used to estimate effects, as well as the development and interpretation of the model output.

- Refugia: if there are deeper waters with higher salinity, it is possible that dolphins may use those areas as refugia during times with prolonged low salinity. However, BSE dolphins do not typically take long dives or stay in close proximity to a channel, and deeper water where refugia may be present is limited. Thus, the impact on the marine mammal assessment should be minimal, as dolphins will likely move up and down in the water column to breathe and move horizontally in space to forage and socialize.

- Multiple stressors: assessing the impacts of a stressor to long-lived, large-bodied, social, intelligent animals in a marine environment is especially difficult. Given the number of and various types of threats marine mammals face in the northern Gulf of Mexico, and the potential for interactive effects of these threats, it can be even more difficult to determine impacts from multiple stressors (for an example, see National Academies of Sciences, Engineering, and Medicine 2017). Where possible in the following sections, there is discussion regarding how multiple stressors may affect impact assessments at a qualitative level, but a quantitative assessment of effects or potential synergistic or antagonistic interactions in a multiple stressor scenario was not undertaken. However, given the BBES Stock's ongoing adverse health effects in the wake of the DWH oil spill, Garrison et al. (2020) use the salinity:survival probability dose-response curve for an unhealthy population (see Section 4.11.5.2 Barataria Bay Estuarine Stock, Impacts on the Population).

- Intensity of impacts on the BBES population: to model how decreasing salinity would affect BBES dolphin survival, the salinity:survival probability dose-response curve was used to estimate the change in BBES dolphin survival rates for a given hydrograph/alternative combination. This dose-response curve is the result of a formal expert elicitation (EE) of marine mammal veterinarians, epidemiologists, and biologists, who were asked to determine the parameters underlying this curve based on "an average BSE dolphin." In other words, the mean of this probability distribution provides an estimate for the average BSE dolphin (for example, in terms of age and health). Some dolphins will be more robust and others will be less robust than the theoretical average BSE dolphin. Panel experts provided input based on a set of mutually agreed upon assumptions that influenced the outcomes. Those assumptions and the confidence intervals associated with the dose-response curve were reported by Booth and Thomas (2021).

- Dolphin recovery time period: the dose-response curve assumes a constant, prolonged exposure to low-salinity waters without breaks. Skin lesion formation can occur rapidly (for example, 24 to 72 hours; McClain et al. 2020), but recovery may require extended periods of time depending on the nature of the lesion and whether the animal is subject to other stressors (for example, skin with mild lesions can slough off after 72 hours and reveal healthy skin underneath, while severe infected/ulcerated lesions may not show signs of improvement for at least 90 days; McClain et al. 2020). It is unclear how this may impact the marine mammal assessment, as dolphin recovery is likely dependent on the severity of the initial exposure, whether there has been introduction of systemic pathogens, the animal's response to that exposure, and a variety of other factors including health status.

- Dolphin repeated inter-annual exposures: The model results presented here consider impacts for any given year. It does not consider repeated annual exposure to low-salinity waters over many years, which could lead to higher individual mortality risk than in the first year from the initial exposure. If this is the case, the approach utilized to assess impacts will likely underestimate the population-level impacts, as the models only look at single years for each decade/alternative combination.

- Model estimates of salinity vs low-salinity thresholds from the literature: the Delft3D Basinwide Model has some unavoidable bias and uncertainty in its outputs, and it was designed specifically to compare the proposed Project alternatives (see Appendix E). Care should be taken when assessing the absolute values of salinity (and other parameters) provided in the following analyses, especially if comparing those absolute values to values in the literature that may be derived within entirely different contexts. Instead, evaluating relative differences between model runs will reduce the uncertainty by comparing results in similar contexts. However, it is still important to consider the general range of the absolute salinity estimates to assess the potential effects on dolphin health/survival. For example, the difference between prolonged exposure to 25 ppt versus 30 ppt is much less pertinent to dolphin health than the difference between prolonged exposure to 7 ppt versus 2 ppt, even though both comparisons have a 5 ppt relative difference. Thus, in the analyses presented in this section, both the absolute Delft3D Basinwide Model salinity projections and the relative differences between alternatives are reported, as necessary for interpretation with regard to dolphin health/survival. In general, projected salinities within the BBES Stock area have a bias of -2.316 ppt (standard deviation of 0.168)—in other words, the Delft3D Basinwide Model generally underestimates salinities in the BBES Stock area by approximately 2.3 ppt (Garrison et al. 2020). Additional discussion of uncertainty in the Delft3D Basinwide Model is found in Section 4.1, Approach to Evaluation of Environmental Consequences.

- Changing BBES Stock boundaries: given the projected changes to the Barataria Basin from all of the proposed Project alternatives (including the No Action Alternative), it is possible that the extent of the BBES Stock boundary would expand farther north during the proposed Project lifetime. Although dolphins can tolerate a range of water quality parameters, photo-identification and satellite-tagging studies indicate that most BSE individuals stay in relatively small usage areas and cannot or would not shift their range (for example, Hubard et al. 2004; Irwin and Würsig 2004; Balmer et al. 2008, 2018a, 2019; Urian et al. 2009; Mullin et al. 2017; Wells et al. 2017; Cloyed et al. 2021), regardless of prolonged and/or drastic changes in environmental conditions (for example, low salinity, severe red tide harmful algal blooms, strong hurricanes, and oil spills; Bassos-Hull et al. 2013, Wells 2014, Mullin et al. 2015, Aichinger-Dias et al. 2017, Fazioli and Mintzer 2020, Takeshita et al. 2021). Thus, based on the robust literature on northern Gulf of Mexico BSE dolphin movements, this analysis assumes that BBES dolphins would not emigrate/move en masse out of the Barataria Basin or entirely change their usage patterns due to sudden changes in their habitat (over months to years). However, it is possible that dolphins would extend their usage patterns to ensure they maintain access to wetland edges for foraging purposes, as the regions north of the barrier islands in the BBES Stock area gradually lose wetland edges over multiple decades.

4.11.4 Construction Impacts

4.11.4.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed, and therefore, no direct impacts on marine mammals from the proposed Project would occur. Ongoing trends of sea-level rise and increasing salinities would continue, but only limited changes to water quality, marsh acreage, aquatic species and other environmental factors impacting marine mammals are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area may be developed for industrial or commercial purposes that may have adverse impacts on marine mammals in the Project area. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal environmental regulations.

4.11.4.2 Applicant's Preferred Alternative

Construction of the proposed Project within Barataria Bay would require pile-driving and dredging activities that generate underwater sound. Vessels used to transport dredging and construction equipment would also generate intermittent continuous noise during transit, positioning, and operation.

Marine mammals are very sensitive to sounds in the ocean, both natural and human-made. Marine mammals produce and hear a broad range of sounds to navigate and communicate because the oceans are much more transparent to sound than to light (National Research Council [NRC] 2003). Disruption to marine mammals due to noise can take a variety of forms such as acoustic masking, behavioral disruption, or non-auditory health effects (Southall et al. 2007). Acoustic masking results when anthropogenic noises interfere with an animal's ability to perceive sounds. Masking can decrease the range at which sound may be perceived, thereby reducing the ability of animals to communicate or, in the case of species that use echolocation to target prey, foraging efficiency. Behavioral responses of marine mammals due to increased sound levels can include reduced vocalizations (Erbe et al. 2018), increased vocalization frequency or amplitude (Hotchkin and Parks 2013, Parks et al. 2007), and/or changes in direction of travel. The duration and extent of the behavioral effects are influenced by the hearing sensitivity of the individual, as well as by its age, sex, current activity, past exposure to the noise, and the presence of dependent offspring. Behavioral effects of an individual are also influenced by the characteristics of the sound, such as the frequency and intensity, and the location and duration of the sound (NRC 2003). By contributing to underwater sound levels, anthropogenic noises resulting from Project construction, operation, and maintenance have the potential to impact active foraging and/or socializing.

Effects of behavioral disturbance to marine mammals due to sound are challenging to quantify as responses to sound can vary between species as well as within species. Additionally, data indicate that not all marine mammals perceive sound at the same sensitivity or frequencies (Richardson et al. 1995, Wartzok and Ketten 1999, Southall et al. 2007, Au and Hastings 2008). As identified in Chapter 3, Section

3.11.4 in Marine Mammals, marine mammals can be categorized into functional hearing groups based on their ability to hear different frequencies (Southall et al. 2007, NMFS 2018b, NOAA 2018b).

Exposure to noise also can result in auditory impairment in marine mammals in the form of temporary and permanent threshold shifts (TTS and PTS) and in extreme cases, hemorrhaging, and death (NMFS 2003). TTS is a temporary, reversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level (NMFS 2018b). Physiologically, hair cells within the ear become fatigued and change shape. The amount of threshold shift and duration of auditory fatigue depending on the duration and level of sound exposure (NRC 2003) depends on the duration and level of sound exposure (NRC 2003). Based on data from cetacean TTS measurements (see Southall et al. 2007 for a review), a TTS of 6 dB is considered the minimum threshold shift, clearly larger than any day-to-day or session-to-session variation in a subject's normal hearing ability (Schlundt et al. 2000, Finneran et al. 2000, Finneran et al. 2002). Exposure that occurs above a certain sound level and duration may cause the hair cells to become permanently damaged, resulting in PTS (NRC 2003). PTS is a permanent, irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level (NMFS 2018b). As with general changes in behavior, the level and durations of sound exposure that cause TTS and PTS are species-specific.

In 2018, NMFS released an update to its Technical Guidance for Assessing the Impact of Anthropogenic Sound on Marine Mammals (NMFS 2018b). The Technical Guidance provides underwater acoustic thresholds for the onset of PTS and TTS, respectively, or changes in the threshold of audibility. PTS and TTS thresholds are dependent upon noise type (impulsive or continuous) and marine mammal hearing group (see Chapter 3, Section 3.11 Marine Mammals). For impulsive sounds, the dual metric acoustic thresholds are presented as a flat or unweighted peak sound pressure (PK [flat]) and hearing group frequency weighted SEL_{cum}. NMFS considers onset of PTS (or TTS) to have occurred when either one of the two metrics is exceeded (whichever comes first). For non-impulsive (continuous) sounds, there is a single SEL_{cum} threshold; however, if a non-impulsive sound has the potential of exceeding the PK sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered. These acoustic thresholds are presented in Table 4.11-1 for the marine mammal hearing group likely to occur in the vicinity of Project construction (mid-frequency cetaceans, which include dolphins; see Chapter 3, Section 3.11 Marine Mammals). NMFS also provides interim guidance on thresholds at which NMFS considers the potential for adverse behavioral effects to occur in marine mammals. Interim thresholds for adverse behavioral effects are 160 dB re:1µPa RMS for impulsive noise (impact pile driving) and 120 dB re: 1 µPa RMS for continuous noise (vibratory pile driving, dredging activities). NMFS is currently updating these thresholds.

Table 4.11-1
Acoustic Thresholds for Mid-frequency Cetaceans (including dolphins)

Pile-Driving Activity or Effect Level	Cumulative Sound Exposure Level (SEL_{cum}) (dB re 1 μPa^2s)	Root Mean Square Sound Level (dB RMS) (dB re 1 μPA)	PK (flat) (dB re 1 μPA)[a]
Temporary Threshold Shift (impulsive/non-impulsive noise)[b,c]	170/178	--	224/ --
Permanent Threshold Shift (impulsive/non-impulsive noise) [b,c]	185/198	--	230/ --
Behavioral Effects (impulsive/non-impulsive noise)[b]	--	160/120	--

Source: NMFS 2018b, NMFS 2020e

[a] The script "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The script associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and the recommended accumulation period is 24 hours.

[b] Use of impact hammers is considered impulsive noise; other sound (for example, vibratory pile driving, dredging) is considered non-impulsive noise.

[c] Includes the general level for temporary or permanent threshold shift onset for cetaceans by hearing frequency, as identified by NMFS (2018b); however, threshold shifts are influenced by the frequency of noise received and a cumulative sound exposure exceeding this level may not cause a threshold shift if outside the range of hearing.

Underwater noise would be generated during pile driving and dredging associated with the Project, as well as through increased vessel traffic. The intensity of underwater noise generated during pile driving depends upon the method of pile driving (impact or vibratory), the material and size of the pile, and the water depth. Although most pile driving would be land-based within the dry cofferdam channel, sheet piles would be driven via vibratory methods for the outfall structure in the basin. In addition, limited pile driving of timber piles (a limited number of piles associated with navigational markers, and 30 piles for a boat pier) would be conducted in the Barataria Basin. By using a practical spreading transmission loss constant (15logR) to account for noise attenuation, a ZOI (the area in which sound levels exceed a threshold) was identified for anticipated in-water activities on marine mammals. Table 4.11-2 identifies the distance at which calculated sound levels from these activities would attenuate to the effects levels described in Table 4.11-1.

Table 4.11-2
Estimated Zone of Influence from Underwater Sounds for Mid-frequency Cetaceans (including dolphins)

Activity and Effect Level	Zone of Influence for Impulsive Sounds (ft)[a]		
	Cumulative Sound Exposure Level (SEL_{cum})	Root Mean Square Sound Level (dB RMS)	Peak Sound Level
24-INCH SHEET PILE, VIBRATORY HAMMER (RIVER AND BASIN)			
Temporary Threshold Shift[b]	MU	--	--
Permanent Threshold Shift[b]	19.4	--	--
Behavioral Effects	--	32,808[c]	--
12-INCH TIMBER PILE, IMPACT HAMMER (BASIN SIDE ONLY)			
Temporary Threshold Shift[b]	MU	--	MU
Permanent Threshold Shift[b]	3.9	--	0
Behavioral Effects	--	152	--
DREDGING (RIVER AND BASIN)			
Temporary Threshold Shift[b]	MU	--	--
Permanent Threshold Shift[b]	0	--	--
Behavioral Effects	--	70,682[c]	--
VESSEL TRAFFIC (RIVER AND BASIN)			
Temporary Threshold Shift[b]	MU	--	--
Permanent Threshold Shift[b]	0	--	--
Behavioral Effects	--	15,230[C]	--

Notes:
MU = Measurement unavailable. Although the NMFS' 2018 Technical Guidance (NMFS 2018b) identifies TTS thresholds, calculations are not yet included in the Technical Guidance user spreadsheet (NMFS 2020f); therefore, the ZOIs are assumed to extend some distance between the PTS and behavioral effect ZOIs.
-- = Acoustic thresholds are not identified for this sound measurement.
[a] Behavioral values calculated using the Greater Atlantic Regional Fisheries Office (GARFO) acoustics tool with the Practical Spreading Loss Model for sound attenuation (NMFS 2020e). PTS values were calculated using NMFS' 2018 Technical Guidance user spreadsheet (NMFS 2020f).
[b] The threshold is the general level for TTS or PTS onset for cetaceans by hearing frequency group as identified by NMFS (2018b).
[c] The practical distance for behavioral effects is anticipated to be no more than 2 miles given the presence of landforms that block sound transmission (WSDOT 2019).

Dredging noise is continuous and is dominated by low-frequency sounds. Marine mammals could be exposed to underwater dredging noise during dredging along the access route in the basin to support construction equipment transport, as well as in the immediate outfall area. The Applicant has not determined the specific methods for dredging but could use both mechanical (such as a clamshell dredge) and hydraulic dredging (such as cutterhead or hopper dredges). Documented source levels for dredging range widely depending on the site characteristics and equipment. Based on literature review, the most likely sound level for Project dredging was determined to be between 172 and 185 dB re1 μPA at 3.3 feet (1 meter) (Richardson et al. 1995; Reine, Clarke, and Dickerson 2014; Jones, Marten, and Harris 2015; Blue Planet Marine 2013; CEDA 2011).

Underwater noise would also be generated by vessels used for construction of the Project, including barges used to transport construction materials. Typical sound levels range from 150 to 170 dB re: 1 µPa for tugboats and ferries (Jasny et al. 2005), or up to 175 dB RMS for transiting dredge vessels (de Jong et al. 2010). Noise from Project-related tugs, barges, and dredging vessels would be transient in the Project area, limited to the time when they are transiting to/from the construction area, and when in-water construction is occurring (about 3.5 years). Noise from these construction vessels would be consistent with other vessel activity in the Project vicinity, such as barges and other commercial vessels traveling through navigational channels in the Barataria Basin.

The BBES bottlenose dolphin stock is presumed to occur throughout the stock management boundary (see Figure 4.11-2), although the highest density of dolphins occurs in the southern portion of the stock management area, near the barrier islands, as discussed in Chapter 3, Section 3.11.2.1 Bottlenose Dolphins in Marine Mammals.

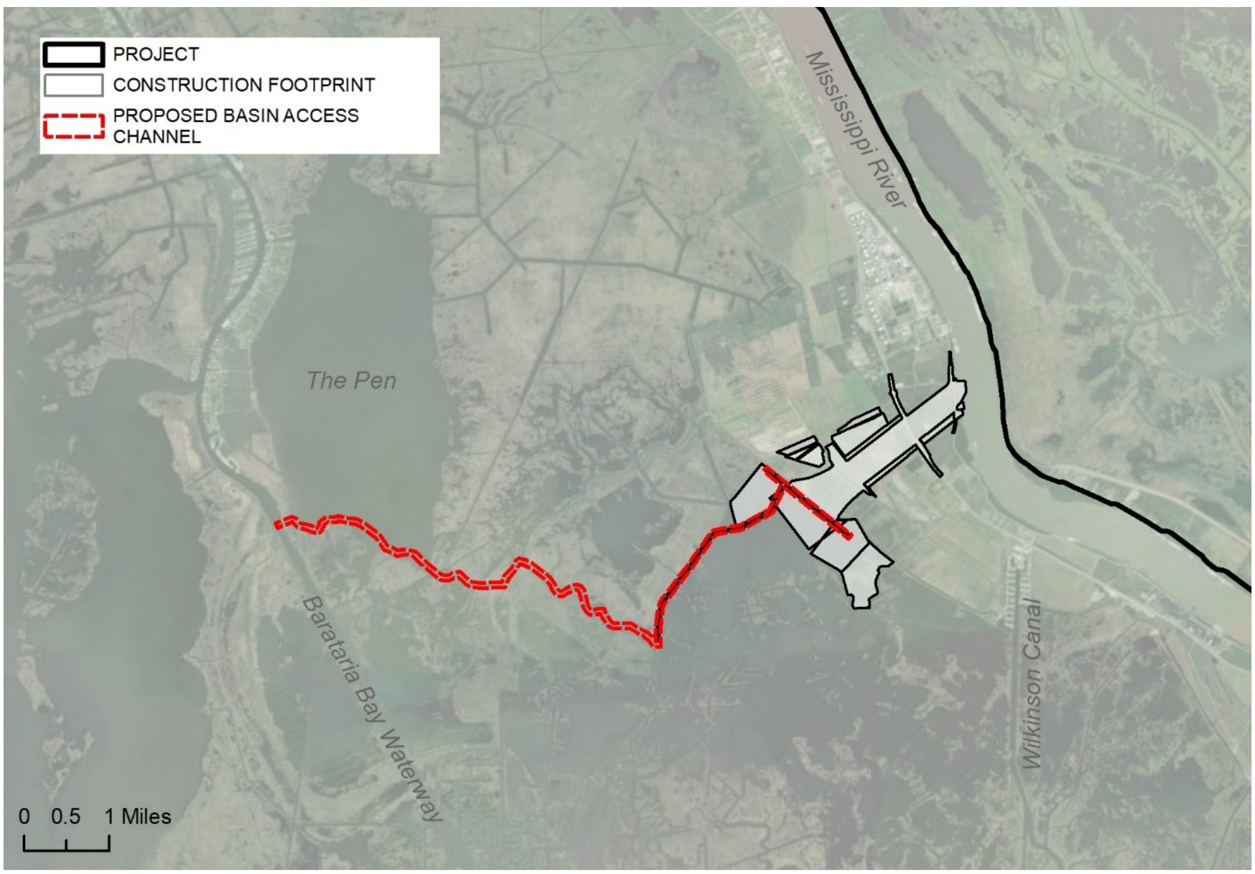


Figure 4.11-2. BBES Dolphin Stock Management Boundary Relative to Sound Producing Elements of the Mid-Barataria Sediment Diversion Project.

While pile driving, dredging, and vessel noise calculations identify adverse behavioral effects on marine mammals within a large ZOI during construction (up to 70,682 feet or 13.4 miles for dredging, see Table 4.11-2), underwater noise does not travel around or through land masses, meaning that land features like islands and bends in waterways block sound transmission (WSDOT 2019). The presence of land masses in the Barataria Basin would generally limit the area exposed to behavioral level noise effects to areas within an underwater "line-of-sight" from the source. Because of the land masses present in the vicinity of the construction areas, dredging sounds are not anticipated to propagate beyond about 2 miles, indicating that increased noise would not likely occur in areas that are highly used by marine mammals. Project vessels are similarly anticipated to be concentrated within the construction footprint, although they may occur in other areas of the Barataria Basin while in transit. Based on the limited PTS ZOI, no noise-related injury on dolphins would be anticipated from construction.

Given the location of dolphins in the Barataria Basin (see Section 4.10 Aquatic Resources), and the presence of land masses that would likely limit the propagation of dredging and vessel noises to areas outside of the general use areas for Barataria Basin dolphins, impacts on marine mammals from construction would be predominantly from transiting construction vessels. Noise-producing construction activities have minimal overlap with the BBES Stock range and thus are anticipated to have negligible to minor, temporary, indirect, and adverse impacts on bottlenose dolphins.

4.11.4.3 Other Action Alternatives

All action alternatives would have the similar construction footprints and the same construction methods as that of the Applicant's Preferred Alternative. As such, the direct and indirect impacts from construction of all other action alternatives would be similar to those described above for the Applicant's Preferred Alternative. However, construction timeframes for the 150,000 cfs Alternatives would be longer by several months and for the 50,000 cfs Alternatives would be shorter by several months as compared to the Applicant's Preferred Alternative. As such, the duration of potential temporary impacts on noise would be slightly longer for the 150,000 cfs Alternatives and slightly shorter for the 50,000 cfs Alternatives. However, given that noise-producing construction activities (including dredging, pile driving, and vessel traffic) have minimal overlap with the BBES Stock range, all other action alternatives, including those with terraces, would also be anticipated to have negligible to minor, temporary, indirect, and adverse impacts on bottlenose dolphins.

4.11.5 Operational Impacts

4.11.5.1 General Impacts on Habitat and the Environment

For the purposes of assessing potential impacts from the proposed Project to marine mammals, the discussion in the following section is limited to impacts on the habitat and the environment in the area within and proximal to the BBES Stock boundaries (see Section 4.11.5.3 for justifications). As discussed in Section 4.11.3.1, this analysis assumes that, in general, BBES dolphins would not, or cannot, shift their range in response to large-scale environmental changes (Wells 2010, McHugh et al. 2011b, Bassos-Hull et al. 2013, Mullin et al. 2015, Wells et al. 2017, Takeshita et al. 2021). For example, BBES dolphins remained in Barataria Bay despite heavy oiling from the DWH oil spill (Aichinger-Dias et al. 2017). This section discusses the impacts of various environmental parameters that are relevant to analyzing the potential impacts on BBES dolphins. Section 4.11.5.2 identifies the potential impacts on dolphins (from the individual level to the population level) from these changes to BBES dolphin habitat/environment. Impacts on other marine mammal stocks and species are discussed in Section 4.11.5.3.

4.11.5.1.1 No Action Alternative

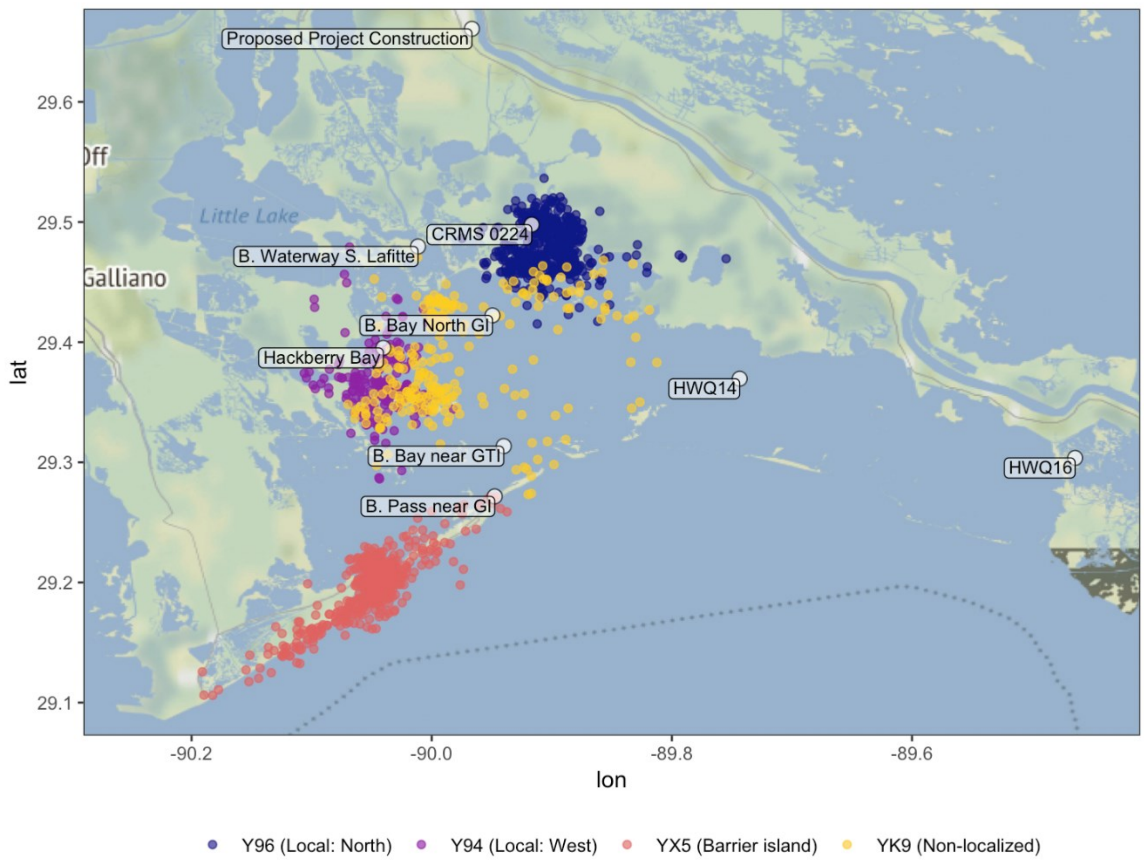
Under the No Action Alternative, ongoing changes in the Project area, such as relative sea-level rise and continuing coastal erosion within the Barataria Basin, would have accelerating impacts on salinity, marsh loss, and water levels over time (especially in the last two decades of the projection [2050 to 2070]), as projected by the results of Delft3D Basinwide Modeling (see Section 4.2.3.2.1 in Geology and Soils). Generally, sea-level rise with continued marsh loss would increase tidal influences and saltwater encroachment in the estuary; however, some seasonal salinity changes would likely continue to occur during periods of high spring discharge from the Mississippi River. This change over time would impact vegetation at locations farther north, which could alter primary productivity in existing wetlands; and increased water levels could cause prolonged inundation, leading to wetland loss and thus loss of faunal nursery habitat (see Section 4.6 Wetland Resources and Waters of the U.S.). This loss of habitat would have major, permanent, indirect, and adverse impacts on aquatic fauna. Overall, under the No Action Alternative, there would be little change from historical trends in the first three decades, but the last two decades would see changes due to sea-level rise and seawater incursion.

4.11.5.1.1.1 Salinity and Temperature

Under the No Action Alternative, the salinity in the Project area during the first decade of modeled conditions (2020 to 2030) is projected to be within the range of the existing monthly average salinities presented in Chapter 3, Section 3.5.2.2, Salinity. Average salinity in the Barataria Basin would continue to show seasonal variability, with the lowest salinities occurring in spring and summer, and the highest salinities occurring in fall and winter. These elevated winter salinities are projected to increase to different degrees throughout the basin, and extend farther north into the basin over the analysis period, most likely due to anticipated increased rates of sea-level rise from 2050 to 2070.

The Delft3D Basinwide Model projected estimates of changing salinity gradients under each Project alternative across the Barataria Basin over time, but it was developed and validated by generating hindcasted salinity estimates across the Barataria Basin for recent years. In Appendix E, the data from the hindcasted model are compared to known salinity station measurements in order to validate the results.

Thus, even for the projected model output, it is convenient to report the modeled salinity values at these station locations (see Figure 4.11-3). To capture potential salinity-related impacts from the No Action Alternative and other action alternatives on example BBES dolphins throughout the stock boundary, the mean Delft3D Basinwide Model-projected salinities were calculated from selected stations that generally correspond to individual BBES dolphin usage patterns based on telemetry data (Wells et al. 2017, Takeshita et al. 2021; Figure 4.11-3, Table 4.11-3, and Figure 4.11-4). In other words, if future individual dolphins exhibit year-long usage patterns similar to previously tagged dolphins, the salinity exposures they would experience under each Delft3D Basinwide Model-simulated decadal year scenario could be estimated.



Source: Takeshita et al. 2021 and unpublished data supporting Takeshita et al. 2021 (Figure provided by NOAA for Draft EIS, 2020).

Figure 4.11-3. Water Quality Station Locations in the Barataria Basin Compared to Usage Patterns of Four BBES Dolphins. Station names are included for stations discussed in this section for comparison of projected impacts. Delft3D Basinwide Model outputs are from Appendix L (Delft Water Quality Data Tables). Each colored set of points represents an individual dolphin tagged during 2017 as examples of the variety of usage patterns among BBES dolphins. Y96 and Y94 are examples of a local usage pattern that maintains relatively small usage areas in the northern or western parts of the BBES Stock area. YX5 is an example of a barrier island-associated usage pattern. YK9 is an example of a non-localized usage pattern with a more extensive range. No dolphins were tagged in the east portion of the BBES Stock area in 2017.

Table 4.11-3
Stations Used for Comparison of Proposed Project Impacts on BBES Dolphins

BBES Dolphin Usage Pattern	Description	Water Quality Stations Used to Calculate Mean Salinity[a]
Barrier Island	Near barrier islands and passes	USGS 073802516 and USGS 291929089562600
Extended movement	Ventures into marshes across the mid- to lower-basin and uses the barrier islands	USGS 2928590900040000, USGS 73802512, USGS 7380251, USGS 073802516, and USGS 291929089562600
Localized movement (“Local”)	West: stays near Hackberry Bay	USGS 73802512
	Central: stays near Wilkinson Bay	Central Station (CRMS 0224)
	Southeast: stays east of Billet Bay	HWQ-14 and HWQ-16

[a] For usage patterns with more than one water quality station listed, the mean was derived by averaging all listed stations

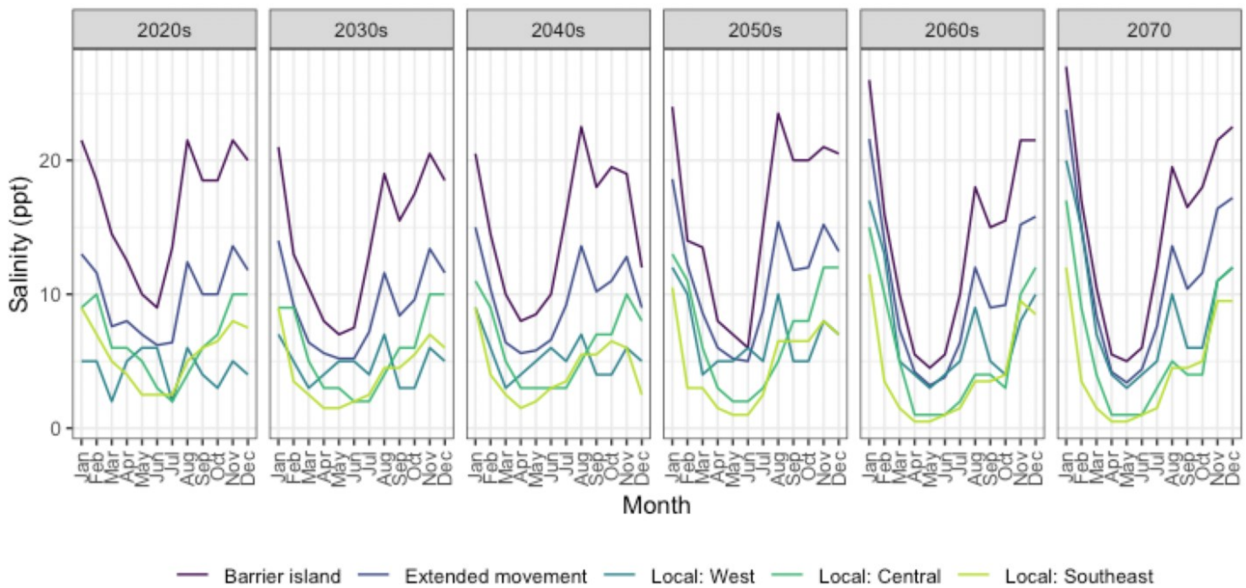


Figure 4.11-4. **Average Modeled Salinity for the No Action Alternative for Five Example BBES Dolphin Usage Patterns under the Historical Representative Hydrographs for Each Decade**. BBES dolphins have a variety of individual usage patterns throughout the Middle/Lower Barataria Basin (Wells et al. 2017, Takeshita et al. 2021). Table 4.11-1 and Figure 4.11-6 describe how Delft3D Basinwide Model salinity values at specific station locations were used to represent salinity exposures for five example BBES dolphin usage patterns. The barrier island usage pattern is exposed to the highest salinities (purple lines), while local usage patterns (west, central, and southeast) are exposed to the lowest salinities (light blue, teal, and green lines, respectively). The extended movement usage pattern includes a large part of the BBES Stock area, and therefore is exposed to moderate salinities (dark blue lines). In later decades, the seasonal variation between the fall/winter maximum salinity and the spring/summer minimum salinity increases for all usage patterns. A discussion of the caveats associated with the Delft3D Basinwide Model and its uncertainties/biases is presented in Section 4.11.3.1.

From 2011 to 2017, researchers deployed 68 satellite-linked tags to assess the movements of BBES dolphins (Wells et al. 2017, Takeshita et al. 2021). Most of the dolphins in these studies were temporarily captured, tagged, and released near Grand Isle; and their movement patterns demonstrate high site-fidelity to the areas near the barrier islands. In June 2017, to specifically investigate movement patterns of BBES dolphins in lower-salinity areas north of Caminada Bay (compared to the higher salinities near the barrier islands), satellite-linked tagging studies of 13 dolphins in the northern part of the BBES Stock area provided information on dolphin usage patterns starting in June, when Delft3D Basinwide Model hindcast-modeled salinities in that area were between 0 and 15 ppt (Takeshita et al. 2021). Analyses of these telemetry data assume that dolphin movements during the months of tag deployment (typically 3 to 6 months) represent year-round movements, and that the movement trends from 2011 through 2017 are generally representative of dolphin movements. These assumptions (and the telemetry results from 2017) are consistent with dolphin movement patterns in other bays, sounds, and estuaries.

The 2017 data indicate that (1) despite low-salinity conditions at the peak of the runoff (June), individual dolphins still used the northern part of the BBES Stock area; and (2) at least some individual dolphins remained in their small usage area in those northern parts of the BBES Stock area for the duration of the tags (Takeshita et al. 2021). For example, the tag on dolphin Y96 in Figure 4.11-3 transmitted for about four months from late June to late October and remained in the proximity of the central station (CRMS 0224). Therefore, to estimate how each yearly hydrograph in the Delft3D Basinwide Model forecast model might affect the salinity exposure for a theoretical future dolphin with a similar usage pattern to Y96 (a local central usage pattern, defined below), the Delft3D Basinwide Model output at the central station (CRMS 0224) under each scenario over the modeled year was analyzed. Other examples of BBES dolphin usage patterns based on patterns seen throughout the telemetry results from 2011 to 2017 were used, including:

> A barrier island-associated usage pattern (dolphins with similar usage patterns have the highest density in the BBES Stock area): range includes primarily waters surrounding Grand Isle, Grand Terre, and adjacent barrier islands, as well as occasional movements into Caminada Bay or to about 1.7 km into the open waters of the Gulf of Mexico (represented by the mean salinities from USGS Station 073802516 and USGS Station 291929089562600);

An extended movement usage pattern: range includes Middle to Lower Barataria Basin, barrier islands, and the marshes around Hackberry Bay, Mud Lake, Wilkinson Bay, and other areas on the edge of Barataria Bay proper (represented by the mean salinities from USGS Station 2928590900040000, USGS Station 73802512, USGS Station 7380251, USGS Station 073802516, and USGS Station 291929089562600); and

Localized movement usage patterns: ranges primarily include back-barrier marshes along the west (for example, Hackberry Bay), central (for example, Wilkinson Bay), or southeast (for example, east of Billet Bay) edges of Barataria Bay proper (see Takeshita et al. [2021] for additional examples of dolphins with telemetry data that support these potential usage patterns). These distinct west, central, and southeast usage patterns are referred to collectively as “local” usage patterns throughout this document.

These mean salinities for the various example usage patterns allow comparison of projected Project impacts for dolphins with different movements and locations in the north-south and east-west directions from the proposed diversion structure (see Figure 4.11-3).

Consistent with historical and existing monthly salinities in the basin (see Chapter 3, Section 3.5.2.2 in Surface Water and Sediment Quality), salinities under the No Action Alternative are projected to be lower toward the northern (central station [CRMS 0224]) and eastern (HWQ-14 and HWQ-16) reaches of the BBES boundary, transitioning to higher saline conditions toward the barrier islands (Barataria Pass near Grand Isle [southern basin]). This is reflected in the overall increasing salinity trend from the lowest salinities of the local usage patterns, to the moderate salinities of the extended movement usage pattern, and then to the highest salinities of the barrier island usage pattern (see Figure 4.11-3).

In the first decade (2020 through 2030), the local dolphin usage patterns experience lower salinities throughout the year compared to the barrier island dolphin usage pattern. Local usage patterns also experience less seasonal variance in salinity between the fall/winter maximum salinity and the spring/summer minimum salinity (see Figure 4.11-3). The extended movement usage pattern includes areas between the barrier islands and the edges of the BBES Stock area, and therefore experiences moderate monthly average salinities compared to the other usage patterns. This is consistent with current and recent historical trends within the BBES Stock area (see Table 4.11-3).

Under the No Action Alternative, the overall difference between the salinities experienced by the local dolphin usage patterns versus the barrier island dolphin usage pattern shrinks in each subsequent decade; however, there is a seasonal difference in this trend. In the last decade of the projections (2060 through 2070), all usage patterns experience higher salinities in the winter and lower salinities in the spring (in other words, the within-year seasonal variation becomes greater) compared to earlier decades; but at both the minimum and the maximum salinities, the differences between the usage patterns become smaller (see Figure 4.11-3).

Thus, in the later decades, all BBES dolphins would experience elevated salinity exposures during the winter (likely due to sea-level rise, which is factored into the Delft3D Basinwide Model and projected to show a sharp increase from 2050 to 2070), and all BBES dolphins would experience decreased salinity exposures during the spring. Salinities in the basin are generally lower in the spring due to freshwater inputs from upstream spring runoff, and salinity is increased in the Project area in the winter months when there is less influence from freshwater inputs. Under the No Action Alternative, elevated winter salinities are projected to extend farther north into the basin over the 50-year analysis period, most likely due to anticipated increased rates of sea-level rise from 2050 to 2070.

Delft3D Basinwide Model results show the existing seasonal pattern in water temperatures, with maximum temperatures in the range of 86°F (30°C) in the summer and minimum temperatures in the range of 55°F (13°C) in the winter, projected to generally continue through 2070. The model projects that, over time, minimum and maximum water temperatures in the basin may show a slight increase (less than 1.8°F [1°C]) during the analysis period.

4.11.5.1.1.2 Sedimentation and Land Loss

Sediment transport within the Barataria Basin would continue to be driven by storm events along with wind- and wave-induced resuspension, which may increase over time as emergent vegetation is lost (see Chapter 3, Section 3.4 Surface Water and Coastal Processes). Delft3D Basinwide Modeling for the No Action Alternative projects that maximum average TSS concentrations would increase over time at all but one modeled station, while minimum average TSS concentrations would remain similar over the analysis period. The increase in maximums is likely related to increased salinity, which contributes to TSS. Details regarding TSS trends are available in Section 4.5.5.6 in Surface Water and Sediment Quality.

As described in detail in Section 4.6.5.1 in Wetland Resources and Waters of the U.S., the Delft3D Basinwide Model projected that, under the No Action Alternative, approximately 298,000 acres (80 percent) of existing marsh vegetation and other above-water landforms in the Barataria Basin would convert to shallow water between year 2020 and 2070, with the greatest percentage of freshwater and brackish losses (or conversion to more saline marsh) occurring near the end of the analysis period (2050 to 2070), when impacts from sea-level rise and subsidence would likely be greatest (in the first three decades, about 7 to 8 percent of wetland acreage is lost each decade, but in the last two decades approximately 12 percent is lost each decade compared to the 2020 total [see Table 4.6-2 in Wetland Resources and Waters of the U.S.]). While the largest proportion of marsh in the proposed Project area is fresh at the beginning and end of the analysis period, the Delft3D Basinwide Model projected about a 172,500-acre (74 percent) loss or conversion of fresh marsh acreage between 2020 and 2070. The Delft3D Basinwide Model also projected about a 65,300-acre (92 percent) loss or conversion of brackish marsh, and a 60,500-acre (91 percent) loss of saline marsh acreage.

The loss of such a large percentage of the basin's marsh vegetation across all wetland types constitutes a substantial loss of foraging habitat for dolphins. However, assessments of key aquatic species predict that crustacean species (shrimp and crab) would experience major decreases in abundance, with the largest decrease after 2050; while bass are also expected to decrease, the primary fish species upon which dolphins prey would experience no measurable change or slight decreases in abundance (see Section 4.11.5.1, Food Web and Ecological Interactions, and Dolphin Prey). Dolphins use wetland edges as foraging areas, where there are both increased concentrations of prey and structure for the dolphins to use to corral prey. The loss of wetlands in the BBES Stock area would result in a gradually increasing from negligible to moderate, permanent, indirect, adverse impacts on dolphin foraging, depending on BBES dolphins' abilities to acclimatize to gradually changing conditions from 2020 to 2070.

4.11.5.1.1.3 Contaminants and Nutrients

Under the No Action Alternative, the potential for increased contaminants and nutrients from freshwater inflows from the diversion into the basin; and any potential associated impacts on aquatic resources, as described for the Applicant's Preferred Alternative, would not occur. Therefore, impacts from contaminants and nutrients are not expected to be greater than current conditions.

4.11.5.1.1.4 Food Web and Ecological Interactions

Rose et al. (2019) analyzed previously derived outputs from two food web modeling platforms for the Mississippi River Delta region, the CASM and the EwE model, as well as a suite of model-derived ecosystem indicators to illustrate the structure and energy flows of the Barataria Basin aquatic food web. This study indicated that (1) detritus plays a very important role in fueling the food web; (2) increased productivity in the spring is channeled up the food web through relatively few pathways and species compared to the rest of the year; (3) energy flows up the food web but quickly dissipates within the first few trophic levels with many consumers eating several of the lower trophic levels (plankton, algae, infauna), as well as small shrimps and crabs; (4) the Barataria Basin food web is relatively complicated and provides many potential pathways for energy to flow to consumers; and (5) because of the redundancy of pathways, the food web shows a high degree of resilience.

In later decades under the No Action Alternative, with sea-level rise introducing increased salinity and water levels in the fall/winter (compared to the first two decades), and more open water in the Barataria Basin, a general shift in the existing estuarine species assemblages and relative abundance of fauna throughout the basin is expected. In a system that would become predominantly open water and soft bottom habitat with a low amount of wetlands, the food web would likely become more plankton-based and less detrital-based. This would represent a reduction in net system energy flow, trophic diversity, and faunal diversity compared to the existing system. The system could therefore be less resilient compared to one with multiple trophic pathways and detrital subsidies (see Section 4.10 Aquatic Resources).

This shift in species assemblage, reduced trophic diversity, and lost production would be a major, permanent, and direct impact of the No Action Alternative. While such a shift in species assemblage and loss of trophic diversity would inherently benefit certain species while adversely impacting others, the shift is neither beneficial nor adverse from an ecosystem-level perspective. However, lost wetland habitat, detritus and benthic production, and estuarine-dependent species recruitment are major adverse impacts on primary and secondary production and food web energy cycling in the estuary, and would likely have adverse impacts on top predators such as dolphins.

The increasing salinities and water depths anticipated to continue over time are projected to result in the conversion of nearly 350,000 acres of marsh habitat and other above-water landforms in the Barataria Basin and birdfoot delta to shallow-water areas between years 2020 and 2070, and may result in the decrease of SAV biomass as salinities increase (Hillmann et al. 2016b). These ongoing impacts in the proposed Project area would reduce the extent of emergent marsh and SAV available to managed species, while increasing the amount of less-sensitive habitat, such as soft bottom and water column habitat, as the marsh recedes. All habitat types in the proposed Project area, especially those located in the lower and mid-basin, would experience changes over time as a result of sea-level rise and saltwater encroachment, although encroachment would occur over time, allowing for managed species and their prey to potentially acclimate to the changes and expand or contract their range accordingly.

Although dolphins as a species are typically flexible feeders with a variety of prey types and foraging strategies, there is little information about how well individuals and/or populations of dolphins can manage long-term (multi-year) shifts in their prey diversity and/or abundance. A study of female dolphins with high site-fidelity within Sarasota Bay, Florida, demonstrated that females (and their associated calves) can "exhibit a high degree of individual specialization in both foraging habitat and trophic level" (Rossman et al. 2015); this could mean that some individuals that rely heavily on one specialized feeding tactic are less resilient to changes in their habitat/food web/prey diversity and abundance. Cloyed et al. (2021) compared the level of site-fidelity and feeding strategy for a variety of cetacean species/groups and observed that species/groups with generalized feeding strategies would be less vulnerable to changes in prey species assemblages, but species/groups with high site-fidelity would be more vulnerable to location-specific habitat changes.

4.11.5.1.1.5 Dolphin Prey

Beyond ecosystem-level effects, impacts from a shift in salinity ranges and the types/abundance of SAV and other habitat types could be beneficial or adverse to differing degrees for individual dolphin prey species, depending on each species' optimal salinity range. Details on the impact of salinity shifts under the No Action Alternative on individual key species to the overall ecosystem are provided in Section 4.10.4.5 in Aquatic Resources. Shifts in the salinity regime, particularly between years 2050 and 2070, could restrict the seasonal movements and result in changes to population distribution of some dolphin prey species as individuals avoid or become precluded from the portion of the Project area where water has become too saline in the winter and/or too fresh in the spring. However, the first two decades (2020 through 2040) should be similar to recent historical conditions.

Thus, a general shift in the existing estuarine species assemblages and relative abundance of fauna throughout the BBES Stock area is expected. With salinity encroachment continuing into the estuary, the system would likely shift over time to support more coastal and marine species (for example, snappers and mackerels) and less freshwater fauna (for example, bass, sunfish, and catfish). Unless the converted open waters remain shallow enough to support SAV establishment and growth in place of the lost marsh, the production of shrimp, crab, and estuarine fishes such as minnows, killifish, pinfish, seatrout, croaker, and drum that rely on vegetated habitats in the estuary, particularly as juveniles, could decline (Turner and Boesch 1988, Browder et al. 1989, Minello et al. 1989, Ault et al. 1998, Castellanos and Rozas 2001, LaPeyre and Gordon 2012).

Section 4.10.4.5 in Aquatic Resources describes the impacts of the No Action Alternative to 12 key species (or species groups) of fish and crustaceans. Ten of the species are known BBES dolphin prey, based on the stomach contents analysis of 37 dead, stranded dolphins from the Barataria Basin (Bowen-Stevens et al. 2021). Table 3.11-3 provides the percentage of dolphins examined that consumed each taxon, as well as the percentage that each of those taxa made up within the overall prey contents of the group of 37 individuals. These 10 key species collectively made up about 75 percent of the total prey contents (it is important to note that the stomach contents of dead, stranded individuals may not represent the diet of healthy dolphins). For all of these dolphin prey species included in the EIS analysis where the HSI model results were considered valid, habitat suitability would decrease over time due to changing salinities and marsh loss (see Section 4.10, Table 4.10-7 in Aquatic Resources). Shrimp (major) and crab (moderate) would experience adverse, indirect, permanent impacts, with gradual decreases in abundance over time and the largest decrease after 2050; however, crustaceans only made up 2.2 percent of the total stomach contents in BBES dolphins (Bowen-Stevens et al. 2021). Of the fish species upon which dolphin typically prey (see Chapter 3, Section 3.11 Marine Mammals, Table 3.11-1), those considered Key Species analyzed in Section 4.10 Aquatic Resources would experience negligible to minor permanent impacts, with a slight to no measurable decrease in abundance over time. There would likely be adverse impacts on both these key species and other potential dolphin prey species (for example, mullet) resulting from a reduction in primary and secondary production and food web cycling in the estuary due to lost wetland habitat, a reduction in detritus and benthic production, and a decline in estuarine-dependent species recruitment.

Overall, the majority of dolphin prey (fish species) are projected to experience a slight to no measurable change in their abundance over time under the No Action Alternative. Therefore, changes in prey abundance would likely cause minor, adverse, permanent impacts on BBES dolphins, depending on the dolphins' ability to acclimatize to decades-long gradual changes in foraging areas.

4.11.5.1.2 Applicant's Preferred Alternative

As discussed in Section 4.4.4.2 in Surface Water and Coastal Processes, operational impacts of the Applicant's Preferred Alternative on existing currents and flow would be direct, permanent, and minor to major (depending on distance from the immediate outfall area) due to widespread and readily apparent impacts on water flow velocity and direction when the proposed Project is operating above base flow (greater than 5,000 cfs and up to 75,000 cfs depending on flows in the river). Tides would not be altered, other than from overall impacts of higher water levels related to sea-level rise. Throughout the analysis period (from 2020 to 2070), salinities in the BBES Stock area are projected to be lower due to the influx of fresh water from the proposed Project. By year 2070, the Applicant's Preferred Alternative is projected to create and sustain approximately 12,700 acres of wetlands (compared to the No Action Alternative) north of the BBES Stock area, which would represent approximately 17.4 percent of the total wetland area in the basin (see Table 4.6-3 in Section 4.6, Wetland Resources and Waters of the U.S.), providing additional habitat for euryhaline prey species that migrate through the BBES Stock area. However, there would be substantial wetland loss in the BBES Stock area due to subsidence and sea-level rise unrelated to the proposed Project. Overall, the Applicant's Preferred Alternative would have immediate, major adverse effects on BBES dolphin habitat (due mostly to low salinity) that would continue throughout the lifetime of the proposed Project. This section discusses the impacts of the Applicant's Preferred Alternative on various environmental parameters that are relevant to analyzing the potential impacts on BBES dolphins. Section 4.11.5.2 identifies the potential impacts on dolphins (from the individual level to the population level) from these changes to BBES dolphin habitat/environment.

4.11.5.1.2.1 Salinity and Temperature

As discussed in detail in Section 4.5, Surface Water and Sediment Quality, the Delft3D Basinwide Model projected that the Applicant's Preferred Alternative would cause immediate and permanent changes to salinity (primarily decreasing salinity) in the Barataria Basin during proposed Project operations. The model projected that minimum average monthly salinities would be consistently lower than those under the No Action Alternative in all projected decades and for all dolphin usage patterns (see Figure 4.11-5). In general, all portions of the BBES Stock area are projected to experience lower minimum average monthly salinities throughout the analysis period.

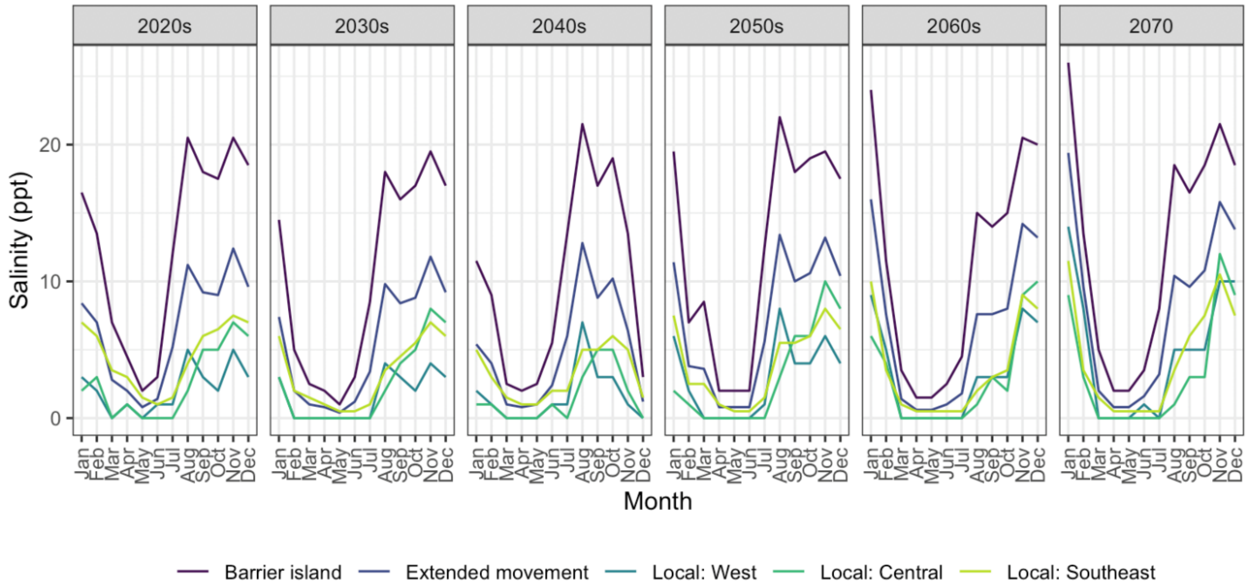


Figure 4.11-5. Average Modeled Salinity for the Applicant's Preferred Alternative for Five Example BBES Dolphin Usage Patterns under Historical Representative Hydrographs for Each Decade. Table 4.11-1 and Figure 4.11-5 describe how Delft3D Basinwide Model salinity values at specific station locations were used to represent salinity exposures for five example BBES dolphin usage patterns. As in the No Action Alternative, barrier island (purple line), extended movement (dark blue line), and local usage patterns (light blue, teal, and green lines) are exposed to the highest, moderate, and lowest salinities, respectively, and in the later decades, the seasonal variation between the fall/winter maximum salinity and the spring/summer minimum salinity increases for all usage patterns. However, under the Applicant's Preferred Alternative, all usage patterns would experience decreased salinities, including local usage patterns spending several months at 0 ppt. The within-year seasonal variation also increases more drastically than in the No Action Alternative. A discussion of the caveats associated with the Delft3D Basinwide Model and its uncertainties/biases is presented in Section 4.11.3.1.

Based on the Delft3D Basinwide Model projections, in the first decade of the proposed Project, all of the example dolphin usage patterns would experience decreased salinity (see Figure 4.11-5 and Figure 4.11-6). The barrier island dolphin usage pattern would see an 8 ppt reduction in salinity from March to May, and the model projected that they would experience between 0 to 5 ppt waters from April to June. While the extended movement and local dolphin usage patterns each remained above 2.5 ppt under the No Action Alternative, they are projected to experience at least four months between 0 and 2.5 ppt under the Applicant's Preferred Alternative (while it is important to consider the uncertainties associated with evaluating absolute projected values from the Delft3D Basinwide Model [see Appendix E], in these analyses relative decreases in salinity are difficult to interpret because the model projected that some of these individual usage patterns would experience 0 ppt, limiting the usefulness of relative decreases in projected salinity). The following decades show a similar trend, but the length of time dolphins would be exposed to low salinity would increase and salinity values would get even closer to 0 ppt compared to the No Action Alternative.

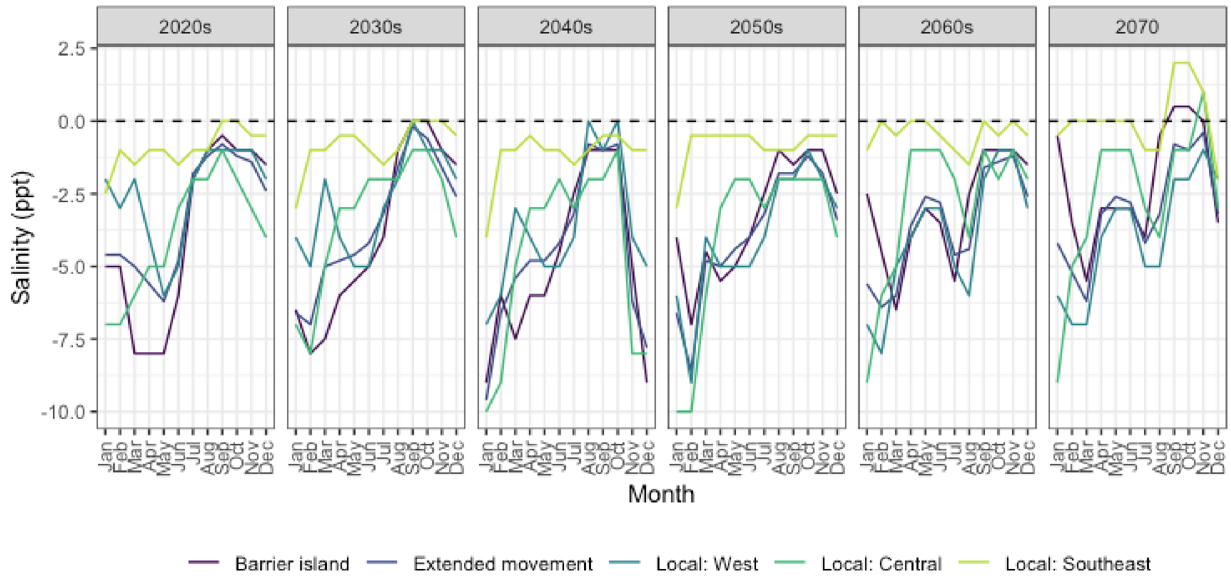


Figure 4.11-6. The Difference in Average Modeled Salinity between the No Action Alternative and the Applicant's Preferred Alternative for Five Example BBES Dolphin Usage Patterns under the Historical Representative Hydrographs for Each Decade. Table 4.11-1 and Figure 4.11-6 describe how Delft3D Basinwide Model salinity values at specific station locations were used to represent salinity exposures for five example BBES dolphin usage patterns. These figures represent the difference between the No Action Alternative and the Applicant's Preferred Alternative.

Throughout the BBES Stock area of the basin, seasonal trends in salinity are projected to remain similar to those under the No Action Alternative (in other words, fresher in spring and more saline in fall/winter). In general, the No Action Alternative and the Applicant's Preferred Alternative are similar (within 2.5 ppt) in the months when the proposed Project is operating at base flow (approximately August through November). However, in all decades, when the proposed Project is operational above base flow (approximately December through July), the Applicant's Preferred Alternative would result in lower salinities (up to 10 ppt lower) compared to the No Action Alternative, reaching or approaching 0 ppt for all dolphin usage patterns other than the barrier island pattern, indicating that all non-barrier island-associated dolphin habitat would essentially be fresh for three to five months each year (depending on the hydrograph for a given year; see Figure 4.11-5). It is difficult to compare the relative decrease between the No Action Alternative and the Applicant's Preferred Alternative because the latter is bounded by 0 ppt. Thus, although it appears that the largest decreases in salinity experienced by non-barrier island dolphins occur from January to March in each decade, this is likely because by March the salinity has reached 0 ppt and cannot decrease any further (see Figure 4.11-6). The local southeast dolphin usage pattern is similarly confounded by fairly constant low salinity at HWQ-14, regardless of the alternative or representative hydrograph.

However, impacts would not be limited to dolphins with usage patterns similar to the local and extended movement usage patterns: the Applicant's Preferred Alternative model output also projected decreases in salinity regimes (compared to the No Action

Alternative) for the barrier island usage pattern (see Section 4.10, Figure 4.10-7 in Aquatic Resources), with normally higher-salinity habitat decreasing by as much as 9 ppt compared to the No Action Alternative, into the 0 to 5 ppt range. The local usage patterns would experience prolonged periods of decreased salinity, as opposed to the barrier island usage pattern, which is projected to have quickly oscillating peaks and drops in salinity. For the barrier island usage pattern, while minimum salinities are projected to be lower than those under the No Action Alternative in all decades, the maximum salinities are projected to remain similar to those under the No Action Alternative; thus, as maximum salinities rise over time due to sea-level rise, within-year seasonal salinity variability would increase over time in this portion of the basin. That is, the barrier island usage pattern would experience a greater range of salinities throughout the year under the Applicant's Preferred Alternative compared to the No Action Alternative because salinities would be lower in spring but remain at similar values in fall when the diversion is at base flow levels.

Salinity exposure for the barrier island usage pattern is complex. Although the amount of difference in salinity levels generally decreases with increasing distance from the outfall area, substantial changes to salinity would occur on the north side of the barrier islands during periods when the diversion is operating above base flow. The barrier islands are an area where the basin's estuarine waters and the more saline nearshore Gulf waters mix, but additions of diverted fresh water under the Applicant's Preferred Alternative would likely move the mixing zone slightly south and decrease salinity substantially (by less than or equal to 9 ppt lower than the No Action Alternative) in the area just north of the barrier islands during the springtime months. However, waters near the barrier islands, due to mixing with high-salinity Gulf waters, have higher salinity than the rest of the Barataria Basin during most of the year; therefore, the lowest monthly springtime salinity projected for the barrier island usage pattern due to the Applicant's Preferred Alternative is estimated to be approximately 1.0 ppt compared to a minimum of 4.5 ppt under the No Alternative Action in 2070.

Operation of the proposed Project would result in decreases in water temperature, which the Delft3D Basinwide Model projected would be most pronounced in the colder months and at locations closest to the diversion structure (see Section 4.5.5.2 in Surface Water and Sediment Quality). The largest anticipated change in average monthly temperature, compared to the No Action Alternative, would be about -11.9°F (6.6°C). Changes in temperatures would be most apparent mid-basin (including Stations HWQ-08 and the station nearest the diversion [CRMS 0276]; see Section 4.10, Figure 4.10-8 in Aquatic Resources), where average monthly temperatures are often projected to decrease more than 5.4°F (3°C) compared to the No Action Alternative, between December and April initially, and into May during the last two decades of operation. Similar but sporadic decreases in temperatures are also projected in winter and spring for stations farther afield (B. Waterway, USACE 82875, and B. Bay North GI), depending on the representative hydrograph.

Overall, under the Applicant's Preferred Alternative, all BBES dolphins are projected to be exposed to lower salinities (up to 10 ppt lower) from January through August in every decade compared to the No Action Alternative. Dolphins with usage patterns similar to the local west and central usage pattern examples are projected to spend up to 6 months at a monthly average of 0 ppt for all projected decades (see Figure 4.11-5). Under the Applicant's Preferred Alternative, dolphins with usage patterns similar to the barrier island example usage pattern would experience a more dramatic intra-annual variation (higher maximum salinities in winter and lower minimum salinities in the spring) over time and in comparison to the No Action Alternative. Colder temperatures may affect dolphins at the northernmost portions of the BBES Stock area, typically in the winter and spring, under some representative hydrographs.

4.11.5.1.2.2 Sedimentation and Land Loss

Operation of the diversion would allow for the input of fresh water and sediment (including contaminants and nutrients) into the Barataria Basin. The Delft3D Basinwide Model projects that the Applicant's Preferred Alternative would cause a permanent, minor to moderate increase in average TSS concentrations in the Barataria Basin during Project operations, with greater (moderate) increases in TSS concentration compared to the No Action Alternative near the diversion and central basin. Additional details regarding TSS trends are provided in Section 4.5.5.6, Surface Water and Sediment Quality, Total Suspended Solids. Based on the anticipated impacts on sediment resuspension in the water column, and the large outflows (and extension of sediment suspension time) associated with the proposed diversion, impacts on fauna from the Applicant's Preferred Alternative would be direct and indirect, adverse, temporary during diversion openings (but permanently recurring throughout the analysis period), and negligible to moderate, with more moderate impacts occurring at the location of the immediate outfall area and decreasing in intensity with distance from the immediate outfall area.

Compared to the No Action Alternative, after 10 years of diversion operations (2030), larger areas of freshwater and intermediate wetlands would occur within the proposed Project area under the Applicant's Preferred Alternative, while brackish and saline marsh areas would decrease compared to the No Action Alternative. Over the next two decades, an overall increase in wetland acreage relative to the No Action Alternative would occur as the shallower open-water areas in the outfall area begin to fill in and become colonized by intermediate marsh species. The most substantial increases in sedimentation would occur within approximately 10 miles of the diversion outlet, with moderate and minor increased sediment deposition extending farther, primarily southward. During this period, trends toward increasing freshwater and intermediate wetlands would continue (see Section 4.6.5.1 in Wetland Resources and Waters of the U.S.). It is unclear how BBES dolphins suffering from the adverse health effects of low salinity might respond to the additional stressor associated with the net decrease in wetlands within the BBES Stock area (projected in both the No Action Alternative and the Applicant's Preferred Alternative).

Under the Applicant's Preferred Alternative (and similar to the No Action Alternative), total wetland acreage in the BBES Stock area would decrease over the course of the analysis period (2020 to 2070), especially in the last two decades, due to sea-level rise and subsidence. Over the course of the proposed Project modeled analysis period, freshwater and intermediate marshes would be lost throughout the BBES Stock area; south and east of Lake Salvador, the remaining wetlands would be limited almost completely to those wetlands in the immediate outfall area, and brackish wetlands would be limited to the few discrete locations shown in Figure 4.6-8 in Section 4.6, Wetland Resources and Waters of the U.S. No saline wetlands would remain in the BBES Stock area except along the Gulf-facing barrier islands. By comparison, under the No Action Alternative, almost all freshwater and intermediate wetlands south and east of Lake Salvador would be lost, and wetlands within this area of the Barataria Basin would be limited to a few discrete areas of brackish and saline marsh (also farther north than the current BBES Stock area).

As discussed in Chapter 3, Section 3.10, Aquatic Resources, wetlands are extremely important to many estuarine and marine dolphin prey species, providing important edge habitat for fish and invertebrates with respect to feeding, reproduction, and refuge (Peterson and Turner 1994, Castellanos and Rozas 2001). In the Atchafalaya River Delta, emerging wetlands resulting from river diversions resulted in the recovery of fish nursery capacity (Thompson and Deegan 1983) and a much greater density of nekton in vegetated areas of freshwater tidal wetlands compared to unvegetated areas.

The increase in freshwater marsh compared to the No Action Alternative would likely have indirect beneficial impacts on estuarine dolphin prey species by allowing for the export of increased primary production, detritus, and prey resources to other areas of the basin that would support the local food web (see Sections 4.11.5.1, Food Web and Ecological Interactions, and Dolphin Prey). The freshwater wetlands projected to be created and maintained at the outfall area (outside of the BBES Stock area) could provide benefits associated with water quality improvement (see Section 3.5 in Wetland Resources and Waters of the U.S.), as well as nursery habitat benefits for dolphin prey species and life stages more tolerant of low salinity (for example, Atlantic croaker, Gulf menhaden, and white shrimp; see Table 4.11-2).

4.11.5.1.2.3 Contaminants and Nutrients

Environmental manipulations, including dredging and diversions, have been identified as a source for increasing the bioavailability of POPs via sediment transport (Eggleton and Thomas 2004). Previously constructed and operational diversions in the vicinity of the proposed Project have included pre- and/or post-diversion sampling that may indicate potential impacts of introduced contaminants and nutrients that could be expected from the proposed Project. Although studies on smaller outfalls/diversions imply negligible impacts on fauna from the influx of river contaminants, the substantially larger outflow of the proposed diversion may result in increased contaminant levels within biota (see Section 4.10.4.4 in Aquatic Resources). Fat-soluble contaminants are biomagnified through the food chain, increasing exposure to higher trophic levels. BBES dolphins are apex predators that feed across trophic levels and throughout various habitat types. This foraging strategy means that dolphins are exposed to comparatively high concentrations of fat-soluble contaminants, and they concentrate those contaminants in their lipid-rich blubber and other tissues. The combined effects of low salinity and increased contaminant exposure may have resulted in the deaths of over 220 dolphins following a substantial rainfall event and subsequent freshwater runoff in coastal Texas (Colbert et al. 1999). In conditions where dolphins have poor body condition, POPs from the blubber can be mobilized into the bloodstream and to organs via the bloodstream, or directly to calves via lactation, resulting in adverse toxic effects (Yordy et al. 2010).

Although estuaries have always received nutrients from natural sources, which is required for the growth and production of the phytoplankton community (and therefore the food web for the estuarine community), anthropogenic sources have increased estuarine nutrient input to levels far exceeding natural inputs (Bricker et al. 1999). This nutrient loading is recognized as an indirect causal agent of hypoxia, HABs, fish kills, shellfish bed closures, and reduced seagrass and coral reef habitats (Bricker et al. 1999, Nixon 2009, Turner et al. 2019).

The Delft3D Basinwide Model projected that the largest changes in monthly average chlorophyll A levels (a proxy for phytoplankton biomass) would occur closest to the immediate outfall area. Increases in algal blooms are projected to occur earlier in the season (during operational months) at stations farther from the immediate outfall area, where water clarity and residence times may be more conducive to algal growth during diversion operation above base flow. Based on the lines of evidence presented in Section 4.10.4.4 in Aquatic Resources, an increased potential (and frequency) of phytoplankton blooms would be likely within the proposed Project area. Whether or not these blooms would become HABs cannot be definitively determined based on currently available knowledge, but if nutrient input from the proposed Project were to trigger either freshwater or marine HABs in the Barataria Basin, impacts on fauna would likely be adverse, minor to moderate, and temporary to short-term, depending on the size and significance of the bloom; and result in death or sub-lethal impacts (for example, reproductive health and behavioral impacts) on exposed individuals, as well as bioaccumulation of toxins up the food chain (CeNCOOS 2018).

Overall, although nutrient loading may result in beneficial impacts on the estuarine environment within the basin through an increase in primary productivity and available food sources, it may also result in detrimental impacts from potential increases in the size and frequency of HABs. Further, and as discussed in Section 4.10.4.4 in Aquatic Resources, increases in phytoplankton biomass may result in decreases in DO. Therefore, impacts on fauna from nutrient loading could result in indirect, minor to moderate (depending on an organism's place in the food web), permanent, and beneficial impacts on fauna within the Barataria Basin through food web production, but may also result in direct and indirect, temporary (but recurring), minor, and adverse impacts on the estuarine community through the potential production of HABs and die-offs from phytoplankton blooms causing pockets of low DO. HABs can affect dolphins from direct toxicity following inhalation and/or ingestion of contaminated prey (Flewelling et al. 2005, Twiner et al. 2012, Cammen et al. 2015), and indirectly by affecting their prey types/abundance (McHugh et al. 2011a, Wells et al. 2019). Dolphins with skin lesions would be especially vulnerable to infections caused by microbial shifts associated with HABs.

As the Delft3D Basinwide Model projects monthly averages of depth-averaged DO only, sporadic pockets of low DO or low bottom-layer DO may nonetheless occur within the basin, which may impact the distribution of dolphin prey species. Pockets of low DO would be most likely to occur during warmer months and at night, when respiration continues but photosynthesis is precluded by the lack of light. Primary production stimulated from nutrient input would also result in organic matter accumulating at the sediment layer, where its decomposition would result in decreases in DO (Reed and Harrison 2016). In areas where water layers are stratified (where salinity or temperature differences preclude mixing of upper and lower water boundaries), this DO draw-down could result in bottom-layer hypoxia or sub-optimal levels of bottom DO (see Section 4.10, Figure 4.10-5 in Aquatic Resources), which would not be evident in the Delft3D Basinwide Model projections. The Barataria Basin is generally considered to be well mixed given the wind, tides, and its shallow average depth (Turner et al. 2019); however, weak-to-moderate stratification does occasionally occur in deeper portions of Barataria Bay, such as the island passes and Barataria Waterway (Orlando et al. 1993).

Therefore, although sporadic and limited areas of low DO may occur, mainly in the summer months, no large or prolonged periods/layers of low DO are projected by Delft3D Basinwide Model, nor anticipated based on the Barataria Basin's identification as a largely well-mixed estuary. Within any pockets of low DO that do form, mobile faunal species are likely to disperse as DO decreases, although mortality may occur in limited instances of larger or prolonged pockets, resulting in a temporary and negligible to minor, adverse, and indirect impact on those species. Thus, pockets of low DO could affect BBES dolphin prey availability/foraging during the spring/summer low-salinity periods.

4.11.5.1.2.4 Food Web and Ecological Interactions

Overall, reduced primary productivity near the immediate outfall area would have permanent (recurring throughout analysis period) and adverse, but negligible to minor, impacts on the food web, as the detritus-based food web should provide temporary resilience to overall system production, whereas increased primary production within the wider basin would result in permanent, moderate, and beneficial impacts on energy flow to lower trophic-level consumers; and permanent, negligible to minor, beneficial impacts on higher trophic-level predators (see Section 4.10.4.4 in Aquatic Resources). However, during these periods with predominantly detritus-based food webs, the system could be less resilient compared to one with multiple trophic pathways. Impacts on lower trophic-level consumers (including benthic infauna) from other abiotic factors (for example, salinity shifts, water flow, and tidal transport) would have a negligible impact on higher trophic-level predators, as the Barataria Basin food web has numerous and redundant connections, and many of the species are opportunistic, trophic generalists feeding on multiple prey types.

The decrease in average salinity in the basin may result in increased biomass of SAV over time, compared to the No Action Alternative. However, the Applicant's Preferred Alternative is projected to result in a winter salinity regime that would provide substantially more habitat that is conducive to the growth of freshwater and intermediate SAV species compared to the No Action Alternative, while decreasing the acreage conducive to the growth of brackish and saline SAV species. Overall, the proposed Project would likely initially result in a temporary, adverse, major, indirect impact on SAV in the basin from a relatively quick change in salinity (see Section 4.10, Table 4.10-1 in Aquatic Resources), which may result in die-offs of species intolerant of the new salinity regime early in the proposed Project's life. However, major, permanent, and indirect beneficial impacts are anticipated for the overall coverage and biomass of low-salinity SAV in the basin once salinity regimes stabilize and new freshwater or intermediate communities become established later in the proposed Project's life; these longer-term increases are anticipated to offset the initial adverse impacts on brackish or saline species in the basin, which would decrease in abundance with the changing salinity regime. This increased primary productivity, increased nursery habitat for aquatic species, and shifts in the food web would play a role in the impacts on dolphin prey species discussed below in Dolphin Prey.

4.11.5.1.2.5 Dolphin Prey

Of the 10 key species analyzed in Section 4.10 Aquatic Resources that are known BBES dolphin prey (representing 75 percent of stomach prey content), the Applicant's Preferred Alternative would result in overall beneficial impacts on six species (red drum, Gulf menhaden, bay anchovy, blue crab, white shrimp, and bass) and a major adverse impact on brown shrimp, minimal adverse impact of spotted seatrout, negligible to minimal adverse impact on southern flounder, and neutral impacts on Atlantic croaker (see Table 4.10-4 in Section 4.10 Aquatic Resources).

Other common species found in dolphin stomachs (Bowen-Stevens et al. 2021) include striped mullet and brief squid. Mullet are euryhaline, and both the adult and juvenile stage of mullet would be found in the Barataria Basin. They spawn most of the year, but the peak is between October and December. Adult striped mullet migrate offshore in large schools to spawn. Juveniles migrate inshore at about 1 inch in size, moving far up into estuaries and tidal creeks. They are usually in schools over sand or mud bottoms (Eschmeyer et al. 1983), between 0 and 32.8 feet (10 meters). Mullet feed on algae, decaying matter, zooplankton, and benthic organisms. NOAA scientists have determined that the Applicant's Preferred Alternative would drive similar (moderate beneficial) impacts on striped mullet and Gulf menhaden. NOAA determined that increased marsh habitat and primary production would benefit mullet populations during the later decades of the proposed Project (2050 to 2070). Changes to salinity are expected to have no effect on mullet because they are euryhaline. Mullet recruitment is expected to be minimally affected due to the timing of recruitment, which occurs when the diversion is typically at minimal base flow. Mullet and Gulf menhaden juveniles are expected to be able to migrate in the Project areas; however, flow conditions may prevent movements near the outfall area when the diversion is operating above base flow.

Adult and juvenile brief squid can be found in the Barataria Basin. Brief squid can tolerate lower salinity than any other known cephalopod, living in water with salinities as low as 17.0 ppt, but the LDWF trawl-monitoring data show catches of brief squid in salinities as low as 6 ppt. The largest concentrations in the northern Gulf seem to be in the waters of high productivity around the Mississippi River Delta and Grand Isle, Louisiana. Brief squid are prevalent in estuaries and shallow coastal waters and bays, and on the inshore shrimp grounds. While they likely feed on shrimp and other small animals, they seem to have a strong predilection for anchovies. Brief squid appear to spawn year-round. NOAA scientists have determined that the Applicant's Preferred Alternative would drive similar (minimal) impacts on brief squid and lane snapper (as described in the EFH Assessment in Appendix N). Brief squid seem to prefer areas with water at salinities above 17 ppt. If this limits the species to the lower basin, where salinity decreases are less drastic during diversion operations, it may still cause the species to move to other more suitable habitats or move out of the basin. Although juveniles migrating from offshore to inshore may be affected by reduced salinity during diversion operations, increased marsh habitat and primary production would benefit anchovy populations during the later decades, providing an important prey source for squid. These impacts on aquatic species could impact prey availability for dolphins.

4.11.5.1.3 Other Action Alternatives

As discussed in Section 4.4.3.1 in Surface Water and Coastal Processes, the other action alternatives would not have substantial differences from the Applicant's Preferred Alternative in terms of modifications to tides, currents, or flow in either the Mississippi River or the Barataria Basin in areas that overlap with the BBES Stock. Alternatives with higher maximum operational flow rates would result in longer periods of low salinity, while alternatives with lower maximum operational flow rates would result in shorter periods of low salinity. For the purposes of marine mammals, terracing would have little effect on the impacts assessments, and so this section focuses on the differences in the operational flow rates. Overall, there would likely be similar immediate and permanent impacts on BBES dolphin habitat and environment from all of the operational alternatives due to decreasing salinity and changes in the types and amounts of wetlands; however, changes in the durations of low salinity are likely to affect BBES dolphin health and survival.

4.11.5.1.3.1 Salinity and Temperature

Modeled average monthly salinities for the historical representative hydrograph for the 50-year analysis period (years 2020 to 2070) indicate that salinity impacts resulting from the other action alternatives would be generally similar to those for the Applicant's Preferred Alternative (see Section 4.5, Figures 4.5-4 through 4.5-6 in Surface Water and Sediment Quality). Alternatives with higher maximum operational flow rates would result in longer periods of low salinity, while alternatives with lower maximum operational flow rates would result in shorter periods of low salinity. Salinity impacts modeled for all action alternatives would generally follow the same seasonal trends as the Applicant's Preferred Alternative, with lower salinities in the spring and early summer months, and higher salinities in the fall and winter months. Neither the variable Project flow rates nor the presence of terraces appear to result in substantial differences in salinity compared to the Applicant's Preferred Alternative (see Section 4.5, Table 4.5-2 and Figures 4.5-4 through 4.5-6 in Surface Water and Sediment Quality). Impacts relevant to BBES dolphins and specific to each of the other alternatives, if any, are described below and discussed in further detail in Section 4.5.5.1 in Surface Water and Sediment Quality.

For the 50,000 cfs Alternatives, representative hydrograph years show little change in salinity from the Applicant's Preferred Alternative, although the western station (Little L. Cutoff) and central station (CRMS 0224) show slightly higher salinities when the diversion is projected to be operating up to the 5,000 cfs base flow (for example, in January), and the southwestern station near Grand Isle [B. Pass at GI]) stays approximately 2 ppt higher than the Applicant's Preferred Alternative throughout the year in all of the representative yearly hydrographs for each decade (see Section 4.5, Figures 4.5-5 and 4.5-6 in Surface Water and Sediment Quality). This means that under the 50,000 cfs Alternatives, there would be fewer days spent at low salinities (for example, under 5 ppt) each year during the spring/summer runoff.

For the 150,000 cfs Alternatives, the hydrographs show further depression of salinities in the central (central station [CRMS 0224]) and western basin (western station [Little L. Cutoff]) stations (since those areas are approximately 0 ppt for most of the months when the diversion gates are projected to be open), with the most substantial changes occurring in the southern basin (southwestern station near Grand Isle [B. Pass at GI]), where there is a faster and more substantial decrease in salinity upon projected openings of the diversion (operating above the 5,000 cfs base flow), between 2 and 4 ppt lower than the Applicant's Preferred Alternative, and a longer duration of salinity less than 5 ppt (between 1 to 2 months; Section 4.5, Figures 4.5-5 and 4.5-6 in Surface Water and Sediment Quality).

No substantial differences in temperature changes were projected between the Applicant's Preferred Alternative and the other action alternatives.

4.11.5.1.3.2 Sedimentation and Land Loss

Types of impacts from the diversion of fresh water and sediment from the other action alternatives would be similar to those described above for the Applicant's Preferred Alternative, although the degree would vary. Sedimentation and turbidity are anticipated to decrease (50,000 cfs Alternatives) or increase (150,000 cfs Alternatives) within the basin based on the total outflow of a given alternative compared to the Applicant's Preferred Alternative. Thus, the alternatives would vary in the total acreage of wetland impacts since they would include terracing features and/or transport different volumes of material from the Mississippi River into the Barataria Basin (see Section 4.6.5.1 in Wetland Resources and Waters of the U.S.).The most substantial impacts on sedimentation would occur within approximately 10 miles of the diversion outlet, with moderate and minor impacts extending farther, primarily southward, but overall, the other alternatives would likely not change the overall impact on wetlands within the current BBES Stock area (compared to the Applicant's Preferred Alternative). Figures 4.6-16 through 4.6-22 (see Section 4.6, Wetland Resources and Waters of the U.S.)

show the total area of wetlands, by wetland cover type, in the Barataria Basin for the No Action Alternative and each action alternative in 2070.

4.11.5.1.3.3 Contaminants and Nutrients

Contaminants and nutrients are anticipated to decrease (50,000 cfs Alternatives) or increase (150,000 cfs Alternatives) within the basin based on the total outflow of a given alternative compared to the Applicant's Preferred Alternative. As discussed under the Applicant's Preferred Alternative, the inflow of nutrients with fresh water would likely result in a larger phytoplankton biomass that may contribute to an increased fish biomass, resulting in major, permanent (ongoing throughout the analysis period), and beneficial impacts on fauna within the Barataria Basin. The inflowing nutrients would decrease (under the 50,000 cfs Alternatives) or increase (under the 150,000 cfs Alternatives) compared to the Applicant's Preferred Alternative. As the Applicant's Preferred Alternative would result in algal blooms, it is likely that more expansive algal blooms would occur with implementation of the 150,000 cfs Alternatives, which would also increase the chance of HABs. Although a triggered HAB (and any resulting decrease in DO) could result in adverse, minor to moderate, and temporary to short-term impacts on fauna, depending on the size and significance of the bloom, the nutrient input could also result in major, permanent (ongoing throughout the analysis period), and beneficial impacts on fauna within the Barataria Basin.

4.11.5.1.3.4 Food Web and Ecological Interactions

Under the Applicant's Preferred Alternative, the Rose et al. (2019) study was used to infer how the existing Barataria Basin food web (as modeled in Dynamic Solutions 2016 and de Mutsert et al. 2017) might be affected in the outfall area and basin-wide.

Based on that analysis, the 50,000 cfs Alternative would show similar or less food web impacts compared to the Applicant's Preferred Alternative. The 50,000 cfs Alternative should have less of an overall effect on energy cycling in the food web and higher trophic-level biomass (potentially including higher trophic-level predator species such as dolphins) than the Applicant's Preferred Alternative.

The 150,000 cfs Alternative would likely show similar or more pronounced food web impacts on the Applicant's Preferred Alternative. If bottom-up impacts from an increase in phytoplankton, phytobenthos, and detritus under the 150,000 cfs Alternative compared to the Applicant's Preferred Alternative increase in duration and magnitude, then changes in high biomass species could also be more detectable in the Barataria Basin. It would still be unlikely that higher trophic-level predator species such as dolphins would show anything beyond minor impacts from the food web under the 150,000 cfs Alternative operational flows.

As discussed in Section 4.5, Surface Water and Sediment Quality neither the 50,000 cfs nor the 150,000 cfs proposed Project flow alternative appears to have a consistent or substantial enough impact on salinities compared to the Applicant's

Preferred Alternative to create clear differences in SAV occurrence. In the immediate outfall area, each terracing alternative would result in additional indirect, permanent, minor (due to limited terrace acreage) benefits to low-salinity SAV and associated nekton. This increased primary productivity, increased nursery habitat for aquatic species, and shifts in the food web would play a role in the impacts on dolphin prey species discussed in Dolphin Prey for the Applicant's Preferred Alternative.

Changes in salinity do not appear to be substantially influenced by either the variable flow or the presence of terraces (see Section 4.5.5.1 in Surface Water and Sediment Quality), and temperatures follow the same trends as the Applicant's Preferred Alternative, with minor differences (see Section 4.5.5.2 in Surface Water and Sediment Quality). As the changes in salinity for the other alternatives are not substantially different from the Applicant's Preferred Alternative, the biomass of SAV, which is expected to increase in freshwater areas, is also not anticipated to substantially change from the Applicant's Preferred Alternative (see Section 4.10.4.1 in Aquatic Resources).

4.11.5.1.3.5 Dolphin Prey

Delft3D Basinwide Model-projected water flow and velocity for the 150,000 cfs Alternatives are projected to occur farther afield, with possible disruptions to larval transport occurring at additional stations (confluence of Bayou Saint Denis and Bayou Cutler, Little Lake to Grand Bayou, Grande Bayou to Hackberry Bay, and Bayou Dulac; see Section 4.10, Figure 4.10-3 in Aquatic Resources) compared to the Applicant's Preferred Alternative, mostly during periods of high flow (late April through early June). Additional incremental impacts would therefore occur on those key species that migrate up and into the estuary during high-flow periods, including brown shrimp, white shrimp, blue crab, bay anchovy, Gulf menhaden, and spotted seatrout. Although larvae of these species may be precluded from entering and settling in these areas during the high-flow period, each species' larval transport period extends over a longer period than the typical highest flow periods. As such, incremental impacts associated with further modification of flow patterns projected for the 150,000 cfs Alternatives would not alter the overall determinations for the key species, as identified above.

As discussed throughout Section 4.10, Aquatic Resources, the other action alternatives generally do not result in substantial changes from that described in the Applicant's Preferred Alternative and, therefore, impacts on key species would be similar to those described above. The larger drivers of impacts on key species in the Barataria Basin include changes in salinity, temperature, SAV/marsh coverage, water flow, and tidal transport.

4.11.5.2 Barataria Bay Estuarine Stock

4.11.5.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would neither be constructed nor operated, and therefore, no direct impacts from operations would occur.

Overall, the BBES Stock habitat and ecosystem is expected to continue along the trends from recent historical conditions in the early decades under the No Action Alternative, with 30,000 to 53,000 acres of wetland loss per decade (see Section 4.6, Table 4.6-3 in Wetland Resources and Waters of the U.S.). However, especially in the last three decades, sea-level rise and the resulting saltwater incursion would drive increased winter salinities and within-year seasonal salinity variability, wetland loss (67,000 to 78,000 acres lost per decade), decreases in SAV and changes to fish habitat, potential food web changes (toward a more planktonic-based food web), and shifts in dolphin prey assemblages and/or abundance (to a more marine assemblage and decreased euryhaline prey abundance).

During the early decades (2020 to 2050), the BBES Stock area is projected to experience wetland loss rates of approximately 8 percent of the 2020 total per decade; see Figure 4.11-7). As there would likely be no impacts on BBES dolphins from salinity, contaminants, or temperature, there would likely be minor impacts on BBES dolphins under the No Action Alternative in the near term due to loss of foraging habitat (wetland edge and nursery area for prey). The following No Action Alternative sections focus on the potential long-term impacts on the BBES Stock in the last two decades of projections (2050 through 2070), when the wetland loss rate increases to 12 percent per decade (see Figure 4.11-4) and the aggregate wetland loss in the BBES Stock area would be over 62 percent of the 2020 total.

4.11.5.2.1.1 General Effects on Dolphin Health

Under the No Action Alternative, the models projected three salinity-related changes to BBES dolphins in the last two decades of the simulations (2050 to 2070) compared to earlier decades: (1) all BBES dolphins (but especially dolphins similar to the local west and central usage patterns) would be exposed to increased maximum salinities (in the winter), (2) all BBES dolphins would be exposed to lower minimum salinities (in the spring), and (3) all BBES dolphins would be exposed to larger intra-annual variability (higher maximums typically in January and lower minimums typically in March). This section discusses the potential effects on BBES dolphins from these three salinity-related changes below.

The increases in salinity during the winter of the last two decades would likely have permanent minor beneficial impacts on BBES dolphins. Increases are likely negligible for dolphins in the southern portion of the basin, but salinity increases are relatively greater for dolphins with usage patterns similar to the local Central and West examples. These dolphins would likely already be at the low end of typical bottlenose dolphin salinity ranges, so increasing their salinity by 5 to 10 ppt from 2020 to 2070 would likely be a permanent, minor to moderate beneficial impact.

All BBES dolphins are projected to be exposed to lower minimum salinities in the spring in the last two decades of the projection (between -2 and -5 ppt change for 2 to 4 months compared to the first decade). Dolphins with usage patterns similar to the barrier island example usage pattern would not be exposed to waters much below 5 ppt and would likely experience negligible impacts. Dolphins with usage patterns similar to the extended movement and local dolphin examples would be exposed to waters with 2 to 4 ppt lower salinity from February to July, which, depending on just how low in absolute ppt the salinity reaches, could represent a permanent moderate adverse impact (in the last two decades of the model's timeline). Potential health effects on dolphins from low salinity are discussed further under the Applicant's Preferred Alternative. Low salinity during the spring (March/April) runoff could be especially detrimental to perinates (animals less than one month old that are particularly vulnerable to stressors/threats) born during the spring calving peak (Wells et al. 1987, Urian et al. 1996, Mattson et al. 2006, Rowe et al. 2010, Miller et al. 2010), decreasing reproductive success (defined as successfully rearing a calf to 1 year of age).

In later decades, the Delft3D Basinwide Model projects that maximum salinity (typically in January) would increase and the minimum salinity (typically in March) would decrease for all BBES dolphins. Thus, dolphins would experience a more drastic decline in salinities from approximately January through April, compared to earlier decades. An expert panel suggested that it is likely that physiological mechanisms by which dolphins respond to lower salinity cannot adequately react if the salinity decreases too quickly. However, quantitative relationships between any rate of salinity decrease and the potential physiological effects are unknown. During an EE exercise, a panel of marine mammal veterinarians and biologists developed dose-response curves for multiple scenarios, including a BSE environment (with a starting salinity range of 15 to 25 ppt) that (1) is flooded with fresh or low-salinity water until salinity drops (at approximately 0.5 ppt/day) to below 5 ppt for an extended period; and (2) experiences an atypical, drastic decrease in salinity within zero to five days (for example, due to increased rainfall from a hurricane) down to below 5 ppt for an extended period (Booth and Thomas 2021). The expert panel determined that the latter scenario (with a more rapid decrease in salinity) would have more detrimental effects on BSE dolphin survival. However, although the Delft3D Basinwide Model projected declines in seasonal salinity would be more rapid in later decades, and therefore could have more severe effects on survival of BBES dolphins, none of the projected declines would be as drastic as the second scenario in the EE.

Throughout the analysis period, sea-level rise drives an increasing loss of wetlands in the current BBES Stock boundary, including saline, brackish, and freshwater marshes (see Figure 4.11-7). It is unclear whether or how this shift to a more open-water basin may affect BBES dolphin movements, behaviors, distribution, social structure and interactions, and overall ability to thrive. However, dolphins with high site-fidelity are likely to be more vulnerable to changes in their habitat (Cloyed et al. 2021). The magnitude of the loss of wetlands would likely affect animals that spend time north of the barrier islands that are especially accustomed to brackish marsh edge habitats. In the southeastern United States, numerous studies have identified that foraging drives dolphin habitat preferences, and dolphins select habitat with structure features such as channels, islands, and/or marshes (reviewed in Allen et al. 2001).

It is possible that sea-level rise can drive both beneficial and adverse impacts on BBES dolphins: the further incursion of seawater may generate additional habitat for dolphins and their prey, and wetlands loss may result in less habitat for dolphins and their prey. As these two processes would likely have different, but possibly overlapping, trends in time and geography across the BBES Stock area, specific groups of BBES dolphins would likely experience quite different impacts, some beneficial, some neutral, and some adverse. For example, if BBES dolphins do prefer to spend time close to marsh edges in search of prey, it is possible that individuals north of the barrier islands would move farther north as sea-level rise gradually creates a more open-water system in the lower- to mid-basin, so that the dolphins remain near wetland structures. In this case, BBES dolphins could experience adverse impacts if this redistribution causes longer exposures to lower salinities farther north in the basin and/or if a shrinking amount of wetland coastline results in increased competition among BBES dolphins.

BBES dolphins have a variety of foraging tactics that they can employ depending on prey availability and their immediate habitat. However, shifts in prey quantity and/or quality across the basin (as discussed in Section 4.10, Aquatic Resources) could impact dolphins' overall nutrition and ability to overcome other stressors. Although dolphins are typically flexible feeders and as a species have adapted to a range of habitats, there is little information about how well an individual and/or stock of dolphins can acclimate to multi-year shifts in their prey diversity and/or abundance (for example, from euryhaline prey assemblages to mostly marine prey assemblages). Dolphins could acclimate to a gradually changing ecosystem over decade-long time scales.

Laidre et al. (2008) evaluated biological and demographic parameters that make Arctic marine mammal species more or less susceptible to climate-induced habitat change. They reported that a species' breadth of distribution and feeding flexibility affect their resilience, as well as a species' reliance on specific habitat structure for access to prey. In theory, assuming that the Laidre et al. (2008) findings are broadly applicable to other marine mammal populations, BBES dolphins' flexible foraging tactics should thus help them be more resilient (for example, Cloyed et al. 2021); however, the reduction in marsh edge habitat in later decades under the No Action Alternative (and all of the other alternatives) could offset this by reducing their access to prey. In addition, there is inadequate data and research available to estimate the energetic cost of adapting to new prey or feeding strategies and the energetic value of those species to determine the impact on the dolphins. It would likely come down to the level of behavioral plasticity of BBES dolphins in the face of multiple stressors (for example, Hamilton et al. 2019, Cloyed et al. 2021), and how they solve cost-benefit tradeoffs at individual and group levels. Laidre et al. (2008) also suggested that larger population sizes should help species' resiliency, which is likely to be true for BBES dolphins in the early decades of the proposed Project, but may be a problem if low salinity drives a substantial decrease in survival probability.

Thus, under the No Action Alternative, the shift to a more marine ecosystem in later decades would impact BBES dolphin prey habitats and assemblages, including lower habitat suitability scores for all dolphin prey species assessed. Section 4.10.4.5 in Aquatic Resources describes moderate to major adverse impacts on brown shrimp, white shrimp, and blue crab; but negligible to minor impacts on fish species upon which dolphins prey. According to one analysis of stomach contents, shrimp and crab make up a small percentage of BBES dolphin diets (approximately 2 percent), while fish make up the majority of the diet (see Table 3.11-3; Bowen-Stevens et al. 2021). Thus, under the No Action Alternative, there would likely be minor, permanent, adverse impacts on dolphin prey abundance. However, it is possible that specific groups of BBES dolphins may experience very different effects. Given that the changes would progress gradually over the analysis period and are especially prominent in the last two decades of the projections, it is possible that BBES dolphins would have time to acclimate to a changing food web, perhaps through cultural transmission (Rossman et al. 2015).

4.11.5.2.1.2 Impacts on the Population from Low Salinity Exposure

The impacts on dolphins from low salinity warrant further examination. Therefore, this section assesses the relationship between low-salinity exposures (defined as 0 to 5 ppt) across the BBES Stock area and the survival rate of BBES dolphins.

Garrison et al. (2020) used the Delft3D Basinwide Model projections for 2020 to 2030 (the first decade in the proposed Project analysis period, which is based on the 1970 Mississippi River hydrograph), including considerations of Delft3D Basinwide Model bias and uncertainty (see Appendix E), to project potential differences in annual exposure to low salinities for the BBES Stock (defined as salinity less than 5 ppt [based on the outcomes of the EE described in Booth and Thomas 2021]), and evaluate the relative impact of each alternative, due to low-salinity exposure only, on the mean annual survival of a simulated BBES population. Their analysis combines these outputs from the Delft3D Basinwide Model and a simulation of random dolphin movements for bottlenose dolphins to predict the annual exposure to low-salinity values. This exposure value is compared to the salinity:survival dose-response curve for a compromised population (due to DWH oil exposure; see Figure 4.11-7; Booth and Thomas 2021) to predict annual survival for each simulated individual, and these survival rates are averaged across all simulated individuals to obtain an estimated mean annual survival for the simulated population from 2020 to 2030. Repeated resampling is used to derive uncertainty around these estimated means that reflects variability in simulated animal spatial distribution, movement patterns, and uncertainty in the dose-response curve (Garrison et al. 2020).

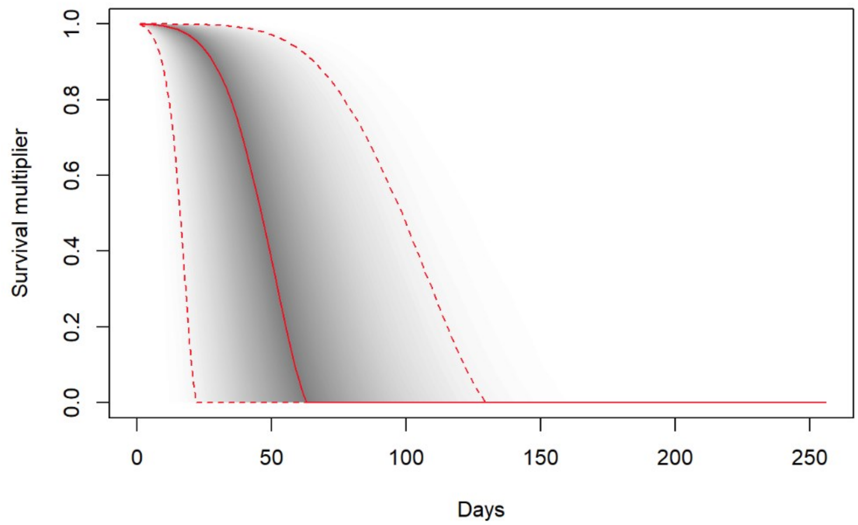


Figure 4.11-7. Dose-response Curve Estimating How Continuous Exposure to Low-salinity Water Affects the Survival Probability of Compromised BSE Dolphins. Booth and Thomas (2021) conducted an EE on the relationship between the duration of continuous low-salinity exposure and survival probability in BSE bottlenose dolphins. The plot shows quantiles of the distribution of 10,000 resulting dose-response curves, where the red solid line is the median and the dashed red lines are the 5th and 95th quantiles.

To establish the relationship between low-salinity exposure and reduced survival, Booth and Thomas (2021) conducted a formal EE (for a detailed description of the EE framework and process, see Martin et al. 2012 and Booth et al. 2015), where they asked a group of marine mammal veterinarians and biologists:

> Given (1) a bay, sound, and estuary environment (in other words, with a typical mean salinity of 15 to 25 ppt) is flooded with fresh or low-salinity water until salinity drops (at approximately 0.5 ppt per day) to below 5 ppt for an extended period of time, and (2) this is an environment in which animals are exposed to other significant stressors and are more likely to be in a "compromised health state"; what is the length (in days) of continuous exposure to salinity below 5 ppt that the average BSE bottlenose dolphin in this population would need to experience to result in death (within 12 months of the start of the event)?

Based on the experts' answers, Booth and Thomas (2021) calculated a dose-response relationship to represent how survival probability decreases as an average dolphin (that is, while some dolphins in a region would be more resilient, and some less resilient, consider the most representative dolphin from that region) from a compromised population spends more days exposed to low-salinity water (in their case defined as less than 5 ppt; see Figure 4.11-7).

For the No Action Alternative, the mean longest continuous duration of low-salinity exposure (less than 5 ppt) for the simulated BBES dolphin population was 13 days (95 percent Confidence Limits [CL]: 8 to 20 days; Garrison et al. 2020). None of the individual strata were projected to have continuous low salinity for more than a month; however, the Central stratum experienced 15 continuous days under 5 ppt (95 percent CL: 7 to 26 days) and the Southeast stratum experienced 23 continuous days under 5 ppt (95 percent CL: 10 to 41 days).

After comparing a random sample of the simulated exposures to the salinity:survival dose-response curve (see Figure 4.11-7), the model projected that in the first decade of proposed Project operations (in other words, using the representative year hydrograph of 1970), the mean annual survival rate, based only on exposure to low salinity, of the simulated population was 0.90 (95 percent CL: 0.75 to 0.98) under the No Action Alternative (see Figure 4.11-8; Garrison et al. 2020). While simulated dolphins in the barrier island and Western strata have higher than average annual survival rates (compared to the total modeled population survival rate), the dolphins in the Southeast stratum are below the overall average.

Thomas et al. (2021) applied the estimated survival rates (and their CL) generated by Garrison et al (2020) to a population model that can project the BBES dolphin population trajectory in the wake of the DWH oil spill (Schwacke et al. 2017). In the No Action Alternative, the model projects that the BBES Stock would recover slowly to its pre-DWH oil spill baseline population size (>3,000 dolphins; Schwacke et al. 2022), at an average of 3 percent (95 percent CI: 1 to 5) annual population growth. On average, the model projects that all four strata would reach baseline sometime after the year 2040.

4.11.5.2.1.3 Intensity of Impact

Under the first two to three decades of the No Action Alternative, BBES dolphins would generally experience similar habitat and environmental conditions as to recent historical trends (in other words, 2010 to 2020). However, from 2050 to 2070, the Delft3D Basinwide Model projected that the aggregate effects from sea-level rise (including the wetland loss seen from 2020 to 2050) would likely affect BBES dolphin habitat, including:

- Although dolphins with usage patterns similar to the local west and central examples could see minor beneficial impacts from increased salinities in the winter months, there are likely to be permanent minor adverse impacts on all BBES dolphins in the spring due to lower minimum salinities (which could coincide with the peak of calving) and increased within-year seasonal differences.

- A decrease in the amount of brackish and saline wetlands would likely have permanent, negligible to moderate, adverse impacts on overall BBES Stock due to the reduction in foraging areas within the BBES Stock area. Major reductions in crustacean prey and minor reductions in fish prey would have minor, permanent, adverse impacts on BBES dolphins. As foraging areas decrease incrementally over time, it is possible that otherwise healthy dolphins could acclimate to shifts in the food web and their prey over the course of the 50-year analysis period. Depending on individual levels of behavioral plasticity and the specific locations where habitats change, some individuals or groups of dolphins (for example, barrier island-associated dolphins or dolphins that successfully shift to hunting in open water) may experience negligible or minor beneficial impacts.

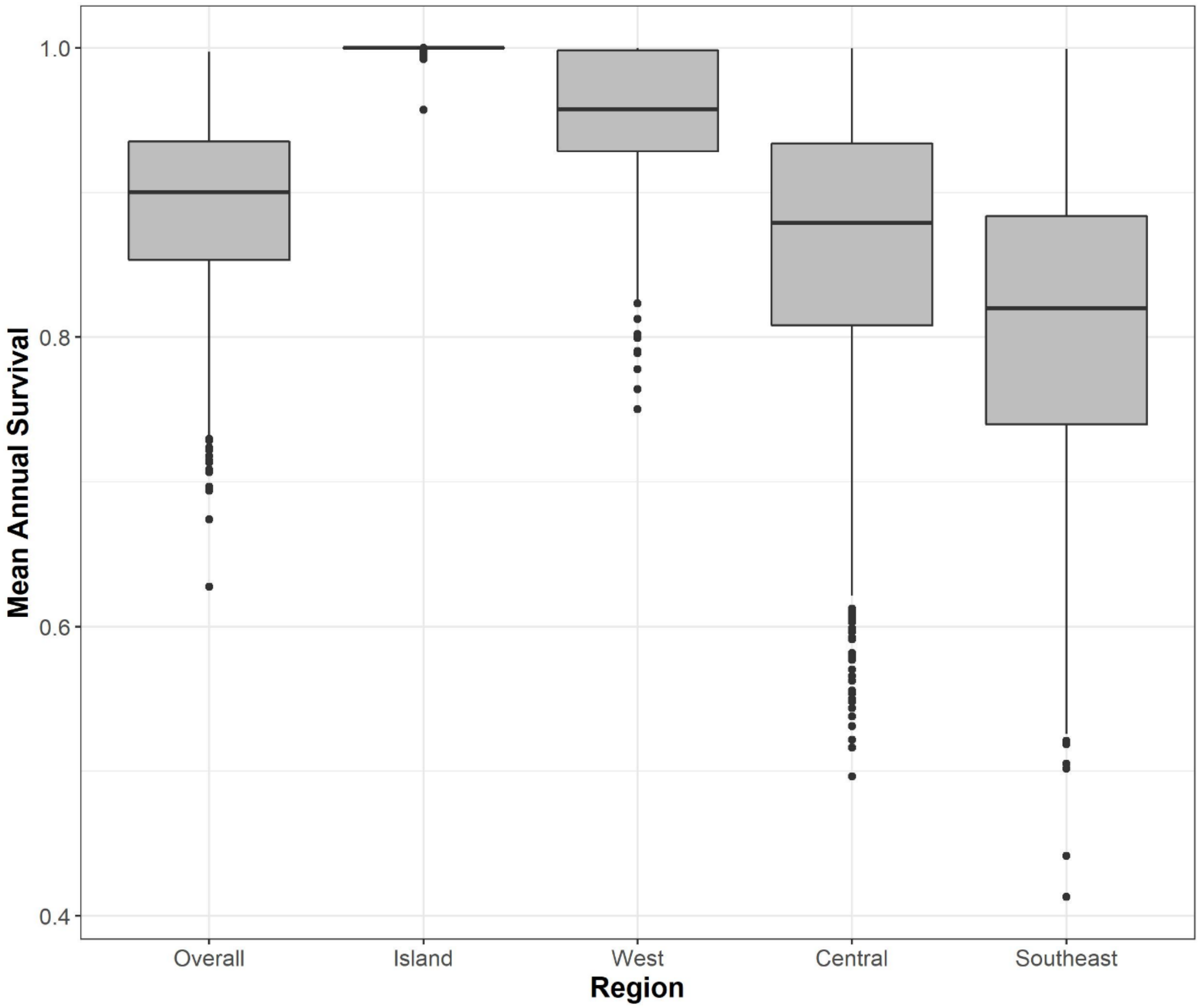


Figure 4.11-8. Box-whisker Plot of Projected Mean Survival Rates for a Simulated BBES Population under the No Action Alternative Based Only on Effects from Salinity. This distribution reflects 1,000 resamples of exposure histories and the salinity:survival dose-response curve (Garrison et al. 2020). Delft3D Basinwide Model salinity inputs are from the representative hydrograph for cycle 0. Within the 1,000 simulated dolphins in the overall sample, the four strata (Island, West, Central, and Southeast) correspond to the subset of animals that started the random movement simulations in each of the strata illustrated in Figure 4.11-2. The overall modeled BBES population has a mean annual survival rate 0.90 (95 percent CL: 0.75 to 0.98) under the No Action Alternative. Simulated dolphins in the Barrier Island stratum do not have any adjustment factor to their mean annual survival rate due to exposure to low salinity. Simulated dolphins in the West stratum are projected to have higher mean annual survival rates than simulated dolphins in the Central and Southeast strata.

Without additional input from the proposed Project, the levels of nutrients that could contribute to HABs, and the levels of contaminants, would remain similar to those seen in the recent past. Therefore, there would be no impacts on BBES dolphins from increased contaminants and nutrients as the frequency and intensity of HAB outbreaks would remain similar to baseline conditions.

It is likely that by 2050, all of the BBES dolphins directly exposed to DWH oil would have died, and so any potential combination of stressors from sea-level rise and the DWH oil spill are unlikely. However, BBES dolphins are exposed to a variety of other stressors (see Chapter 3, Section 3.11.4 in Marine Mammals) that may interact additively, synergistically, or antagonistically to the effects from sea-level rise.

Overall, for BBES dolphins under the No Action Alternative, (1) they would experience gradually increasingly adverse impacts throughout the analysis period, with the impacts being most problematic in the last two to three decades of the analysis period (as wetland loss accrues), allowing for potential acclimation; (2) they would experience seasonal low-salinity effects; (3) the potential impacts would mostly affect dolphins in the northern part of the BBES Stock area where there is a lower density of dolphins; and (4) population numbers would likely remain functional to maintain the viability of the stock in most places throughout the BBES Stock area. Thus, overall, the No Action Alternative would likely have gradually increasing minor, permanent, adverse impacts on BBES dolphins.

4.11.5.2.2 Applicant's Preferred Alternative

Under the Applicant's Preferred Alternative, the proposed Project would have immediate and permanent major adverse impacts on BBES dolphin habitat and environment. Overall, the BBES Stock habitat and ecosystem would experience reduced salinity immediately upon operational activities and persisting throughout the analysis period compared to the No Action Alternative (when the diversion is projected to be operating above 5,000 cfs base flow), and a decrease in brackish and saline wetlands compared to the No Action Alternative. However, in the last two decades, sea-level rise and the resulting saltwater incursion would offset some of the reductions in salinity (in the southern part of the BBES Stock area), as well as exacerbate wetland loss in the BBES Stock area (reducing foraging areas for BBES dolphins). However, the Applicant's Preferred Alternative would generate low-salinity wetlands in the outfall area, slowing the loss of wetlands north of the BBES Stock area compared to the No Action Alternative.

4.11.5.2.2.1 <u>General Effects on Dolphin Health</u>

The primary stressor on BBES dolphins from the Applicant's Preferred Alternative would be prolonged exposure to low-salinity water. Low salinity can negatively affect dolphins through direct contact with the skin or external surfaces of the animal, and through fresh water ingested incidentally during foraging (see Figure 4.11-9). Exposure can cause visible changes to the skin, resulting in lesions such as color changes, sores, or sloughing, which indicate progressive stages of the skin's impaired ability to maintain an effective barrier (for example, Simpson and Gardner 1972, Greenwood et al. 1974, Colbert et al. 1999, Wilson et al. 1999, Gulland et al. 2008, Duignan et al. 2020). Over time, the skin biome changes and may become overgrown with external mats comprised of fungi, algae, and/or bacteria. Once the physiological and morphological integrity of the skin is altered, secondary infections and both intracellular (hydropic degeneration) and extracellular uptake of water may occur. Similar to the impact observed in skin, low-salinity water ingestion may also alter intracellular and extracellular water absorption in the gut, contributing to osmotic imbalance, cellular damage, and susceptibility for localized and/or systemic infections. Although cetaceans can suffer from a wide variety of skin lesions, veterinarians and field biologists can differentiate many of these types. Often, they refer to skin lesions characteristic of exposure to low-salinity water as “fresh water-like lesions” (for example, Wilson et al. 1999). For the purposes of this EIS, this analysis only considers fresh water-like lesions in the text, and therefore all references to skin lesions herein should be considered fresh water-like skin lesions as determined by the veterinarians and field biologists that conducted each study.

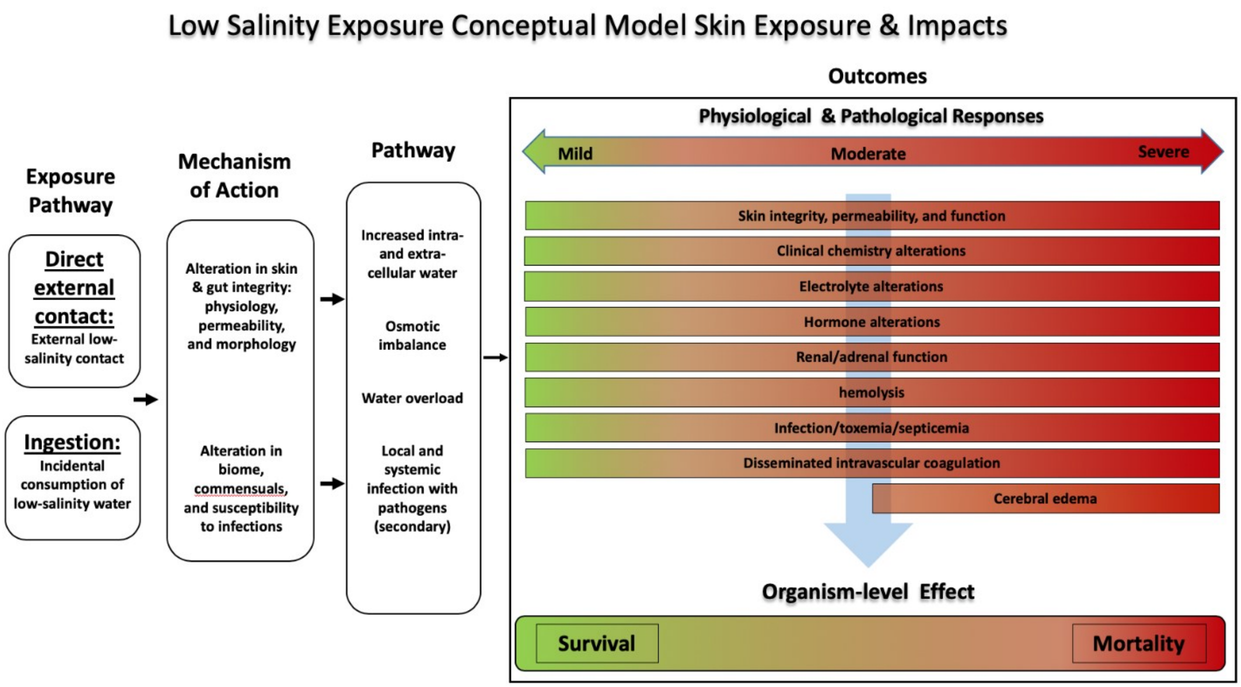


Figure 4.11-9. Conceptual Model of How Low Salinity Can Cause Adverse Health Effects to Bottlenose Dolphins. When dolphins are exposed to low-salinity water, either by direct external contact with their skin or by ingestion (typically incidental consumption), the osmolality differences can disrupt the integrity of the skin/gut lining and alter the skin/gut biome. These cellular- and tissue-level effects can drive osmotic and water imbalances and/or local and systemic infections. Depending on the severity of the abnormalities in these pathways, the exposed dolphin could suffer a variety of physiological/pathological responses, including abnormal skin integrity, permeability, and function; clinical chemistry alterations; electrolyte or hormone alterations; renal/adrenal dysfunction; hemolysis; infection, toxemia, and septicemia; disseminated intravascular coagulation; and/or cerebral edema. The severity and combination of these responses would determine the mortality risk for each individual dolphin.

Increased freshwater uptake by the skin or gut lining has been associated with a variety of physiological or pathological changes, as shown in Figure 4.11-9 (for example, electrolyte or hormone imbalances, decreased osmolality, over-hydration, and cellular hemolysis/anemia; Hui 1981, Andersen and Nielsen 1983, Ewing et al. 2017, Deming et al. 2020). Under some conditions, osmotic imbalance, cellular damage, and/or secondary infection can deteriorate from mild to severe, resulting in systemic impacts (for example, hemolysis, anemia, septicemia/toxemia, and cerebral or pulmonary edema), which may lead to death.

While effects on the gut and skin would likely occur simultaneously in wild dolphins, the most visible indicators in free-swimming cetaceans are skin abnormalities; however, the severity of skin lesions may not be fully predictive of the severity of internal health conditions. Depending on the environment, timing, and other biological factors, skin lesions may progress and resolve in cycles as dolphins are exposed to lower- and higher-salinity waters (Mullin et al. 2015, Ewing et al. 2017, Deming et al. 2020, Fazioli and Mintzer 2020, McClain et al. 2020). Skin lesions may resolve; however, secondary infections and internal physiological impacts may still represent a substantial health risk. Some dolphins with skin lesions may recover if they return to higher-salinity waters and are not overcome by additional stressors (for example, infections or nutritional stress from reduced prey quality/quantity and increased energetic needs).

Under some circumstances, adverse health effects from low-salinity exposure can result in the death of individuals. Especially in situations when additional stressors (for example, low temperatures, extreme weather, exposure to contaminated environments, and human activities) are present, adverse effects may be more severe and therefore more likely to result in reduced reproductive success and survival. Some examples from the literature and recent case studies include:

- From 2005 to 2007, 30 to 40 dolphins were reported in eastern Lake Pontchartrain, Louisiana (where dolphins are historically rare), most with minor-to-severe skin lesions that were likely associated with exposure to low-salinity water (Mullin et al. 2015). Lesion severity appeared to be seasonal, and worsened and improved with lower and higher salinities, respectively. After additional surveys, up to 70 individuals were identified in the area up to year 2010, with an average of 36.5 identified dolphins per season. Salinity and water temperatures in the Lake Pontchartrain area were unusually low in winter 2010, after which only one target area dolphin was sighted in another location. Twenty-seven dolphin strandings occurred in this area in spring 2010 (March and April). The authors suggested that the mostly likely outcome for these dolphins was that most of them eventually died from low-salinity exposure or the combination of annual, prolonged low-salinity exposures and low water temperatures in 2010 (Mullin et al. 2015).

- From 2011 to 2014, NMFS tracked a dolphin living in the northern canals and surrounding waterways near the Lakeshore Estates subdivision of Lake Pontchartrain (Mullin et al. 2015). The last sighting of this dolphin, on June 3, 2014, was in waters with 2.0 ppt salinity, and the dolphin had extensive freshwater skin lesions covering approximately 50 percent of his body. The dolphin was found dead on June 15, 2014; his extensive freshwater skin lesions and three years of low-salinity exposures likely contributed to his death or were the primary factor.

- Periodic flooding in Galveston, Texas, has resulted in dolphins with skin lesions, where the severity of the lesions generally correlates with the number of days of low salinity in Galveston Bay (Fazioli and Mintzer 2020). From 2015 to 2019, there were four major flooding events, which resulted in long periods of lower salinity in the bay and increased skin lesion prevalence and severity in dolphins. For example, in 2019, after the wettest year on record in the United States, Galveston Bay was below 5 ppt for 22 days and below 10 ppt for 63 days. Similar to the Lake Pontchartrain situation, individual dolphins in Galveston Bay that had skin lesions during periods of low salinity were also observed with improved skin condition during longer periods (several years) of higher salinity. For example, two dolphins that stranded dead in 2019 with severe skin mats and lesions were consistently observed in the bay from 2015 to 2019. During that 5-year period, their skin lesions grew worse in severity during lower-salinity exposure periods and less in severity during higher-salinity exposure periods.

- In 1992 in Texas, more than 260 dolphins died after a period of record rainfall (Colbert et al. 1999, Litz et al. 2014). The resulting runoff increased pesticide concentrations in the bay and drove salinities under 10 ppt from December 1991 to April 1992. Although no definitive cause was determined for the die-off, there was low salinity in the habitat and increased contaminant loads in the water; dolphins with zero-positivity for morbillivirus antibodies co-occurred with the UME; and the dolphins exhibited evidence of circular skin lesions and a gray, pasty substance on the skin, which were consistent with prolonged freshwater exposure (Duignan et al. 1996, Colbert et al. 1999, Litz 2014).

- Bottlenose dolphins that were reported out-of-habitat (for example, up a river or creek), displaced by hurricanes or storm events (in other words, trapped in inland lakes, canals, ponds, or ditches), or stranded during known flood events were examined in Level A stranding data from the southeast United States (Level A stranding records [1996 to 2019] were extracted on March 3, 2016 and May 10, 2019 from https://www.fisheries.noaa.gov/national/marine-life-distress/national-stranding-database-public-access). Estimated (for example, from nearby USGS buoy data) or measured salinity was compared to the minimum exposure duration (in other words, from the start of a known flood event, landfall of hurricane/tropical cyclone, or from the time an animal was reported out-of-habitat until it either died or was rescued) to determine outcomes for dolphins in waters at different salinity levels. Sixteen dolphins were exposed to waters with salinity equal to or less than 5 ppt; of those exposed dolphins, six lived (38 percent) and 10 died (63 percent). Dolphins that lived were exposed to low-salinity conditions for between 5 and 12 days;

dolphins that died were exposed for between 9 and 79 days. Seven dolphins were exposed to salinity conditions between 10 and 15 ppt; of those exposed dolphins, five (71 percent) lived and 2 died (29 percent). Dolphins that lived were exposed to salinity conditions between 10 and 15 ppt for 20 to 43 days; dolphins that died were exposed for 25 to 62 days.

- McClain et al. (2020) reported on adverse health effects from freshwater exposure in managed dolphins under human care. Dolphins developed skin lesions within 2 to 38 days of exposure to low salinity. The prevalence of skin lesions was inversely proportional to the salinity levels and the duration of time the dolphin spent in low-salinity water. In 28.5 percent of the dolphins, veterinarians documented serum electrolyte changes within 1 to 13 days after initial exposure; however, the electrolyte changes were mild and did not result in clinical symptoms. This is likely due to the dolphins' mineralocorticoid response and conserving their electrolytes via their kidneys and adrenal glands. However, they report that "if an animal has compromised kidneys and/or adrenal glands, they may be more susceptible to rapid and life-threatening serum electrolyte changes." BBES dolphins exposed to DWH oil in 2010 suffered adrenal dysfunction (Schwacke et al. 2014).

- In 2019, there was a four-fold increase in stranded bottlenose dolphins (n = 337 vs. a historical average of 83 dolphins) from Taylor County, Florida through Louisiana, the vast majority of which (88 percent) occurred from February through June (Deming and Garrison 2021). NMFS declared a UME (https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2020-bottlenose-dolphin-unusual-mortality-event-along-northern) from February 1, 2019 to November 30, 2019. In total, 337 bottlenose dolphins were found stranded during the event with only 9 of those dolphins documented as stranded alive. Peak strandings occurred between February 1, 2019 and June 30, 2019 with 88 percent (297/337) of the strandings occurring during that period. The number of reported strandings is likely an underestimate due to reduced effort and coverage in the marine mammal stranding network at the time. The majority of carcasses were in moderate to advanced states of decomposition, limiting the analyses that could be conducted. A high prevalence of dolphins exhibited skin lesions consistent with exposure to low-salinity waters (Mississippi = 47 percent, Louisiana = 30 percent, Alabama= 10 percent, Florida= 7 percent, of fresh to moderately decomposed cases). Based on necropsy, histopathology, and diagnostic findings and the extreme environmental conditions documented in the northern Gulf of Mexico during this time period, the cause of the mortality event was determined to be environmentally driven by exposure to low-salinity waters resulting from extreme freshwater discharge from watersheds that drain into the northern Gulf of Mexico, including rivers in Florida, Alabama, Mississippi, and Louisiana. This unprecedented amount of freshwater discharge during the winter, spring and summer months of 2019 resulted in a drop in salinity levels across the coastally associated waters in the region, which was most pronounced and prolonged in the Western Mississippi Sound. The unprecedented amount of freshwater discharge during 2019 resulted in a decrease in salinity levels (to below 10 ppt) across the coastal waters in the region. This was most pronounced and prolonged in the Western Mississippi Sound due to the massive freshwater discharge from the Mississippi River and associated spillway openings, including the Bonnet Carré Spillway as well as flooding from other watersheds into other BSE environments. Stranded dolphins with freshwater lesions were observed after 17 days of exposure below 5 ppt, and the number of stranded animals with lesions peaked at 40 days below 5 ppt.

As discussed in Chapter 3, Section 3.11.3 in Marine Mammals, the DWH oil spill caused adverse health effects, reduced survival, and reduced reproductive success in BBES dolphins. Ongoing poor maternal health in BBES dolphins is a driving factor in the stock's continued poor reproductive success rates since the DWH oil spill (Lane et al. 2015, Kellar et al. 2017). While oil exposure likely caused poor health in a cohort of reproductive females at the time of the spill, the adverse health effects associated with low-salinity exposure could also affect reproductive success in BBES dolphins under the proposed Project. Low salinity during the spring (March/April) runoff could also be especially detrimental to perinates born during the spring calving peak (Wells et al. 1987, Urian et al. 1996, Mattson et al. 2006, Rowe et al. 2010, and Miller et al. 2013), further decreasing reproductive success (defined as successfully rearing a calf to one year of age).

As described in Section 4.11.5.1, the Applicant's Preferred Alternative would expose all BBES dolphins to reduced salinities for extended durations, depending on how long the proposed Project is operating above base flow. For example, the Delft3D Basinwide Model projects that, under the representative hydrograph, dolphins with usage patterns similar to the barrier island example usage pattern are projected to be exposed to three months of waters with approximately 2 to 4.5 ppt salinity, which represents a negative 8 ppt change in the spring in any given year during the first decade (see Figure 4.11-6). The local Central and West usage patterns would be exposed to two to four months of waters with 0 ppt in any given year during the first decade, and six months of 0-ppt waters in any given year during the second decade. In the later decades (2050 to 2070), long-term effects from sea-level rise and winter saltwater incursion would increase winter maximum salinities and Mississippi River discharges causing lower minimum salinities in the spring, and driving a larger within-year seasonal variability.

Based on data from (1) dolphins stranded or living in habitats experiencing low-salinity trends, (2) managed dolphins exposed to low salinities (usually for veterinary purposes), and (3) out-of-habitat dolphins stranded in freshwater situations (for example, ponds after flooding/hurricanes), prolonged exposures to low salinity (like those seen under the Applicant's Preferred Alternative) are likely to result in illness/disease and, in some cases, death. This is especially likely considering the other stressors BBES dolphins would face under the Applicant's Preferred Alternative (for example, conversion of salt/brackish wetland habitat to fresh wetland habitat in the BBES Stock area [which also occurs under the No Action Alternative]). The BBES dolphin population is also still compromised from the adverse health effects from the DWH oil spill (Schwacke et al. 2022). Dolphins exposed to DWH oil continue to suffer from dysfunctional adrenal systems for at least 4 years post-exposure (Smith et al. 2017), which may impair their physiological response to fluctuations in salinity.

Estimates of specific uncertainty/bias for absolute values are summarized in Section 4.11.3.1 and discussed in more detail in Appendix E and Garrison et al. (2020). As a conservative estimate (from the proposed Project perspective, not the dolphins' perspective) to understand how the Applicant's Preferred Alternative could affect BBES dolphin survival, this assessment of potential impacts assumes that days at 0 ppt in the model projections are a reasonable proxy for "low salinity" (as considered by the EE panel at less than 5 ppt). In the first decade of model projections, the local Central and West dolphin usage patterns spend two to four months (or approximately 60 to 120 days) in waters with an average of 0 ppt, and six months at 0 ppt in the second decade (or approximately 180 days). The barrier island and local southeast example dolphin usage patterns do not overlap with waters with projected monthly average salinities of 0 ppt.

Based on this comparison, dolphins with the local Central and West example usage patterns (with compromised health from the DWH oil spill and a changing habitat/environment) would have a low likelihood of surviving a given year in the first decade (at the most conservative end, for 60 days of exposure at or below 5 ppt, the mean dose-response curve has a survival probability of 0 percent for 60 days of exposure), and no likelihood of surviving through a given year in the second decade of the projections. However, the curve derived from the EE is based on the "average" BBES dolphin from a compromised population (although the difference in the curves for the compromised population and uncompromised populations is small). Some dolphins would be healthier and more robust, and therefore more likely to survive freshwater exposures; while others would be less healthy, less resilient (for example, sick or young animals), and therefore less likely to survive freshwater exposures. Dolphins with usage patterns similar to the local central, west, and southeast example usage patterns may be acclimated to lower-salinity exposures, and therefore more robust, or they may be suffering low-level adverse health effects that may be exacerbated by the impacts from the Applicant's Preferred Alternative, and therefore less robust.

In the long-term under the Applicant's Preferred Alternative, lower-salinity trends (as compared to the No Action Alternative) would continue throughout the BBES Stock area. In the last two decades, the fresh water released into the basin from the proposed Project would partially offset the increasing salinity from sea-level rise and saltwater incursion. The increased within-year seasonal variability for the barrier island-associated dolphins in the last two decades of the model would likely be similar enough to the No Action Alternative, and over a long enough period (at least 2 months from January to March), that the difference in impacts from sea-level rise between the two alternatives would be negligible. Any dolphins present around the barrier islands in the later decades would be exposed to salinities 3 to 7.5 ppt lower than the No Action Alternative in the spring, but it would be more intermittent than the salinities farther north in the basin.

Moving to potential impacts from wetland loss during the analysis period (especially once the losses have accrued into the last two to three decades), although many BBES dolphins have strong site-fidelity to select portions of the Barataria Basin (for example, staying in relatively small usage areas near wetland coastlines regardless of fluctuations in salinity), it is unclear how BBES dolphins would respond to the gradual, long-term loss of wetlands throughout the current BBES Stock area. For BBES dolphins that survive the immediate salinity decreases (upon operation of the proposed Project) in the central and western part of the current BBES Stock area, if they prefer to use wetland-edge habitat regardless of the salinity, these animals may be (1) exposed to even more prolonged and depressed salinity exposures if they move north following the receding marsh edge; and (2) at risk of additional intraspecies competition as the amount of wetland-edge habitat shrinks (in all areas of the basin except within approximately 10 miles of the immediate outfall area). These wetlands-related impacts within the BBES Stock area would be similar to those under the No Action Alternative; however, BBES dolphins suffering from low-salinity effects under the Applicant's Preferred Alternative may be less resilient against these wetland-related impacts.

It is also possible that some individual dolphins are more successful in an open water basin system (this usage pattern has not been seen in BBES tagging studies to date [Wells et al. 2017, Takeshita et al. 2021]), and so the long-term impacts would likely be dependent on individual behavior and dietary plasticity (Cloyed et al. 2021). However, adverse health effects from the yearly prolonged low-salinity exposure may affect dolphins' ability to acclimate to gradual long-term changes in their habitat. Furthermore, if the potential HABs and increase in contaminants from the Applicant's Preferred Alternative do manifest, BBES dolphins would be less resilient to these stressors due to the low-salinity exposure (and vice versa).

The impacts of the Applicant's Preferred Alternative on salinity and wetlands in the BBES Stock area are projected to result in a shift in the amount of SAV, and a relative decrease in saline and brackish wetlands. Brown shrimp, southern flounder, and spotted seatrout would be adversely affected by the Applicant's Preferred Alternative, compared to the No Action Alternative, but euryhaline prey species would see benefits from the wetlands created and sustained near the proposed Project area, as well as from the increased productivity throughout the basin (compared to the No Action Alternative).

As described under the No Action Alternative, over the analysis period of the Applicant's Preferred Alternative, there would be a net loss of wetlands and the benefits they provide in the BBES Stock area for dolphin prey. Individual dolphins suffering the effects from multiple stressors (for example, DWH oil exposure, low-salinity exposures under the Applicant's Preferred Alternative) may face a tradeoff between maximizing their short-term energy intake and dedicating physiological resources to recovery and survival (Wells et al. 2010, Cloyed et al. 2021) following the cessation of above-base-flow operations. Any potential effects from the net decrease in wetlands and the prey they support (under both the No Action Alternative and the Applicant's Preferred Alternative) would likely manifest differently for individual BBES dolphins, depending on their overall health (for example, sick dolphins typically require increased energy intake to recover), behavioral and phenotypic plasticity (in other words, how well an individual is able to cope with change), and their social interactions (for example, mothers teaching YOY dolphins various feeding tactics). However, dolphins experiencing poor health as a result of other forms of stressors (besides prey- related issues; for example, salinity fluctuations) would also likely depend on increased food quantity/quality (compared to when the individual is healthy) in order to overcome the metabolic costs associated with managing the stress from those adverse effects (for example, Mizock 1995, Curry 1999, Elsasser et al. 2000, and Sapolsky 2004). Conversely, a dolphin suffering from the effects of non-prey-related stress may not have the energy required to use their typical array of flexible foraging tactics or effectively acclimate to changing habitats. If the Applicant's Preferred Alternative impacts any of these aspects of dolphin health/behavior, their ability to cope with the overall decrease in wetlands may be compromised.

BBES dolphins that were alive in 2010 and exposed to DWH oil are currently suffering adverse health effects, decreased survival rates compared to healthy populations, and decreased reproductive success (Schwacke et al. 2022). These individuals would be especially susceptible to the effects of low salinity, and changes to their habitat and prey abundance. If the adverse health impacts of the proposed Project contribute to further decreases in reproductive success (likely due to further decreases in maternal health) of animals surviving in low-salinity waters, it could have substantial impacts on the recovery trajectory of the BBES Stock population.

4.11.5.2.2.2 Impacts on the Population from Low Salinity Exposure

Although there would be a variety of impacts on BBES dolphins from the proposed Project, the impacts from low salinity warrant further investigation. Therefore, this section assesses the relationship between low-salinity exposures (defined as 0 to 5 ppt) across the BBES Stock area and the survival rate of BBES dolphins.

Garrison et al. (2020) estimated the longest continuous durations under 5 ppt salinity and the mean survival rate of a simulated BBES dolphin population (specifically with respect to low-salinity exposure) under all alternatives, including the Applicant's Preferred Alternative and compared it a simulated population under the No Action Alternative. For the Applicant's Preferred Alternative, using the representative year hydrograph (that is, the average based on historical hydrographs) the median longest streak of days with salinity under 5 ppt for the overall population was approximately 38 days longer (95 percent CL: 25 to 52 days) than under the No Action Alternative (less than 5 ppt) (see Table 4.11-4; Garrison et al. 2020). The difference was mostly driven by simulated dolphins in the West and Central strata, where simulated dolphins experienced 49 more days (95 percent CL: 21 to 79 days) and 72 more days (95 percent CL: 47 to 95 days), respectively, of salinity less than 5 ppt under the Applicant's Preferred Alternative compared to the No Action Alternative.

Table 4.11-4
Projected Durations of the Median Longest Streak of Low-Salinity Exposure (less than 5 ppt) in a Given Year for a Simulated BBES Dolphin Population under the No Action Alternative and the Applicant's Preferred Alternative (Average River Flow Hydrograph)[a]

Region	No Action Alternative	Applicant's Preferred Alternative	Difference
Overall	13 (8 to 20)	51 (40 to 63)	38 (25 to 52)
Island	0 (0 to 1)	11 (7 to 15)	11 (7 to 15)
West	6 (1 to 19)	55 (31 to 84)	49 (21 to 79)
Central	15 (7 to 26)	87 (67 to 109)	72 (47 to 95)
Southeast	23 (10 to 41)	38 (20 to 60)	14 (-12 to 41)

[a] The difference between the two alternatives is also provided. Values are the median longest streak duration as a number of days with the 95 percent CL in parentheses (Garrison et al. 2020).

Using a salinity:survival dose-response curve for a compromised dolphin population, as developed by EE (Booth and Thomas 2021), this simulation model projects that in the first decade of proposed Project operations (using the representative year hydrograph) the mean annual survival rate for the simulated population is 0.30 lower under the Applicant's Preferred compared to the No Action Alternative (see Table 4.11-5 and Figure 4.11-10; Garrison et al. 2020). In other words, under the No Action Alternative, simulated BBES dolphins have an 89 percent likelihood of surviving any given year from 2020 to 2030; under the Applicant's Preferred Alternative, simulated BBES dolphins have a 59 percent likelihood of surviving any given year from 2020 to 2030 based on the projected decreased salinity levels from the proposed Project.

Table 4.11-5
Projected Mean Annual Survival Rates Due to Low-salinity Exposure for a Simulated BBES Dolphin Population under the No Action Alternative and the Applicant's Preferred Alternative in the First Decade of the Proposed Project[a]

Region	No Action Alternative	Applicant's Preferred Alternative	Difference
Overall	0.89 (0.75 to 0.98)	0.59 (0.28 to 0.83)	-0.30 (-0.02 to -0.64)
Island	1.00 (1.00 to 1.00)	0.94 (0.61 to 1.00)	-0.07 (-0.40 to 0.00)
West	0.96 (0.86 to 1.00)	0.56 (0.12 to 0.89)	-0.40 (-0.60 to -0.84)
Central	0.86 (0.61 to 0.99)	0.29 (0.04 to 0.68)	-0.57 (-0.14 to -0.88)
Southeast	0.81 (0.58 to 0.97)	0.68 (0.37 to 0.93)	-0.12 (0.21 to -0.48)

[a] The difference between the two alternatives is also provided. Values are the median survival rates from the bootstrap samples with the 95 percent CL in parentheses, as calculated for cycle 0 (2020 to 2030) (Garrison et al. 2020). Discrepancies in the differences are due to rounding.

The model projects statistically significant (*p* less than 0.05) decreases in all of the individual strata, with especially sharp declines in the projected mean annual survival rates of simulated dolphins in the West and Central strata under the Applicant's Preferred Alternative compared to the No Action Alternative (see Table 4.11-5 and Figure 4.11-10; Garrison et al. 2020). The mean annual survival rate of simulated dolphins in the Central and West strata are 0.57 lower (95 percent CL: 0.14 to 0.88

lower) and 0.40 lower (95 percent CL: 0.60 to 0.84 lower) under the Applicant's Preferred Alternative compared to the No Action Alternative.

Comparing the No Action Alternative and the Applicant's Preferred Alternative, the differences in the projected mean annual survival rates for these simulated groups imply that the low salinity associated with the Applicant's Preferred Alternative would drive rapid declines in the abundance of dolphins in the West (a 0.40 decrease in annual survival rate compared to the No Action Alternative; 95 percent CL: 0.60 to 0.84 decrease) and Central (a 0.57 decrease in annual survival rate compared to the No Action Alternative; 95 percent CL: 0.14 to 0.88 decrease) regions (see Table 4.11-5). Although defining the change in population over a given decade (or longer) is not supported by the simulation, the low annual survival rates identified in Table 4.11-5 suggest that after a decade of operations under the Applicant's Preferred Alternative, the only region with an abundance of dolphins similar to the No Action Alternative would be in the Barrier Island stratum (a 0.06 decrease in annual survival rate; 95 percent CL: -0.04 to 0.00 decrease).

Thomas et al. (2022) applied the estimated survival rates (and their CL) generated by Garrison et al. (2020) to a population model that projects the BBES dolphin population trajectory in the wake of the DWH oil spill (Schwacke et al. 2017, Schwacke et al. 2022). Under the Applicant's Preferred Alternative, with the decreased survival rates due to low salinity, the model projects that dolphins in the Western and Central strata would be functionally extinct (defined as less than or equal to 1 within 10 years, and the dolphins in the Southeast stratum would be functionally extinct within 50 years. After 1 year of operations in a representative hydrograph year, the model projects a median excess mortality under the Applicant's Preferred Alternative of 537 dolphins (95 percent CI: 112 to 1,400) compared to the No Action Alternative, or 26 percent of the stock (95 percent CI: 6 to 63). In drier years, the amount of mortality would be less and in wetter years, the amount of mortality would be higher. After 50 years of operations, the model projects that only 85 dolphins would remain in the BBES Stock (95 percent CI: 7 to 516), compared to 3,216 (95 percent CI: 2,740 to 3,808) under the No Action Alternative – all of which live in the Barrier Island stratum. This represents a 97 percent difference in population size (95 percent CI: 84 to 100) under the Applicant's Preferred Alternative compared to the No Action Alternative.

In other words, model estimates project that low-salinity conditions from the Applicant's Preferred Alternative would cause permanent, major, adverse effects on the BBES dolphin stock. The habitat most impacted includes that north of the barrier islands, resulting in substantial reductions in survival rates of BBES dolphins across the basin, but especially in the Western and Central strata (Garrison et al. 2020), as well as in the population recovery of dolphins in all of the strata. Overall, it is likely that the only dolphins living in the BBES Stock area after a 50 years of operations under the Applicant's Preferred Alternative would be in the Barrier Island stratum; however, this area would also see statistically significant reductions in survival rate compared to the No Action Alternative. Any dolphins remaining in the West, Central, and Southeastern strata would likely experience increasing habitat degradation from accelerating loss of wetlands and longer continuous durations to low-salinity waters.

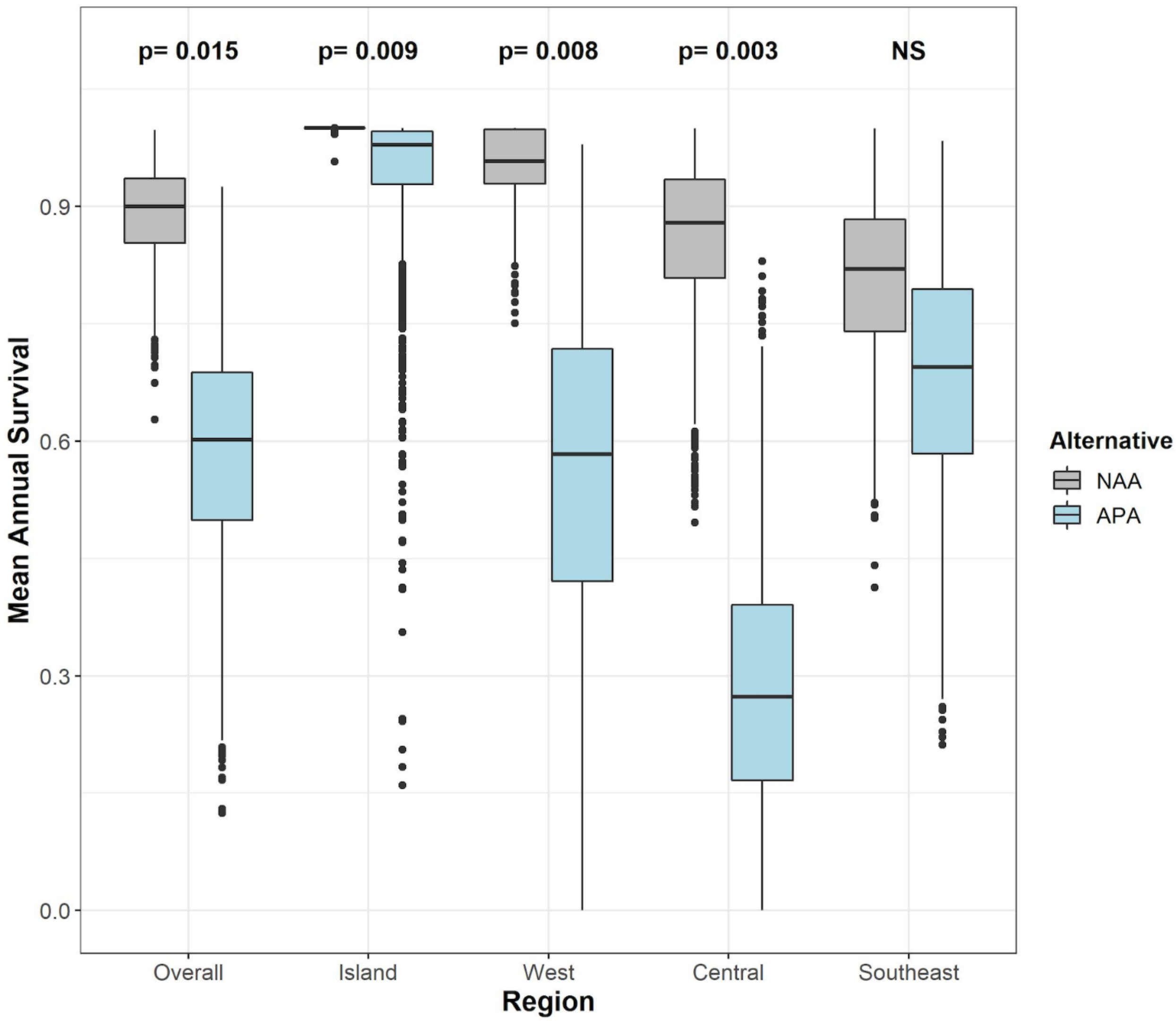


Figure 4.11-10. Box-whisker Plot of Mean Survival Rates Due to Low-salinity Exposure for a Simulated BBES Population under the No Action Alternative (NAA) Compared to the Applicant's Preferred Alternative (APA). These distributions reflect 1,000 resamples of exposure histories and the salinity:survival dose-response curve for each alternative (Garrison et al. 2020). Delft3D Basinwide Model salinity inputs are from the representative hydrograph for cycle 0. Within the respective 1,000 dolphins in the overall samples, the four strata (Island, West, Central, and Southeast) correspond to the subset of animals that started the random movement simulations in each of the strata illustrated in Figure 3.11-2. The overall modeled BBES population has a mean annual survival rate of 0.60 (95 percent CL: 0.27 to 0.83) under the Applicant's Preferred Alternative (APA; blue boxes) compared to 0.90 (95 percent CL: 0.75 to 0.98) under the NAA; gray boxes). There are statistically significant decreases in mean survival rate in each of the individual strata, but the difference between the Applicant's Preferred Alternative and the No Action Alternative are especially large in the West and Central strata. The *p*-values indicate the results of significance tests between the No Action Alternative and the Applicant's Preferred Alternative overall and within each stratum. They were determined by calculating the bootstrap distribution of the differences between the two alternatives. The proportion of these differences that was less than or equal to zero reflects the likelihood of no difference between the simulated population mean survival rates.

4.11.5.2.2.3 Intensity of Impact

Under the Applicant's Preferred Alternative, BBES dolphins would experience immediate impacts from the onset of the proposed Project operations, mainly due to decreased salinity levels. Additionally, from 2050 to 2070, the Delft3D Basinwide Model projected that sea-level rise would likely affect BBES dolphin habitat (as described in Section 4.11.5.1). Impacts would likely include:

- Decreased salinity levels throughout the BBES Stock area throughout the analysis period would cause permanent, major adverse impacts on BBES dolphins. Dolphins in the Western (40 percent decrease; 95 percent CL: 60 to 84 percent) and Central (57 percent decrease; 95 percent CL: 14 to 88 percent) strata would be especially adversely impacted, while barrier island-associated dolphins would be less-adversely impacted (7 percent decrease; 95 percent CL: 0 to 40 percent); however, all groups would be more adversely impacted than compared to conditions under the No Action Alternative. Garrison et al. (2020) estimated that under the Applicant's Preferred Alternative, median annual survival rates for the simulated BBES population would be 0.30 lower compared to the No Action Alternative, based on changes in salinity throughout the BBES Stock area. Thomas et al. (2022) project that dolphins in the Western, Central, and Southeastern strata would become functionally extinct under the Applicant's Preferred Alternative, and the Barrier Island stratum would be severely impacted, resulting in a remnant BBES Stock comprised of approximately 85 dolphins. The timing of the proposed Project operations would result in the lowest salinity levels in the BBES Stock area right at the peak of dolphin calving, representing a serious threat to late-term pregnant mothers, fetuses, and perinates that are more vulnerable than the average BBES dolphin. This would likely decrease reproductive success rates in BBES dolphins. Overall, BBES dolphins would experience major, permanent, adverse impacts from the decreases in salinity associated with the Applicant's Preferred Alternative.

- Under both the No Action Alternative and the Applicant's Preferred Alternative, there would be a net loss of wetlands (with lower loss under the Applicant's Preferred Alternative compared to the No Action Alternative) and their associated benefits to dolphin prey in the BBES Stock area. However, dolphins that are adversely impacted by low salinity under the Applicant's Preferred Alternative would likely be less able to cope with the loss of foraging structure (wetland edge) associated with the net loss of wetlands in the BBES Stock area, potentially exacerbating the adverse impacts on BBES dolphins from decreased salinity levels. Animals suffering from adverse health effects are likely to (1) recover from skin lesions and/or infections more quickly with increased nutrient uptake (Rousseau et al. 2013) and (2) not have the energy required to perform normal activities, including switching among foraging tactics or effectively acclimating to gradually changing habitats. Overall, dolphin prey species would increase in abundance under the Applicant's Preferred Alternative compared to the No Action Alternative (see Section 4.10.4.4 in Aquatic Resources); and would therefore provide minor, permanent, beneficial impacts on BBES dolphins. However gradually increasing negligible to moderate adverse impacts from the loss of foraging structure for BBES dolphins suffering from the adverse health effects associated with low-salinity exposure would likely offset some of these benefits.

- Overall, although nutrient loading may result in beneficial impacts on the estuarine environment within the basin through an increase in primary productivity and available food sources, it may also result in detrimental impacts from potential increases in the size and frequency of HABs. Further, and as discussed in Section 4.10.4.4 in Aquatic Resources, increases in phytoplankton biomass may result in pockets of decreased DO. Therefore, impacts on fauna from nutrient loading could result in indirect, minor to moderate (depending on an organism's place in the food web), permanent, and beneficial impacts on fauna within the Barataria Basin through food web production, but may also result in direct and indirect, temporary (but recurring), minor, and adverse impacts on the estuarine community through the potential production of HABs and die-offs from phytoplankton blooms causing pockets of low DO. HABs can affect dolphins from direct toxicity following inhalation and/or ingestion of contaminated prey (Flewelling et al. 2005, Twiner et al. 2012, Cammen et al. 2015), and indirectly by affecting their prey types/abundance (McHugh et al. 2011a, Wells et al. 2019).

The combination of stressors from decreased salinity, a reduction in wetlands and their associated dolphin prey species (which occurs under both the No Action Alternative and the Applicant's Preferred Alternative), and an increased risk of HABs would be especially adverse for BBES dolphins that were directly exposed to DWH oil. As of 2018, dolphins exposed to DWH oil continue to have low reproductive success, lower survival rates, and adverse health effects (including adrenal dysfunction). These dolphins would be less likely to mount a normal physiological response to low-salinity exposures, and are therefore more likely to succumb to the combination of multiple stressors.

As described in this assessment, the impacts on BBES dolphins under the first decade of the Applicant's Preferred Alternative are markedly higher in the Western and Central strata compared to the Barrier Island stratum (although all of the strata have statistically significant decreases). Compared to the No Action Alternative, under the Applicant's Preferred Alternative the annual survival decreases by 0.40 (95 percent CL: 0.60 to 0.84) in the Western stratum and 0.57 (95 percent CL: 0.14 to 0.88) in the Central stratum. The Barrier Island stratum annual survival decreases by 0.07 (95 percent CL: 0.00 to 0.40) under the Applicant's Preferred Alternative. Thus, it is likely that after 10 years of these annual survival rates, there would be few dolphins remaining in the BBES Stock area except for those surviving around the barrier islands. Thomas et al. (2022) project that dolphins in the Western, Central, and Southeastern strata would be functionally extinct, and that the Barrier Island stratum would be 91 percent smaller (95 percent CI: 47 to 99) by the end of operations under the Applicant's Preferred Alternative compared to the No Action Alternative.

To integrate these annual survival rates into an assessment of the impacts of low salinity on the BBES dolphin population, the distribution of dolphins throughout the BBES Stock area was considered. The first robust boat-based surveys of the BBES Stock were conducted from 2011 to 2014 as part of the DWH NRDA to assess the injuries to dolphins (and their potential recovery) from oil spill exposure (McDonald et al. 2017). The transect lines for the surveys did not include much of the interior Barataria Bay marsh edge areas (for example, at the northern and eastern portions of the BBES Stock area). Thus, McDonald et al. (2017) likely overestimates the proportion of the BBES Stock represented by barrier island-associated dolphins, which was complicated by the mortalities associated with the DWH oil spill, as well as the potential movement of dolphins from their peripheral habitats in response to shoreline oiling.

In 2019, Garrison et al. (2020) designed surveys to establish an abundance estimate for the entire BBES Stock area as part of research activities to inform the proposed Project EIS. Their survey transect lines included the interior portions of the Barataria Bay marsh edge areas that were not included in McDonald et al. (2017). The results indicate that while there is a high density of dolphins associated with the barrier islands, the total abundance of dolphins near the barrier islands is similar to the abundance in each of the Western and Central strata. Therefore, Garrison et al. (2020) provide the most up-to-date and robust assessment of BBES dolphin abundance and distribution throughout the BBES Stock area.

The projections of future impacts on the BBES dolphins from Garrison et al. (2020) and Thomas et al. (2021, 2022) are based on model results that rely on historic hydrography. If future river flows differ from the modeled hydrographs, then survival rates in a given year may be greater than or less than those modeled.

Overall, the impacts on BBES dolphins under the Applicant's Preferred Alternative include (1) immediate and permanent, major, adverse impacts on survival from low salinity throughout the BBES Stock area; (2) adverse effects on health and reproduction from multiple stressors including low-salinity exposure, loss of wetlands (and associated benefits to dolphin prey) in the BBES Stock area (also occurring under the No Action Alternative) which will affect prey, lower temperatures, an increased risk of HABs, and the residual effects from the DWH oil spill; and (3) based on the estimated decreases in survival rates, there would be a substantial reduction in population numbers. Thus, the Applicant's Preferred Alternative would likely have permanent, major, adverse impacts on BBES dolphins.

4.11.5.2.3 Other Action Alternatives

As discussed in Sections 4.10 in Aquatic Resources, and 4.11.5.1, the other action alternatives have similar trends in their impacts on BBES dolphins as those described in the Applicant's Preferred Alternative. Although the magnitude of those impacts depends on the maximum flowrate, the differences among the 50,000 cfs

Alternatives, the 75,000 cfs Alternatives, and the 150,000 cfs Alternatives do not change the overall permanent, major, adverse impacts on marine mammals.

Changes in the maximum and minimum salinity levels in the BBES Stock area do not appear to be greatly influenced by either the variable flow or the presence of terraces (see Section 4.5.5.1 in Surface Water and Sediment Quality, and 4.11.5.1), although under the 150,000 cfs Alternatives, dolphins near the barrier islands would experience waters 2 to 4 ppt lower than under the No Action Alternative. Overall, alternatives with higher maximum operational flow rates would result in longer periods of low salinity, while alternatives with lower maximum operational flow rates would result in shorter periods of low salinity. Thus, under the 150,000 cfs Alternative, the simulated BBES dolphin population was projected to experience a longer continuous duration (67 days longer; 95 percent CL: 53 to 81 days) in waters under 5 ppt compared to the No Action Alternative (see Table 4.11-6; Garrison et al. 2020). Under the 50,000 cfs Alternative and the Applicant's Preferred Alternative, the Barrier Island stratum saw relatively small differences in the continuous durations at less than 5 ppt compared to the No Action Alternative (6 days more with 95 percent CL: 4 to 8; and 11 days more with 95 percent CL: 7 to 15 days, respectively), but under the 150,000 cfs Alternative, the Barrier Island stratum saw 38 more days (95 percent CL: 28 to 48) of continuous exposure to low salinity compared to the No Action Alternative.

Table 4.11-6
Differences between the Projected Duration of Low-Salinity Exposure (less than 5 ppt) for a Simulated BBES Dolphin Population under the No Action Alternative (NAA) and Each Action Alternative[a]

	50,000 cfs Alternative vs No Action Alternative	Applicant's Preferred Alternative vs No Action Alternative	150,000 cfs Alternative vs No Action Alternative
Overall	31 (18 to 44)	38 (25 to 52)	67 (53 to 81)
Island	6 (4 to 8)	11 (7 to 15)	38 (28 to 48)
West	40 (10 to 73)	49 (21 to 79)	87 (59 to 117)
Central	60 (37 to 83)	72 (47 to 95)	107 (89 to 126)
Southeast	13 (-14 to 40)	14 (-12 to 41)	33 (5 to 61)

[a] Values are number of days in a given year in the cycle 0 with the 95 percent CL in parentheses (Garrison et al. 2020).

The resulting changes in mean survival of the overall simulated BBES dolphin population under each alternative are shown in Table 4.11-7 and Figure 4.11-11 (Garrison et al. 2020). The projected mean survival rate for each of the simulated populations under all of the action alternatives (50,000 cfs, 75,000 cfs, and 150,000 cfs) is substantially lower than the No Action Alternative. However, the 150,000 cfs Alternative has especially lower predicted survival rates compared to the No Action Alternative than either the 50,000 cfs Alternative or the Applicant's Preferred Alternative, mostly due to the drastic difference in the Barrier Island stratum (a 0.39 decrease in annual survival rate compared to the No Action Alternative; 95 percent CL: 0.02 to 0.91 decrease), but also due to the relatively large decreases in the West (0.71 decrease in annual survival rate compared to the No Action Alternative; 95 percent CL: 0.28 to 1.00

decrease) and Central (a 0.79 decrease in annual survival rate compared to the No Action Alternative; 95 percent CL: 0.38 to 0.99 decrease) strata.

Table 4.11-7
Differences between the Projected Mean Survival Rate due to Low-salinity Exposure of a Simulated BBES Dolphin Population under the No Action Alternative (NAA) and Each Action Alternative[a]

	50,000 cfs Alternative vs No Action Alternative	Applicant's Preferred Alternative vs No Action Alternative	150,000 cfs Alternative vs No Action Alternative
Overall	-0.22 (0.00 to -0.49)	-0.30 (-0.02 to -0.64)	-0.54 (-0.17 to -0.82)
Island	-0.02 (0.00 to -0.15)	-0.07 (0.00 to -0.40)	-0.39 (-0.02 to -0.91)
West	-0.27 (-0.01 to -0.63)	-0.40 (-0.06 to -0.84)	-0.71 (-0.28 to -1.00)
Central	-0.45 (-0.07 to -0.78)	-0.57 (-0.14 to -0.88)	-0.79 (-0.38 to -0.99)
Southeast	-0.09 (0.21 to -0.41)	-0.12 (0.21 to -0.48)	-0.26 (0.13 to -0.64)

[a] Values are median survival rates in any given year in cycle 0 from the bootstrap samples with the 95 percent CL in parentheses (Garrison et al. 2020).

Beyond the differences in salinity, the 150,000 cfs Alternative would result in approximately double the amount of wetlands created/sustained compared to the Applicant's Preferred Alternative. However, as with the Applicant's Proposed Alternative, the additional wetlands are anticipated to be created in the outfall area, restricting the created/maintained marsh to areas outside of the BBES dolphin stock area. The additional wetlands would provide benefits to dolphin prey migrating between the outfall area and the open waters of the Gulf of Mexico, providing seasonal higher abundance of prey within the BBES Stock area. However, the net loss of wetlands within the BBES Stock area under all of the alternatives (including the No Action Alternative) would impact BBES dolphins, especially dolphins suffering adverse health effects (for example, from low-salinity exposure).

Therefore, the other alternatives would also have a permanent, major adverse impact on BBES dolphins. A lower maximum output (50,000 cfs) would reduce the number of days BBES dolphins are exposed to low-salinity waters and therefore improve the population's average survival rate, while a higher maximum output (150,000 cfs) would increase the number of days and reduce the population's average survival rate (Garrison et al. 2020). However, these differences would not likely change the impacts determinations described under the Applicant's Preferred Alternative, and therefore BBES dolphins would see permanent, major, adverse impacts under the other action alternatives.

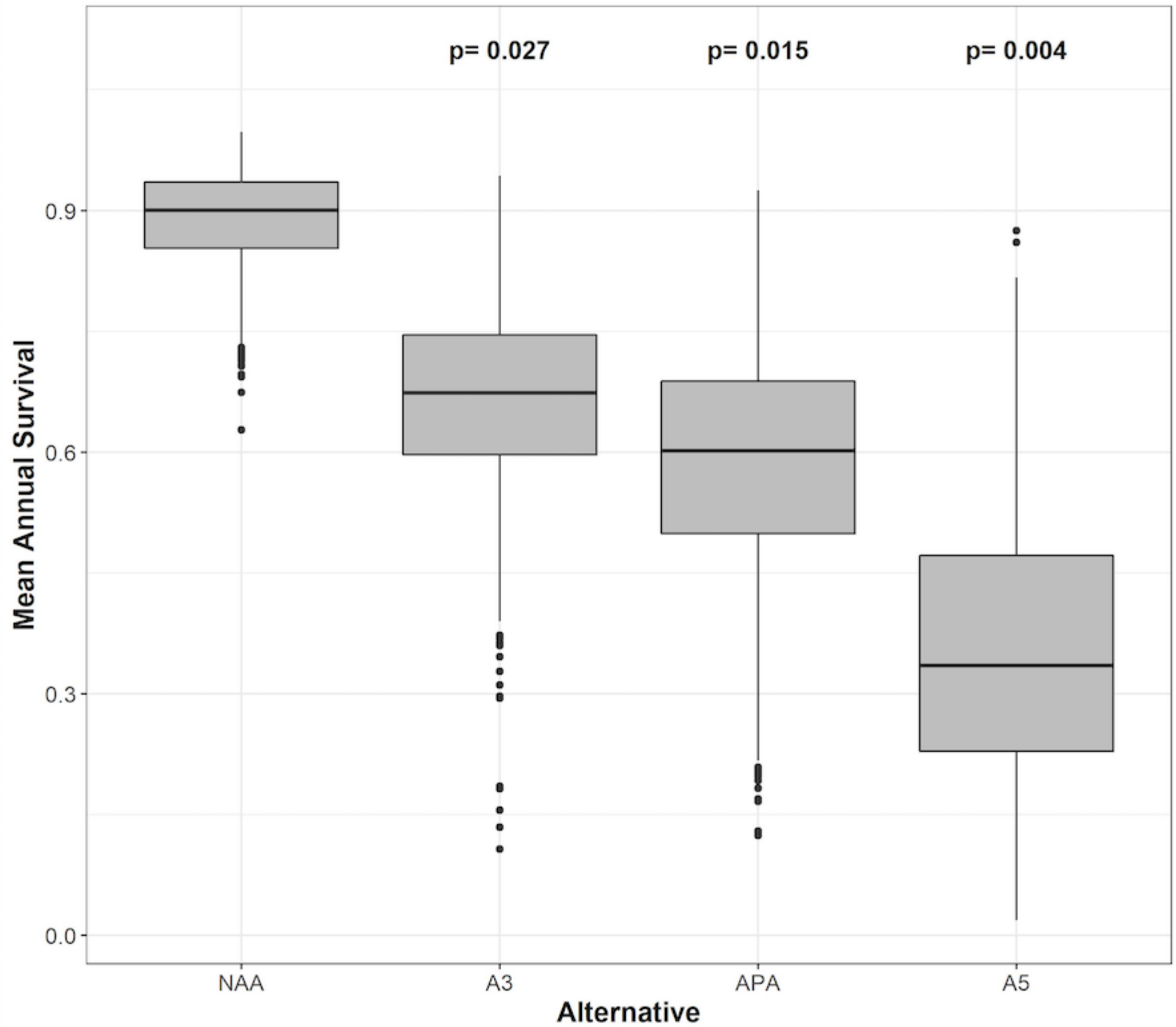


Figure 4.11-11. Box-whisker Plot of Mean Survival Rates Due to Low-salinity Exposure for a Simulated BBES Dolphin Population under Four Proposed Project Alternatives. NAA = No Action Alternative, A3 = Alternative 3 (50,000 cfs diversion), APA = Applicant's Preferred Alternative (75,000 cfs diversion), A5 = Alternative 5 (150,000 cfs diversion). These distributions reflect 1,000 resamples of exposure histories and the salinity:survival dose-response curve for each alternative (Garrison et al. 2020). Delft3D Basinwide Model salinity inputs are from the representative hydrograph for cycle 0. Mean survival rates under the three action alternatives are substantially lower than the No Action Alternative, however the rates are much lower for the 150,000 cfs Alternative (including a large decrease in the mean survival rate of dolphins in the Barrier Island stratum). The *p*-values indicate the results of significance tests between the No Action Alternative and each of the other alternatives. They were determined by calculating the bootstrap distribution of the differences between the two alternatives. The proportion of these differences that was less than or equal to zero reflects the likelihood of no difference between the simulated population mean survival rates.

4.11.5.3 Other Dolphin Stocks Considered

Beyond the BBES Stock and the five stocks discussed below, there are also dolphins that reside in the estuaries south of the mouth of the Mississippi River and southeast of the BBES Stock area (Hayes et al. 2019). These dolphins are not currently considered in any NOAA stock assessment report. Further research is required to determine whether they affiliate with the BBES Stock or if they should be delineated as a unique stock. Dolphins in this region may experience similar types of impacts from the proposed Project similar to BBES dolphins in the Southeast stratum, however they are even further from the outfall area, and therefore, the magnitude of the impacts would likely be lower. Thus, dolphins southeast of the BBES Stock area and south of the Mississippi River mouth would likely experience negligible to minor permanent adverse effects from the Applicant's Preferred Alternative and the other 50,000 and 150,000 cfs Alternatives. Although this section discusses only five other stocks, there is the potential for impacts on other stocks of northern Gulf of Mexico dolphins. The Mississippi River output can have an influence on large-scale flows, eddies, currents, and productivity levels in the northern Gulf of Mexico, which may affect shelf and offshore species.

4.11.5.3.1 Terrebonne-Timbalier Estuarine System (TTES) Stock

The TTES Stock of common bottlenose dolphins principally uses the bay and estuarine system to the west of Barataria Bay. Given that movement observed to date between the TTES and BBES stocks has been limited to a small number of individual dolphins (Mullin et al. 2018), and given the hypothesis that BSE dolphins cannot or would not shift their range in response to changes in the environment (see Chapter 3, Section 3.10.3 in Aquatic Resources; Wells 2010, Mullin et al. 2015, Takeshita et al. 2021), it is unlikely that TTES dolphins would be impacted by the proposed Project, either directly from low salinity/other environmental effects or indirectly from movement of BBES dolphins out of Barataria Bay and into Timbalier and Terrebonne Bays in response to the proposed Project. However, if BBES dolphins emigrate into or spend more time in the TTES habitat, the addition of these dolphins would increase the number of dolphins in the local area, potentially increasing competition for food and habitat, thereby impacting the TTES dolphins.

4.11.5.3.2 Mississippi River Delta (MRD) Estuarine Stock

The MRD Stock resides in the estuaries to the east of the Mississippi River, and therefore MRD dolphins are not projected to be exposed to low-salinity waters or experience broader environmental/habitat changes associated with the proposed Project. Thus, it is unlikely that MRD dolphins would be impacted by the proposed Project. It is unclear whether the dolphins south of the Mississippi River mouth affiliate with the MRD Stock, but potential impacts on those dolphins are discussed above. As discussed with the TTES Stock, it is very unlikely that BBES dolphins would move into the MRD Stock Area; however, if it did occur, the addition of these dolphins would increase the number of dolphins in the local area, potentially increasing competition for food and habitat, thereby impacting the MRD dolphins.

4.11.5.3.3 Northern and Western Coastal Stocks

The Northern and Western Coastal Stocks of common bottlenose dolphins mostly inhabit the coastal waters of the northern Gulf of Mexico from the shoreline to waters around 20 m in depth; however, they may make intermittent forays into BSE habitats and may socialize with BSE dolphins. Although the low salinity and other environmental changes from the proposed Project may affect the areas where coastal dolphins spend time (for example, inlets and barrier islands), those areas are a very small portion of coastal dolphin habitat. Any exposure to environmental conditions produced by the proposed Project would likely have less of an effect on coastal dolphins, because low-salinity waters are projected to extend only narrowly into the coastal habitat and these dolphins can move into higher-salinity waters away from the coastline. In other words, it is unlikely that the majority of their usual habitat would be affected.

It is a possibility that if BBES dolphins emigrate into coastal dolphin habitat, there may be increased competition for coastal resources. However, this is unlikely because (1) to date, there are no examples from satellite-tagging data or photo-identification surveys of BBES dolphins transitioning to long-term coastal ranging/behaviors (Wells 2010, Wells et al. 2017, Takeshita et al. 2021); and (2) BBES dolphins seem to have high site-fidelity within the Barataria Basin, even in the face of environmental changes such as prolonged low salinity (Takeshita et al. 2021). However, if BBES dolphins emigrate into or spend more time in coastal stocks' habitat, the addition of these dolphins would increase the number of dolphins in the local area, potentially increasing competition for food and habitat, thereby impacting the coastal dolphins that spend more time in this area.

4.11.5.3.4 Atlantic Spotted Dolphins

Like coastal common bottlenose dolphins, Atlantic spotted dolphins belonging to the northern Gulf of Mexico Stock range quite far across the Gulf of Mexico. They are seen out to waters as deep as the 656-foot (200-meter) isobath. As the majority of their range is far from Barataria Bay, and they share many of the traits of coastal common bottlenose dolphins described above, it is unlikely that Atlantic spotted dolphins would be impacted by the proposed Project either directly or due to indirect competition from BBES emigrants because, for reasons described above, BBES animals are not expected to leave Barataria Bay to inhabit coastal waters.

4.11.6 Summary of Potential Impacts

Table 4.11-8 summarizes the potential impacts on marine mammals for each alternative. Details are provided in Sections 4.11.4 and 4.11.5 above.

Table 4.11-8
Summary of Potential Impacts on Marine Mammals from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on marine mammals from construction of the proposed Project would occur. • Future development in the proposed Project vicinity could result in impacts on marine mammals.
Operational Impacts	• The loss of wetlands in the BBES Stock area would result in a gradually increasing from negligible to moderate, permanent, indirect, adverse impacts on dolphin foraging, depending on BBES dolphins' abilities to acclimatize to gradually changing conditions from 2020 to 2070. • Changes in prey abundance would likely cause minor, adverse, permanent impacts on BBES dolphins, depending on the dolphins' ability to acclimatize to decades-long gradual changes in foraging areas. Specific groups of BBES dolphins may experience different effects. Given that the changes would progress gradually over the analysis period and are especially prominent in the last two decades of the projections, it is possible that BBES dolphins would have time to acclimate to a changing food web. • Although dolphins in the mid-basin would see minor beneficial impacts from increased salinities in winter months, there are likely to be permanent minor to moderate adverse impacts on all BBES dolphins in the spring due to lower minimum salinities (which would coincide with the peak of calving) and increased within-year seasonal differences. • Overall, the No Action Alternative would likely have gradually increasing minor, permanent, adverse impacts on BBES dolphins.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Noise-producing construction activities (including dredging and pile driving) have minimal overlap with the BBES Stock range and are anticipated to have negligible to minor, temporary, indirect, and adverse impacts on bottlenose dolphins.
Operational Impacts	• Permanent, major, adverse impacts on BBES dolphins under the Applicant's Preferred Alternative would be primarily due to the prolonged exposure to low salinities compared to the No Action Alternative. • Immediate decreases in salinity levels within the BBES Stock area throughout the analysis period would cause permanent, major adverse impacts on BBES dolphin health, survival, and reproduction. Dolphins north of the barrier islands would be especially adversely impacted, while barrier island-associated dolphins would be less-adversely impacted; however, all groups would be more adversely impacted than compared to conditions under the No Action Alternative. • Based on the projected decreases in survival rates due to prolonged low-salinity exposure, there would be a substantial reduction in population numbers. • The timing of the proposed Project operations would result in the lowest salinity levels in the BBES Stock area right at the peak of dolphin calving, representing a serious threat to late-term pregnant mothers, fetuses, and perinates that are more vulnerable than the average BBES dolphin. This would likely decrease reproductive success rates in BBES dolphins. • The increase in freshwater marsh near the proposed Project outfall compared to the No Action Alternative would likely have minor, permanent, indirect, beneficial impacts on estuarine euryhaline dolphin prey species by allowing for the export of increased primary production, detritus, and prey resources to other areas of the basin that would support the local food web. • Under both the No Action Alternative and the Applicant's Preferred Alternative, there would be a net loss of wetlands and their associated benefits to dolphin prey in the BBES Stock area. However, dolphins that are adversely impacted by low salinity under the Applicant's Preferred Alternative would likely be less able to cope with the loss of foraging structure (wetland edge) associated with the net loss of

Table 4.11-8
Summary of Potential Impacts on Marine Mammals from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	wetlands in the BBES Stock area, likely exacerbating the adverse impacts on BBES dolphins from decreased salinity levels. • Although studies on smaller outfalls/diversions imply negligible impacts on fauna from the influx of river contaminants, the substantially larger outflow of the proposed diversion may result in increased contaminant levels within biota, especially for apex predators (like dolphins) that further concentrate those contaminants in their lipid-rich blubber and other tissues. • An increased potential (and frequency) of phytoplankton blooms may be likely within the proposed Project area. If nutrient input from the proposed Project were to trigger HABs, impacts on dolphins and their prey species would likely be adverse, minor to moderate, and temporary to short-term, depending on the size and significance of the bloom; and result in death or sub-lethal impacts (for example, reproductive health and behavioral impacts) on exposed dolphins, as well as bioaccumulation of toxins up the food chain. • Overall, the Applicant's Preferred Alternative would have immediate, major adverse effects on BBES dolphins and dolphin habitat (due mostly to low salinity) that would continue throughout the lifetime of the proposed Project. • It is unlikely that TTES, MRD, Northern Coastal Stock, Western Coastal Stock, or Atlantic Spotted dolphins would be impacted by the proposed Project, either directly from low salinity/other environmental effects or indirectly from movement of BBES dolphins out of Barataria Bay in response to the proposed Project.
50,000 cfs Alternative	
Construction Impacts	• Impacts are anticipated to be the same as the Applicant's Preferred Alternative.
Operational Impacts	• Permanent, major, and adverse impacts on BBES dolphins under the 50,000 cfs Alternative would be primarily due to the prolonged exposure to low salinities compared to the No Action Alternative, but impacts would be slightly less adverse than the Applicant's Preferred Alternative due to the lower flow rate. • Immediate decreases in salinity levels within the BBES Stock area throughout the analysis period would cause permanent, major adverse impacts on BBES dolphin health, survival, and reproduction. Dolphins north of the barrier islands would be especially adversely impacted, while barrier island-associated dolphins would experience similar impacts under both the Applicant's Preferred Alternative and the 50,000 cfs Alternative. • Based on the projected decreases in survival rates due to prolonged low-salinity exposure, there would be a substantial reduction in population numbers compared to the No Action Alternative. There would be similar projected decreases in survival rates between the Applicant's Preferred Alternative and the 50,000 cfs Alternative. • The timing of the proposed Project operations would result in the lowest salinity levels in the BBES Stock area right at the peak of dolphin calving, representing a serious threat to late-term pregnant mothers, fetuses, and perinates that are more vulnerable than the average BBES dolphin. This would likely decrease reproductive success rates in BBES dolphins. • The increase in freshwater marsh compared to the No Action Alternative would likely have indirect beneficial impacts on estuarine euryhaline dolphin prey species by allowing for the export of increased primary production, detritus, and prey resources to other areas of the basin that would support the local food web. However, the impacts would be less beneficial than under the Applicant's Preferred Alternative due to the decreased amount of wetlands north of the BBES Stock area. • Under the No Action Alternative and the 50,000 cfs Alternative, there would be a net loss of wetlands and their associated benefits to dolphin prey in the BBES Stock area. However, dolphins that are adversely impacted by low salinity under the 50,000 cfs Alternative would likely be less able to cope with the loss of foraging structure (wetland edge) and the reduction in prey abundance associated with the

Table 4.11-8
Summary of Potential Impacts on Marine Mammals from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	net loss of wetlands in the BBES Stock area, likely exacerbating the adverse impacts on BBES dolphins from decreased salinity levels. • Although studies on smaller outfalls/diversions imply negligible impacts on fauna from the influx of river contaminants, the substantially larger outflow of the proposed diversion may result in increased contaminant levels within biota, especially for apex predators (like dolphins) that further concentrate those contaminants in their lipid-rich blubber and other tissues. Any impacts would be less adverse than the Applicant's Preferred Alternative due to the lower flow rate. • An increased potential (and frequency) of phytoplankton blooms would be likely within the proposed Project area. If nutrient input from the proposed Project were to trigger HABs, impacts on dolphins and their prey species would likely be adverse, minor to moderate, and temporary to short-term, depending on the size and significance of the bloom; and result in death or sub-lethal impacts (for example, reproductive health and behavioral impacts) on exposed dolphins, as well as bioaccumulation of toxins up the food chain. Any impacts would be less adverse than the Applicant's Preferred Alternative due to the lower flow rate. • It is unlikely that TTES, MRD, Northern Coastal Stock, Western Coastal Stock, or Atlantic Spotted dolphins would be impacted by the proposed Project, either directly from low salinity/other environmental effects or indirectly from movement of BBES dolphins out of Barataria Bay in response to the proposed Project.
150,000 cfs Alternative	
Construction Impacts	• Impacts are anticipated to be the same as the Applicant's Preferred Alternative.
Operational Impacts	• Permanent, major, and adverse impacts on BBES dolphins under the 150,000 cfs Alternative would be primarily due to the prolonged exposure to low salinities compared to the No Action Alternative, but impacts would be slightly more adverse than the Applicant's Preferred Alternative due to the higher flow rate. • Immediate decreases in salinity levels within the BBES Stock area throughout the analysis period would cause permanent, major adverse impacts on BBES dolphin health, survival, and reproduction. Dolphins north of the barrier islands would be especially adversely impacted. However, barrier island-associated dolphins would also experience relatively greater impacts under the 150,000 cfs Alternative compared to both the No Action Alternative and the Applicant's Preferred Alternative. • Based on the projected decreases in survival rates due to prolonged low-salinity exposure, there would be a substantial reduction in population numbers compared to the No Action Alternative. There would be larger projected decreases in survival rates under the 150,000 cfs Alternative compared to the Applicant's Preferred Alternative. • The timing of the proposed Project operations would result in the lowest salinity levels in the BBES Stock area right at the peak of dolphin calving, representing a serious threat to late-term pregnant mothers, fetuses, and perinates that are more vulnerable than the average BBES dolphin. This would likely decrease reproductive success rates in BBES dolphins. • The increase in freshwater marsh compared to the No Action Alternative would likely have indirect beneficial impacts on estuarine euryhaline dolphin prey species by allowing for the export of increased primary production, detritus, and prey resources to other areas of the basin that would support the local food web. However, the impacts would be more beneficial than under the Applicant's Preferred Alternative due to the increased amount of wetlands north of the BBES Stock area. • Under the No Action Alternative and the 150,000 cfs Alternative, there would be a net loss of wetlands and their associated benefits to dolphin prey in the BBES Stock area. However, dolphins that are adversely impacted by low salinity under the 150,000 cfs Alternative would likely be less able to cope with the loss of foraging

Table 4.11-8
Summary of Potential Impacts on Marine Mammals from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	structure (wetland edge) and the reduction in prey abundance associated with the net loss of wetlands in the BBES Stock area, likely exacerbating the adverse impacts on BBES dolphins from decreased salinity levels. • Although studies on smaller outfalls/diversions imply negligible impacts on fauna from the influx of river contaminants, the substantially larger outflow of the proposed diversion may result in increased contaminant levels within biota, especially for apex predators (like dolphins) that further concentrate those contaminants in their lipid-rich blubber and other tissues. Any impacts would be more adverse than the Applicant's Preferred Alternative due to the higher flow rate. • An increased potential (and frequency) of phytoplankton blooms would be likely within the proposed Project area. If nutrient input from the proposed Project were to trigger HABs, impacts on dolphins and their prey species would likely be adverse, minor to moderate, and temporary to short-term, depending on the size and significance of the bloom; and result in death or sub-lethal impacts (for example, reproductive health and behavioral impacts) on exposed dolphins, as well as bioaccumulation of toxins up the food chain. Any impacts would be more adverse than the Applicant's Preferred Alternative due to the higher flow rate. • It is unlikely that TTES, MRD, Northern Coastal Stock, Western Coastal Stock, or Atlantic Spotted dolphins would be impacted by the proposed Project, either directly from low salinity/other environmental effects or indirectly from movement of BBES dolphins out of Barataria Bay in response to the proposed Project.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on marine mammals as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on marine mammals due to the construction of terraces would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on marine mammals as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on marine mammals due to the presence of terraces would be negligible.

4.12 THREATENED AND ENDANGERED SPECIES

4.12.1 Area of Potential Impacts

Threatened and endangered species include those that are terrestrial (occur in uplands or wetlands), aquatic (occur in marine, estuarine, or fresh waters), or both. Impacts from construction on terrestrial threatened and endangered species would occur within, and in close proximity to, the footprint of each individual Project component developed during construction (for example, the diversion complex, laydown yards, access roads, dredged material disposal areas). Impacts on aquatic threatened and endangered species during construction would occur within, and in close proximity to, estuarine or fresh water overlapping active construction or beneficial use areas. Indirect impacts on all species would occur in a larger area that would be dependent on the specific pathway for impacts. For example, noise associated with construction would extend beyond the footprint of the Project components, to the distance at which noise attenuates back to ambient conditions.

During operations, direct impacts on terrestrial and aquatic species would occur from the presence of the diversion and auxiliary structures in species habitats, as well as from the direct movement of water, nutrients, and sediment from the Mississippi River to the Barataria Basin. Direct impacts on aquatic species would also occur if organisms are directly displaced by the fresh water and sediment entering the Barataria Basin. In general, direct impacts would be considered to be those that have immediate impacts on a species, causing them to move away from an area (for example, salinity changes or loss of trees) or causing a physiological effect (for example, reduced fitness/reproductive success). Indirect impacts would occur on species within, and outside of, the outfall area as the habitat and food web dynamics change over time and fauna ingress or egress from the altered habitat.

4.12.2 Federally Listed or Proposed Threatened and Endangered Species

Federally listed species identified as occurring within the Project area are discussed below and include the West Indian manatee, five species of sea turtles, the giant manta ray, the pallid sturgeon, two shorebirds (piping plover and red knot), and the black rail. Four whale species, the oceanic whitetip, and the Gulf sturgeon were identified in the proposed Project parishes, or offshore of them, but are not within the areas affected by the proposed diversion; these species are discussed in Chapter 3, Section 3.12.1 in Threatened and Endangered Species but are not further discussed as construction and operation of the proposed Project would have no effect on them.

For actions involving major construction activities with the potential to affect listed species or designated critical habitat, such as the proposed Project, the lead federal agency must prepare a Biological Assessment (BA) and submit its BA to the USFWS and/or NMFS. The USACE provided its BA to NMFS on February 24, 2021, and to USFWS on July 2, 2021, along with requests to initiate formal consultation and develop Biological Opinions for the species that USACE determined may be affected by the proposed Project (see Table 4.12-1). The BA for the proposed Project is included as Appendix O1 to this EIS. With respect to species under NMFS jurisdiction, the BA determined that the proposed Project is likely to adversely affect green, Kemp's ridley, and loggerhead sea turtles; may affect but is not likely to adversely affect the leatherback and hawksbill sea turtles; and would have no effect on designated critical habitat for the loggerhead sea turtle. The BA also acknowledged a no effect determination for four whales, the oceanic whitetip shark, and the giant manta ray. With respect to species under USFWS jurisdiction, the BA determined that the proposed Project is likely to adversely affect pallid sturgeon and may affect but is not likely to adversely affect the eastern black rail, piping plover, red knot, and West Indian manatee, along with two sea turtles on nesting beaches (Kemp's ridley and loggerhead). The BA also determined that there would be no effect on designated critical habitat for the piping plover and proposed critical habitat for the red knot (added by correspondence dated October 28, 2021), and no effect on three species of sea turtles on nesting beaches (green, hawksbill, and leatherback).

On December 13, 2021, the USFWS and NMFS individually issued Biological Opinions, which concur with the not likely to adversely affect determinations, determine that the Project would not jeopardize the continued existence of pallid sturgeon (USFWS) and green, Kemp's ridley, and loggerhead sea turtles (NMFS) and concur that the Project would not result in adverse modification to critical habitat. The NMFS Biological Opinion also determined that the giant manta ray is not likely to be adversely affected by the Project, which the USACE originally indicated would not be affected by the Project. The Biological Opinions include Incidental Take Statements (setting forth allowable incidental take for adversely affected species), reasonable and prudent measures (to minimize impacts of takings on specific species) and Conservation Recommendations (voluntary conservation measures to assist species' recovery) as applicable. The Biological Opinions are presented in Appendices O3 (USFWS) and O4 (NMFS).

The species discussions in this section incorporate and rely, in part, on assessments in the BA. Although the BA includes the information that was necessary for formal consultation under the ESA, Section 4.12 also includes the information to comply with NEPA, including an assessment of alternatives.

The determinations from the BA are included in Table 4.12-1 and include:

- no effect: the proposed Project would not affect a listed species;
- may affect, not likely to adversely affect: effects on a listed species are expected to be discountable (extremely unlikely to occur), insignificant (the impact would never reach the scale where take occurs), or completely beneficial; and
- may affect, likely to adversely affect: adverse effects on a listed species may occur as a direct or indirect result of the proposed Project and the effect is not discountable, insignificant, or beneficial.

Table 4.12-1
Endangered Species Act Determinations, as identified in the Project Biological Assessment[a]

Listed Species	Status	Effects Determination	
		Species	Critical Habitat
West Indian manatee	T	NLAA	NA
Green sea turtle	T	LAA	NA
Hawksbill sea turtle	E	NLAA	NA
Kemp's ridley sea turtle	E	LAA	NA
Leatherback sea turtle	E	NLAA	NA
Loggerhead sea turtle	T	LAA	NE
Pallid Sturgeon	E	LAA	NA
Piping plover	T	NLAA	NE
Red knot	T	NLAA	NA[b]
Eastern Black Rail	T	NLAA	NA

E = Endangered; T = Threatened; NA = not applicable; LAA = may affect, likely to adversely affect; NLAA = may affect, not likely to adversely affect; NE = no effect

[a] The giant manta ray (*Manta birostris*) was identified with a "no effect" determination in the BA issued with the Draft EIS; however, the species was included in the NMFS Biological Opinion for the Project, included as Appendix O4 to the Final EIS, with a determination of NLAA.

[b] Although there is no designated critical habitat for the red knot, critical habitat has been proposed in the Project area (see Chapter 3, Section 3.12.1 in Threatened and Endangered Species).

In addition to summarizing the ESA determination made in the BA, a corresponding NEPA determination of impact is also provided in this section, based on the definitions provided in the DWH PDARP (DWH NRDA Trustees 2016a) and Section 4.1, Approach to Evaluation of Environmental Consequences. They include the following threatened and endangered species indicators for the following impacts:

- No impact: there is no discernible or measurable impact. This would generally correlate with an ESA Section 7 no effect determination;
- Negligible impact: the impact on a threatened or endangered species would be at the lowest levels of detection, barely measurable, with no perceptible consequences. This impact would generally correlate with an ESA Section 7 may affect, not likely to adversely affect determination;
- Minor impact: impacts on threatened or endangered species, their habitats, or the natural processes sustaining them could be detectable, but small and localized, and could not measurably alter natural conditions. Some impacts on individuals may occur; however, these would not result in negative impacts on feeding, reproduction, resting, migrating, or other factors affecting local and adjacent population levels. This impact would generally correlate with an ESA Section 7 may affect, not likely to adversely affect determination or may affect, likely to adversely affect determination with small amounts of authorized "take" as defined under the ESA;

- Moderate impact: impacts on threatened or endangered species, their habitats, or the natural processes sustaining them could be detectable and some alteration in the numbers of species or occasional responses to disturbance by some individuals could be expected, with some negative impacts on feeding, reproduction, resting, migrating, or other factors affecting local and adjacent population levels. Impacts could occur in key habitats, but sufficient population numbers or habitat could remain functional to maintain the viability of the species both locally and throughout their range. This impact would generally correlate with an ESA Section 7 may affect, likely to adversely affect determination; or

- Major impact: impacts on threatened or endangered species, their habitats, or the natural processes sustaining them could be detectable, widespread, and permanent. Substantial impacts on the population numbers of a species; or interference with their survival, growth, or reproduction could be expected. There could be impacts on key habitats, resulting in substantial reductions in species numbers. This impact would generally correlate with an ESA Section 7 may affect, likely to adversely affect determination.

4.12.2.1 West Indian Manatee

4.12.2.1.1 Construction Impacts

4.12.2.1.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The proposed Project area would continue to provide suitable aquatic habitat for the West Indian manatee during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). Further, manatees are considered unlikely to occur at the location of the proposed diversion's construction footprint due to difficulties in maneuvering to the immediate area (see below). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse effect on threatened and endangered species. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws, including the ESA for federally listed species.

4.12.2.1.1.2 Applicant's Preferred Alternative

As discussed in Chapter 3, Section 3.12.1.1 in Threatened and Endangered Species, manatees are rarely sighted in Louisiana but could be present as transient visitors within the Barataria Basin, most likely in areas with water depths between 4.9 and 19.7 feet, where they can forage for aquatic vegetation (USFWS 2019b). Although

Delft3D Basinwide Model outputs indicate that water depths of about 5 feet do exist in the immediate vicinity (within 0.5-mile) of the diversion complex and beneficial use areas, they are not present to the extent where manatees would be likely to transit to areas affected by construction. Therefore, potential impacts on the West Indian manatee during construction would likely be limited to those associated with proposed Project-related vessel traffic transiting through established or proposed waterways.

West Indian manatees are susceptible to vessel interactions and can be injured or killed if struck. CPRA has indicated that vessels used during construction would generally be slow-moving equipment barges (moving 8 knots or less); however, manatees may travel in transit ways and may have less room to maneuver to avoid vessel traffic. To minimize the potential for vessel impacts, CPRA has indicated that it would adhere to USFWS BMPs regarding the West Indian manatee. These measures include advising staff that manatees may approach the proposed Project area, providing staff with materials to assist in the identification of manatees, instructing staff to avoid feeding manatees, and contacting the USFWS and LDWF if a manatee is sighted. As manatees are rare in the Project area and Project personnel would be trained to identify, and be aware of West Indian manatees, the potential for a vessel strike would likely be minimal.

Aquatic activities during Project construction (such as dredging, vessel operations, and pile driving) have the potential to physically disturb or displace West Indian manatees. The loudest underwater sound that manatees may encounter would be generated by impact pile-driving activities. Outfall pile-driving activities would be located along the south edge of the diversion construction. In the mid-region of Barataria Basin, the construction area accounts for only a small fraction of available habitat for West Indian manatees, allowing them to pass safely around the construction area. Manatees present within the area during pile-driving activities may be affected by elevated underwater sound levels. When practicable, the use of vibratory hammers, rather than impact hammers, to install in-water piles would avoid the major potential physical effects to organisms from barotrauma; in-water impact pile driving is currently only proposed in the Mississippi River.

Manatees have been found to avoid areas of elevated underwater noise, even within preferred seagrass habitats (Miksis-Olds et al. 2007). Therefore, it is likely that all construction activities that increase underwater noise, such as vessel operations, dredging, or pile driving, would result in avoidance behaviors and temporary displacement from foraging areas, resulting in reduced foraging success and undue energy expenditure. The duration of such a response is expected to be only short-term and intermittent, correlating with brief encounters with mobile vessels or instances of pile driving.

Given the unlikely occurrence of this species in the construction area, and CPRA's use of USFWS-recommended BMPs, proposed Project construction *is not likely to adversely affect* the West Indian manatee and impacts are therefore considered negligible to minor and adverse.

4.12.2.1.1.3 Other Alternatives

Direct and indirect impacts on the West Indian manatee due to the construction of the 50,000 cfs and 150,000 cfs Alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion complex would have the same proposed features with similar construction footprints and construction duration. The width of the conveyance channel bottom and intake channel would be narrower for the 50,000 cfs Alternative (164 and 93 feet wide, respectively) and wider for the 150,000 cfs Alternative (630 and 300 feet wide, respectively) as compared to the Applicant's Preferred Alternative (300 and 194 feet wide, respectively), which could result in more or less fill material available for placement in the beneficial use areas as compared with the Applicant's Preferred Alternative. The construction of these other action alternatives would also require similar vessel traffic patterns and construction time frames (the 50,000 cfs Alternatives would require fewer vessel transits for materials and fewer construction months, while the 150,000 cfs Alternatives would require more vessels and construction time).

Given the similarities in location and footprint of the action alternatives to the Applicant's Preferred Alternative, only slight differences in potential impacts on the West Indian manatee would occur, specifically related to the slightly shorter or longer duration of construction and the slightly decreased or increased potential for vessel-related and noise impacts for the 50,000 cfs and 150,000 cfs alternatives, respectively. Therefore, these action alternatives *are not likely to adversely affect* the West Indian manatee and impacts are therefore likely to be negligible to minor and adverse.

Although dredged material would be placed in water for the construction of terraces, suitable habitat is not present in this area to the extent where manatees would be likely to transit to areas affected by terrace construction. Therefore, as compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on manatees as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives described above.

4.12.2.1.2 Operational Impacts

4.12.2.1.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from operations would occur. The Project area would continue to provide suitable aquatic habitat for the West Indian manatee, until habitat characteristics were otherwise modified. For example, and as noted in Section 4.2.3.2.1 in Geology and Soils, Delft3D Basinwide Modeling results project that under the No Action Alternative, land loss in the Barataria Basin would continue, resulting in the conversion of approximately 298,000 acres of emergent wetlands and other above-water landforms to subaqueous shallow water by year 2070. Although the deeper water levels may provide expansion opportunities for the manatee, it may also result in changes to the distribution of SAV (a food source for the manatee) in the Barataria Basin due to increasing water depths from sea-level rise. These impacts would occur gradually over time and are likely to be negligible given the range of salinities and forage available to manatees.

4.12.2.1.2.2 Applicant's Preferred Alternative

As discussed in Section 4.4.4.2.2.2 in Surface Water and Coastal Processes, when compared to the No Action Alternative, the Applicant's Preferred Alternative would result in decreased overall water depths in the outfall area (see Figure 4.4-12), although the remainder of the open basin would continue the trend of deepening depths due to sea-level rise. Overall water level increases in the Barataria Basin may result in an expanded area being accessible to manatees. Further, as discussed in Section 4.5 Surface Water and Sediment Quality, average salinity concentrations are projected to be consistently lower than the salinity concentrations under the No Action Alternative, with the exception of the area near the birdfoot delta, which would slightly increase in salinity over time due to a reduction in freshwater flows to the delta and sea-level rise. Given that manatees require regular access to fresh water (see Chapter 3, Section 3.12.1.1 in Threatened and Endangered Species), the maintenance of freshwater areas over time may benefit transiting manatees as they travel across the Gulf Coast.

In addition to decreasing salinity, Project operations are anticipated to decrease water temperatures in much of the basin during peak flows (see Section 4.10.4.4 in Aquatic Resources). The West Indian manatee could occur throughout the year in the Project area, individuals are most likely to be present in late spring through early fall, when monthly average temperatures are not anticipated to drop below manatee's minimum temperature tolerance 68°F (20°C).

Although only occurring as transients within the Barataria Basin, the USFWS identifies the protection and re-establishment of SAV as a recovery objective for manatees in Florida (USFWS 2001). As discussed in Section 4.10.3 in Aquatic Resources, the decrease in salinity in the Barataria Basin may result in increased total biomass of SAV over time when compared to the No Action Alternative, but may also result in a shift over time to include more fresh and intermediate SAV species.

Although maintenance of freshwater pockets within the Barataria Basin, and the land accretion allowing maintenance/establishment of SAV, would benefit manatees transiting through the Barataria Basin and along the Gulf Coast, the beneficial impacts would likely be insignificant considering the rarity of individuals within the Barataria Basin.

Adverse noise impacts on manatees due to maintenance dredging, if required, would be negligible. The underwater noise generated during maintenance dredging would be similar to the levels described above for construction of the proposed Project. However, periodic, individual maintenance dredging events would be conducted in the outfall area as needed (based on sedimentation rates within the outfall transition feature and federally maintained navigational channels) and would require a much shorter timeframe than the dredging that would be conducted to construct the Project.

Overall, operation of the proposed Project is *not likely to adversely affect* the West Indian manatee and impacts are therefore likely to be negligible to minor and adverse.

4.12.2.1.2.3 Other Alternatives

As manatees travel between fresh and marine waters, minor changes in salinity between these action alternatives are not anticipated to have a direct effect on any individuals traveling into the Barataria Basin. Further, as discussed in Section 4.5 Surface Water and Sediment Quality, neither the 50,000 cfs nor the 150,000 cfs Project flow alternatives appear to have a consistent or significant enough impact on salinities compared to the Applicant's Preferred Alternative to create clear differences in SAV occurrence. Maximum and minimum average monthly salinities (see Section 4.5 Surface Water and Sediment Quality, Table 4.5-2), show little relative difference between the Applicant's Preferred Alternative and the 50,000 cfs or 150,000 cfs Alternatives. Similarly, no significant differences in temperature changes were projected between the Applicant's Preferred Alternative and these other action alternatives. The impacts of decreased temperatures on West Indian manatees from the 50,000 cfs and 150,000 cfs Alternatives would be similar to those described for the Applicant's Preferred Alternative. Additionally, noise impacts would be similar to the Applicant's Preferred Alternative and negligible.

Given that minimal differences in SAV availability and temperatures are anticipated between these action alternatives, only slight differences in potential impacts on the West Indian manatee would occur. Therefore, the 50,000 cfs and 150,000 cfs Alternatives *are not likely to adversely affect* the West Indian manatee and impacts are therefore likely to be negligible to minor and adverse.

Terraces are believed to create conditions favorable to more SAV coverage when compared to the non-terraced alternatives. Field studies have found that marsh terraces in Louisiana promote the occurrence of SAV and increased SAV biomass compared to unterraced shallow marsh ponds, suggesting that the terrace alternatives may have a beneficial impact on SAV (Cannaday 2006, Brasher 2015). The terracing reduces fetch across the water surface, resulting in reduced wave action, erosion, and turbidity, and therefore greater opportunities for SAV establishment. However, as manatees are not anticipated to be likely in the area where the terraces would be located, an increase in SAV at these locations would have limited benefits to manatees. Therefore, as compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on manatees as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives described above.

4.12.2.2 Sea Turtles

As discussed in Chapter 3, Section 3.12 Threatened and Endangered Species, five species of sea turtles are present in the northern Gulf of Mexico, including the green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. Green and Kemp's ridley sea turtles are considered more likely to occur in the inshore waters of the

Project area (inside of the barrier islands) whereas the loggerhead sea turtle is likely present only in low abundance, and the hawksbill and leatherback sea turtles are considered unlikely to occur.

4.12.2.2.1 Construction Impacts

4.12.2.2.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The proposed Project area would continue to provide suitable terrestrial (beach) and aquatic habitat for sea turtles during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have an impact on aquatic habitat for sea turtles. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws, including the ESA.

4.12.2.2.1.2 Applicant's Preferred Alternative

Data from NMFS stranding records (NMFS 2020c), field researcher observations (Pulver et al. 2012, Scott-Denton et al. 2014) and published material on species life histories (see Chapter 3, Section 3.12.1.1 in Threatened and Endangered Species and Appendix O) indicate that all five listed species of sea turtles have the potential to occur in the marine portions of the Project area. Sea turtles are most likely restricted to areas near, or outside of, the barrier islands, with the exception of the Kemp's ridley sea turtle, which may occur further inshore in Barataria Bay (Coleman et al. 2017). Green and Kemp's ridley sea turtles are considered more likely to occur in the inshore waters of the Project area (inside of the barrier islands) whereas the loggerhead sea turtle is likely present only in low abundance, and the hawksbill and leatherback sea turtles are considered unlikely to occur. Sea turtles present in the Barataria Basin have feeding, swimming, or resting behaviors that keep them near the surface, where they may be vulnerable to vessel strikes, as well as entrapment by construction equipment and activities, in the unlikely event they are present in the construction area. As discussed in Chapter 3, Section 3.12.1.1 in Threatened and Endangered Species, there has been only limited sea turtle nesting documented in the Project area and no documented nesting in the construction area. Additionally, there is no critical habitat designated for any sea turtles in the Project construction area.

Project vessels associated with construction would transit the Barataria Basin using existing transit paths to minimize the potential for vessel strikes of sea turtles, CPRA has indicated that it would adhere to USFWS and NMFS-recommended BMPs during construction and operation of the proposed Project, which would include NMFS' *Vessel Strike Avoidance Measures and Reporting for Mariners* (NMFS 2008). Further, CPRA would implement NMFS' *Sea Turtle and Smalltooth Sawfish Construction Conditions* to minimize the potential for entanglement, vessel strike, and dredging impacts and NMFS' *Measures for Reducing Entrapment Risk to Protected Species*, to minimize the potential for sea turtles to become trapped behind or within naturally or artificially enclosed areas (NMFS 2006, NMFS 2012a).

CPRA would dredge estuarine soft bottoms and transit routes using hydraulic or mechanical means. CPRA has indicated that it would conduct dredging in the basin using floating tracked excavators and shallow draft cutter suction dredges. CPRA would not use hopper dredges, a dredge type that is known to impact sea turtles during use (NMFS 2007b). Dredging activities during construction would be temporary and local in nature because dredging in the Barataria Basin would be confined within the immediate outfall area and in a section of the access channel in The Pen. Although dredging actions could potentially result in injury to sea turtles, it is unlikely that they would occur in the dredging footprint, or the beneficial use placement areas, and CPRA's implementation of agency-recommended BMPs would further minimize the potential for impact (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan).

Multiple Environmental Assessments have been prepared by NMFS for Barataria Basin area projects involving marsh restoration activities using dredged material from offshore borrow areas, which were deemed not likely to adversely affect sea turtles (NMFS 2012b, 2013). These projects did include NMFS-recommended mitigation measures to minimize the potential for impacts on sea turtles, including incorporating measures for reducing the potential impacts from construction and entrapment to endangered species. CPRA has indicated that it would adhere to USFWS and NMFS-recommended BMPs during construction and operation of the proposed Project, as discussed above.

The primary forage component for green sea turtles, and a component of other sea turtle's diets, is SAV. Depending on the specific action occurring, SAV may either be lost (removed or covered during Project installation) or would be adversely impacted by the turbidity and sedimentation caused by construction activities. For example, dredged material placement in proposed beneficial use areas would smother any SAV present. Construction of the outfall transition feature would also involve removal or replacement of SAV habitat. However, the types of SAV present in the construction footprint (freshwater and intermediate SAV species) are not considered primary forage for sea turtles. Because a USGS analysis (DeMarco et al. 2018) indicates the likely presence of SAV throughout open-water areas in the Project area, and sea turtles are considered unlikely to occur in the construction footprint, this impact is expected to be negligible.

As identified in Table 4.12-2, acoustic thresholds for sea turtle injury and behavioral effects are relatively high and the noise-producing activities in the Barataria Basin (see Table 4.8-3 in Section 4.8 Noise) would only exceed the behavioral noise threshold during dredging near the diversion structure, and only for a distance of about 15 feet, which is not likely to result in impacts on sea turtles.

Table 4.12-2 Acoustic Thresholds for Sea Turtles		
Activity or Effect Level	**Root Mean Square Sound Level (dB RMS) (dB re 1 µPA)**	**Peak Sound Level (dB re 1 µPA)[a]**
Temporary Threshold Shift	--	226
Permanent Threshold Shift	--	232
Behavioral Effects	175	--
Source: NMFS 2019		

Given that sea turtles would be unlikely to occur in the construction footprint, and in consideration of the impacts and BMPs discussed above in the unlikely event that they were present, construction of the proposed Project is *not likely to adversely affect* sea turtles in the marine environment and impacts are likely to be negligible. In addition, there would be *no effect, and therefore no impact,* on nesting beaches or critical habitat, given the distance of these habitats from the construction area.

4.12.2.2.1.3 Other Alternatives

As discussed for the West Indian manatee (see Section 4.12.2.1), the construction requirements of the 50,000 cfs and 150,000 cfs Alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion complex would have the same proposed features and similar construction footprints. Only slight differences between the alternatives would occur based on the construction footprint, dredged material placement, vessel traffic patterns, and construction duration, and therefore impacts on sea turtles from construction would be similar to those discussed for the Applicant's Preferred Alternative.

Given the similarities in location and footprint of the action alternatives to the Applicant's Preferred Alternative, only slight differences in potential impacts on the sea turtles would occur, specifically related to the slightly shorter or longer duration of construction and the slightly decreased or increased potential for vessel-related impacts for the 50,000 cfs and 150,000 cfs alternatives, respectively. Therefore, the construction of either of these alternatives is *not likely to adversely affect* sea turtles in the marine environment and impacts would therefore likely be negligible. Construction of either alternative would have *no effect* and thus no impact on nesting beaches or critical habitat, given the distance of these habitats from the construction area.

For the terrace alternatives, although dredged material would be placed in water for the construction of terraces, the terrace construction sites are within the mid-basin, in the immediate outfall, and are not within areas that sea turtles are likely to travel to. Therefore, as compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on sea turtles as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives described above.

4.12.2.2.2 Operational Impacts

4.12.2.2.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from operations would occur. The Project area would continue to provide suitable terrestrial (beach) and aquatic habitat for sea turtles, until or unless habitat characteristics were otherwise modified. For example, and as noted in Section 4.2.3.2.1 in Geology and Soils, Delft3D Basinwide Modeling results project that under the No Action Alternative, land loss in the Barataria Basin would continue, resulting in the conversion of approximately 298,000 acres (80 percent) of emergent wetlands and other above-water landforms to subaqueous shallow water by year 2070. In addition, winter salinities are expected to increase over time, especially within the stations in the Lower Barataria Basin (see Section 4.5 Surface Water and Sediment Quality). The deeper waters and changing salinity levels may allow sea turtles to utilize habitats farther inshore as time progresses. However, sea turtles would also experience significant losses of potential nesting beaches along the barrier islands due to sea-level rise, assuming current trends continue (see Figure 4.12-1).

The loss of marsh habitat would affect the faunal populations of the Barataria Basin, including sea turtle prey items. For example, crabs are a main prey species of loggerhead and Kemp’s ridley sea turtles, and a decline in the local abundance of blue crab could have an indirect impact on these species, including a potentially significant impact on the Kemp’s ridley population (Seney and Landry 2011; NMFS, USFWS, and SEMARNAT 2011). Blue crabs are expected to have a moderate population decline over time in the Project area related to the loss of marsh vegetation (see Section 4.10.4.5 in Aquatic Resources), resulting in a reduction of primary prey species and a likely shift to more available prey species.

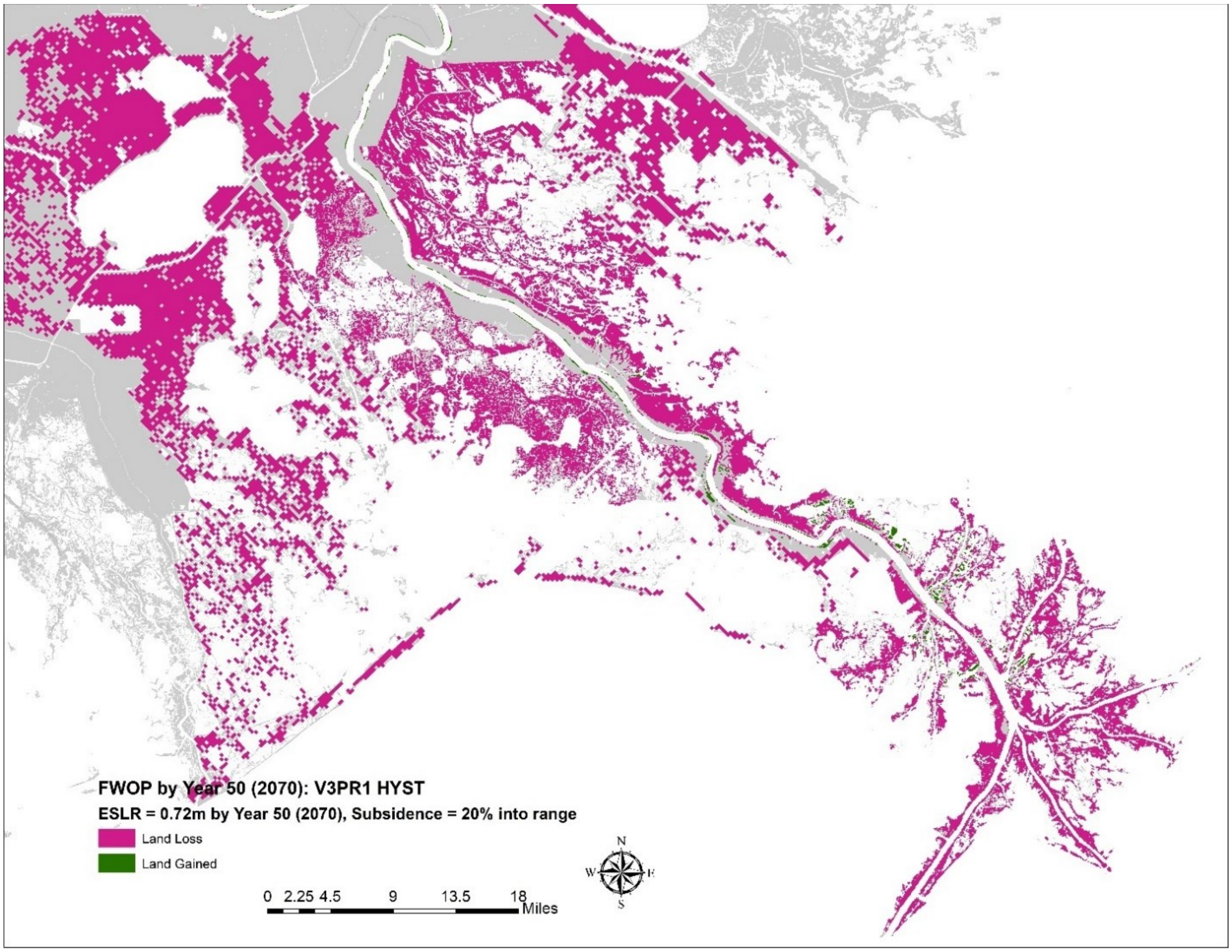


Figure 4.12-1. No Action Alternative Identifying Projected Land Loss in the Project Area by 2070.

Increases in water depth from sea-level rise may allow SAV to become established in newly submerged areas, but may also result in some currently suitable areas becoming less suitable for SAV (or specific SAV species) as water depth, salinity, wave action, and turbidity increase (see Section 4.10.4.1 in Aquatic Resources). Although the overall likelihood of occurrence of SAV in the Project area is expected to decrease over time (slowly at first, with larger decreases after 2050), the higher-salinity habitat near the barrier islands, which is likely the primary foraging ground for green sea turtles in the Barataria Basin, may retain SAV in areas with suitable water depths, and likely along the jetties and rocks where green turtle feeding on macroalgae has been observed.

Green and Kemp's ridley sea turtles are considered most likely to occur in the inshore waters of the Project area, with green turtles occurring near the barrier islands in the lower basin and Kemp's ridleys present in the lower and lower-mid basin. Loggerhead sea turtles are likely present in low abundances in the lower basin, and hawksbill and leatherback sea turtles are considered unlikely to occur in the Project area. Although four of the sea turtle species would likely be restricted to areas near to, or outside of, the barrier islands, the Kemp's ridley may be present further inshore, especially in the spring months (March through May; Coleman et al. 2017). Because the Kemp's ridley sea turtle is identified as having core use habitat in the Barataria Basin and the population could be affected by the moderate decline in blue crab over time, impacts on Kemp's ridley sea turtle are likely to be minor to moderate and adverse. The No Action Alternative will likely result in minor adverse impacts on the green and loggerhead sea turtles; although the expansion of higher-salinity waters into the basin may allow for additional foraging grounds, some adverse impacts on these species may occur from sea-level rise and changes in SAV and the prey base. Because the hawksbill and leatherback sea turtles are considered unlikely to occur in the Barataria Basin and naturally changing conditions in the Project area would occur slowly over time, the No Action Alternative would have no impact on these species.

4.12.2.2.2.2 Applicant's Preferred Alternative

4.12.2.2.2.2.1 Aquatic Habitat

As discussed in detail in Section 4.5 Surface Water and Sediment Quality, Delft3D Basinwide Modeling projects that the Applicant's Preferred Alternative would cause long-term, minor to moderate changes to salinity (primarily decreasing salinity) in the Barataria Basin during proposed Project operations. The model projects that by year 2070, average salinity concentrations would be consistently lower than those under the No Action Alternative, with the exception of the area near the birdfoot delta, which would slightly increase in salinity over time due to a reduction in freshwater flows to the delta and sea-level rise. In addition to the general trends over time, salinity would be variable across years, decreasing while the diversion is open (flowing greater than the 5,000 cfs base flow) and increasing after it closes (flowing at the 5,000 cfs base flow). In Section 4.10 Aquatic Resources, Figure 4.10-7 depicts the southwestern station near Grand Isle (B. Pass at GI), which identifies that, for both the No Action and Applicant's Preferred Alternatives, salinity in the Barataria Basin varies naturally during the course of the year according to various environmental factors. However, the Applicant's Preferred Alternative is projected to reach, or approach, 0 ppt at some places in the basin during periods when the diversion is open (flowing greater than the 5,000 cfs base flow), indicating that certain brackish or saline habitats would essentially be fresh during periods of each year. Although low salinity associated within freshwater input is not of particular concern for sea turtles themselves, it may indirectly affect them by altering habitat and prey, as discussed below (Ortiz et al. 2000, NMFS 2019a).

The decrease in salinity in the Barataria Basin may result in increased biomass of SAV over time when compared to the No Action Alternative, but would also result in a shift over time to include more fresh and intermediate SAV species. However, as shown in Section 4.10 Aquatic Resources, Figure 4.10-3, salinity regimes conducive to the growth of more saline SAV species would continue to occur along the barrier islands and birdfoot delta, providing potential forage opportunities for the green, hawksbill, and loggerhead sea turtles. See Section 4.10.4 in Aquatic Resources for additional discussion of the proposed Project on SAV.

As discussed in Chapter 3, Section 3.12.1.1 in Threatened and Endangered Species, most sea turtles eat a variety of prey items, including many that occur in predominantly nearshore or offshore waters (for example, jellyfish, sponges, urchins, and multiple species and/or life stages of fishes and crabs). In Section 4.5 Surface Water and Sediment Quality, Figures 4.5-3 and 4.5-7 depict the projected salinities for the No Action Alternative and Applicant's Preferred Alternative, respectively, over time; these projections indicate that salinity changes seaward of the barrier islands, and therefore impacts on nearshore and offshore prey species (or life stages of prey species), would be negligible to minor. This lack of notable change in nearshore and offshore salinity indicates that direct impacts on nearshore developmental habitat for Kemp's ridleys are not likely to occur.

However, prey species (or life stages thereof) occurring in the estuary could be affected by the inflow of fresh water and sediments from the diversion complex. As noted in Chapter 3, Section 3.12.1.1 in Threatened and Endangered Species, crabs are a main prey species of loggerhead and Kemp's ridley sea turtles and a decline in the local abundance of blue crab could have an indirect impact on these species, including a potentially significant impact on the Kemp's ridley population (Seney and Landry 2011; NMFS, USFWS, and SEMARNAT 2011). As discussed in Section 4.10.4.5 in Aquatic Resources, operation of the proposed Project is anticipated to have negligible to minor beneficial impacts on the local blue crab population (compared to the No Action Alternative), such that no adverse effects on loggerhead and Kemp's ridley sea turtles from changes in blue crab availability is anticipated.

Changes in local shrimp populations (including a decrease in the brown shrimp population and a negligible to minor increase in the white shrimp population) may result in changes to the shrimp fishery in the Project area (see Section 4.14.4.2 in Commercial Fisheries). If these changes result in shrimp fishers focusing on locations lower in the basin or in nearshore/offshore waters (where more sea turtles would be present), it may increase the potential for interactions between fishers and sea turtles, which is a primary threat to sea turtles. Increased interactions could increase the rate of injury and mortality to sea turtles present in the Project area.

Sea turtles are susceptible to cold-stunning events if the water temperature reaches 50°F (10°C), with death occurring between 41 to 43.7°F (5 to 6.5°C; NMFS 2018d). Delft3D Basinwide Modeling (under representative hydrographs for each decade) projects that the average temperatures at some locations in the proposed Project area would decrease slightly between December and February compared to the No Action Alternative, including additional locations reaching temperatures of 50°F (10°C) or below. Temperatures are projected to drop to 43.7°F (6.5°C) at HWQ-08 in the immediate outfall area (each modeled decade; see Section 4.4 Surface Water and Coastal Processes, Figure 4.4-4 for a map of the Delft3D Basinwide Model stations) or at the Barataria Bay Waterway (B. Waterway station shown in Figure 4.4-4) (two of the five modeled decades). The proposed Project could therefore allow for a higher chance of cold-stunning, and an introduced chance of death if a sea turtle were present mid-basin during January or February (or specifically at the immediate outfall area location [HWQ-08] during December). However, if sea turtles are present in the basin during winter months, they would be most likely to occur in the lower basin near the barrier islands, where cold-stunning would be less likely to occur. Although Kemp's ridley sea turtles venture further inshore, those northern movements are generally restricted to the spring, when warmer waters are present (Coleman et al. 2017, Valverde and Holzwart 2017). Thus, sea turtles are unlikely to be present in the mid-basin during January or February when temperatures are at their coldest.

Fibropapillomatosis disease (a virus), which causes benign tumors in sea turtles, has been linked to degraded marine habitats (NMFS 2019b). Increases in contaminants in both biota (sea turtle prey), and in the basin in general (see Section 4.5 Surface Water and Sediment Quality), from the diversion of water and sediment from the Mississippi River into the Barataria Basin, could potentially increase the incidence of fibropapillomatosis expression (tumor growth) in individual sea turtles. As discussed in Section 4.10.4.4 in Aquatic Resources, studies of operational diversions in the vicinity of the proposed Project (Caernarvon and Davis Pond Freshwater Diversions) have implied negligible impacts on fauna from the influx of river contaminants (Conzelmann et al. 1996, Jenkins et al. 2008); however, the substantially larger outflow of the proposed diversion may result in increased contaminant levels in biota. Increased contaminants may lead to additional health or other deleterious effects on sea turtles, the certainty and magnitude of which is unknown at this time.

Shifts in species composition of phytoplankton communities are commonly attributed to changes in nutrient supply ratios. For example, spring eutrophication from nitrogen loading of the Mississippi River to the Gulf of Mexico has been linked to enhanced phytoplankton production and the development of hypoxic zones. Similar impacts could also result from freshwater diversion into coastal basins. The diversion at Caernarvon was a major source of nutrients to the estuary (Day et al. 2009) and the phytoplankton blooms that occurred in the months following diversion operation suggested that nutrient loading may have been a contributing factor to the blooms. Therefore, operation of the proposed Project may result in an increase in phytoplankton blooms within the proposed Project area, which could result in additional food resources for sea turtle prey. Conversely, increases in phytoplankton could result in HABs or dissolved oxygen that could decrease available food resources for sea turtle prey (see Section 4.10.4.4 in Aquatic Resources). Sea turtles themselves are susceptible to brevetoxins associated with blooms of *Karenia brevis*, a dinoflagellate responsible for "Florida Red Tide" (Magaña et al. 2003). Sea turtle stranding rates are especially high during red tides, and necropsies have indicated the presence of brevetoxins in dead turtles. *K. brevis* is present throughout the Gulf of Mexico; however, blooms are typically associated with temperatures between 71 and 82°F (22 and 28°C) in higher-salinity waters along the Gulf shelf (Magaña et al. 2003). As the proposed Project is projected to result in decreased salinity and temperatures, it is unlikely to result in blooms of K. brevis.

Adverse noise impacts on sea turtles due to maintenance dredging, if required, would be negligible. As described for manatees, periodic, individual maintenance dredging events would be conducted in the outfall area as needed and would require a much shorter timeframe than the dredging that would be conducted to construct the Project.

Given that the hawksbill and leatherback, sea turtles would likely be limited to areas near to, or outside of, the barrier islands, and that limited effects on habitat and prey resources are expected in these portions of the Project area, the proposed Project *is not likely to adversely affect* these two species and negligible to minor adverse impacts are likely. However, the Kemp's ridley sea turtle is more likely to occur at locations in the mid-basin where impacts on salinity and temperature would be more prominent, and has been identified as having core use habitat in the Barataria Basin, which may make it more susceptible to changes in available habitat. Similarly, green and loggerhead sea turtles have the potential to occur in the lower basin with possible distribution into the mid-basin, although to a lesser extent than Kemp's ridley sea turtles. Due to the possible shift in commercial shrimp fishing efforts (that is, more shrimp fishing efforts in the lower basin), increased negative interactions between turtles and fishing gear may occur, potentially resulting in the injury or death of sea turtles. Therefore, operation of the proposed Project *is likely to adversely affect* the Kemp's ridley, green, and loggerhead sea turtle and minor to moderate adverse impacts are possible.

4.12.2.2.2.2.2 Nesting Beaches

Land loss at the barrier islands would occur throughout the analysis period if not otherwise mitigated over time; however, this land loss is also projected to occur under the No Action Alternative and is not the result of the proposed Project. Further, as discussed above, salinities seaward of the barrier islands are not anticipated to change substantially based on operation of the diversion. As the loggerhead sea turtle is the only documented sea turtle to nest in the Barataria Basin, the proposed Project is anticipated to have *no effect* and thus no impact, on the hawksbill, green, Kemp's ridley, or leatherback sea turtles on nesting beaches. Given the recent restoration efforts on multiple barrier islands and headlands, there is potential for greater nesting of loggerhead sea turtles in the future; however, the seaward facing beaches are not likely to be impacted by the Project and therefore, Project operation *is not likely to adversely affect* loggerhead sea turtles on nesting beaches.

4.12.2.2.2.2.3 Critical Habitat

Loggerhead critical habitat has been designated based, in part, on the presence of convergence zones, surface-water downwelling areas, and other factors, that allow for the concentration of *Sargassum*, water temperatures suitable for optimal growth of *Sargassum*, and inhabitance of loggerhead sea turtles. As discussed in Section 4.4.4.2.2.2 in Surface Water and Coastal Processes, operational impacts of the Applicant's Preferred Alternative on existing currents and flow would be permanent, minor to major, and adverse due to localized increases in water levels and marsh submergence, especially when the diversion gates are open (flowing greater than the 5,000 cfs base flow). The operating diversion would create a general north-to-south flow as fresh water moves towards the Gulf of Mexico; however, as discussed above, impacts on salinity patterns outside of the barrier islands are not projected to change substantially between the Applicant's Preferred Alternative and the No Action Alternative, which indicates that changes in currents at those locations are also not significant. Therefore, *no effect* and thus no impact on loggerhead sea turtle critical habitat is anticipated.

4.12.2.2.2.3 Other Alternatives

4.12.2.2.2.3.1 Aquatic Habitat

The other action alternatives generally do not result in significant changes from that described in the Applicant's Preferred Alternative and therefore, impacts on sea turtles would be similar to those described above. The larger drivers of impacts on sea turtles in the Barataria Basin include changes in temperature, SAV coverage, and prey availability. Temperatures for the action alternatives follow the same trends as the Applicant's Preferred Alternative, with minor differences (see Section 4.5.5.2 in Surface Water and Sediment Quality). As the changes in salinity for the other alternatives are not substantially different from the Applicant's Preferred Alternative, the biomass of SAV, which is expected to increase in freshwater areas, is also not anticipated to substantially change from the Applicant's Preferred Alternative (see Section 4.10.4.1 in Aquatic Resources), such that it would not cause different impacts on turtles.

As discussed in Section 4.10.4.5 in Aquatic Resources, Delft3D Basinwide Model-projected water flow and velocity for the 150,000 cfs Alternative is projected to occur farther afield, with possible disruptions to the larval transport periods of key species, including the blue crab, occurring at additional locations compared to the Applicant's Preferred Alternative. However, because the larval transport period of blue crab (and other prey species) extends over a long period, the incremental impacts associated with flow differences from the 150,000 cfs Alternative compared to the Applicant's Preferred Alternative would not alter the overall impacts identified above for blue crab, nor for the sea turtles that are anticipated to prey on them in the basin (Kemp's ridley and loggerhead).

Given that the hawksbill and leatherback sea turtles would likely be limited to areas near, or outside of, the barrier islands, and the limited effects on habitat and prey resources in these portions of the Project area, the 50,000 cfs or 150,000 cfs Alternatives may affect but *is not likely to adversely affect* these two species and impacts are likely to be negligible to minor adverse. However, the Kemp's ridley sea turtle is more likely to occur at locations in the mid-basin where impacts on salinity and temperature would be more prominent, and has been identified as having core use habitat in the Barataria Basin, which may make it more susceptible to changes in available habitat. Similarly, green and loggerhead sea turtles have the potential to occur in the lower basin with possible distribution into the mid-basin however to a lesser extent than Kemp's ridley sea turtles. Due to the possible shift in commercial shrimp fishing efforts (that is, more shrimp fishing efforts in the lower basin), increased negative interactions between turtles and fishing gear may occur, potentially resulting in the injury or death of sea turtles. Therefore, operation of the 50,000 cfs or 150,000 cfs

Alternatives *is likely to adversely affect* the Kemp's ridley, green and loggerhead sea turtles and impacts are therefore likely to be minor to moderate and adverse.

As discussed for the West Indian manatee above, terraces are believed to create conditions favorable to more SAV coverage when compared to the non-terraced alternatives by reducing fetch across the water surface, resulting in reduced wave action, erosion, and turbidity, and therefore greater opportunities for SAV establishment. Although additional areas of SAV would benefit sea turtles (mainly the green, loggerhead, and Kemp's ridley sea turtles), the terraces would be in the immediate outfall area, which are not expected to be used by sea turtles. Therefore, an increase in SAV at these locations would have limited benefits to sea turtles. Therefore, as compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on sea turtles as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives described above.

4.12.2.2.2.3.2 Nesting Habitat

As discussed in Section 4.5 Surface Water and Sediment Quality, neither the variable flow rate nor the presence of terraces appear to have a consistent or significant impact on salinities at the barrier islands, and none are likely along the seaward facing beaches. Therefore, the action alternatives are anticipated to have *no effect* and thus no impact on the hawksbill, green, Kemp's ridley, or leatherback sea turtles on nesting beaches, and would not be likely to adversely affect loggerhead sea turtles while on nesting beaches.

4.12.2.2.2.3.3 Critical Habitat

As discussed in Section 4.4.4.2.2.2 Surface Water and Coastal Processes, impacts on currents for the other alternatives are projected to be similar to those projected for the Applicant's Preferred Alternative. Therefore, *no effect* and thus no impact on loggerhead sea turtle critical habitat is anticipated.

4.12.2.3 Pallid Sturgeon

4.12.2.3.1 Construction Impacts

4.12.2.3.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The riverine portion of the proposed Project area would continue to provide suitable pallid sturgeon habitat during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have an impact on pallid sturgeon. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws, including the ESA.

4.12.2.3.1.2 Applicant's Preferred Alternative

Construction activities in the Mississippi River, such as dredging, vessel operations, pile driving, and pier construction, have the potential to disturb or injure pallid sturgeon present within the action area. The Mississippi River is about one-half mile wide at the Project location, which may not allow avoidance of areas of elevated construction noise, which could extend miles from construction (see Section 4.10.3.4 in Aquatic Resources). The loudest underwater sound that sturgeon may encounter would be generated by impact pile-driving activities, which have the potential to injure fish present within 3,281 feet of these activities and would occur 8 to 12 hours per day for 1 to 2 months (see Section 4.8 Noise, Table 4.8-4). High underwater noise levels are known to injure and/or kill fish by causing barotraumas (injuries caused by pressure waves, such as hemorrhage and rupture of internal organs), as well as causing temporary stunning and alterations in behavior (Turnpenny et al. 1994, Turnpenny and Nedwell 1994, Popper 2003, Hastings and Popper 2005). Behavioral responses may occur within about 2.9 miles of pile driving, and may include avoidance of the area, a startle response, or delayed foraging. According to Feist et al. (1992), broad-band pulsed noise (for example, impact pile-driving noise) rather than continuous, pure tone noises (for example, vibratory pile driving) are more effective at altering fish behavior. Although other construction activities, such as vessel operations, dredging, or vibratory pile driving would also result in increased noise, the produced noise levels are not anticipated to result in behavioral shifts of sturgeon.

The cofferdam and a river trestle dock would be built into the Mississippi River during construction of the intake system, which would temporarily remove about 3 acres of aquatic habitat from potential use (see Figure 2.8-1 in Chapter 2); any individuals entrapped within the cofferdams would be isolated and potentially lost. Presence of the cofferdams would likely lead to increased water velocity and changes in sediment movement, including scouring near the cofferdam and deposition downstream where water velocities would normalize. After construction, the cofferdams would be removed to allow the gated control structure to connect to the river. Although construction would result in temporary, minor, and adverse impacts on habitat immediately adjacent to the gated control structure and temporary dock, these impacts are anticipated to be insignificant to sturgeon. Further, although take could occur if a sturgeon were entrapped within the cofferdam, the small area of construction and the likely limited occurrence of the species in the Project area indicates that this potential effect is extremely unlikely to occur. However, based on the potential for injury during impact pile driving, construction of the proposed Project *may affect, and is likely to adversely affect* the pallid sturgeon and minor, adverse impacts are likely.

4.12.2.3.1.3 Other Alternatives

As discussed in Section 4.12.2.1, construction of the 50,000 cfs and 150,000 cfs Alternatives would require similar construction footprints on the river side, and would require the same construction activities (including impact pile driving in the Mississippi River), resulting in similar impacts as the Applicant's Preferred Alternative. Based on the potential for injury during impact pile driving, construction of the 50,000 cfs or 150,000 cfs Alternative *may affect, and is likely to adversely affect* the pallid sturgeon, and minor adverse effects are likely. The construction of terraces is not anticipated to result in impacts on the species, given that the terraces would be placed within the Barataria Basin, outside of the pallid sturgeon's habitat. Therefore, the 75,000 cfs, 50,000 cfs, and 150,000 cfs Terrace Alternatives would have the same construction impacts on pallid sturgeon, described above for the non-terrace alternatives, as compared to the No Action Alternative.

4.12.2.3.2 Operational Impacts

4.12.2.3.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no effect and thus no impacts from operations would occur. The proposed Project area would continue to provide suitable riverine habitat for pallid sturgeon, until or unless habitat characteristics were otherwise modified.

4.12.2.3.2.2 Applicant's Preferred Alternative

Operational impacts on the pallid sturgeon would generally be associated with potential entrainment through the gated control structure. Entrainment could lead to individual mortality or transfer into the Barataria Basin. Either of these impact pathways would result in the effective removal of entrained individuals from the viable population.

Entrainment of pallid sturgeon is known to occur as a result of freshwater diversions from the Mississippi River. During emergency operations of the Bonnet Carré Spillway (at RM 133) in 2011, the recorded entrainment of 20 pallid sturgeon was attributed to the magnitude of the spillway's discharge rates, which averaged 207,909 cfs and reached a maximum flow of 315,930 cfs. Operations of the spillway in 2008 had a maximum flow of 160,144 cfs and entrained 14 pallid sturgeon. Emergency operations of the spillway in 2016, which was open for 22 days and had a maximum discharge of 202,500 cfs, did not result in recorded entrainment of pallid sturgeon but did record one entrained shovelnose sturgeon. No larvae of the genus *Scaphirhynchus* were collected after the spillway openings, although larval collection usually requires considerable effort (USFWS 2018d). Other studies (Schultz 2013) found that small numbers of pallid sturgeon were entrained by the Davis Pond Freshwater Diversion at RM 119. Smaller diversions at RM 83.8, 81.5, 64.5, and 63.9 were also sampled; however, no pallid sturgeon were detected.

The specific reasons for entrainment are currently unknown but have been hypothesized to include one or more of the following reasons: (1) sturgeon are near the structure during the opening (immediate entrainment of individuals), (2) sturgeon actively enter the structure to obtain refuge or prey, or to move into a perceived transit path, or (3) sturgeon are passively or actively entrained during down-river migration

(USFWS 2018d). Pallid sturgeon also have positive rheotaxis and orient towards flow (Hoover et al. 2011). This may affect the likelihood that sturgeon would enter the diversion intake.

Pallid sturgeon density is thought to be extremely low in the Lower MRD and habitat suitability is thought to decrease south of New Orleans towards the delta. Although limited sampling has occurred in the area, the nearest recorded capture of an adult pallid sturgeon was at River Mile 80, about 19 miles upriver of the proposed Project, but south of New Orleans (USFWS 2016a). Although the proposed Project would have lower flow rates than those identified during operation of the Bonnet Carré Spillway, diversions of up to 75,000 cfs would result in permanent, moderate, and adverse impacts on the existing currents and water flow in the Mississippi River, creating a ZOI that would turn existing downstream flow towards the intake channel (see Section 4.4.4.2 in Surface Water and Coastal Processes). Overall displacement and entrainment rates would be dependent upon the swimming capabilities, water velocity, and life stage habitat requirements for fish (USACE 2008a). However, the altered current pattern would allow adult sturgeon present in the area to passively or actively enter the gated control structure during migration, or in search of refuge or food, representing a moderate adverse impact on the pallid sturgeon.

Although the ZOI in which existing flow would be substantially altered would be relatively small in comparison to the area of the Mississippi River at the location of the diversion (see Section 4.4 Surface Water and Coastal Processes, Figure 4.4-32), and the density of pallid sturgeon is believed to be low south of New Orleans, sturgeon caught in the modified flow or seeking refuge or food sources within the gated control structure would be entrained and would likely be removed from the viable population. A population viability model prepared by Friedenberg and Siegrist (2019) indicated that, based on various models and entrainment calculations, the Applicant's Preferred Alternative could entrain between 7 and 58 pallid sturgeon (age 1 or above) during each operational year, which would result in the direct loss of between 350 and 2,403 pallid sturgeon over the analysis period (see Appendix O for detailed information on entrainment assessment). This loss of sturgeon from the population would leave fewer individuals available to reproduce which would result in reduced population growth ranging from 0.07 to 0.43 percent per year. In consideration of the potential take of sturgeon from the proposed Project over the 50-year analysis period, the proposed Project *may affect and is likely to adversely affect* the pallid sturgeon and moderate adverse impacts on the species are therefore likely.

4.12.2.3.2.3 Other Alternatives

Impacts on Mississippi River flows and currents would increase under the 150,000 cfs Alternative as compared to the Applicant's Preferred Alternative, with up to twice as much water diverted during operations and likely resulting in a larger ZOI in which existing downstream flow would turn towards the intake channel. As identified above, this turn in downstream flow may result in sturgeon orienting towards and entering the gated control structure. In contrast, impacts on river flow at the diversion would be less under the 50,000 cfs Alternative as compared to the Applicant's Preferred

Alternative. Further, although entrainment models were not completed for the action alternatives, the higher flow associated with the 150,000 cfs Alternative would result in a higher entrainment rate of pallid sturgeon into the Barataria Basin and a further reduction in annual population growth; similarly, the 50,000 cfs Alternative would result in a lower entrainment rate than the Applicant's Preferred Alternative. However, as take is likely in all scenarios, each alternative *may affect, and would be likely to adversely affect*, the pallid sturgeon and moderate adverse impacts on the species are therefore likely.

The presence of terraces in the immediate outfall area would not result in entrainment of pallid sturgeon. Therefore, the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives with terraces alternatives would have the same operational impacts on pallid sturgeon described above, as compared to the No Action Alternative.

4.12.2.4 Piping Plover and Red Knot

4.12.2.4.1 Construction Impacts

4.12.2.4.1.1 <u>No Action Alternative</u>

Under the No Action Alternative, construction of the proposed Project would not occur. Mud flats and similar habitats in the construction footprint would continue to provide suitable foraging habitat for the piping plover and red knot during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have an impact on piping plover and red knot foraging habitat. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws, including the ESA.

4.12.2.4.1.2 <u>Applicant's Preferred Alternative</u>

Piping plover and red knot occurrence in the Project area is generally restricted to the barrier islands, where the coastal beaches provide foraging for invertebrates, although mud and intertidal flats may also be used throughout the basin to a lesser degree, especially for the piping plover (see Chapter 3, Section 3.12.1.3 in Threatened and Endangered Species). The proposed diversion complex is about 20 miles north/northeast of these beaches (which include designated [piping plover] and proposed [red knot] critical habitat) and therefore would have no effect on them. Although mud and intertidal flats closer to the diversion complex may be used for foraging during migrations, they would be used in a limited capacity and the birds would be able to relocate during any active construction if the activities overlapped. Therefore, construction of the proposed Project is not likely to adversely affect (would have negligible impacts on) the piping plover and red knot.

4.12.2.4.1.3 Other Alternatives

As discussed for the West Indian manatee (see Section 4.12.2.1), the construction requirements of the 50,000 cfs and 150,000 cfs Alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion complex would have the same proposed features and similar construction footprints. Only slight differences between the alternatives would occur based on the operational footprint, dredged material placement, vessel traffic patterns, and construction duration. Piping plover and red knot occurrence in the Project area is generally restricted to the barrier islands, where the coastal beaches provide foraging for invertebrates. Therefore, construction of the other alternatives is not likely to adversely affect (would have negligible impacts on) the piping plover and red knot and would have no effect (no impact) on the designated (piping plover) or proposed (red knot) critical habitat.

As terrace construction would occur within the immediate outfall area with no impact on barrier islands, as compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on the piping plover and red knot as the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives described above.

4.12.2.4.2 Operational Impacts

4.12.2.4.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from operations would occur. Barrier islands, mud flats, and similar habitats in the proposed Project area would continue to provide suitable foraging habitat for the piping plover and red knot, until or unless habitat characteristics were otherwise modified. However, the Delft3D Basinwide Model has projected that sea-level rise would submerge the majority of the birdfoot delta area and much of the barrier islands by 2070 (see Figure 4.12-1); this land loss would also decrease the amount of critical habitat available to these two species. Therefore, the sea-level rise that would occur under the No Action Alternative would likely have moderate, adverse impacts on the piping plover, red knot, and designated (piping plover) and proposed (red knot) critical habitat.

4.12.2.4.2.2 Applicant's Preferred Alternative

Modeled water levels near Grand Isle and in the birdfoot delta would not change substantially over time from the No Action Alternative, but are projected to increase over time as a result of sea-level rise (see Section 4.4 Surface Water and Coastal Processes, Figures 4.4-18 and 4.4-19). Although the rise in water levels may decrease the amount of beach habitat available for wintering birds, the impacts would not be related to the proposed Project. Conversely, sediment input from the diversion would build land in the outfall, which would result in the creation of mudflats prior to the establishment of wetland vegetation. This land accretion would likely be a negligible benefit to the piping plover and red knot as they typically use the barrier islands for foraging.

Salinity trends in the Barataria Basin would change as a result of the proposed Project, with average salinity concentrations generally projected to be lower than those under the No Action Alternative, with the exception of one station in the birdfoot delta area (birdfoot delta [CRMS 0163]) where salinity would rise slightly as compared to the No Action Alternative, likely due to predicted sea-level rise, as well as projected water elevation and bottom elevation changes due to the proposed Project. Impacts on salinity at Grand Isle (B. Pass at GI) are projected to be minor (barely detectable and localized) during the dry winter months and moderate during the wet spring months when the gates would be open (flowing greater than the 5,000 cfs base flow) (see Section 4.5 Surface Water and Sediment Quality, Figure 4.5-6); these salinity patterns would likely be similar at the adjacent barrier islands. Over time, Delft3D Basinwide Modeling projects that the salinity differences between the Applicant's Preferred Alternative and the No Action Alternative would begin to align more closely at this station, such that the differences in salinity would be negligible to minor by year 2070 of operation. Projected sea-level rise over the analysis period is discussed in Section 4.4.2 in Surface Water and Coastal Processes. Although changes in salinity could result in alteration of the infaunal prey species present along the coastal beaches, the benthic community would likely return quickly after disturbance given the dynamic nature of the Barataria Basin and the natural potential for salinity shifts over the course of the year (see Section 4.5 Surface Water and Sediment Quality, Figures 4.5-3 and 4.5-10). Changes in salinity are likely to cause no more than negligible to minor adverse impacts on the two bird species or their prey and operation of the proposed Project may affect but *is not likely to adversely affect* the piping plover or red knot.

The piping plover has critical habitat designated in the proposed Project area, which includes the barrier islands and a location within the birdfoot delta (see Chapter 3, Section 3.12 Threatened and Endangered Species, Figure 3.12-1). Diversion of fresh water and sediments into the Barataria Basin would result in fewer sediments reaching the birdfoot delta. This decrease in sediments is projected to result in land loss in the birdfoot delta as compared to the No Action Alternative see Section 4.2 Geology and Soils); however, regardless of the proposed Project, the Delft3D Basinwide Model has projected that sea-level rise would submerge the majority of the birdfoot delta area, including the critical habitat located there, by 2070 (see Figure 4.12-2). As such, the 45 percent loss of land in the birdfoot delta, when compared to the No Action Alternative, would be farther inland than the location of the current critical habitat. Similarly, land loss along the barrier islands is projected to occur over time, which would minimize available foraging habitat. Figure 4.12-2 depicts the projected change in land cover in 2070 between the Applicant's Preferred Alternative and the No Action Alternative. Given that the loss of the critical habitat unit in the birdfoot delta, and the minimization of critical habitat areas along the barrier islands, would occur through projected sea-level rise unrelated to the proposed Project, operation of the proposed Project would have *no effect* and thus no impact on critical habitat for the piping plover because operation of the proposed Project is not likely to change the coastal processes that would continue to influence barrier island morphology. Proposed critical habitat for the red knot (which includes additional barrier islands but excludes the birdfoot delta when compared to piping plover critical habitat) would be similarly affected by sea-level rise.

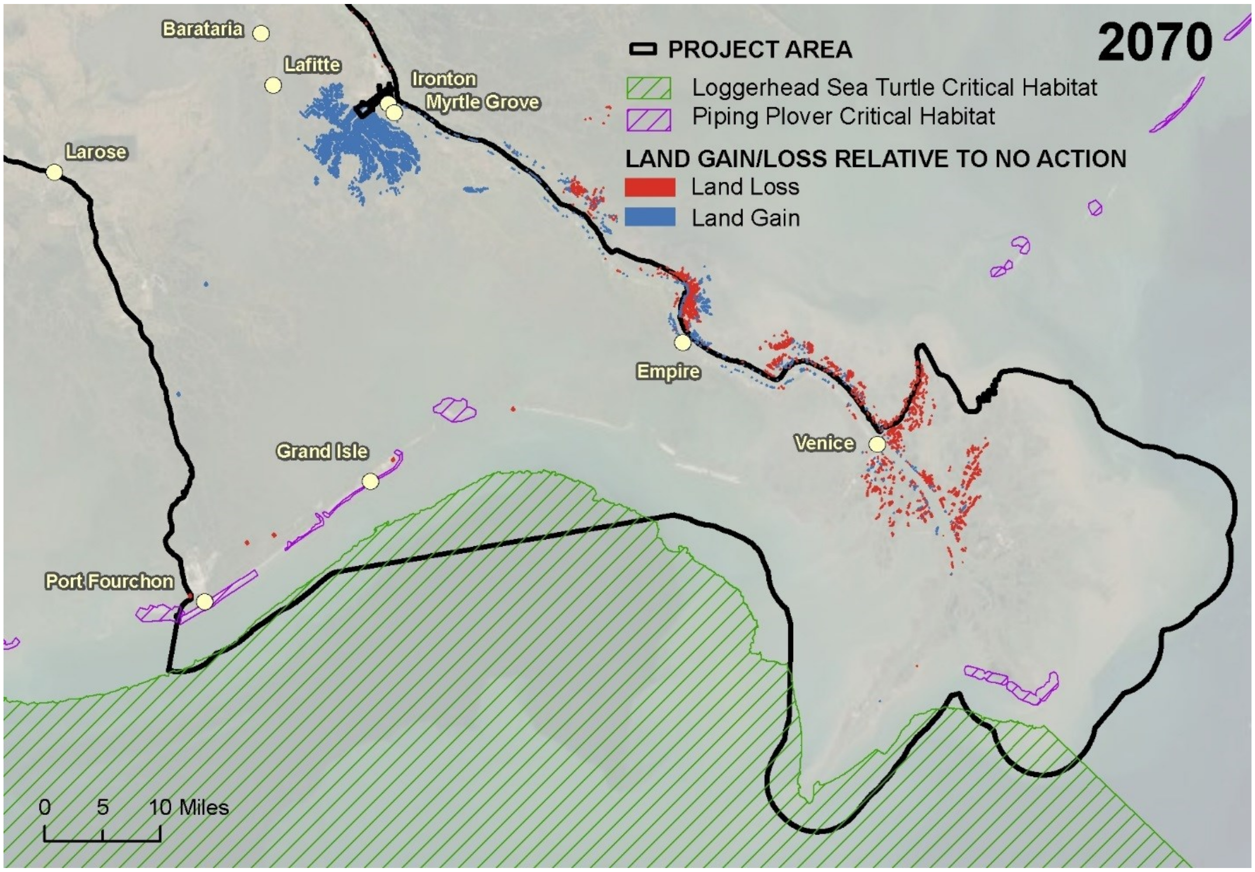


Figure 4.12-2. Land Gain/Loss Relative to the No Action Alternative for the Year 2070.

4.12.2.4.2.3 Other Alternatives

As shown in Section 4.5 Surface Water and Sediment Quality, Figure 4.5-6, impacts on salinity at the barrier islands (Grand Isle) from the action alternatives would follow similar trends as those described above, with slight increases (50,000 cfs Alternatives) or decreases (150,000 cfs Alternatives) in salinity compared to the Applicant's Preferred Alternative. Therefore, each action alternative *is not likely to adversely affect* the piping plover and red knot.

Regarding land loss over time, each of the other action alternatives including the terrace alternatives are projected to result in similar impacts from land loss in the birdfoot delta when compared to the No Action Alternative (see Section 4.2 Geology and Soils). As with the Applicant's Preferred Alternative, this relative land loss is farther inland on the birdfoot delta than the current location of the piping plover critical habitat, and the action alternatives would have *no effect* and thus no impact on critical habitat for the piping plover because operation of the proposed Project is not likely to change the coastal processes that would continue to influence barrier island morphology.

Proposed critical habitat for the red knot (which includes additional barrier islands but excludes the birdfoot delta when compared to piping plover critical habitat) would be similarly affected by sea-level rise.

4.12.2.5 Eastern Black Rail

4.12.2.5.1 Construction Impacts

4.12.2.5.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The proposed Project area would continue to provide suitable marsh habitat for the black rail during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have an impact on black rail habitat. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws, including the ESA.

4.12.2.5.1.2 Applicant's Preferred Alternative

As discussed in Chapter 3, Section 3.12.1 in Threatened and Endangered Species, black rails prefer higher elevation wetlands and marshes with infrequent flooding. Although wetlands are present in the footprint of the diversion, they are either forested wetlands or maintained, agricultural wetlands that are not preferred by black rails. The preferred high marshes are not present in the footprint of construction; however, construction activities may disrupt resident black rails in marsh near the construction footprint during their nesting and non-nesting seasons. Foraging birds would likely leave the area during active construction, but noise, artificial lighting, and human disturbance adjacent to nesting activity could cause nest avoidance or abandonment. However, given the expectation of low densities in the general Project area, construction activities are *not likely to adversely affect* black rails and impacts on the species are considered negligible.

4.12.2.5.1.3 Other Alternatives

As discussed for the West Indian manatee (see Section 4.12.2.1), the construction requirements of the other action alternatives including the terrace alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion complex would have the same proposed features and similar construction footprints. Only slight differences between the alternatives would occur based on the operational footprint, dredged material placement, vessel traffic patterns, and construction duration. As discussed for the Applicant's Preferred Alternative, high marsh is not present in the construction footprint of these alternatives, such that impacts would be restricted to the disruption of individuals in proximity to construction activities, if present. However, given the expectation of low densities in the Project area, these impacts are anticipated to be unlikely to occur and construction activities are *not likely to adversely affect* black rails and impacts on the species are likely to be negligible.

4.12.2.5.2 Operational Impacts

4.12.2.5.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed, and therefore no impacts from operations would occur on potential marsh habitat near the diversion complex or in the Barataria Basin. The proposed Project area would continue to provide potentially suitable marsh habitat for the black rail, until or unless habitat characteristics were otherwise modified. For example, and as noted in Section 4.2.3.2.1 in Geology and Soils, Delft3D Basinwide Modeling results project that under the No Action Alternative, land loss in the Barataria Basin would continue, resulting in the conversion of approximately 298,000 acres of emergent wetlands and other above-water landforms to subaqueous shallow water by year 2070. Changes in marsh habitat would occur gradually over time and would likely result in negligible impacts on the black rail.

4.12.2.5.2.2 Applicant's Preferred Alternative

Peak operation flows are predicted to change the water quality within the mid-basin, initially inundating marsh vegetation in the immediate outfall area and shifting brackish marsh habitats to fresh/intermediate marsh habitats in the outfall area over the analysis period. This impact to emergent vegetation and invertebrate communities would be short-term, although the annual startup of operations (including acute decreases in salinity) may result in recurring impacts on the benthic population (see Section 4.10.4.2 in Aquatic Resources). The temporary decrease in available quality marsh habitat, if present in the immediate outfall area, due to initial marsh inundation by the proposed Project is not anticipated to substantially affect the mobile black rail.

The proposed Project is anticipated to add and maintain areas of marsh habitat adjacent to and near the Project diversion, while slightly decreasing the amount of marsh in the birdfoot delta, resulting in a net preservation of marsh habitats in comparison to the No Action Alternative over time. Changes to marsh habitat vegetation and infaunal communities would change the composition of available prey resources for the black rail, but would also preserve and increase the area of available marsh habitat in the mid-basin over time. Long-term effects to black rail, which do not show preference between marsh types, are anticipated to be positive, with black rail benefiting from areas of marsh habitat creation and preservation. Because the density of black rail in the Project area is anticipated to be low and impacts are generally short-term or beneficial, operation of the proposed Project *is not likely to adversely affect* the black rail and impacts are likely to be negligible.

4.12.2.5.2.3 Other Alternatives

During operation, each action alternative would have slightly different impacts associated with wetland creation; however, these differences would not result in significant changes in area habitat. Wetland gains in the Barataria Basin, when compared to the No Action Alternative, are projected to be 9,240 acres for the 50,000 cfs Alternative, increasing incrementally across the terraced and non-terraced alternatives and reaching a projected maximum increase of 26,408 acres for the 150,000 cfs + Terraces Alternative (see Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-4). Wetland losses within the birdfoot delta would generally increase as sediments are diverted from the Mississippi River, resulting in a projected loss of between 2,434 and 2,891 acres of wetlands by 2070. Although there would be a net increase in wetlands, the density of black rail in the Project area is anticipated to be low and therefore impacts from the operation of any action alternative *not likely to adversely affect* the black rail and impacts are considered to be negligible.

4.12.2.6 Giant Manta Ray

4.12.2.6.1 Construction Impacts

4.12.2.6.1.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed. As the giant manta ray is not expected to be present in the areas where construction activities would occur, the No Action Alternative would have no impact on the giant manta ray.

4.12.2.6.1.2 Applicant's Preferred Alternative

Giant manta rays are expected to occur around the barrier islands and river outlets, and possibly a short way up into the Barataria Basin. They are not expected to occur up in the shallow marsh habitats where Project construction activities would occur, and therefore are not expected to be affected by construction-related effects such as noise, turbidity, and vessel traffic. Because of the potential presence in the basin, but the unlikely presence of giant manta ray within or near the construction area, construction of the Project would have a negligible impact on the giant manta ray and is *not likely to adversely affect* the species.

4.12.2.6.1.3 Other Alternatives

The construction requirements of the 50,000 cfs and 150,000 cfs Alternatives would be similar to those for the Applicant's Preferred Alternative, with slight differences between the operational footprints, dredged material placement, vessel traffic patterns, and construction duration. However, because giant manta rays are not expected to occur up in the shallow marsh habitats where the Project construction activities would occur, construction of the other alternatives would also have a negligible impact on the giant manta ray and are *not likely to adversely affect* the species.

4.12.2.6.2 Operational Impacts

4.12.2.6.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from operations would occur. Although sea-level rise would continue to submerge lands in the Project area, resulting in slightly deeper waters over time, the depths in the northern basin are unlikely to rise to the extent of providing suitable or preferred depths for the species. Therefore, the No Action Alternative would have no impact on the giant manta ray.

4.12.2.6.2.2 Applicant's Preferred Alternative

Operational effects (changes in salinity, temperature, and turbidity/nutrients) are expected to be very minor in the outer edges of the Project area where giant manta rays are expected to occur. Therefore, Project operations would have a negligible effect on the species and thus the Project is *not likely to adversely affect* the giant manta ray.

4.12.2.6.2.3 Other Alternatives

During operation, each action alternative would have slightly different impacts associated with salinity, temperature, and turbidity/nutrients in the lower basin; however, these differences would not result in significant changes in area habitat. Therefore, operation of any action alternative *not likely to adversely affect* the manta ray and impacts are considered to be negligible.

4.12.3 State-listed Threatened and Endangered Species

4.12.3.1 Saltmarsh Topminnow

4.12.3.1.1 Construction Impacts

4.12.3.1.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The proposed Project area would continue to provide suitable aquatic habitat for the saltmarsh topminnow during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have an impact on saltmarsh topminnow. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.12.3.1.1.2 Applicant's Preferred Alternative

Impacts on the saltmarsh topminnow could be caused by local disturbance and soil/sediment work. About 682 acres of open water, most of which would be estuarine waters that are potentially suitable habitat for the saltmarsh topminnow, would be impacted during construction of the diversion complex. About 173.9 acres of emergent wetlands would also be affected during construction (excluding 69 acres in the beneficial use areas; see Table 4.6-1 in Section 4.6 Wetland Resources and Waters of the U.S.).

As discussed in Section 4.5 Surface Water and Sediment Quality, temporary, minor or moderate construction impacts on water quality would result from the resuspension of fine sediments in the water column associated with in-water activities or runoff of soils and sediment from nearby work areas, resulting in increased turbidity and TSS, and subsequent decreased dissolved oxygen. Increases in turbidity and TSS could reduce available dissolved oxygen, reduce swimming performance, and increase the temperature of the water column (Kjelland et al. 2015); however, these impacts are expected to decrease with distance from the construction area. Impacts of noise on fish from pile driving in the Barataria Basin are discussed in Section 4.10.3.4 in Aquatic Resources; although behavioral impacts may occur if individuals are in proximity to specific construction activities (such as within 705 feet of pile driving), injurious levels would extend only up to 10 feet, such that no injury would be anticipated based on estimated sound levels. Given the limited areas of disturbance, the temporary and localized nature of dredging and construction activities in the Barataria Basin, and the widely available habitat in the Project area (shallow, fresh to saltwater areas), construction activities in the Barataria Basin would likely have minor, temporary, adverse, direct and indirect impacts on the saltmarsh topminnow population.

4.12.3.1.1.3 Other Alternatives

As discussed for the West Indian manatee (see Section 4.12.2.1), the construction requirements of the 50,000 cfs and 150,000 cfs Alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion complex would have the same proposed features and similar construction footprint, with only slight differences between the alternatives based on the operational footprint, dredged material placement, vessel traffic patterns, and construction duration. The construction impacts associated with the terrace alternatives which would result in additional sediments being placed in open water, would be negligible given the amount of suitable habitat elsewhere in the Project area. Given the similarities in location and footprint of the action alternatives to the Applicant's Preferred Alternative, the construction of any action alternative including the terrace alternatives would have minor, temporary, adverse, direct and indirect impacts on the saltmarsh topminnow population.

4.12.3.1.2 Operational Impacts

4.12.3.1.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from operations would occur. The proposed Project area would continue to provide suitable aquatic habitat for the saltmarsh topminnow, until or unless habitat characteristics were otherwise modified. For example, and as noted in Section 4.2.3.2.1 in Geology and Soils, Delft3D Basinwide Modeling results project that under the No Action Alternative, land loss in the Barataria Basin would continue, resulting in the conversion of approximately 298,000 acres of emergent wetlands and other above-water landforms to subaqueous shallow water by year 2070. This loss of marsh habitat would decrease the availability of protected, quiet, fresh waters favored by the species, likely resulting in additional stress on the species over time, resulting in a minor, permanent, indirect, and adverse, over the long-term.

4.12.3.1.2.2 Applicant's Preferred Alternative

Operational impacts would generally be associated with the introduction of fresh water and sediments, as well as nutrients, from the Mississippi River into the Barataria Basin. The saltmarsh topminnow is found in salinities up to 20 ppt, but is most commonly found in salinities between 1 and 4 ppt (76 FR 49412, Robertson 2016). As discussed in Section 4.5 Surface Water and Sediment Quality, average salinity concentrations under the Applicant's Preferred Alternative are projected to be consistently lower than the salinity concentrations under the No Action Alternative, with the exception of the area near the birdfoot delta, which would slightly increase in salinity over time due to reduced freshwater inputs and projected sea-level rise. Although the Barataria Basin is generally projected to remain within the salinity range of the species for the No Action Alternative (see Section 4.5 Surface Water and Sediment Quality, Figure 4.5-3), the general decrease in relative salinity from the Applicant's Preferred Alternative would maintain larger areas of habitat within the lower-salinity range of the species (in which they are more common). Although the salinity regime is projected to shift in some locations (from predominately intermediate to predominantly fresh or from predominately marine to predominately intermediate), estuarine species can often adapt to salinity variability, including relatively rapid decreases in salinity (occurring over 24 hours or more; Bachman and Rand 2008), such as those that may occur during onset of operations above base flow. As Bachman and Rand's (2008) study included four species, each of which are in the same Order of fishes as the saltmarsh topminnow (Order Cyprinodontiformes, including guppies, mollies, swordtails, and killifish), it is likely that the saltmarsh topminnow would show similar adaptability.

The diversion of sediments would result in increased turbidity and sedimentation within the Barataria Basin. These impacts would be similar to those discussed for construction, although the duration and extent of turbidity and sedimentation would be greater in magnitude and duration. Further, the introduction of sediments would allow for the maintenance of 12,700 acres more wetlands in the basin, when compared to the No Action Alternative, which would result in a beneficial impact on the species from the presence of quieter waters protected by wetlands. The introduction of fresh water and sediments would also result in increased nutrients being introduced into the basin, which could have both beneficial (from increased primary production) and adverse (from potential decreases in dissolved oxygen and increased potential for HABs) effects, as discussed in Section 4.10 Aquatic Resources. Changing habitat and increased sedimentation would result in adverse impacts on the saltmarsh topminnow, but the proposed Project would also result in beneficial impacts from the maintenance of more wetland habitat compared to the No Action Alternative. Overall, the species is likely to experience minor to moderate, permanent, direct and indirect, beneficial impacts from operation of the proposed Project, with the moderate impacts occurring later in the analysis period as wetlands are maintained and created in the outfall area.

4.12.3.1.2.3 Other Alternatives

During operation, each action alternative would have slightly different impacts associated with salinity changes, sedimentation, and wetland creation; however, these differences would not result in significant changes in area habitat. For example, wetland gains in the Barataria Basin, when compared to the No Action Alternative, are projected to be 9,240 acres for the 50,000 cfs Alternative, increasing incrementally across the terraced and non-terraced alternatives and reaching a projected maximum increase of 26,408 acres for the 150,000 cfs + Terraces Alternative (see Section 4.6 Wetland Resources and Waters of the U.S., Table 4.6-4). Wetland losses within the birdfoot delta would generally increase as sediments are diverted from the Mississippi River, resulting in a projected loss of between 2,434 and 2,891 acres of wetlands by 2070. Although adverse impacts on wetlands would occur in the birdfoot delta, the maintenance and creation of wetlands in the upper and mid portions of the Barataria Basin would result in minor to moderate, permanent, direct and indirect, beneficial impacts from operation of any of the action alternatives, including the terrace alternatives, with the moderate impacts occurring later in the analysis period as wetlands are maintained and created in the outfall area.

4.12.3.2 Bald Eagle

4.12.3.2.1 Construction Impacts

4.12.3.2.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The proposed Project area would continue to provide suitable nesting and foraging habitat for the bald eagle during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that could have an impact on the bald eagle. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws, including the Bald and Golden Eagle Protection Act.

4.12.3.2.1.2 Applicant's Preferred Alternative

Impacts on the bald eagle during construction of the proposed Project would be caused by construction noise, lighting, and increases in human activity in the construction area. As discussed in Chapter 3, Section 3.12.2.2 in Threatened and Endangered Species, although bald eagles are known to nest in the Project area, no current bald eagle nests are present in proximity to the construction footprint (USFWS 2019c); however, CPRA would also conduct preconstruction surveys to verify the absence of bald eagle nests and would consult with the USFWS if any were encountered. Development of the diversion complex would result in the permanent loss of 154.9 acres of upland forested habitat and 21.7 acres of forested wetlands within the terrestrial footprint of the proposed Project that could be used for nesting. Noise, artificial lighting, and increased human presence could cause startling of bald eagles, prolonged nest avoidance, and premature nest departure by eaglets which could lead to injury, reduced productivity, or nest abandonment, if present at the time of construction (USFWS 2019d). Given the limited timeframe of construction, and the lack of known bald eagle nests within 3 miles of construction, impacts on bald eagles from the clearing of potential future nesting habitat would be adverse but negligible.

4.12.3.2.1.3 Other Alternatives

As discussed for the West Indian manatee (see Section 4.12.2.1), the construction requirements of the other five action alternatives would be similar to those described above for the Applicant's Preferred Alternative because each diversion complex would have the same proposed features and a similar construction footprint, although slight differences between the alternatives would occur based on the construction footprint, dredged material placement, vessel traffic patterns, and construction duration. The construction of terraces would have no additional impact on nesting habitat. Therefore, similar to the Applicant's Preferred Alternative, construction of the other alternatives would result in negligible impacts on bald eagles through the clearing of potential future nesting habitat.

4.12.3.2.2 Operational Impacts

4.12.3.2.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed and therefore no impacts from operations would occur. The proposed Project area would continue to provide suitable aquatic foraging habitat for the bald eagle; however, Delft3D Basinwide Modeling results project that under the No Action Alternative, land loss in the Barataria Basin would continue, resulting in the conversion of approximately 298,000 acres of emergent wetlands and other above-water landforms to subaqueous shallow water by year 2070. As marsh presence often congregates aquatic species, loss of marsh habitat may result in increased foraging costs for the bald eagle. However, given the varied diet of bald eagles, this impact would likely be negligible.

4.12.3.2.2.2 Applicant's Preferred Alternative

Once construction of the diversion complex is complete, no additional vegetation clearing would be conducted as part of the Project and therefore no further impacts on potential nesting habitat would occur. Changes in salinity and land accretion within the Barataria Basin would result in modifications of habitat usage by aquatic species, and possibly in altered foraging habits for eagles as they adapt to changing habitats, but the diverse diet of bald eagles, including various species of fish, as well as birds, reptiles, amphibians, invertebrates, and mammals indicates that any change in fish species assemblages at a given location would not result in measurable impacts on bald eagles (The Cornell Lab of Ornithology 2019).

In addition to habitat alteration, the diversion could result in an increase in contaminants in the Barataria Basin. Historically, the introduction of environmental contaminants to the eagle's food resource resulted in eggshell thinning and, ultimately, reduced reproductive success (USFWS 1989). Monitoring of the Davis Pond Freshwater and Caernarvon Diversions indicated that some contaminants were being introduced into the receiving areas from the Mississippi River. Further examination of those contaminant concentrations by the USFWS revealed that the increase was not to a level that would cause adverse effects to bald eagles (Jenkins et al. 2008). Although there are prohibitions of certain pesticides, a diversion of this size would introduce agricultural runoff, which may lead to declines in water quality in the Barataria Basin and subsequent impacts eagle food resources. If contaminants are present in the diverted water to the extent that eagle prey items are contaminated, impacts on bald eagles in the Project area could be negligible to moderate, permanent, indirect, and adverse, depending on the extent of prey contamination, and of bald eagle consumption of contaminated prey.

4.12.3.2.2.3 Other Alternatives

Once construction of the diversion complex is complete, none of the action alternatives would require any additional vegetation clearing and therefore no further impacts on potential nesting habitat would occur due to the Project. Each of the action alternatives would have slight differences in the projected change in salinity and land accretion within the Barataria Basin; however, given the diverse diet of bald eagles, including various species of fish, as well as birds, reptiles, amphibians, invertebrates, and mammals indicates that any change in fish species assemblages at a given location would not result in measurable impacts on bald eagles (The Cornell Lab of Ornithology 2019). The 150,000 cfs Alternative would likely result in increased contaminants being introduced into the basin compared to the Applicant's Preferred Alternative, which could increase the potential for decreased reproductive success in bald eagles over the long-term; conversely, the 50,000 cfs Alternative would have a less potential for decreased reproductive success. Therefore, the 50,000 cfs Alternative would likely have a negligible to minor, permanent, indirect, and adverse impact on bald eagles and the

150,000 cfs Alternative would likely have a minor to moderate, permanent, indirect, and adverse impact on bald eagles.

The presence of terraces for any flow alternative would not impact the salinity, vegetation clearing, or potential input of contaminants compared to its non-terraced flow alternative. Therefore, as compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on the bald eagle as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives described above.

4.12.4 Summary of Potential Impacts

Table 4.12-5 summarizes the potential impacts on threatened and endangered species for each alternative. Details are provided in Sections 4.12.1 through 4.12.3 above.

Table 4.12-5
Summary of Potential Impacts on Threatened and Endangered Species from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impact from construction of the proposed Project would occur on federally or stated-listed threatened and endangered species, or special status species. • Future development in the proposed Project vicinity could result in impacts on threatened and endangered species, but determination of these impacts would be speculative. Any future impacts would be required to comply with applicable permits and regulations.
Operational Impacts	• No impact on the West Indian manatee, hawksbill and leatherback sea turtle, pallid sturgeon, and giant manta ray. • Minor adverse impact on the loggerhead and green sea turtles, and saltmarsh topminnow. • Negligible impact on the black rail and bald eagle. • Minor to moderate adverse impact on Kemp's ridley sea turtle, piping plover (and critical habitat), and red knot (and proposed critical habitat).
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• No effect (no impact) on loggerhead sea turtle critical habitat, five species of sea turtles on nesting beaches, piping plover critical habitat, and red knot proposed critical habitat. • Likely to adversely affect (minor adverse impact on) pallid sturgeon due to construction noise. • Not likely to adversely affect (negligible to minor impact on) West Indian manatee, piping plover, red knot, five species of sea turtles in marine environments, black rail, and giant manta ray. • Minor, temporary, adverse, and direct/indirect impacts on saltmarsh topminnow. • Negligible impact on bald eagles from loss of potential nesting trees and indirect disturbances from construction activities.
Operational Impacts	• No effect (no impact) on four species of sea turtles on nesting beaches, or loggerhead or designated (piping plover) or red knot (proposed) critical habitat (compared to the No Action Alternative). • Not likely to adversely affect (negligible to minor adverse impact on) West Indian manatee; hawksbill, and leatherback sea turtles in marine environments; the loggerhead sea turtle on nesting beaches; piping plover; red knot; black rail; and giant manta ray.

Table 4.12-5 Summary of Potential Impacts on Threatened and Endangered Species from Each Alternative	
Impact Type	**Impact Description (as Compared to No Action Alternative unless Otherwise Stated)**
	• Likely to adversely affect (minor to moderate) adverse impact on the Kemp's ridley, green, and loggerhead sea turtles and pallid sturgeon. • Minor to moderate, permanent, direct and indirect, beneficial impacts on the saltmarsh topminnow. • Negligible to moderate, permanent, indirect, and adverse impacts on bald eagle from potential contaminant uptake.
50,000 cfs Alternative	
Construction Impacts	• No effect (no impact) on loggerhead sea turtle critical habitat, five species of sea turtles on nesting beaches, piping plover critical habitat, and red knot proposed critical habitat. • Likely to adversely affect (minor adverse impact on) pallid sturgeon due to construction noise. • Not likely to adversely affect (negligible impact on) West Indian manatee, piping plover, red knot, five species of sea turtles in marine environments, black rail, and giant manta ray. • Minor, temporary, adverse, and direct/indirect impacts on saltmarsh topminnow. • Negligible impact on bald eagles from loss of potential nesting trees and indirect disturbances from construction activities.
Operational Impacts	• No effect (no impact) on four species of sea turtles on nesting beaches, or loggerhead or designated (piping plover) or red knot (proposed) critical habitat (compared to the No Action Alternative). • Not likely to adversely affect (negligible to minor adverse impact on) West Indian manatee; hawksbill, and leatherback sea turtles in marine environments; the loggerhead sea turtle on nesting beaches; piping plover; red knot; black rail, and giant manta ray. • Likely to adversely affect (minor to moderate adverse impact on) the Kemp's ridley, green, and loggerhead sea turtles and pallid sturgeon. • Minor to moderate, permanent, direct and indirect, beneficial impacts on the saltmarsh topminnow. • Negligible to moderate, permanent, indirect, and adverse impacts on bald eagle from potential contaminant uptake.
150,000 cfs Alternative	
Construction Impacts	• No effect (no impact) on loggerhead sea turtle critical habitat, five species of sea turtles on nesting beaches, piping plover critical habitat, and red knot proposed critical habitat. • Likely to adversely affect (minor adverse impact on) pallid sturgeon due to construction noise. • Not likely to adversely affect (negligible impact on) West Indian manatee, piping plover, red knot, five species of sea turtles in marine environments, black rail, and giant manta ray. • Minor, temporary, adverse, and direct/indirect impacts on saltmarsh topminnow. • Negligible impact on bald eagles from loss of potential nesting trees and indirect disturbances from construction activities.
Operational Impacts	• No effect (no impact) on four species of sea turtles on nesting beaches, or loggerhead or designated (piping plover) or red knot (proposed) critical habitat (compared to the No Action Alternative). • Not likely to adversely affect (negligible to minor adverse impact on) West Indian manatee; hawksbill and leatherback sea turtles in marine environments; the loggerhead sea turtle on nesting beaches; piping plover; red knot; black rail, and giant manta ray.

Table 4.12-5
Summary of Potential Impacts on Threatened and Endangered Species from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	• Likely to adversely affect (minor to moderate adverse impact on) the Kemp's ridley, green, and loggerhead sea turtles and pallid sturgeon. • Minor to moderate, permanent, direct and indirect, beneficial impacts on the saltmarsh topminnow. • Negligible to moderate, permanent, indirect, and adverse impacts on bald eagle from potential contaminant uptake.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on threatened and endangered species as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on threatened and endangered species due to the construction of terraces would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on threatened and endangered species as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional beneficial impacts on manatees, sea turtles (mainly the green, loggerhead, and Kemp's ridley sea turtles) black rail and saltmarsh minnow due to the presence of terraces would be negligible. No additional impacts from presence of terraces on pallid sturgeon, piping plover, red knot, giant manta ray, or bald eagle.

4.13 SOCIOECONOMICS

This section describes impacts of Project alternatives and the No Action Alternative on seven socioeconomic resources, which include the following topics:

- economy, employment, business, and industrial activities;
- population;
- housing and property values;
- tax revenue;
- public services and utilities;
- community cohesion; and
- protection of children.

The section first describes the area of potential impacts for these resources, guidelines for socioeconomic impact determinations, and key drivers of socioeconomic impacts followed by the analysis of impacts of the construction phase and the operational impacts of all alternatives on each resource above. Socioeconomic impacts of the Project alternatives on environmental justice and the commercial fishing industry are addressed separately in Section 4.15 Environmental Justice and Section 4.14 Commercial Fisheries.

4.13.1 Area of Potential Impacts

During construction, the area of potential impacts on socioeconomic resources, with the exception of community cohesion and property values, encompasses the broader Project area, which includes all or portions of the following parishes: Ascension, Assumption, Lafourche, Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, and St. John the Baptist. It is expected that the majority of the Project workforce would come from within the state, and, in particular, most of the direct and multiplier impacts would likely be experienced in the broader New Orleans region (included in the 10-parish Project area) due to the high concentration of economic activity in that area. The area of potential construction impacts on community cohesion and housing/property values would be within the immediate vicinity (about 0.5-mile) of the construction footprint, including the community of Ironton.

During operations, the area of potential impacts could extend throughout the 10-parish Project area due to indirect socioeconomic impacts, but, as described further in Section 4.13.3 below, most impacts would likely be concentrated in Plaquemines, Lafourche, and Jefferson Parishes. The area of impact that would occur outside of federal levee protection focuses on communities most impacted, which include communities within approximately 10 miles to the north and 20 miles to the south of the immediate outfall area, including Lafitte, Myrtle Grove, Woodpark, Hermitage, Suzie Bayou, Grand Bayou, and Happy Jack (see Figure 4.13-1). For some socioeconomic indicators including tax revenue losses, population, economic impacts on some industries, and housing and property values, the geographic area of analysis is limited by data availability, as explained in more detail in each subsection below. The area of potential impacts associated with sedimentation in navigation channels focuses on non-federal channels nearest to the proposed diversion structure, including those shown in Figure 4.13-2 below, where sedimentation from proposed Project operations would accumulate to the extent that the access for deeper-draft vessels would be impacted unless impacts are mitigated by increased dredging.

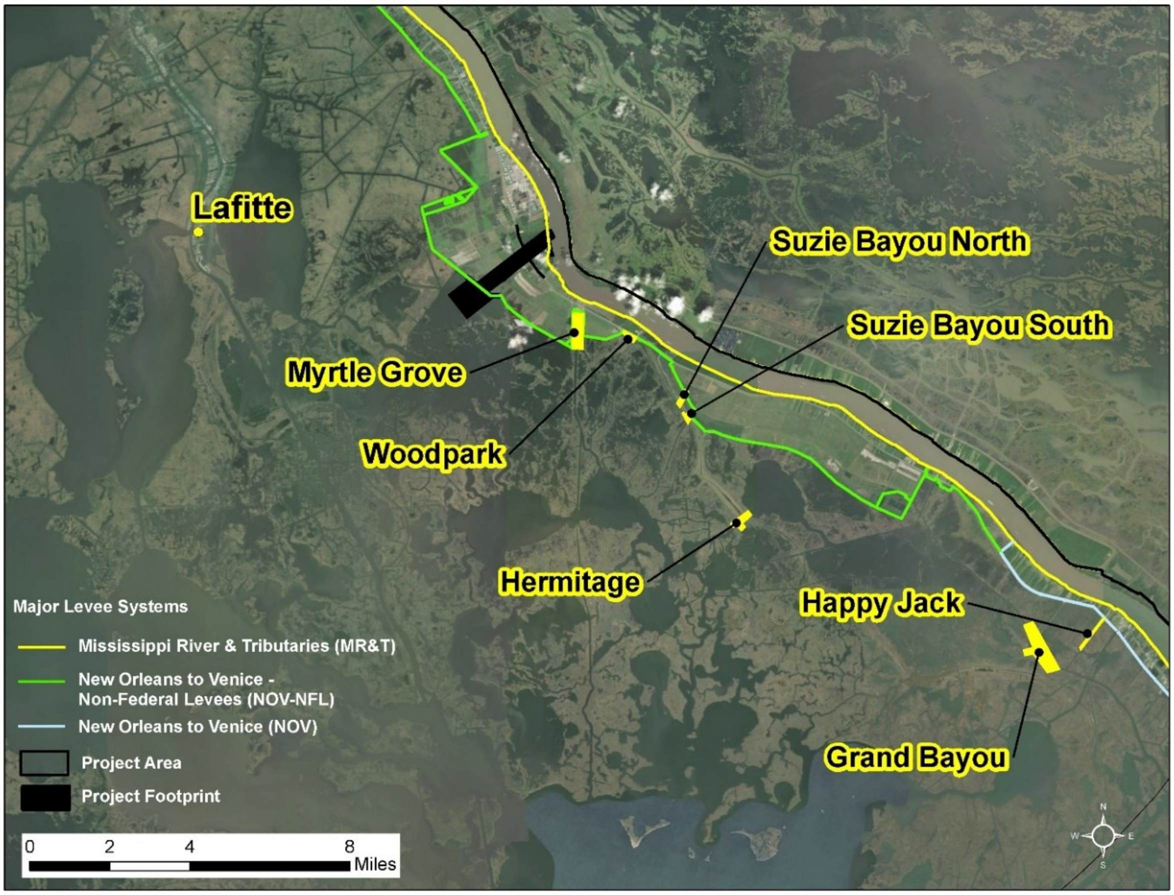


Figure 4.13-1. Communities Outside of Federal Flood Protection Affected by Indirect Socioeconomic Impacts Related to Tidal Flooding Impacts of the Proposed Diversion Structure.

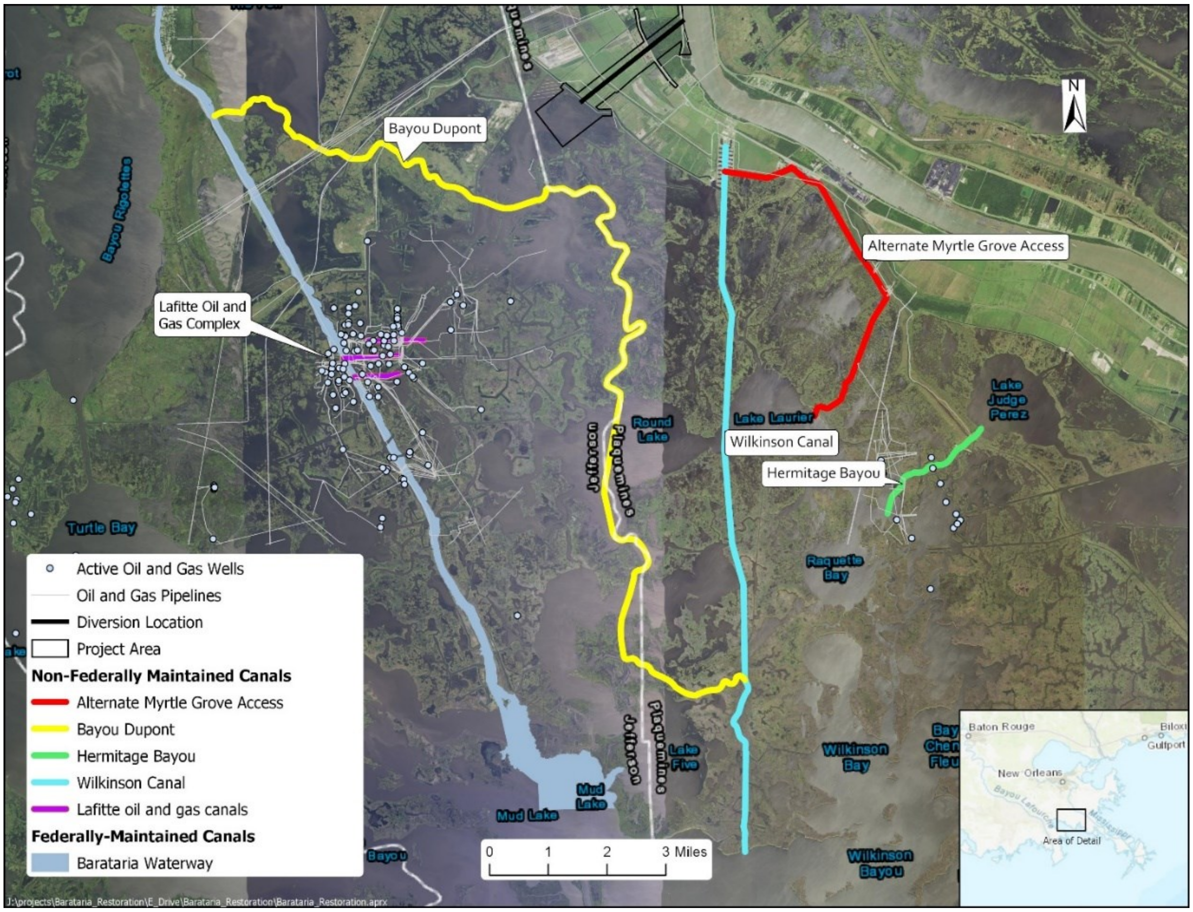


Figure 4.13-2. Canals and Waterways in the Barataria Basin within the Proposed Project Outfall Area.

4.13.2 Guidelines for Socioeconomics Impact Determinations

Impact intensities for socioeconomics are based on the definitions provided in Section 4.1 and the following socioeconomic-specific indicators for negligible, minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on socioeconomics would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: a few individuals, groups, businesses, properties, or institutions would be affected. Impacts would be small and localized. These impacts are not expected to substantively alter social and/or economic conditions. An example could include a noticeable effect on several properties in a neighborhood;
- moderate: many individuals, groups, businesses, properties, or institutions would be affected. Impacts would be readily apparent and detectable in local

and adjacent areas and would have a noticeable effect on social and/or economic conditions in the Project area; an example could include a noticeable disruption of a group of businesses that could affect revenues or jobs; and

- major: a large number of individuals, groups, businesses, properties, or institutions would be affected. Impacts would be readily detectable and observed, extend over a widespread area, and would have a substantial influence on social and/or economic conditions in the Project area. An example could include a substantial community-wide effect that disrupts business revenues or jobs.

Impact durations are also considered. Some of the expected operational socioeconomic impacts are considered long-term to permanent, in that they continue for more than several years, up to the 50-year analysis period. Long-term or permanent impacts and benefits offer a different scenario in terms of adaptation than short-term impacts or benefits. For short-term (continuing for approximately 3 years following construction) impacts, adaptation can be quick and focused, whereas for longer-term impacts, planned adaptation may have to be modified as scenarios change over time and predicted outcomes may change.

4.13.3 Key Drivers of Socioeconomic Operational Impacts

Apart from potential commercial fishing impacts discussed in Section 4.14 Commercial Fisheries and recreation impacts discussed in Section 4.16 Recreation and Tourism, the primary socioeconomic impacts of proposed Project operations would be related to changes in the frequency of tidal flooding and storm hazards. Storm surge and flooding would adversely affect social and economic conditions in the Project area by interrupting business activities and damaging infrastructure. In addition, increased sedimentation in navigation channels and canals associated with Project alternatives would result in additional impacts on socioeconomic activities that utilize the canals, including both recreational boaters and commercial fishers, if they are not mitigated. Additional detail on each of these key drivers is presented within each socioeconomic resource section, where appropriate, to inform and describe socioeconomic-related impacts due to these impacts.

For context, tidal flooding, storm hazards, and sedimentation in navigation channels impacts are summarized below. Further details on tidal flooding, storm hazards, and sedimentation in navigation channels are provided in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, and Section 4.21 Navigation, respectively.

4.13.3.1 Tidal Flooding

To assess non-storm (tidal) flooding impacts under both the No Action Alternative and the Applicant’s Preferred Alternative on communities in the Barataria Basin not protected by federal levee systems, the Water Institute examined modeled water surface elevations in three focus communities in the basin: Lafitte, Myrtle Grove, and Grand Bayou. These three communities are generally representative of other communities in the basin, including Hermitage, Suzie Bayou Woodpark, and Happy Jack (see Figure 4.13-1 above). Lafitte, Myrtle Grove, and Grand Bayou also represent varying levels of exposure to tidal flooding. For example, Grand Bayou has no structural protection and would experience similar tidal flooding as the unprotected communities of Hermitage, Suzie Bayou, and Happy Jack. Myrtle Grove impacts would be similar to the neighborhood of Woodpark due to their close proximity and because the level of flood protection is similar between these two communities (CPRA 2019d).

4.13.3.1.1 Flooding Impacts on Communities Outside of Federal Levees

Results of the tidal flooding study on communities in the basin outside of federal levees are shown in Table 4.20-2 in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction. Relative to the No Action Alternative, operation of the Applicant's Preferred Alternative would be expected to cause minor to major, adverse, long-term impacts on public health and safety due to increased tidal flooding in Barataria Basin communities located outside of federal levees within about 10 miles north of the immediate outfall area, including Lafitte, and approximately 20 miles south of the immediate outfall area, including Myrtle Grove, Hermitage, Suzie Bayou, Woodpark, Happy Jack, and Grand Bayou. In general, minor increases in flooding would occur in communities farther from the immediate outfall area or with higher inundation thresholds, as described in Section 4.20.4.2 in Public Health and Safety, Including Flood and Storm Hazard Risk Reduction. As compared to the No Action Alternative, operation of the Applicant's Preferred Alternative is projected to increase tidal flooding (assuming conditions of the 2011 hydrograph) at Lafitte by 4 days in 2020 (initial year of operation) and 15 days in 2040, in Myrtle Grove by 119 days in 2020 and 67 days in 2040, and in Grand Bayou by 56 days in 2020 and 21 days in 2040 (see Table 4.20-2 in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction). Over several decades, the impacts of the Project would be diminished as sea-level rise and subsidence become the primary control on tidal flooding in these communities. In recognition of this potential for increased flooding impacts due to the diversion operation, CPRA is planning to acquire Project servitudes on those properties within these communities that are projected to experience increased flooding due to diversion operations. More details regarding these potential actions are set forth in Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan.

4.13.3.2 Storm Hazards

As discussed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, under the No Action Alternative, storm surge and wave height would markedly increase and intensify over the next 50 years in the Project area. The ADCIRC (Advanced CIRCulation) model results consistently show an increase in projected surge elevation in the Project area for all modeled storm events over time under the No Action Alternative. Under the No Action Alternative, ADCIRC modeling projects that storm surge levels would increase between 1.4 to 7.3 feet across the basin depending on location during 1 percent AEP (100-year) storms over the next 50 years.

4.13.3.2.1 Storm Hazard Impacts on Communities Outside of Federal Levees

As compared to the No Action Alternative, the Applicant's Preferred Alternative would cause negligible to minor, permanent, beneficial impacts on public health and safety related to decreases in storm surge and wave heights north of the diversion. It would also result in minor to moderate, permanent, adverse impacts on public health and safety related to increases in storm surge and wave heights south of the diversion. For example, in modeled year 2070, the Applicant's Preferred Alternative is projected to cause a maximum decrease in storm surge elevations of 1.0 foot at the WBV Levees during a 1 percent AEP (100-year) storm (see Table 4.20-7in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction). At the same time, operation of the proposed Project is anticipated to cause increases in storm surge of up to 1.7 feet near Myrtle Grove in 2070.

4.13.3.2.2 Storm Hazard Impacts on Communities Protected by Federal Levees

Impacts on communities protected by federal levees would be related to levee overtopping. As compared to the No Action Alternative, during 1 percent AEP (100-year) storms the Applicant's Preferred Alternative would cause negligible to minor, beneficial impacts on decreasing levee overtopping north of the proposed diversion structure and negligible to minor, adverse impacts on increasing levee overtopping south of the immediate outfall area (see Figure 4.13-3 for projected NOV-NFL Levee locations of overtopping and Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more information).

4.13.3.3 Sedimentation in Barataria Basin Navigation Channels

Operation of the diversion would lead to an increase in sedimentation in channels and canals in the outfall area that are important to both recreational boaters and commercial fishers. Increased sedimentation in these waterways would increase costs of dredging to maintain the channels at depths acceptable to most vessels. If depths are not maintained, access to the channels may be restricted for some boats. While the sedimentation is not expected to affect smaller recreational boats, as they can operate in depths as shallow as 2 feet, some vessels may be unable to operate in water less than 3 feet in depth. As a result, there would likely be an increased need for maintenance dredging in channels in the outfall area or other mitigation measures (see Figure 4.13-2). If additional dredging is not undertaken, adverse impacts on recreational and commercial activities, including oil and gas industry transit and commercial fishing activities that utilize these channels, would occur. In addition, property values for properties that rely on access to those channels could be adversely affected.

4.13.4 Construction Impacts

4.13.4.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur; as such, no impacts on socioeconomic resources from construction of the Project would occur. Because of its low elevation and proximity to coastal lakes, bays, and the Gulf of Mexico, the Project area would continue to be vulnerable to storm surge and flooding caused by sea-level rise, land subsidence, and the continued loss of wetlands (see Chapter 3, Section 3.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more information about storm hazards in the Project footprint). As stated previously, storm surge and flooding adversely affect social and economic conditions in the Project area by interrupting business activities and damaging infrastructure. Between 2000 and 2017, the population of Plaquemines Parish declined by 12.5 percent; much of this decline is attributed to Hurricane Katrina (Barnes and Virgets 2017). Only limited changes to the area's susceptibility to storm hazards and coastal inundation are expected to occur under the No Action Alternative during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project).

Current trends under the No Action Alternative would be similar to existing conditions described in Chapter 3, Section 3.13 Socioeconomics. It is predictable that at some future point the construction area of the proposed Project may be developed for industrial or commercial purposes and may impact the local or regional economy, employment, businesses, and industrial activity; however, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal standards.

4.13.4.2 Applicant's Preferred Alternative

For clarity, construction impacts under the Applicant's Preferred Alternative are discussed separately for each of the seven socioeconomic topics, including: Economy, Employment, Business, and Industrial Activity; Population; Housing and Property Values; Tax Revenues; Public Services and Utilities; Community Cohesion; and Protection of Children.

4.13.4.2.1 Economy, Employment, Business, and Industrial Activity

Under the Applicant's Preferred Alternative, there would be moderate to major, temporary, beneficial impacts on the regional economy, employment, businesses, and industrial activity as a result of construction-related spending in the region. Some impacts would be local to the area around the Project footprint in Plaquemines Parish associated with local sales related to construction work, while other impacts would be distributed across the State of Louisiana and local jurisdictions. Construction impacts (including the design phase) were modeled assuming a 5-year construction period using an input-output model (IMPLAN) for the State of Louisiana, as it is expected that the majority of the Project workforce would come from within the state (see Appendix H). IMPLAN is a widely used industry-standard input-output data and software system used by many federal and state agencies to estimate regional economic impacts. The underlying data for IMPLAN are derived from multiple federal sources, including the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the U.S. Census Bureau (USACE 2019b). The IMPLAN model estimates economic impacts for four metrics:

- employment reflects a mix of full-time and part-time job-years[67] that result from additional employment demand created by a project;
- labor income captures all employment income received as part of the project-related employment demand, including wages, benefits, and proprietor income;
- gross regional product (or value added) reflects the total value of all output or production minus the costs of intermediate outputs (value added is analogous to gross domestic product); this includes payroll taxes, sales taxes, excise taxes, and property taxes; and
- economic output (sales) reflects the total value of all output or production, including the costs of intermediate and final outputs.

For each of these metrics, impacts are reported as direct, indirect, and induced impacts as follows:

- direct impacts are the production changes or expenditures that directly result from an activity or policy, in this case spending on the proposed Project;
- indirect impacts are "ripple" impacts that result from changes in the output of industries that supply goods and services to industries that are directly affected; and
- induced impacts are changes in household consumption arising from changes in employment and associated income that result from direct and indirect impacts.

Total construction expenditures (spending) during construction of the proposed Project were estimated in the Draft EIS to be $1.309 billion under the Applicant's Preferred Alternative, of which 17 percent would be spent during the design phase, and 83 percent would be spent during the construction phase (2020 dollars). These costs

[67] IMPLAN defines a "job" as a full-time job lasting 12 months, which is equivalent to two jobs lasting six months each. A job can be either full-time or part-time. We convert the IMPLAN job-year results to full-time equivalents (FTEs) using sector-specific conversion factors developed by IMPLAN.

are subject to adjustment prior to the start of construction if the proposed Project is permitted and funded.[68] For comparison, in 2018, Plaquemines Parish had an overall GDP of just under $3.2 billion and a workforce of about 9,500, while the statewide GDP was nearly $260 billion with a workforce of roughly 2 million (Federal Reserve Bank of St. Louis 2020). Assuming design and construction occur over a 5-year period, the proposed Project, including indirect and induced impacts, would support employment that would be equivalent to 29 percent of the workforce in Plaquemines Parish. However, although a portion of expenditures and employment would occur in the parish, much of the spending and employment supported by the proposed Project is anticipated to be distributed throughout the Project area. Regardless, the employment and expenditures on the proposed Project would be substantial and represent a major benefit.

4.13.4.2.1.1 Design Phase

The majority of expenditures on design, engineering, project management, and permitting, as well as associated economic benefits, would occur during the preconstruction planning phase. Table 4.13-1 summarizes the estimated total regional economic impacts of design phase expenditures. As shown, over $197 million in economic output (sales) would be generated by the engineering and design expenditures over the design phase of approximately 5 years. Estimated annual impacts for the design phase would include an increased job demand (statewide) of 264 jobs, including direct, indirect, and induced jobs. Average annual increased labor income (wages) associated with expenditures on design would be approximately $18.6 million (assuming a 5-year design window). Increased annual regional sales associated with the design phase would be approximately $39.4 million.

Table 4.13-1
Economic Benefits of Engineering and Design – Applicant's Preferred Alternative (2018$)

Impact Type	Employment	Labor Income	Gross Regional Product	Economic Output (sales)
Total Economic Impacts for all Engineering and Design Costs				
Direct impact	580	$59,050,000	$56,259,000	$100,214,000
Indirect impact	300	$15,905,000	$22,254,000	$38,145,000
Induced impact	440	$17,981,000	$33,630,000	$58,672,000
Total impact	1,320	$92,936,000	$112,143,000	$197,031,000
Average Annual Impacts over a 5-Year Time Period				
Direct impact	116	$11,810,000	$11,252,000	$20,043,000
Indirect impact	60	$3,181,000	$4,451,000	$7,629,000
Induced impact	88	$3,596,000	$6,726,000	$11,734,000
Total impact	264	$18,587,000	$22,429,000	$39,406,000
Notes: Totals may not sum due to rounding.				

[68] Due to increases in the general inflation rate, as well as corresponding increases to most cost components of the Project, including but not limited to construction materials, construction activities, and wages, and given projections that such increases are projected to continue into the future, the estimated cost of the Project is expected to increase.

4.13.4.2.1.2 Construction Phase

Table 4.13-2 shows the employment, labor income, gross regional product, and economic output that are expected to result from construction of the proposed Project under the Applicant's Preferred Alternative. Altogether, nearly $1.5 billion in economic output (sales) would be generated by construction expenditures. For the construction phase, estimated annual impacts would include an increased job demand (statewide) of 2,500 jobs, including direct, indirect, and induced jobs. Average annual increased labor income (wages) associated with expenditures on construction would be approximately $130 million (assuming a 5-year construction window). Increased annual regional sales associated with the construction phase would be approximately $298 million. As IMPLAN provides results based on yearly output, results were first calculated using the total costs of the proposed Project to derive total impacts across all years (top half of table) and then divided across the 5-year construction period to calculate annual results (see Appendix H for additional methodology).

Table 4.13-2
Economic Benefits from Construction – Applicant's Preferred Alternative (2018$)

Impact Type	Employment	Labor Income	Gross Regional Product	Economic Output (sales)
Economic Impacts for all Construction Expenditures (total over entire construction period)				
Direct impact	8,200	$461,328,000	$543,456,000	$862,593,000
Indirect impact	1,200	$65,837,000	$120,158,000	$231,443,000
Induced impact	3,000	$121,230,000	$226,716,000	$395,942,000
Total impact	12,400	$648,395,000	$890,331,000	$1,489,978,000
Average Annual Impacts (assuming a 5-Year Construction Period)				
Direct impact	1,600	$92,266,000	$108,691,000	$172,519,000
Indirect impact	200	$13,167,000	$24,032,000	$46,289,000
Induced impact	600	$24,246,000	$45,343,000	$79,188,000
Total impact	2,500	$129,679,000	$178,066,000	$297,996,000
Notes: Totals may not sum due to rounding.				

A separate analysis of economic impacts of the proposed MBSD Project was completed by Loren C. Scott & Associates, Inc. (2019) that used somewhat different inputs and a slightly different modeling technique (input-output tables from the Bureau of Economic Analysis) to estimate the economic impacts on Plaquemines Parish and the broader region (Plaquemines, St. Bernard, Orleans, and Jefferson Parishes). Despite these differences, the study projected that impacts of construction would be similar to those estimated in this EIS. The study found that across the region (defined as Plaquemines, Orleans, St. Bernard, and Jefferson Parishes) over the 5-year construction period: business sales would increase by over $1.9 billion (compared with $1.4 billion in this EIS for engineering, design, and construction); household earnings would increase by $503 million (compared with $635 million in this EIS); 1,963 jobs would be created (compared with 2,324 in this EIS). The study further found that Plaquemines Parish would experience an increase of $1.4 billion in sales, $98 million in annual household earnings, and an average annual increase of 340 jobs over the construction period.

In addition to the beneficial impacts, minor to moderate, short-term, adverse impacts would also be expected to occur for residents and businesses located within and immediately adjacent to the construction area associated with increases in traffic, and associated increases in noise and dust. These impacts could temporarily affect existing businesses nearby the proposed Project by decreasing their accessibility, along with decreasing air quality and increasing noise. CPRA would implement measures to minimize impacts from air and noise emissions and traffic congestion during construction. See Sections 4.7 Air Quality, 4.8 Noise, and 4.22 Land-Based Transportation for more details about construction impacts on air quality, noise, and transportation, respectively and CPRA's proposed actions to minimize these impacts.

4.13.4.2.1.3 Lands within the Project Construction Footprint

Construction of the proposed Project would permanently alter approximately 1,376.0 acres of uplands, wetlands, and water in Jefferson and Plaquemines Parishes (see Section 4.18 Land Use and Land Cover), with the majority of impacts occurring in uplands, including cultivated crops and pasture/hay (462.5 acres) and grasslands (32.9 acres).

As of 2017 there were 99,779 acres of farms in Plaquemines Parish, meaning the Project-induced change in acreage would represent a loss of less than 1 percent of farmland in the parish (NASS 2019). As a result, construction of the proposed Project would result in a minor, permanent, adverse impact on agricultural outputs and employment in the Project area. Although this would be a minor impact across the entire span of agricultural production in the parish, there is the potential for individuals with affected lands to experience more than minor impacts.

CPRA intends to acquire these lands through voluntary negotiation with the landowner, but if CPRA and the landowners are unable to reach agreement, CPRA may decide to acquire one or more of the properties through eminent domain. In either case, the owners would be fairly compensated for lands that are purchased by CPRA. Any impacts would be limited to the cost of adjusting operations to the new conditions. For example, these costs could include set up costs to move operations to a different location, or costs to adjust operations to a smaller area.[69] However, in order to address this effect, the analysis assumes property owners would be compensated for this production loss through purchase price. The overall volume of agricultural output from these property owners would not be significant at a regional scale. As such, the impacts of agricultural land conversion would have minor, permanent, adverse impacts

[69] For example, based on anecdotal evidence, the proposed Project would split a tract of land utilized for grazing into two separate sections which would be inaccessible to each other, potentially resulting in an adverse impact on this property owner along with those in similar situations.

on economic activity that would have occurred in that area, but would be instead converted to Project uses.

4.13.4.2.2 Population

Construction activities under the Applicant's Preferred Alternative would result in negligible impacts on population in the Project area. The construction of the proposed Project would require a workforce of approximately 1,300 individuals, on average over the 5-year construction period. Nearly 75 percent of workers across all industries in Plaquemines Parish between 2002 and 2015 commuted from other areas (U.S. Census Bureau 2019a). As such, most construction workers (skilled and specialized) would likely reside outside of the proposed Project area and commute into the Project site. Census commuter flows data suggests that most workers from outside Plaquemines Parish commute from Jefferson and Orleans Parishes (U.S. Census Bureau 2018). Some workers on the proposed Project could be drawn from outside the state to reside temporarily in the Project area. Given the relatively small number of workers (less than 1 percent) compared to the 10-parish Project area (1.2 million), this would represent a negligible increase in population.

4.13.4.2.3 Housing and Property Values

Construction of the proposed Project would have minor, short-term, adverse indirect impacts on the value of housing and properties located within 0.5-mile of the construction footprint. Minor to moderate, temporary, adverse direct construction impacts would occur on lands within the construction footprint. Adjacent lands, including nearby residences and businesses, would also have impacts from construction noise and dust, and traffic congestion along LA 23 and other local roads due to construction trucks and construction worker vehicles. In Ironton, noise generated from pile driving is expected to attenuate to levels that meet the recommended hourly L_{eq} for residential land (67 dBA), which is the sound level established for annoyance by USEPA (FHWA 2006). Pile driving would occur periodically over about 2.5 years.

These minor to moderate construction-related impacts could cause minor, short-term, adverse indirect impacts on property values for residential and commercial properties as properties affected by traffic disruptions, noise, and dust could be considered less desirable during and immediately following the construction period (Siethoff and Kockelman 2002, Downs 1992). Areas within the proposed Project construction footprint would be permanently altered once the proposed Project is built. As discussed in Section 4.18 Land Use and Land Cover, the upland portion of the construction footprint would impact a mix of agricultural (which may be actively tilled or fallow land), forested, developed, and open land. This would affect areas within a floodplain district that allows certain uses, including industrial uses, subject to approval. The transition from private ownership to governmental ownership would result in removal from the tax base, resulting in minor, permanent, adverse impacts on assessed property values in the parish.

4.13.4.2.4 Tax Revenue

Construction of the proposed Project would be expected to have minor to moderate, temporary, beneficial impacts on sales and income taxes. Some impacts would be local to the area around the Project footprint in Plaquemines Parish associated with local sales related to construction work, while other impacts would be distributed across the State of Louisiana and local jurisdictions. In addition, minor, permanent, adverse impacts on property tax receipts in Plaquemines Parish would occur related to permanent changes to taxable properties.

As described above in the Economy, Employment, Business, and Industrial Activity section, the projected cost of constructing the Applicant's Preferred Alternative is $855.8 million. Tax revenues are expected to increase with the purchase of materials and increased spending from construction and professional service personnel traveling to the area during the construction period. Some of the spending for equipment and materials for the proposed Project would include purchases within the state or local jurisdictions, which would increase tax receipts for those jurisdictions. Loren C. Scott & Associates (2019) estimated that over the 5-year construction period, the proposed MBSD Project would result in an additional $4.4 million in local taxes and fees for Plaquemines Parish, and a total of $22.8 million, and $35.2 million, in local government treasury revenue and statewide tax revenues respectively at the region level (defined as Plaquemines, Orleans, St. Bernard, and Jefferson Parishes). Assuming these are sales taxes, this anticipated increase would have represented an increase of approximately 41 percent relative to 2019 sales taxes collected in Plaquemines Parish. In addition, design and construction of the Applicant's Preferred Alternative would bring approximately 2,700 jobs to the region. Most of these employees would be expected to commute from outside of Plaquemines Parish; as discussed above, nearly 75 percent of workers across all industries in Plaquemines Parish between 2002 and 2015 commuted from other areas (U.S. Census Bureau 2019a). To the extent that any employees would be state residents that would not have otherwise been employed, or would have had lower paying jobs, construction employment for the proposed Project would increase state income tax revenues.

With respect to property taxes, there are 12 parcels that are fully or partially located within the Project footprint. The current assessed value of the portion of these properties in the construction footprint was estimated to be $4.7 million with property tax receipts of $187,000 (2020 dollars, based on data obtained from the Plaquemines Parish Assessor's Office on March 26, 2020; analysis by Jacobs and Abt Associates).[70] If these properties are removed from the tax base, there could be a reduction in local property tax receipts of up to $187,000 annually.

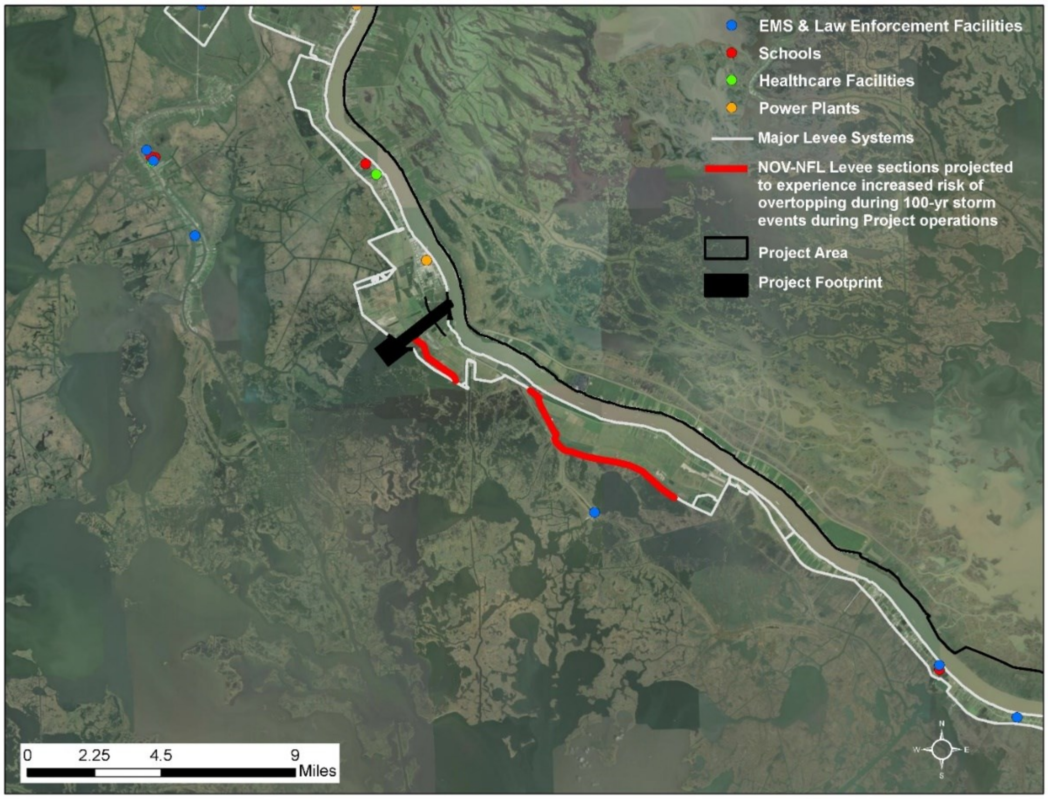
Total property tax receipts for Plaquemines Parish were approximately $65 million in 2018 (Louisiana State Tax Commission 2019). The quantifiable property tax

[70] Some of the 12 parcels contain sub-parcels with separate assessed values. This analysis assumes that the full sub-parcel that overlaps with the Project footprint is purchased even if only a portion overlaps the Project footprint and that temporarily affected properties from construction are also purchased.

impacts from construction of the proposed Project and removal of taxable land from the parish would represent approximately 0.3 percent of all property tax receipts collected by the parish in 2018. In addition to removal of specific parcels from the tax base, the proposed Project would be expected to have minor, short-term, adverse indirect impacts on property tax receipts due to minor, short-term, adverse impacts on property values around the Project footprint as those areas may be considered less desirable during the construction period.

4.13.4.2.5 Public Services and Utilities

As described earlier, construction of the proposed Project would cause minor, short-term, adverse impacts on property taxes, and minor, short-term, beneficial impacts on sales and use tax revenue (see the Tax Revenue section above). As such there could be some minor, short-term, beneficial and adverse impacts on public services funded by these taxes. Local sales and property taxes provide funding for services such as police and fire protection, education, sewerage and drainage projects, and road construction. Construction of the proposed Project would not impact schools, electric power plants, or water supply and treatment facilities, as there are none in the Project construction footprint, although there are several facilities located within the 10-parish Project area, including a power plant associated with the Alliance Refinery just north of the Project construction footprint located behind federal levee protection (see Figure 4.13-3). Construction activities are not expected to affect this power plant or other public service and utility facilities in the Project area.



Source: Map prepared using power plants from the U.S. Department of Homeland Security (2017b), healthcare facilities from Louisiana Department of Health (2016), schools from the National Center for Education Statistics (2017) and EMS and law enforcement facilities from the U.S. Geological Survey (2017) National Structured Dataset.

Figure 4.13-3. Location of Public Service Facilities and Flood Protection Surrounding the Project Footprint.

4.13.4.2.6 Community Cohesion

Ethnicity, neighborhood character, the availability of public and private facilities and services, and the shared values and perceptions of local residents all contribute to community cohesion (see Chapter 3, Section 3.13 Socioeconomics for more information about community cohesion in the Project area). While construction activities may cause temporary, minor to moderate, adverse impacts on residents and businesses located within 0.5-mile of the construction site in the form of increased noise, dust, and traffic congestion, these impacts are not expected to lead to changes in community cohesion. Thus, impacts on community cohesion under the Applicant's Preferred Alternative are expected to be negligible. CPRA would implement measures to minimize impacts from air and noise emissions and traffic congestion during construction (see Sections 4.7 Air Quality, 4.8 Noise, and 4.22 Land-Based Transportation for more details about construction impacts on air quality, noise, and transportation and CPRA's proposed actions to minimize these impacts).

4.13.4.2.7 Protection of Children

Overall, construction of the proposed Project is expected to have a negligible effect on protection of children. During construction, the increase in jobs and economic activity in the area as a result of the proposed Project (as discussed above in Economy, Employment, Business, and Industrial Activity) may create better economic conditions for some families in the area, leading to better conditions for children. However, construction is also expected to have minor to moderate, adverse impacts on the neighboring community of Ironton, offsetting some of the economic gains that may positively impact children. Moreover, children needing to travel on LA 23 to access school and other essential services may experience delays due to reduced roadway capacity and additional traffic during construction. However, CPRA would implement measures to minimize impacts from air and noise emissions and traffic congestion during construction.

4.13.4.3 Other Alternatives

4.13.4.3.1 Economy, Employment, Business, and Industrial Activity

For the other alternatives impacts on the economy, employment, business, and industrial activity, regional impact analyses have been developed based on the expected construction expenditures for each of the other alternatives relative to the No Action Alternative. Impacts of each alternative are discussed separately below.

4.13.4.3.1.1 <u>50,000 cfs Alternative</u>

The design and construction phase of the 50,000 cfs Alternative would have moderate to major, temporary, beneficial impacts on regional spending and employment as compared to the No Action Alternative. Impacts would be similar, but somewhat less, than impacts of the Applicant’s Preferred Alternative due to a shorter duration of construction. Table 4.13-3 summarizes the total economic impacts for all construction expenditures under the 50,000 cfs Alternative, as well as the average annual impacts if construction were to occur over a 5-year period. For the construction phase, estimated annual impacts would include an increased job demand (statewide) of 2,200 jobs including direct, indirect, and induced jobs. Average annual increased labor income (wages) associated with expenditures on construction would be approximately $116.4 million (assuming a 5-year construction window). Increased regional sales associated with the construction phase would be approximately $267.7 million. On average over a 5-year period, there would be a construction workforce of approximately 2,200 workers (direct impact). A total of $1.3 billion in economic output or sales would be supported by the construction expenditures across all years.

Table 4.13-3 Economic Benefits from Construction – 50,000 cfs Alternative (2018$)				
Impact Type	**Employment**	**Labor Income**	**Gross Regional Product**	**Economic Output (sales)**
Economic Impacts for All Construction Expenditures (total over entire construction period)				
Direct impact	7,400	$413,644,000	$492,198,000	$773,728,000
Indirect impact	1,100	$59,197,000	$107,978,000	$208,314,000
Induced impact	2,700	$109,223,000	$204,260,000	$356,404,000
Total impact	11,200	$582,063,000	$804,436,000	$1,338,446,000
Average Annual Impacts (assuming a 5-Year Construction Time Period)				
Direct impact	1,500	$82,729,000	$98,440,000	$154,746,000
Indirect impact	200	$11,839,000	$21,596,000	$41,663,000
Induced impact	500	$21,845,000	$40,852,000	$71,281,000
Total impact	2,200	$116,413,000	$160,888,000	$267,690,000
Notes: Totals may not sum due to rounding.				

Minor, short-term, adverse impacts would be expected to occur for residents and businesses located within and immediately adjacent to the construction area associated with increases in traffic, and associated increases in noise and dust, which could temporarily affect business opportunities nearby the Project site by decreasing their accessibility, decreasing air quality, and increasing noise. CPRA would implement measures to minimize impacts from air and noise emissions and traffic congestion during construction. Construction of the proposed Project would result in a minor, permanent, adverse impact on agricultural outputs and employment in the Project area. Impacts would be similar, but somewhat less than the Applicant's Preferred Alternative due to a shorter duration of construction.

4.13.4.3.1.2 150,000 cfs Alternative

The design and construction phase of the 150,000 cfs Alternative would have moderate, temporary, beneficial impacts on regional spending and employment as compared to the No Action Alternative. Impacts would be similar, but somewhat higher, than the Applicant's Preferred Alternative due to a longer duration of construction.

Table 4.13-4 summarizes the total economic impact for all construction expenditures under the 150,000 cfs Alternative, as well as the average annual impacts if construction were to occur over a 5-year period, relative to the No Action Alternative. A total of $2.3 billion in economic output or sales would be supported by construction expenditures across all years under the 150,000 cfs Alternative. For the construction phase, estimated annual impacts would include an increased job demand (statewide) of 3,900 jobs, including direct, indirect, and induced jobs. Average annual increased labor income (wages) associated with expenditures on construction would be approximately $205.0 million (assuming a 5-year construction window). Increased annual regional sales associated with the construction phase would be approximately $464.5 million. A total of $2.3 billion in economic output or sales would be supported by the construction expenditures across all years.

Table 4.13-4 Economic Benefits from Construction – 150,000 cfs Alternative (2018$)				
Impact Type	**Employment**	**Labor Income**	**Gross Regional Product**	**Economic output (sales)**
Economic Impacts for All Construction Expenditures (total over entire construction period)				
Direct impact	13,200	$732,880,000	$871,274,000	$1,345,538,000
Indirect impact	1,900	$100,658,000	$183,231,000	$351,690,000
Induced impact	4,700	$191,453,000	$358,036,000	$625,299,000
Total impact	19,800	$1,024,990,000	$1,412,541,000	$2,322,527,000
Average Annual Impacts (assuming a 5-Year Construction Period)				
Direct impact	2,600	$146,576,000	$174,255,000	$269,108,000
Indirect impact	400	$20,132,000	$36,646,000	$70,338,000
Induced impact	900	$38,291,000	$71,607,000	$125,060,000
Total impact	3,900	$204,999,000	$282,508,000	$464,505,000
Note: Totals may not sum due to rounding.				

Minor, short-term, adverse impacts would be expected to occur during the construction phase for residents and businesses located within and immediately adjacent to the construction area associated with increases in traffic, and associated increases in noise and dust, which could temporarily affect business opportunities nearby the proposed Project, by decreasing accessibility to businesses within the construction footprint. CPRA would implement measures to minimize impacts from air and noise emissions and traffic congestion during construction. Construction of the proposed Project would result in a minor, permanent, adverse impact on agricultural outputs and employment in the Project area. Impacts would be similar, but slightly higher, than the Applicant's Preferred Alternative due to a longer duration of construction.

4.13.4.3.1.3 Terrace Alternatives

The socioeconomic impacts of the design and construction phase of the terrace alternatives would be similar under the corresponding flow capacity alternatives without terraces, and as such, would have moderate to major, temporary beneficial impacts on regional spending and employment, as compared to the No Action Alternative. The construction of marsh terraces under any of the capacity alternatives would slightly increase adverse impacts for residents and businesses located within and immediately adjacent to the construction area associated with increases in traffic, and associated increases in noise and dust, which could add slight temporary adverse impacts on business opportunities nearby the proposed Project. As under all other alternatives, CPRA would also implement measures to minimize impacts from air and noise emissions and traffic congestion during construction.

Inclusion of spending on marsh terraces under any of the capacity alternatives would slightly increase the regional economic benefits of these alternatives as compared to the flow capacity alternatives. In particular, the terrace requirements would add additional demand for 12 jobs over the construction period over and above impacts anticipated from flow capacity alternatives without terraces. Average annual labor income (wages) under the terrace alternatives associated with expenditures on design would increase by approximately $649,000 (assuming a 5-year construction window) as compared to the flow capacity alternatives. Increased annual regional sales associated with the construction phase would be approximately $1.7 million more than impacts anticipated for the flow capacity alternatives.

4.13.4.3.2 Population

Impacts on population due to the construction of the other five action alternatives would be similar to those described above for the Applicant’s Preferred Alternative, with negligible impacts on population. Most construction workers would be expected to commute from other parishes or states and reside temporarily in the 10-parish Project area during the 5-year construction period. The addition of terrace construction in the immediate outfall area under the three terraces alternatives would not impact population trends.

4.13.4.3.3 Housing and Property Values

Similar to the Applicant’s Preferred Alternative, the other alternatives would result in minor to moderate, temporary, adverse impacts on air quality, noise, and traffic congestion from construction activities would result in minor, short-term, adverse indirect impacts on the value of housing and properties located within 0.5-mile of the proposed Project construction activities as compared to the No Action Alternative. CPRA would implement measures to minimize impacts from air and noise emissions and traffic congestion during construction.

As compared with the Applicant’s Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition features would be wider and construction timeframes several months longer for alternatives with 150,000 cfs flow volumes, while these features would be narrower and construction timeframes shorter for alternatives with 50,000 cfs flow volumes. Therefore, the duration of minor, temporary, adverse impacts on housing and property values could be somewhat longer or shorter, respectively, as compared with the Applicant’s Preferred Alternative under these alternatives. The addition of terrace construction in the immediate outfall area under the three terraces alternatives would not impact housing and property values as compared the flow capacity alternatives without terraces.

4.13.4.3.4 Tax Revenue

Similar to the Applicant’s Preferred Alternative, the 50,000 cfs Alternative is expected to have minor to moderate, short-term, beneficial impacts on sales and use taxes across the State of Louisiana and local jurisdictions and minor, permanent, adverse impacts on property tax receipts in Plaquemines Parish as compared to the No Action Alternative. The 50,000 cfs Alternative would likely have a somewhat smaller beneficial impact on sales and use and income taxes than the Applicant’s Preferred Alternative given the lower construction costs ($820 million) and need for fewer direct construction jobs (1,260 jobs). While the 50,000 cfs Alternative would have a minor, permanent, adverse impact on property taxes, the impact is expected to be slightly less than the Applicant's Preferred Alternative due to the smaller Project size.

The impact on sales and use taxes resulting from the 150,000 cfs Alternative would be moderate, short-term, and beneficial. The 150,000 cfs Alternative would likely have a somewhat larger beneficial impact on sales and use and income taxes collected than the Applicant's Preferred Alternative given the higher construction cost ($1.2 billion) and need for more direct construction jobs (1,840 jobs). Adverse impacts on property taxes related to construction impacts are also expected to be minor and permanent under the 150,000 cfs Alternative, though these impacts are expected to be slightly more adverse than what would occur under the Applicant's Preferred Alternative due to the larger Project footprint.

The alternatives that include the construction of terraces would have very similar impacts on tax revenues as each of the flow capacity alternatives without terraces.

4.13.4.3.5 Public Services and Utilities

Similar to the Applicant's Preferred Alternative, construction of the other alternatives would have minor, short-term, beneficial impacts on public services associated with increased sales receipts in Plaquemines Parish and minor, short-term, adverse impacts associated with reduced property tax revenues. Negligible impacts on utilities would be expected. The addition of terrace construction in the immediate outfall area under the three terraces alternatives would not impact public services and utilities.

4.13.4.3.6 Community Cohesion

Similar to the Applicant's Preferred Alternative, the construction of the diversion under the other alternatives is also expected to have negligible impacts on community cohesion. While construction activities may cause temporary, adverse impacts on a small number of residents and businesses, these impacts are not expected to lead to changes in community cohesion (for example, ethnicity, neighborhood character, the availability of public and private facilities and services, and the shared values and perceptions of local residents). The addition of terrace construction in the immediate outfall area under the three terraces alternatives would not impact community cohesion.

4.13.4.3.7 Protection of Children

Similar to the Applicant's Preferred Alternative, the construction of the diversion under the other alternatives is also expected to have negligible impacts on protection of children. While construction activities may cause temporary, adverse impacts on a small number of residents and businesses, the increases in economic activity should offset any economic changes that would affect the welfare of children within the affected communities. The addition of terrace construction in the immediate outfall area under the three terraces alternatives would not impact protection of children.

4.13.5 Operational Impacts

This section presents the impacts of Project operations over the 50-year analysis period on each of the seven socioeconomic topics including: Economy, Employment, Business, and Industrial Activity; Population; Housing and Property Values; Tax Revenues; Public Services and Utilities; Community Cohesion; and Protection of Children. For each of the socioeconomic topics, impacts are broken out by alternative. Where appropriate, additional detail is presented for impacts related to sedimentation of navigation channels, and impacts related to flooding and storm hazards.

4.13.5.1 Economy, Employment, Business, and Industrial Activity

4.13.5.1.1 No Action Alternative

There are approximately 29,000 total businesses in the 10-parish Project area, with approximately 660 businesses in operation in Plaquemines Parish (U.S. Census Bureau 2017). This number would change over time even absent environmental changes. However, increasing subsidence, storm surge, and tidal flooding would affect ongoing economic activities in the Project area under the No Action Alternative. Because of the substantial risk of future large storm events and flooding, impacts on the economy, employment, business, and industrial activities are likely to be adverse under the No Action Alternative, particularly for areas located outside of flood protection in the Barataria Basin. Many businesses and establishments are located inside flood protection, but impacts could also include large storm events that would affect all areas. As such, impacts under the No Action Alternative are assumed to be moderate to major, permanent and adverse.

4.13.5.1.1.1 <u>Flooding and Storm Hazards</u>

Under the No Action Alternative, there would be a general trend of increasing sea-level rise, subsidence, flooding, and storm hazards in the Project area resulting in infrastructure damages, increased frequency of business disruptions and losses, and diminished employment opportunities. These would result in major, adverse, permanent impacts on many economic activities as well as resident populations under the No Action Alternative.

The Fourth National Climate Assessment finds that future sea-level rise and increased storm frequency and severity associated with climate change is expected to slow the rate of economic growth across the United States over the 21st century (USGCRP 2018). These impacts may be particularly acute in coastal communities, including those in the Project area. Neumann et al. (2015) forecast that absent mitigation measures, some of the largest increases in damages in the United States over the next century would occur in the New Orleans metropolitan area specifically.

According to Fleming et al. (2018), coastal properties and public infrastructure along U.S. coastlines are threatened by tidal flooding, sea-level rise, and storm surge, which are likely to result in negative impacts on adjacent economies. The study finds that many industries that make up a significant portion of coastal economies – for example, fisheries and tourism – may also experience negative impacts as a result of these risks, further exacerbating impacts on the economy. A recent study estimates that approximately 4,100 miles of roads across all of southern Louisiana are currently at risk from coastal flooding with estimated replacement costs of $1.2 billion and that those numbers could more than double over the next 50 years (2018 dollars) (Barnes and Virgets 2018). These impacts on infrastructure would impact economic activities throughout the Project area under the No Action Alternative.

Increased storm damages will make it increasingly difficult for businesses to operate in the Project area. Employment opportunities would likely diminish in these areas over time.

4.13.5.1.1.2 Sedimentation in Barataria Basin Navigation Channels

Federal and non-federal navigation channels in the Barataria Basin are widely used for recreational and commercial purposes, as described in detail in Chapter 3, Section 3.16 Recreation and Tourism and Section 3.21 Navigation. Dredging is undertaken to maintain navigational depths in both federal and non-federal channels. Over the long-term, dredging requirements may increase or decrease in response to relative sea-level rise as well as changes in sediment supply from flooding, overwash, and bankline erosion. Under the No Action Alternative, dredging activities are assumed to continue. See Section 4.21 Navigation for more information about dredging requirements in navigation channels in the basin under the No Action Alternative.

4.13.5.1.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative would result in negligible to minor, permanent, beneficial impacts on business and industrial activities in the west bank New Orleans area north of the diversion from reduced storm hazards. In addition, minor, permanent, adverse impacts on the regional economy, employment, businesses, and industrial activity would occur as a result of increased tidal flooding and storm surge in areas outside flood protection in the Barataria Basin, particularly in the 2030s to 2050s in areas near the immediate outfall area (approximately 10 miles north and 20 miles south).

4.13.5.1.2.1 Flooding and Storm Hazards

Due to Project-induced reductions in storm surge in the Barataria Basin generally north of the proposed diversion structure, the Applicant's Preferred Alternative would have minor, permanent, beneficial impacts on business and industrial activities as compared to the No Action Alternative. In addition, as described in Section 4.13.3, relative to the No Action Alternative, operation of the proposed Project would be expected to increase the frequency and duration of tidal flooding in Barataria Basin communities located outside of federal levees and within about 10 miles north and 20 miles south of the immediate outfall area including Myrtle Grove, Hermitage, Suzie Bayou, Woodpark, Happy Jack, and Grand Bayou. Increased tidal flooding would likely result in impacts such as additional damages to infrastructure (for example, roads) and increased risk of vehicle damage, accumulation of siltation and sludge, cemetery inundation, and interruption of emergency services in areas outside of flood protection than would have occurred in those areas under the No Action Alternative. This may result in a need to accelerate investment in infrastructure necessary to maintain the functionality of residences, businesses, and recreational properties relative to the No Action Alternative. In recognition of this potential for increased flooding impacts due to the diversion operation, CPRA is planning to acquire Project servitudes on those properties within these communities that are projected to experience increased flooding due to diversion operations. More details regarding these potential actions are set forth in Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan.

These disruptions resulting from increased flooding and storm hazards would represent minor, permanent, adverse impacts on the regional economy, particularly in the 2030s to 2050s. Impacts are considered to be minor due to the relatively small number of businesses that would experience these impacts, relative to the 660 businesses operating in Plaquemines Parish in 2018. However, impacts on individual operations could be substantial. See Section 4.20 Public Health and Safety, including Flood and Storm Hazard Risk Reduction for additional information about Project impacts on tidal flooding and storm hazards.

4.13.5.1.2.2 Sedimentation in Barataria Basin Navigation Channels

As described in Section 4.13.3.3, sedimentation in navigation channels and canals in the outfall area would increase over time due to operations under the Applicant's Preferred Alternative. If not mitigated, this has the potential to result in adverse impacts on economic activities that utilize the canals. Although impacts on individual operations could be substantial, economic impacts of these changes would be negligible in the study area. To the extent that additional dredging is undertaken to avoid these impacts, the costs of dredging would represent the adverse impacts of this sedimentation. The LA TIG assessed the potential magnitude of dredging costs that may be required to mitigate increases in sedimentation in channels and canals not dredged by the federal government under the Applicant's Preferred Alternative, using the Wilkinson Canal as an example. The analysis provides an illustrative example of potential dredging costs under a scenario where dredging occurs to certain depth levels once every decade. These costs are not considered representative of actual dredging costs to offset impacts since dredging was assumed to occur once every decade irrespective whether such dredging was necessary to maintain the depth, and without consideration of potential variables such as the dredging method and project size that could affect costs. Subject to these caveats, the LA TIG estimated that dredging costs would increase over time, from a projected per effort cost of between $11,000 to $350,000 in the 2020s, to up to $900,000 per effort in the 2060s (see the Evaluation of Non-Federally Maintained Channels and Canals included in Appendix H for more information about the dredging cost analysis). For details regarding mitigation measures, see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan.

4.13.5.1.3 Other Alternatives

4.13.5.1.3.1 50,000 cfs Alternative

Similar to the Applicant's Preferred Alternative, disruptions to business operations in communities outside flood protection within approximately 10 miles north and 20 miles south of the immediate outfall area due to increases in tidal flooding would occur under the 50,000 cfs Alternative. These disruptions would represent minor, permanent, adverse impacts on the regional economy as compared to the No Action Alternative. Unmitigated sedimentation impacts from the proposed Project could also result in minor adverse socioeconomic impacts. Impacts are considered to be minor due to the relatively small number of businesses that would experience these impacts. See Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for data on tidal flooding impacts under the Other Alternatives.

Also similar to the Applicant's Preferred Alternative, economic impacts of the 50,000 cfs Alternative related to reductions or increases in storm surge and wave heights in populated areas from the alternative would be negligible to minor, permanent, and beneficial north of the proposed diversion and minor, permanent, and adverse south of the proposed diversion.

4.13.5.1.3.2 150,000 cfs Alternative

Similar to the Applicant's Preferred Alternative, disruptions to business operations in communities outside flood protection within approximately 10 miles north and 20 miles south of the immediate outfall area due to increases in tidal flooding would occur under the 150,000 cfs Alternative. These disruptions would represent minor, permanent, adverse impacts on the regional economy as compared to the No Action Alternative. Unmitigated sedimentation impacts from the proposed Project could also result in minor adverse socioeconomic impacts. Impacts are considered to be minor due to the relatively small number of businesses that would experience these impacts. See Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for data on tidal flooding impacts under the Other Alternatives.

Also similar to the Applicant's Preferred Alternative, economic impacts of the 150,000 cfs Alternative related to reductions or increases in storm surge and wave heights in populated areas from the alternative would be negligible to minor, permanent, and beneficial north of the proposed diversion and minor, permanent, and adverse south of the proposed diversion.

4.13.5.1.3.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area would have minimal impacts on economy, employment, and business during operations relative to the No Action Alternative. The terrace alternatives would have impacts on the regional economy similar to those anticipated under the corresponding flow capacity alternatives without terraces. See Section 4.20 Public Health and Safety, Including

Flood and Storm Hazard Risk Reduction for data on storm hazard impacts under the Other Alternatives.

4.13.5.2 Population

While population may be affected by changes in tidal flooding and storm hazards, changes in sedimentation in navigation channels would not be expected to affect population. As such, this section addresses tidal flooding and storm hazard impacts on population for each alternative. Changes in population due to changes in sedimentation in navigation channels are not addressed further in this section.

4.13.5.2.1 No Action Alternative

Under the No Action Alternative, increased storm hazard-related inundation and tidal flooding and decreasing property values would potentially cause major, permanent, adverse impacts on population due to outmigration from the Project area over the 50-year analysis period. This would include the Barataria Basin and northern parts of the Project area including the New Orleans area, and portions of St. Charles, St. James, St. John the Baptist, Ascension, Assumption, and northwest Lafourche Parishes. These parishes have a total population of approximately 238,000 (19 percent of the total population of the Project area), of which a relatively small percentage reside adjacent to Barataria Bay (U.S. Census ACS 2012-2016).

People would continue to commute to coastal areas within the Project area for employment in the fishing and other offshore industries, including oil and gas development, including Plaquemines Parish in particular. Over time, some areas may require investment to shore up infrastructure and retain accessibility. Large-scale storm events or other coastal hazards would intensify these trends. By the 2050s and beyond, major adverse impacts on population and migration would occur as a result of these trends in the Project area. Areas outside flood protection in the Barataria Basin would be among the most severely affected, as most of those areas would become flooded for most of the year over the 50-year analysis period, likely becoming uninhabitable without significant investments in adaptation measures.

The loss of business and employment opportunities is an important driver of outmigration. With business displacement and flooding limiting commuting and other transportation opportunities and, in anticipation of future storm risks, zoning changes, and/or land loss, many residents of Gulf Coast communities migrated inland following major hurricanes of the 2000s to avoid the negative consequences of storm events (Austin et al. 2014). As stated in Section 4.13.4 above, the majority of people who work in Plaquemines Parish live outside the parish and commute either daily or seasonally to their jobs in coastal areas (U.S. Census Bureau 2019a, The Data Center 2014). This would likely continue.

FEMA maintains flood insurance rate maps, which delineate base flood elevations and flood risk premium zones. As flood risk in the Project area increases, updates to those maps would likely increase the number of properties falling within a

SFHA. Homes and businesses in an SFHA require flood insurance to secure a government-backed mortgage or qualify for some disaster assistance programs. They are also subject to additional permitting requirements for new construction, rebuilding, or extensive repair activities. Insurance and permitting requirements increase costs associated with living on the coast (Austin et al. 2014). For those who own their homes outright, inclusion in a flood risk zone can reduce property values and increase the difficulty of selling a home (Posey and Rogers 2010, Bin and Kruse 2006). Although some homes may not be damaged by flooding because the structures themselves are or would be raised, higher water levels would damage roads and other infrastructure. While it is expected that this trend would encourage outmigration, some residents may be inclined to stay in place, specifically those participating in local resource-based economies – particularly shrimp, oyster, and crab fisheries, as shown by observed historical behavior of residents entering professions in natural resource industries in an area when hurricanes, oil spills or other economic factors affecting a region have forced many to move out (Colten et al. 2018). Federally built levees in the Project area would continue to provide some protection from storm surge and tidal flooding; in addition, homeowners could purchase federally-backed flood insurance, encouraging some people to remain in the coastal region.

4.13.5.2.2 Applicant's Preferred Alternative

North of the diversion where the proposed Project is projected to reduce wave heights and storm surge, the Applicant's Preferred Alternative would result in negligible to minor, permanent, beneficial impacts on communities inside and outside of federal levee systems from reduced storm surge elevation inland of the diversion (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more details). Minor reductions in storm surge heights and levee overtopping would be localized and most likely limited to federal levees north and northwest of the proposed Project in Plaquemines, Jefferson, St. Charles, and Lafourche Parishes. As Ouattara and Strobl (2014) have demonstrated, there is an effect of increased outmigration from areas at risk of hurricane damages. As such, minor reductions in storm hazards would be anticipated to marginally reduce pressure to migrate away from affected coastal communities north of the diversion where storm hazards would be reduced, resulting in negligible to minor, beneficial, permanent impacts in these areas.

At the same time, the proposed Project would cause minor to moderate, short-term and permanent adverse impacts on population outmigration from communities within approximately 20 miles south of the immediate outfall area. The intensity of tidal flooding impacts on population in these communities as compared to the No Action Alternative would become minor or negligible by 2070 due to the influence of sea-level rise increasing the overall water levels.

Generally, it is likely that ongoing trends in population would continue in coastal areas in the Project area, particularly in southern Plaquemines Parish under the Applicant's Preferred Alternative, and people would continue to move inland and away from increased coastal hazards over time. Similar to the No Action Alternative, people would continue to commute to southern Plaquemines Parish for employment in the fishing and other offshore industries, including oil and gas development. Outmigration would be further encouraged in the basin south of the immediate outfall area and outside of flood protection, where storm surge and wave height are projected to increase. As described in Chapter 3, the population of these communities outside of flood protection is estimated to be less than 500, which includes some seasonal residents. Areas within federal levee protection would likely experience less substantial decreases in population due to greater protections from flooding and storm surge.

4.13.5.2.3 Other Alternatives

4.13.5.2.3.1 50,000 cfs Alternative

Similar to the Applicant's Preferred Alternative, the 50,000 cfs Alternative would be expected to have negligible to minor, permanent, beneficial and adverse impacts on population and migration related to storm surge north and south of the proposed diversion (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for further details about storm and flooding hazards related to the other alternatives). The 50,000 cfs Alternative would also have minor to moderate, adverse, permanent impacts on population outmigration in communities in the basin outside of federal levee protection due to Project-induced increases in tidal flooding.

4.13.5.2.3.2 150,000 cfs Alternative

Similar to the Applicant's Preferred Alternative, the 150,000 cfs Alternative would be expected to have negligible to minor, permanent, beneficial and adverse impacts on population and migration related to storm surge north and south of the proposed diversion. The 150,000 cfs Alternative would also have minor to moderate, adverse, permanent impacts on population outmigration in communities in the basin outside of federal levee protection due to Project-induced increases in tidal flooding.

4.13.5.2.3.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area would have negligible impacts on population patterns during operations relative to the No Action Alternative. The terrace alternatives would have impacts on population similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.13.5.3 Housing and Property Values

Impacts on housing and property values are discussed below for impacts related to flooding and storm hazards, as well as sedimentation of navigation channels.

4.13.5.3.1 No Action Alternative

As discussed in the sections below, impacts on housing and property values under the No Action Alternative as compared to existing conditions are expected to be negligible for areas inside of flood protection, while for areas outside of flood protection, major, permanent, adverse impacts are expected over the 50-year analysis period.

4.13.5.3.1.1 Flooding and Storm Hazards

Under the No Action Alternative, increases in sea-level rise and diminished capacity of wetlands to provide protection from storm hazards are expected to continue, increasing the risk of damage to private and public infrastructure from flooding. This in turn would be expected to impact property values as demonstrated in the literature on the various coastal impacts from storm surge, sea-level rise, and tidal flooding without adaptation (for example, Fleming et al. 2018, Beltran et al. 2018, Speyer and Ragas 1991).

Under the No Action Alternative, it is assumed that federal levees would be maintained throughout the 50-year analysis period, which would continue to provide a degree of protection for communities located within federal flood protection from flooding impacts. As such, communities located inside of federal flood protection levees are expected to experience negligible impacts on housing and property values due to tidal flooding. However, as discussed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, major, adverse, permanent increases in storm hazard-related to inundation during 1 percent AEP (100-year) storms are expected throughout the basin, including in areas protected by federal levees. The No Action Alternative would cause major overtopping along portions of the Larose to Golden Meadow and Lafitte Levee systems in both the 4 percent and 1 percent AEP storms in 2070. Under the No Action Alternative, storm surge levels would be projected to increase between 1.4 to 7.3 feet across the basin depending on location during 1 percent storms over the next 50 years (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction).

Under the No Action Alternative, housing and property values for properties outside flood protection are expected to decline due to increased risk of storm surge related inundation, resulting in major, permanent, adverse impacts; risk of inundation would depend on location. Across a broad literature, various researchers have demonstrated the significant costs of sea-level rise and storm surge. In addition to the studies mentioned above, for New Orleans specifically, Neumann et al. (2015) show how storm surge can be an amplifying factor in addition to sea-level rise, substantially increasing the costs associated with property damages in the area; the greatest costs are felt in low lying areas with significant coastal development and greater storm activity. In many cases, these estimates are not specific to housing and property values, but a broader set of costs that include and are likely to influence property values. Existing evidence from a meta-analysis on the effect of flood risk on property values specifically demonstrates a 4.6 percent price reduction for houses located within floodplains across many contexts (Beltran et al. 2018). Using housing sales data from 1971 to 1986, Speyer and Ragas (1991) demonstrate how living in a floodplain in New Orleans specifically reduces property values, attributable to the increase in mandatory insurance costs. Together, these studies support the conclusion that increased tidal flooding and storm surge anticipated throughout the century is expected to have negative impacts on property values in the Project area under the No Action Alternative.

In communities in the Barataria Basin outside of federal levee systems, water surface elevations are expected to be exceeded on nearly a daily basis towards the end of the 50-year analysis period and storm hazard-related inundation and damages would continually increase (see Section 4.13.3 above and Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction). It is likely that residents and businesses in these communities would be adversely affected under the anticipated environmental conditions, which in turn would affect property values. In particular, as shown in Table 4.20-2, by 2050 the communities of Myrtle Grove and Grand Bayou are expected to be affected by tidal flooding for more than 60 percent of the year; tidal flooding would similarly affect other areas outside of federal flood protection. This is likely to result in moderate to major, permanent, adverse impacts on property values as the area becomes less desirable (Fleming et al. 2018, Beltran et al. 2018, Speyer and Ragas 1991).

Federally-backed flood insurance is anticipated to remain available for all residents of NFIP-participating communities under the No Action Alternative, unless large-scale changes to the NFIP program occur. As described in Chapter 3 Section 3.13 Housing and Property Values, the average premium for a flood insurance policy in the parishes within the Project area is $642 per year (2019 dollars). These premiums are likely to increase in the near term under the No Action Alternative as part of FEMA's revised risk policy (see Table 3.13-4 in Chapter 3 for additional details).

Barnes and Virgets (2017) estimated the potential damage if a storm similar to Hurricane Katrina (size and storm track) were to hit the Louisiana coast in the next 25 or 50 years. Due to the future expected loss in wetlands that currently serve as a buffer zone to the New Orleans area, damages are estimated to be much higher than they were in 2005.[71] The study predicts total physical damage (measured as replacement costs) in the New Orleans region could be as high as $1.3 billion in 25 years and $1.7 billion in 50 years (less optimistic scenario). This includes residence replacement costs of up to $336 million in 25 years and $410 million in 50 years.[72]

4.13.5.3.1.2 Sedimentation in Barataria Basin Navigation Channels

As described in Section 4.13.3.3, private residences in the Barataria Basin are located along locally maintained channels and canals providing residents access to the bay and Gulf from their properties. Under the No Action Alternative, local, municipal, and federal proponents are expected to maintain channel depths sufficient to allow for the passage of marine vessels to support current uses. Over the 50-year analysis period, increases or decreases in dredging requirements may occur due to sea-level

[71] As defined in Barnes and Virgets (2017), the New Orleans region encompasses the following parishes: Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, and St. Tammany.

[72] Total replacement costs represent the cost to replace physical assets (residential and business properties) expected to be damaged in a storm event.

rise and related increases in sediment supply from flooding, overwash, and bankline erosion.

4.13.5.3.2 Applicant's Preferred Alternative

Impacts on housing and property values under the Applicant's Preferred Alternative as compared to the No Action Alternative are expected to vary depending on location due to differences in expected sedimentation and flooding and storm hazard impacts as discussed in the sections below. As compared to the No Action Alternative, for areas north of the diversion, minor, permanent, beneficial impacts on housing and property values are expected. As compared to the No Action Alternative, areas 10 miles north and 20 miles south of the immediate outfall area outside of flood protection would experience minor to moderate, permanent, adverse impacts on housing and property value, while impacts on areas inside flood protection and further south would be negligible to minor.

4.13.5.3.2.1 Flooding and Storm Hazards

Impacts of flooding and storm hazards under the Applicant's Preferred Alternative as compared to the No Action Alternative would vary by location. Project operations would reduce storm surge north of the proposed diversion structure by creating new wetlands and sustaining existing wetlands, which would induce hydraulic friction and resistance, reducing the inland extent of storm surge and limiting the height of waves. Due to these Project-induced reductions in storm surge north of the proposed diversion structure, the Applicant's Preferred Alternative would have minor, permanent, beneficial impacts on housing and property values north of the proposed Project in areas both inside and outside of federal flood protection levees. Reducing storm surge with the operation of the diversion would generate benefits in terms of avoided damages north of the proposed diversion, which could lead to preservation of property values. While the exact location and scope of properties impacted and the associated property values that would be protected are not known, impacts would likely be localized.

As compared to the No Action Alternative, due to Project-induced increases in storm surge heights south of the proposed diversion structure and increases in tidal flooding in communities near the immediate outfall area (approximately 10 miles north and 20 miles south) outside of federal levees, the Applicant's Preferred Alternative would have minor to moderate, permanent, adverse impacts on housing (including increased flood potential) and property values. Impacts in the communities of Myrtle Grove, Hermitage, Suzie Bayou, Woodpark, Happy Jack, and Grand Bayou would be more substantial than in other areas (see Figure 4.13-1). In addition, negligible to minor increases in the risk of levee overtopping gulfward of the immediate outfall area following delta formation (after approximately 20 years of Project operations) may contribute to impacts in communities inside levees, with the greatest increases in communities within the NOV-NFL Levee system closest to the proposed Project. For other areas inside levees, or farther south of the diversion, impacts of Project operations on housing and property values would be negligible.

Based on property assessment information from the Plaquemines Parish Assessor, the total assessed value for the 532 identified parcels in the seven affected communities in Plaquemines Parish was $5.9 million in 2019 (see Table 4.13-5) (Plaquemines Parish Assessor 2019). The assessed value represents only 10 percent of the fair market value for residential properties and undeveloped parcels (Plaquemines Parish Assessor 2022). The total estimated property value based on online value estimates (not appraisals) for potentially affected properties in these communities is approximately $88 million (see Table 2-6 in Appendix H). While parcels can be empty or have more than one housing unit, for context, there are an estimated 10,202 housing units in Plaquemines Parish according to the Census Bureau; approximately 14 percent of these housing units (1,385) are vacant (U.S. Census Bureau 2018).

Table 4.13-5
Assessed Values[a] of Residential Properties Located near the Proposed Project Site outside Flood Protection

Community	Assessed Value[a]	Count of Parcels
Myrtle Grove	$3,176,997	167
Hermitage	$499,134	84
Suzie Bayou North	$236,751	43
Suzie Bayou South	$280,511	51
Woodpark	$242,571	32
Happy Jack	$1,308,541	116
Grand Bayou	$140,748	39
Total	**$5,885,253**	**532**

Source: Assessed Value and Count of Parcels data from Plaquemines Parish Assessor 2019 provided by Abt/Jacobs on behalf of CPRA. Appendix H1 presents estimates of total property value by community.

[a] Assessed values for residential properties represent 10% of the fair market value except where such properties are subject to an assessment freeze due to age, disability, or other reasons as set forth in the Louisiana Constitution, Art. 7, Section 18. See https://www.plaqueminesassessor.com/faqs.html.

These more frequent occurrences in flooding and increases in storm surge heights due to the proposed Project as compared to the No Action Alternative could lead to decreases in property values in these areas, as demonstrated in empirical studies such as McAlpine and Porter (2018). The total assessed value of nearly $5.9 million (or approximately $88 million in total estimated property value, as reported in Appendix H1) in these various communities near the proposed Project outside of flood protection (see Table 4.13-5) are estimates of total property value that could be at risk of damage under the Applicant's Preferred Alternative. However, these periodic inundation events are generally not expected to cause damages to existing elevated residential structures or other structures that have existing flood protection enhancements (CPRA 2019c). Damages may occur to various infrastructure (for example, roads) and increased risk of vehicle damage, accumulation of siltation and sludge, cemetery inundation, and interruption of emergency services in areas outside of flood protection than would have occurred in those areas under the No Action Alternative. This may result in a need to accelerate investment in infrastructure needed to maintain the functionality of residences, businesses, and recreational properties. In recognition of this potential for increased flooding impacts due to the diversion operation, CPRA is considering acquiring Project servitudes on those properties within communities that are projected to experience increased flooding due to diversion operations. More details regarding these potential actions are set forth in the Mitigation Plan (see Appendix R).

Federally-backed flood insurance is anticipated to remain available for all residents of NFIP-participating communities under the Applicant's Preferred Alternative. Considering the ongoing implementation of Risk Rating 2.0, it is difficult to predict how flood insurance rates may change in the future. If FEMA were to revise the estimated flood risk of properties in the Project area, flood insurance rates could change relative to the No Action Alternative. In particular, in communities projected to experience increases in tidal flooding and/or storm hazards due to Project operations, some properties may experience increases in flood insurance rates relative to the No Action Alternative in the earlier years of the Project. However, the magnitude of any difference in insurance rates is uncertain. By 2050, the difference in annual days of tidal flooding between the No Action and the Applicant's Preferred Alternative is expected to decrease to minor, and thereafter the dominant driver of tidal flooding would be related to sea-level rise.

4.13.5.3.2.2 Sedimentation in Barataria Basin Navigation Channels

As described in Section 4.13.3.3, sediment deposition in channels and canals in the outfall area that are not maintained by federal entities, such as the Wilkinson Canal, may increase under the Applicant's Preferred Alternative. If not mitigated, this deposition could prevent uses of these channels, which could adversely impact property values for properties served by those channels and canals. For example, if the Wilkinson Canal access or usability is impacted by sedimentation from the Project operations, the ability of the private residences on this canal to access the bay and Gulf from their properties may be reduced. If not mitigated, this may result in a moderate, permanent, adverse reduction in property values in communities accessed by these channels.

4.13.5.3.3 Other Alternatives

4.13.5.3.3.1 50,000 cfs Alternative

As compared to the No Action Alternative, and similar to the Applicant's Preferred Alternative, the 50,000 cfs Alternative would also result in moderate, permanent, adverse impacts on the value of properties served by locally maintained navigation channels and canals due to increased sedimentation if additional dredging is not undertaken.

Inside federally maintained flood protection, operation of the 50,000 cfs Alternative is expected to have negligible to minor, permanent, beneficial and adverse impacts on housing and property values related to Project impacts on storm surge north and south of the proposed diversion, respectively. Outside federal flood protection, impacts would be more varied. Like the Applicant's Preferred Alternative, the 50,000 cfs Alternatives would have minor, permanent, adverse impacts on property values compared to the No Action Alternative, but impacts on property values would be slightly less due to the lower occurrence of tidal flooding caused by this alternative compared to the Applicant's Preferred Alternative.

4.13.5.3.3.2 150,000 cfs Alternative

As compared to the No Action Alternative, and similar to the Applicant's Preferred Alternative, the 150,000 cfs Alternative would also result in moderate, permanent, adverse impacts on the value of properties served by locally maintained navigation channels and canals due to increased sedimentation if additional dredging is not undertaken.

Relative to the Applicant's Preferred Alternative, the 150,000 cfs Alternative would have larger adverse impacts on property values as a result of a higher frequency of tidal flooding expected, representing moderate, permanent, adverse impacts (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for further details about storm and flooding hazards related to the other alternatives). These periodic inundation events may result in a need to accelerate investments in infrastructure needed to maintain the functionality of residences, businesses, and recreational properties. Additional investments would be needed under the 150,000 cfs Alternative as compared to the Applicant's Preferred Alternative.

4.13.5.3.3.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area would have minimal impacts on housing and property values during operations relative to the No Action Alternative. The terrace alternatives would have impacts on housing and property values similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.13.5.4 Tax Revenue

This section addresses potential impacts on local sales and use and property taxes. Impacts on tax revenues are discussed below for impacts related to flooding and storm hazards, as well as sedimentation of navigation channels.

4.13.5.4.1 No Action Alternative

The general outmigration trends anticipated in the area under the No Action Alternative (discussed above in Section 4.13.5.2) are expected to result in minor to moderate, permanent, adverse impacts on sales and use taxes in the Project area related to reductions in population and changes in business sales and revenues. Impacts on property taxes would vary, in line with the impacts on property values discussed in the previous section. Specifically, impacts on property taxes under the No Action Alternative as compared to existing conditions are expected to be negligible for areas inside of flood protection, while for areas outside of flood protection, moderate to major, permanent, adverse impacts are expected. The remainder of this section describes the anticipated impacts on property taxes for impacts related to sedimentation of navigation channels and impacts related to flooding and storm hazards.

4.13.5.4.1.1 Flooding and Storm Hazards

Under the No Action Alternative, continuing decreases in population and increases in outmigration and relocation resulting from tidal flooding and storm hazards outside of federal flood protection would continue to have negative impacts on the property base throughout the Project area. As a result, tax revenues tied to property taxes in areas outside of federal flood protection are expected to decline over the analysis period resulting in moderate to major, permanent, adverse impacts under the No Action Alternative.

4.13.5.4.1.2 Sedimentation in Barataria Basin Navigation Channels

Various private residences in the Barataria Basin that contribute to property taxes are located along locally maintained channels and canals providing residents access to the bay and Gulf from their properties. Under the No Action Alternative, local, municipal, and federal proponents would be expected to continue to maintain channel depths sufficient to allow for the passage of marine vessels. Over the 50-year analysis period increases or decreases in dredging requirements may occur due to sea-level rise and related increases in sediment supply from flooding, overwash, and bankline erosion.

4.13.5.4.2 Applicant's Preferred Alternative

Sales and use tax revenues are expected to experience negligible to minor, permanent, adverse impacts under the Applicant's Preferred Alternative as compared to the No Action Alternative. This would result from expected increased outmigration from the area due to the proposed Project; as the population declines, sales of goods and services in the area may decline, resulting in reduced sales and use tax collections. Outmigration is anticipated to be the only driver of change in sales and use tax revenue in the operations phase of the proposed Project. For the west bank New Orleans area north of the diversion, minor permanent beneficial impacts on property taxes are expected. For areas near the immediate outfall area (approximately 10 miles north and 20 miles south), areas outside of flood protection would experience minor, permanent, adverse impacts on property taxes while for areas inside flood protection and further south impacts would be negligible. If not mitigated, additional moderate, permanent, adverse impacts on property tax receipts could occur related to property value impacts from reduced navigation channel access.

The remainder of this section further describes the anticipated impacts on property taxes related to flooding and storm hazards and sedimentation of navigation channels.

4.13.5.4.2.1 Flooding and Storm Hazards

Project impacts on property tax revenues within the Project area would follow trends in impacts on property values associated with tidal flooding and storm hazards (see Section 4.13.5.4). Due to Project-induced reductions in storm surge north of the proposed diversion structure, the Applicant's Preferred Alternative could have minor, permanent, beneficial impacts on property tax revenues north of the proposed Project in areas both inside and outside of federal flood protection levees, including the west bank New Orleans area.

In areas where property values would be expected to decrease as a result of the Applicant's Preferred Alternative, property tax revenues would also be expected to decline. Due to Project-induced increases in storm surge heights south of the proposed diversion structure and increases in tidal flooding in basin communities outside of federal levees, as compared to the No Action Alternative, the Applicant's Preferred Alternative would have minor, permanent, adverse impacts on property tax revenues. Specifically, property tax revenues would decline as a result of expected declines in property values in communities near the immediate outfall area (approximately 10 miles north and 20 miles south) outside of federal levee protection (see Figure 4.13-1). For other areas inside levees or farther south of the diversion, impacts of Project operations on property tax revenues would be negligible.

While the area of potential impacts includes the birdfoot delta, the majority of the affected land in the delta is publicly owned (LA TIG 2020). The privately owned land that does exist in the birdfoot delta is currently taxed as marsh, which is taxed at a low tax rate, and private property owners typically pay taxes for eroded marsh to maintain ownership claims (LA TIG 2020).

4.13.5.4.2.2 Sedimentation in Barataria Basin Navigation Channels

As described in Section 4.13.3.3, sediment deposition in channels and canals in the outfall area that are not maintained by federal entities, such as the Wilkinson Canal, may increase under the Applicant's Preferred Alternative. If not mitigated, this deposition may restrict use by some vessels of these channels, which could adversely impact property values for properties served by those channels and canals. For example, if the Wilkinson Canal access or usability is impacted by sedimentation from the Project operations, the ability of the private residences on this canal to access the bay and Gulf from their properties may be reduced. If not mitigated, this may result in future lower assessed property valuation of these residences and subsequent moderate, permanent, adverse indirect impacts on property tax receipts in Plaquemines Parish. Details regarding these mitigation measures are set forth in Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan.

4.13.5.4.3 Other Alternatives

4.13.5.4.3.1 50,000 cfs Alternative

Operations under the 50,000 cfs Alternative would be expected to have indirect impacts on tax revenues that would be similar to the Applicant's Preferred Alternative. Under the 50,000 cfs Alternative, the proposed Project is expected to have negligible to minor, adverse, impacts on sales and use tax revenues, driven only by a slight increase in outmigration relative to trends anticipated under the No Action Alternative. Under the 50,000 cfs Alternative, in the west bank New Orleans area north of the diversion, the proposed Project would be expected to have minor, permanent, beneficial indirect impacts on property tax revenues as compared to the No Action Alternative.

As compared to the No Action Alternative and similar to the Applicant's Preferred Alternative, tidal flooding and storm hazards impacts would be expected to adversely impact property values in communities within 20 miles of the diversion located outside of flood protection. As such, property tax receipts from properties in these communities would also be expected to decline. For the 50,000 cfs Alternative, those property tax revenue impacts are expected to be slightly lower than the Applicant's Preferred Alternative, but still impacts would be minor, permanent, and adverse as compared to the No Action Alternative.

4.13.5.4.3.2 150,000 cfs Alternative

Impacts of the 150,000 cfs Alternative would be similar to the Applicant's Preferred Alternative and 50,000 cfs Alternative. However, impacts on tax revenues would be slightly higher. Impacts of the 150,000 cfs Alternative would nonetheless be minor, permanent, and adverse as compared to the No Action Alternative. Areas inside levees and areas outside levees farther south of the immediate outfall area would experience negligible impacts on tax revenues, as compared to the No Action Alternative.

4.13.5.4.3.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area would have minimal impacts on tax revenues during operations as compared to the No Action Alternative. The terrace alternatives would have the same impacts on tax revenue as described above for their corresponding flow capacity alternatives without terraces.

4.13.5.5 Public Services and Utilities

Two types of impacts on public services and utilities are considered: direct impacts on infrastructure, and indirect impacts corresponding with the expected impacts on tax revenues discussed in the previous section. Local sales and property taxes provide funding for services such as police and fire protection, education, sewerage and drainage projects, and road construction. Both public services and utilities infrastructure could be affected by changes in flooding and storm hazards. Note, changes in sedimentation in navigation channels would not be expected to affect public services and utilities and as such are not addressed separately in this section.

4.13.5.5.1 No Action Alternative

Moderate to major, permanent, adverse impacts on Jefferson and Plaquemines Parishes public facilities and utilities could occur under the No Action Alternative due to increased tidal flooding and storm hazards. Current trends of closures and decreases in services in schools, health care facilities, emergency response, libraries, and post offices are expected to continue under the No Action Alternative. Barnes and Virgets (2018) predicts that 130 public schools in the Louisiana coastal area would be at a higher risk of coastal flooding over the next 50 years without future action.[73] These schools would experience at least 1 foot of flooding under the 2017 Coastal Master Plan's medium flood depth scenarios. A number of schools fall within Jefferson and Plaquemines Parishes. The same report predicts that 18 hospitals in the 10-parish Project area would be at a higher risk of coastal flooding over the next 50 years without future action.

Figure 3.13-3 in Chapter 3, Section 3.13 Socioeconomics shows the location of schools and other public service facilities located near the Project footprint. While most are located within flood protection or in northern parts of the Project areas (parishes such as Orleans, St. Charles, and St. John the Baptist) that are not likely to be substantially impacted by increased tidal flooding or storm surge, there are several EMS and law enforcement facilities, two public schools, and a healthcare facility located outside of flood protection, several of which are near Jean Lafitte. These facilities are at risk from increased tidal flooding and storm hazards. Jean Lafitte is home to an elementary school as well as a middle/high school. The middle/high school (Fisher Middle/High School) had an enrollment of 518 as of 2020 (Louisiana Department of Education 2020). The community is also the site of a healthcare facility, one of the few in the immediate region. Increased flooding and storm hazards could adversely impact public access to these public service facilities. Additionally, projected decreases in population and an increase in outmigration/relocation under the No Action Alternative in some parts of Plaquemines and Jefferson Parishes would reduce the demand for public services and utilities. Simultaneously, declines in tax revenue could impact the ability of local parish governments to fund certain public services (for example, schools).

4.13.5.5.2 Applicant's Preferred Alternative

Two types of impacts on public services are expected to result from the Applicant's Preferred Alternative as compared to the No Action Alternative. First, increases in tidal flooding and storm hazards caused by operations of the Applicant's Preferred Alternative could have a direct impact on facilities and public access to public service facilities. In particular, as described under the No Action Alternative, while most public services and utilities infrastructure are located inside flood protection, a few are

[73] Barnes and Virgets (2018) study area includes the portions of the coast included in the 2017 Master Plan modeling effort to assess storm surge-based flooding; see Figure 1 in their report for a map.

not. These facilities that are located outside of federal flood protection near the immediate outfall area would experience direct adverse impacts as a result of increased tidal flooding (approximately 10 miles north and 20 miles south) and storm hazards (south of the diversion) from the proposed Project. In particular, there are at least seven facilities outside of flood protection that could be affected, five of which are near the community of Jean Lafitte, including several EMS and law enforcement facilities, two public schools, and a healthcare facility that could be impacted by increased flooding due to operation of the Applicant's Preferred Alternative. These facilities would also be affected under the No Action Alternative, but the number of days of flooding would be increased under the Applicant's Preferred Alternative (see Section 4.13.3.1 Tidal Flooding above). Beneficial impacts on public service infrastructure and utilities are expected in areas farther from the diversion and to the north due to minor decreases in storm hazards as compared to the No Action Alternative.

Second, because public services are typically funded by tax revenues and local residents, the Applicant's Preferred Alternative would have impacts on public services and utilities similar to impacts on tax revenues and population (see Section 4.13.5.4). In parishes where tax revenues and population would be expected to decrease as a result of tidal flooding and storm hazard impacts associated with the Applicant's Preferred Alternative (that is, Plaquemines and Jefferson Parishes), funding for public services and utilities would be expected to decline.

Overall, minor, permanent, adverse impacts on public services and utilities in Plaquemines and Jefferson Parishes would be expected under the Applicant's Preferred Alternative as compared to the No Action Alternative.

4.13.5.5.3 Other Alternatives

4.13.5.5.3.1 50,000 cfs Alternative

Operations under the 50,000 cfs Alternative would result in minor, permanent, adverse impacts on public services and utilities in areas near (within about 20 miles) of the immediate outfall area as compared to the No Action Alternative, similar to impacts under the Applicant's Preferred Alternative. These impacts would result from potential direct impacts on infrastructure from increased flooding and indirect impacts due to decreased funding as a result of decreasing taxes. For the 50,000 cfs Alternative, those public service and utility impacts would be expected to be slightly less intense than the Applicant's Preferred Alternative, as the intensity of flooding and storm hazards would be less.

4.13.5.5.3.2 150,000 cfs Alternative

Also similar to the Applicant's Preferred Alternative, operations under the 150,000 cfs Alternative would result in minor, permanent, adverse impacts on public services and utilities in areas near the immediate outfall area (approximately 10 miles north and 20 miles south) as compared to the No Action Alternative. The 150,000 cfs Alternative would be expected to have slightly more intense impacts on public services and utilities than the Applicant's Preferred Alternative as the intensity of flooding and storm hazards would be greater.

4.13.5.5.3.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area would have negligible impacts on public services and utilities during operations as compared to the No Action Alternative. The terrace alternatives would have impacts similar to the corresponding flow capacity alternatives without terraces.

4.13.5.6 Community Cohesion

This section focuses on the impacts from tidal flooding and storm hazards on community cohesion over the 50-year analysis period. Changes in sedimentation in navigation channels would not be expected to affect community cohesion and as such are not addressed further in this section.

4.13.5.6.1 No Action Alternative

Chapter 3, Section 3.13 Socioeconomics provides additional detail related to measures of community cohesion; see especially Table 3.13-4, which highlights indicators, including access to social services, basic needs, economic security, education, governance, health, safety, and social connectedness.

Under the No Action Alternative, where the current trends continue, there would be moderate, permanent, adverse impacts on community cohesion in the Project area. People that have built communities, raised their families, and earned a living along the coast of Louisiana have a deep connection to the place, interwoven with and dependent on the rich natural resources of the state (Gramling and Hagelman 2005). Over time, rural populations living in coastal areas have adapted to various occupations, including fisheries, recreation, agriculture, and coastal/offshore oil and gas activities. Growth has periodically been modified or halted with the occurrence of large storm events, which has changed the configuration of development patterns over time. As discussed above in Section 4.13.5.2, outmigration and population declines in some parts of the Barataria Basin are expected to continue as a result of land loss and increases in storm surge and inundation from storms. For these areas, community cohesion is also expected to decline under the No Action Alternative as individuals and families are dispersed to different areas within and outside of coastal Louisiana.

4.13.5.6.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative is expected to have minor to moderate, permanent, adverse impacts on community cohesion, depending on location. This range reflects varying impacts due to changes in tidal flooding and storm hazards across locations under the Applicant's Preferred Alternative as compared to the No Action Alternative. In communities near the immediate outfall area (within 20 miles) outside of flood protection (see Figure 4.13-1) moderate adverse impacts on community cohesion would be expected due to increased tidal flooding. Because these communities are small and somewhat isolated, the Applicant's Preferred Alternative may result in sizeable impacts on community cohesion if individuals, particularly permanent residents, relocate or experience a loss in livelihood or public services due to Project impacts. These impacts are expected to occur within the first few decades of diversion operation when the Applicant's Preferred Alternative drives increased flooding as compared to the No Action Alternative. In other areas farther from the diversion site or behind flood protection, minor adverse impacts on community cohesion would be expected. Overall, because the Applicant's Preferred Alternative would be expected to accelerate adverse impacts on some small communities, this alternative would have minor to moderate, permanent, adverse impacts on community cohesion, as compared to the No Action Alternative.

As described in Chapter 3, Section 3.13 Socioeconomics, Jefferson, Lafourche, and Plaquemines Parishes all have low social connectedness based on a set of indicators of coastal community well-being prepared by NOAA (Buck et al. 2015).[74] To the extent that these communities experience an acceleration of outmigration due to the Applicant's Preferred Alternative (primarily anticipated in Plaquemines Parish, as described in Section 4.13.2), social connectedness well-being may be further reduced, exacerbating the baseline low social connectedness. Moreover, many communities in the Project area have a high reliance on commercial or subsistence fishing activities (see Chapter 3, Section 3.14 Commercial Fisheries, Table 3.14-10 Commercial Fishing Engagement and Reliance Indices by Coastal Community). The proposed Project is expected to adversely impact those fishing activities for shrimp and oysters, which may in turn result in adverse impacts on community cohesion. Access to social services is also low in Lafourche and Plaquemines Parishes. Section 4.13.4.2 Public Services and Utilities, demonstrates that the proposed Project may adversely impact delivery of public services in Plaquemines and Jefferson Parishes in particular as a result of increased tidal flooding and storm hazards from the proposed Project. Finally, locally owned businesses, as well as housing and property values, may experience adverse impacts due to the proposed Project (see Sections 4.13.5.1 and 4.13.5.3, respectively), resulting in strains on community cohesion.

4.13.5.6.3 Other Alternatives

4.13.5.6.3.1 50,000 cfs Alternatives

Operations under the 50,000 cfs Alternative would result in minor to moderate, permanent, adverse impacts on community cohesion as compared to the No Action Alternative, similar to the impacts under the Applicant's Preferred Alternative. For the 50,000 cfs Alternative, those community cohesion impacts would be expected to be slightly less intense than the Applicant's Preferred Alternative.

[74] Social connectedness is defined as a community's ability to exchange resources, engage in activities to build and maintain social cohesion, and respond and recover from perturbations.

4.13.5.6.3.2 150,000 cfs Alternatives

Operations under the 150,000 cfs Alternative would also result in minor to moderate, permanent, adverse impacts on community cohesion as compared to the No Action Alternative. The 150,000 cfs Alternative would be expected to have slightly more intense impacts on community cohesion than the Applicant's Preferred Alternative.

4.13.5.6.3.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area would have negligible impacts on community cohesion during operations as compared to the No Action Alternative. The terrace alternatives would have impacts similar to their corresponding flow capacity alternatives without terraces.

4.13.5.7 Protection of Children

EO No. 13045, Protection of Children from Environmental Health Risks and Safety Risks, requires that federal agencies identify and assess environmental health risks and safety risks that may disproportionately affect children. More details about the circumstances of children in the Project area can be found in Chapter 3, Section 3.13 Socioeconomics.

This section focuses on the impacts from flooding and storm surge on protection of children over the 50-year analysis period. Changes in sedimentation in navigation channels would not be expected to affect protection of children and as such are not addressed further in this section.

4.13.5.7.1 No Action Alternative

The No Action Alternative would have a minor, permanent, adverse impact on the welfare of children. In Louisiana, 28 percent of children live below the poverty line, higher than the national average of 21 percent (U.S. Census Bureau 2017); poverty is an important determinant in children's health (AAP Council on Community Pediatrics 2016). Lafourche Parish (21 percent) and Plaquemines Parish (20 percent) are both similar to the national average, but below the state average, while Jefferson Parish (49 percent) has a substantially higher percentage of children living below the poverty line than either the state or the nation. Under the No Action Alternative, these conditions would likely remain similar, although increased tidal flooding and storm hazards could threaten the safety of living conditions and leave children vulnerable. These conditions also impact tax revenues which would worsen school conditions, or ability to access schools using public infrastructure in affected areas. As discussed above in Section 4.13.5.5, there are two schools located in Jean Lafitte (an elementary school and a combined middle/high school) that are outside flood protection (see Figure 4.13-3). Both at-risk schools are located in Jefferson Parish, while public school facilities in Plaquemines Parish are located behind federal flood protection, and would not be at risk. To the extent that adverse impacts resulting from increasing tidal flooding or storm surge would limit access to or funding of these schools, children's health and safety may be impacted. Also, if fishing conditions decline under the No Action Alternative, children in families reliant upon commercial fishing in the Project area would be adversely affected. These factors would lead to diminished conditions for the long-term welfare of children.

4.13.5.7.2 Applicant's Preferred Alternative

In areas with increased risk of tidal flooding or inundation from storm events (that is, communities located near the proposed immediate outfall area [approximately 10 miles north and 20 miles south] and outside of federal flood protection), minor, permanent, adverse impacts on children would be expected. However, in the areas in the northern portion of the Project area, decreased storm hazard risks could have a minor, permanent, beneficial impact on children due to greater stability of the tax base, public services, and less risk of a major storm event ruining economic or living conditions. Under the Applicant's Preferred Alternative, when compared to the No Action Alternative increased tidal flooding and storm hazards could leave children's health and safety more vulnerable in some communities near the immediate outfall area of the proposed Project (within approximately 10 miles north and 20 miles south) in areas outside of federal flood protection. Specifically, as discussed in Section 4.13.5.4, declining tax revenue could adversely impact public services, specifically schools, which would disproportionately impact children's health and safety. Increased tidal flooding or storm surge and inundation may also impact the ability for children to access their schools. Further, weakened economic conditions in areas that are at higher risk from storm hazards may put more children at risk of falling below the poverty line, with associated impacts on health outcomes. In particular, children in communities reliant on shrimp or other commercial fisheries adversely affected by the Applicant's Preferred Alternative would be adversely impacted if their families were unable to continue making a living fishing. A decline in socioeconomic status can expose children to food insecurity and loss of healthcare.

4.13.5.7.3 Other Alternatives

4.13.5.7.3.1 <u>50,000 cfs Alternative</u>

Similar to the Applicant's Preferred Alternative, minor, permanent, adverse impacts would be expected under the 50,000 cfs Alternative as compared to the No Action Alternative for children in communities located near the immediate outfall area (approximately 10 miles north and 20 miles south) and outside of federal flood protection, while minor, permanent, beneficial impacts would be expected under either alternative for children living in the northern parts of the Project area. For the 50,000 cfs Alternative, impacts on children would be expected to be slightly less intense than the Applicant's Preferred Alternative.

4.13.5.7.3.2 <u>150,000 cfs Alternative</u>

Similar to the Applicant's Preferred Alternative, minor, permanent, adverse impacts would be expected under the 150,000 cfs Alternative as compared to the No Action Alternative for children in communities located near the immediate outfall area (approximately 10 miles north and 20 miles south) and outside of federal flood protection, while minor, permanent, beneficial impacts would be expected under either alternative for children living in the northern parts of the Project area. The 150,000 cfs Alternative would be expected to have slightly more intense impacts on children than the Applicant's Preferred Alternative.

4.13.5.7.3.3 Terrace Alternatives

The presence of terraces in the immediate outfall area would have negligible impacts on protection of children during operations as compared to the No Action Alternative. The three terrace alternatives would have the same impacts on children as those anticipated under the corresponding flow capacity alternatives without terraces.

4.13.6 Summary of Potential Impacts

Table 4.13-6 summarizes the potential impacts on socioeconomics for each alternative. Details are provided in Sections 4.13.2 through 4.13.5 above.

Table 4.13-6
Summary of Potential Impacts on Socioeconomics from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on economy, employment, business, and industrial activity; population; housing and property values; tax revenue; public services and utilities; community cohesion, and protection of children expected. Current trends in adaptation to environmental conditions would continue.
Operational Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** General trend of land loss and increased flooding decreases business opportunities. Moderate to major, permanent, adverse impacts on economic activities. • **Population:** Major, permanent, adverse impacts on population outmigration due to increased public health and safety risks from storm damage, structural damages, and related economic factors. • **Housing and Property Values:** Negligible (inside flood protection) to major (outside flood protection), permanent, adverse impacts on property values. • **Tax Revenue:** Minor to moderate permanent, adverse impacts on sales and use revenues in the Project area. Impacts on property taxes are expected to be negligible for areas inside of flood protection, while for areas outside of flood protection, where populations are generally smaller, moderate to major, permanent, adverse impacts are expected. • **Public Services and Utilities:** Moderate to major, permanent, adverse impacts. Trend of outmigration would lead to less tax revenue and less available funding for spending on public services. Increased flooding and land loss could also impact delivery of utility services. Current trends of closures and decreases in public services in expected to continue. • **Community Cohesion:** Moderate permanent, adverse impacts on community cohesion. • **Protection of Children:** Minor, permanent, adverse impacts on the welfare of children.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** Moderate to major, temporary, beneficial impacts from job creation and increased economic activity in the Project area. Short-term, minor to moderate, adverse impacts on

Table 4.13-6
Summary of Potential Impacts on Socioeconomics from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
	some businesses located in the direct vicinity of construction activities associated with increased traffic, noise, and dust during construction. Minor, permanent, adverse impacts on agricultural outputs and employment in areas in and near the proposed Project footprint. • **Population:** Negligible impacts on population in the Project area. • **Housing and Property Values:** Minor, short-term, adverse impacts on properties within the construction footprint as well as properties within approximately 0.5-mile around the footprint. Minor to moderate, temporary, adverse direct construction impacts would occur on lands within the construction footprint as well as adjacent lands, including nearby residences and businesses. • **Tax Revenue:** Minor to moderate, short-term, beneficial impacts on sales and use and income taxes across the State of Louisiana and local jurisdictions associated with construction spending, particularly in Plaquemines Parish. Minor, permanent, adverse impacts on property taxes receipts in Plaquemines Parish associated with reduced housing and property values. • **Public Services and Utilities:** Minor short-term benefits to public services associated with increased sales tax receipts, primarily in Plaquemines Parish. Minor short-term adverse impacts on public services associated with reduced property taxes. Negligible impacts on utilities. • **Community Cohesion:** Negligible impacts on community cohesion. • **Protection of Children:** Negligible impacts on protection of children.
Operational Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** Negligible to minor, permanent, beneficial impacts on business and industrial activities in the west bank New Orleans area north of diversion from reduced storm hazards. Minor, permanent, adverse impacts on the regional economy, employment, businesses, and industrial activity as a result of increased tidal flooding and storm surge in areas outside flood protection in the Barataria Basin, particularly in the 2030s to 2050s in areas near the immediate outfall area (within 10 miles north and 20 miles south). Depending on the degree of flood impact, CPRA plans to acquire Project servitudes on affected properties within communities to compensate property owners for the impacts of diversion-induced flooding on the value of their properties. • **Population:** Minor to moderate, short-term and permanent, adverse impacts on communities near the immediate outfall area (within 10 miles north and 20 miles south) and outside of flood protection due to increased tidal flooding and associated outmigration. Long-term, negligible to minor, beneficial impacts due to additional storm surge protection for the west bank New Orleans area north of the diversion. Depending on the degree of flood impact, CPRA plans to acquire Project servitudes on affected properties within communities to compensate property owners for the impacts of diversion-induced flooding on the value of their properties. • **Housing and Property Values:** In the west bank New Orleans area north of the diversion, the Project would be expected to have minor, permanent, beneficial impacts on housing and property values as the land gained as a result of the proposed Project would decrease the risks of storm hazards. Minor to moderate, permanent, adverse impacts on housing and property values would occur in communities near the immediate outfall area (within 10 miles north and 20 miles south) and outside of flood protection. Negligible to minor impacts for areas inside flood protection and for areas further (more than 20 miles) south of the diversion. • **Tax Revenue**: Minor, permanent, beneficial impacts on property tax revenues in the west bank New Orleans area north of the diversion. Minor, permanent, adverse impacts in areas outside of flood protection near the immediate outfall area (within 10 miles north and 20 miles south); negligible impacts expected in areas farther from the immediate outfall area. Negligible impacts for areas inside flood protection.

Table 4.13-6
Summary of Potential Impacts on Socioeconomics from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
	• **Public Services and Utilities:** Minor, permanent, beneficial impacts on public service facilities and delivery in the west bank New Orleans area due to decreased storm hazard risks and increased tax revenue. Public services and utilities infrastructure located outside of federal flood protection near the immediate outfall area (within 10 miles north and 20 miles south) would experience direct adverse impacts. Decreased tax revenues in Plaquemines and Jefferson Parishes would reduce funding for public services. Overall minor, permanent, adverse impacts on delivery of public services in Plaquemines and Jefferson Parishes. • **Community Cohesion:** Minor to moderate, permanent, adverse impacts on community cohesion in communities near the immediate outfall area (within 10 miles north and 20 miles south) outside of flood protection related to outmigration. • **Protection of Children:** Minor, permanent, adverse impacts on children in communities near the immediate outfall area (within 10 miles north or 20 miles south) outside of flood protection. Minor, permanent, beneficial impacts on children in the west bank New Orleans area north of the diversion.
50,000 cfs Alternative	
Construction Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** Project design and construction would have moderate to major, temporary, beneficial impacts on economic output and employment as compared to the No Action Alternative. Some minor, short-term adverse impacts due to additional increases in traffic, noise, and dust, but somewhat less than impacts of the Applicant's Preferred Alternative due to a shorter duration of construction as compared to the Applicant's Preferred Alternative. Minor, permanent, adverse impacts on agricultural outputs and employment in areas in and near the proposed Project footprint. • **Population:** Negligible impacts on population as compared to the No Action Alternative, consistent with the Applicant's Preferred Alternative. • **Housing and Property Values:** Minor, short-term, adverse indirect impacts on the value of housing and properties located within 0.5-mile of the proposed Project construction footprint as compared to the No Action Alternative. • **Tax Revenue:** Minor to moderate, temporary, beneficial impacts on sales and income taxes across the State of Louisiana and local jurisdictions and minor, permanent, adverse impacts on property taxes receipts in Plaquemines Parish as compared to the No Action Alternative. • **Public Services and Utilities:** Minor short-term benefits to public services associated with increased sales tax receipts, primarily in Plaquemines Parish. Minor short-term adverse impacts on public services associated with reduced property taxes as compared to the No Action Alternative. Negligible impacts on utilities as compared to the No Action Alternative. • **Community Cohesion:** Negligible impacts on community cohesion as compared to the No Action Alternative. • **Protection of Children:** Overall negligible impacts on protection of children as compared to the No Action Alternative.
Operational Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** Negligible to minor, permanent, beneficial impacts on business and industrial activities in the west bank New Orleans area north of diversion from reduced storm hazards as compared to the No Action Alternative. Minor, permanent, adverse impacts on the regional economy, employment, businesses, and industrial activity as a result of increased tidal flooding and storm surge in areas outside flood protection in the Barataria Basin, particularly in the 2030s to 2050s in areas near the immediate outfall area (within 10 miles north and 20 miles south) as compared to the No Action Alternative. Depending on the degree of flood impact, CPRA plans to acquire Project servitudes on affected properties within communities to compensate property owners for the impacts of diversion-induced flooding on the value of their properties.

Table 4.13-6 Summary of Potential Impacts on Socioeconomics from Each Alternative	
Impact Type	**Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)**
	• **Population:** Minor to moderate, permanent, adverse impacts on communities near the immediate outfall area (within 10 miles north and 20 miles south) outside of flood protection due to tidal flooding and outmigration as compared to the No Action Alternative. Depending on the degree of flood impact, CPRA plans to acquire Project servitudes on affected properties within communities to compensate property owners for the impacts of diversion-induced flooding on the value of their properties. Long-term, negligible to minor, beneficial impacts due to additional storm surge protection for the west bank New Orleans area north of the immediate outfall area. • **Housing and Property Values:** In the west bank New Orleans area north of the diversion, the Project would be expected to have minor, permanent, beneficial impacts on housing and property values as the land gained as a result of the proposed Project would decrease the risks of storm hazards as compared to the No Action Alternative. Minor to moderate, permanent, adverse impacts on housing and property values would occur in communities near the immediate outfall area (within 20 miles) outside of flood protection. Negligible impacts for areas inside flood protection and further south. • **Tax Revenue**: Minor to moderate, permanent, beneficial impacts on property tax revenues in the west bank New Orleans area north of the diversion as compared to the No Action Alternative. Minor, permanent, adverse impacts in areas outside of flood protection near the immediate outfall area (within 10 miles north and 20 miles south); negligible impacts expected in areas further from the outfall. Negligible impacts for areas inside flood protection and further south. • **Public Services and Utilities:** Minor, permanent, beneficial impacts on public service delivery in the west bank New Orleans area due to decreased storm hazard risks and increased tax revenue as compared to the No Action Alternative. Minor, permanent, adverse impacts on delivery of public services in communities near the immediate outfall area (within 10 miles north and 20 miles south) outside of flood protection. • **Community Cohesion:** Minor to moderate, permanent, adverse impacts on community cohesion in communities near the immediate outfall area (within 10 miles north and 20 miles south) and outside of flood protection related to outmigration as compared to the No Action Alternative. • **Protection of Children:** Minor, permanent, adverse impacts on children in communities near the immediate outfall area (within 20 miles) outside of flood protection as compared to the No Action Alternative. Minor, permanent, beneficial impacts on children in the in the west bank New Orleans area north of the diversion as compared to the No Action Alternative.
150,000 cfs Alternative	
Construction Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** Project design and construction would have moderate to major, temporary, beneficial impacts on economic output and employment as compared to the No Action Alternative. Some additional minor, short-term adverse impacts due to additional increases in traffic, noise, and dust as compared to the Applicant's Preferred Alternative. • **Population:** Negligible impacts on population in the Project area as compared to the No Action Alternative, consistent with the Applicant's Preferred Alternative. • **Housing and Property Values:** Minor, short-term, adverse impacts on properties in the area within and adjacent to the proposed Project footprint as compared to the No Action Alternative. Longer duration as compared to the No Action Alternative. • **Tax Revenue:** Moderate temporary, beneficial impacts on sales and income taxes across the State of Louisiana and local jurisdictions and minor, permanent, adverse impacts on property taxes receipts in Plaquemines Parish as compared to the No Action Alternative.

Table 4.13-6
Summary of Potential Impacts on Socioeconomics from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
	• **Public Services and Utilities:** Minor short-term benefits to public services associated with increased sales tax receipts, primarily in Plaquemines Parish as compared to the No Action Alternative. Minor short-term adverse impacts on public services associated with reduced property taxes. Negligible impacts on utilities. • **Community Cohesion:** Negligible impacts on community cohesion as compared to the No Action Alternative. • **Protection of Children:** Overall negligible impacts on protection of children as compared to the No Action Alternative.
Operational Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** Negligible to minor, permanent, beneficial impacts on business and industrial activities in the west bank New Orleans area north of diversion from reduced storm hazards as compared to the No Action Alternative. Minor, permanent, adverse impacts on the regional economy, employment, businesses, and industrial activity as a result of increased tidal flooding and storm surge in areas outside flood protection in the Barataria Basin, particularly in the 2030s to 2050s in areas near the immediate outfall area (within 10 miles north and 20 miles south). Depending on the degree of flood impact, CPRA plans to acquire Project servitudes on affected properties within communities to compensate property owners for the impacts of diversion-induced flooding on the value of their properties. Minor, permanent, adverse impacts on agricultural outputs and employment in areas in and near the proposed Project footprint. • **Population:** Minor to moderate, permanent, adverse impacts on communities near the immediate outfall area (within 10 miles north and 20 miles south) outside of flood protection due to tidal flooding and outmigration as compared to the No Action Alternative. Depending on the degree of flood impact, CPRA plans to acquire Project servitudes on affected properties within communities to compensate property owners for the impacts of diversion-induced flooding on the value of their properties. Long-term, negligible to minor, beneficial impacts due to additional storm surge protection for the west bank New Orleans area north of the diversion. • **Housing and Property Values:** In the New Orleans area north of the diversion, the Project would be expected to have minor, permanent, beneficial impacts on housing and property values as the land gained as a result of the proposed Project would decrease the risks of storm hazards as compared to the No Action Alternative. Minor to moderate, permanent, adverse impacts on housing and property values would occur in communities near the immediate outfall area (within 10 miles north and 20 miles south) outside of flood protection. Negligible to minor impacts for areas inside flood protection and further south. • **Tax Revenue**: Minor to moderate, permanent, beneficial impacts on property tax revenues in the west bank New Orleans area north of the diversion as compared to the No Action Alternative. Minor, permanent, adverse impacts in areas outside of flood protection near the immediate outfall area (within 10 miles north and 20 miles south); negligible impacts expected in areas further from the outfall. Negligible impacts for areas inside flood protection and further south. • **Public Services and Utilities:** Minor, permanent, beneficial impacts on public service delivery in the New Orleans area due to decreased storm hazard risks and increased tax revenue as compared to the No Action Alternative. Minor, permanent, adverse impacts on delivery of public services in communities near the immediate outfall area (within 10 miles north and 20 miles south) outside of flood protection. • **Community Cohesion:** Minor to moderate, permanent, adverse impacts on community cohesion in communities near the immediate outfall area (within 10 miles north and 20 miles south) outside of flood protection related to outmigration as compared to the No Action Alternative. • **Protection of Children:** Minor, permanent, adverse impacts on children in communities near the immediate outfall area (within 10 miles north and 20 miles

Table 4.13-6 Summary of Potential Impacts on Socioeconomics from Each Alternative	
Impact Type	**Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)**
	south) outside of flood protection as compared to the No Action Alternative. Minor, permanent, beneficial impacts on children in the west bank New Orleans area north of the diversion.
Terrace Alternatives	
Construction Impacts	• **Economy, Employment, Businesses, and Industrial Activity:** The three terrace alternatives would have similar construction impacts as those described under the corresponding flow capacity alternatives without terraces (50,000, 75,000, and 150,000 cfs Alternatives). Inclusion of spending on marsh terraces under any of the capacity alternatives would slightly increase the regional economic benefits of these alternatives as compared to the flow capacity alternatives. • **All Other Socioeconomic Activities**: The three terrace alternatives would have impacts that would be similar to those anticipated under the corresponding flow capacity alternatives without terraces.
Operational Impacts	• **All Socioeconomic Activities**: The three terrace alternatives would have impacts that would be similar to those anticipated under the corresponding flow capacity alternatives without terraces

4.14 COMMERCIAL FISHERIES

4.14.1 Area of Potential Impacts

The Project area includes two basins for commercial fisheries (the Barataria Basin and a portion of the Mississippi River Basin) and overlaps with 13 commercial fisheries sub-basins, as delineated by the LDWF (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-1). Construction impacts on commercial fisheries would likely occur within and immediately adjacent to (within 0.5 mile) the proposed construction footprint, but may also occur along roadways leading to the Project area due to traffic congestion from construction vehicles. The area of potential operational impacts for commercial fisheries includes the entire Project area, encompassing all or portions of the surrounding parishes: Ascension, Assumption, Lafourche, Jefferson, Orleans, Plaquemines, St. Charles, St. John the Baptist, St. James, and St. Bernard. This area of operational impacts includes communities with economic ties to the commercial fishing industry, including residences of commercial fishers, businesses that supply the commercial fishing industry (such as ice and bait shops), gas stations, restaurants, marinas, as well as shippers, dealers, processors, and retail sales operations.

4.14.2 Guidelines for Commercial Fishing Impact Determinations

Considerations for determining impact intensities for commercial fishing are discussed in Section 4.1; the following provides specific definitions of no impact, negligible, minor, moderate, and major impacts for use in evaluating commercial fisheries impacts:

- no impact: no discernible or measurable impact;

- negligible: the impact on commercial fisheries would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: a few individuals, groups, businesses, properties, or institutions would be affected. Impacts would be small and localized. These impacts are not expected to substantively alter social and/or economic conditions;
- moderate: many individuals, groups, businesses, properties, or institutions would be affected. Impacts would be readily apparent and detectable in local and adjacent areas and would have a noticeable effect on social and/or economic conditions in the Project area; and
- major: a large number of individuals, groups, businesses, properties, or institutions would be affected. Impacts would be readily detectable and observed, extend over a widespread area, and could have a substantial influence on social and/or economic conditions in the Project area.

To investigate potential changes in commercial fishing under the No Action and action alternatives, the impact analysis relies heavily on the aquatic resource impact analysis (see Section 4.10.4.5 Key Species in Aquatic Resources), which evaluates the potential impact of environmental changes on species and species groups, including shrimp, oysters, crab, and finfish. For the key species, factors considered in Section 4.10 Aquatic Resources include changes in water flow (velocity and direction), salinity, temperature, turbidity, sedimentation, nutrient input and primary productivity (for fueling the food web), amount of marsh vegetation, bottom substrates, and dissolved oxygen. The impact analyses were informed in part by HSIs, modeled over time using outputs from the Delft3D Basinwide Model, which consider the value of combined habitat characteristics, such as vegetative cover and temperature, to the juvenile or sub-adult life stage of a key species. Impacts on species abundance provide a reasonable proxy for understanding likely impacts of the alternatives on commercial catch in affected areas. See Appendix H for more information about the methodology for evaluating commercial fishing impacts. The commercial fishing industry is faced with a great deal of uncertainty related to general economic factors such as fuel costs, prices, competition from imports, and consumer preferences for seafood harvested from the region relative to import products. To simplify the analysis, fuel costs and consumer preferences are assumed to remain unchanged during the study period.

It is important to note that the analysis considers how anticipated changes to the physical environment would influence the behavior of those engaged in commercial fishing, which may also change the location and/or extent of commercial fishing activity and have impacts on the regional economy. History illustrates the dynamic nature of the commercial fishing industry, which includes a mix of individuals who focus efforts within a basin, or on a particular species, as well as those who are active across multiple basins and species (Barnes et al. 2017). The industry is expected to respond to environmental changes in some areas by shifting effort to other geographic areas. These substitutions will reduce, but probably not fully offset impacts of environmental changes.

4.14.3 Construction Impacts

4.14.3.1 No Action Alternative

Under the No Action Alternative, the Project would not be constructed and there would be no Project-generated impacts on commercial fisheries. Ongoing trends of sea-level rise and increasing salinities discussed in Section 4.14.4.1 below would continue, but limited changes to commercial fishing are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point, the area of the proposed Project may be developed for industrial or commercial purposes that would disrupt fishing activities, limit access, or otherwise affect current fishing quality in this area. However, it would be speculative to guess what exactly those future developments might be or whether they would occur within the 5-year analysis period (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal law and regulations.

4.14.3.2 Applicant's Preferred Alternative

Construction of the Project would likely have temporary, minor, adverse impacts on commercial fishing activities. As discussed in Section 4.22 Land-Based Transportation, construction activities over the 5-year construction period under the Applicant's Preferred Alternative are not expected to result in road closures; however, southbound roadway capacity on LA 23, the main thoroughfare along the west bank of the Mississippi River, would be reduced at times, which could impact access for those engaged in commercial fishing activities. There may be roadway traffic delays and congestion from the mobilization of crews and equipment, which may contribute to minor, temporary delays in accessing ports used for commercial fishing south of the proposed diversion. These impacts are not anticipated to measurably affect commercial fishers on other roadways (for example, LA 1 in Lafourche Parish).

Impacts on the use of main navigation channels within the Mississippi River and the Barataria Basin associated with construction of the diversion complex and auxiliary structures would include minor increases in water-based traffic. Construction equipment and materials would be barged in from vendors north and south of the proposed Project site, causing minor increases in marine traffic in the Lower Mississippi River, Harvey Canal, GIWW, Barataria Bay Waterway, and Bayou Dupont. This would cause minor reductions in access for commercial fishing vessels when Project vessels are in transit through these waterbodies. These minor, adverse impacts would be temporary, occurring over the 5-year construction period, and intermittent, based on the expected number and frequency of construction vessels, as described in Section 4.21 Navigation.

4.14.3.3 Other Alternatives

Construction impacts on commercial fishing in the Project area from the 50,000 cfs Alternatives (with and without terraces) and the 150,000 cfs Alternatives (with and without terraces) would be similar (temporary, minor, and adverse) to the Applicant’s Preferred Alternative. As compared with the Applicant’s Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition feature of the proposed diversion structure would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes, and the overall construction footprint of all action alternatives would be similar. Additionally, construction timeframes for the 150,000 cfs Alternatives would be longer by several months and for the 50,000 cfs Alternatives shorter by several months as compared to the Applicant’s Preferred Alternative. As such, the duration of potential temporary, minor, adverse impacts due to construction-related road traffic and water-based traffic delays associated with increased vessel traffic in main navigation channels of the Mississippi River and the Barataria Basin for the delivery of construction materials would be several months longer or shorter, respectively, than the Applicant’s Preferred Alternative. The construction of terraces in the basin under the three terrace alternatives would have minimal impacts on commercial fishing vessels transiting the Barataria Basin due to additional minor increases in water-based construction traffic. Therefore, all action alternatives (with and without terraces) would have temporary, minor, adverse impacts on commercial fishing activities during construction.

4.14.4 Operational Impacts

4.14.4.1 No Action Alternative

4.14.4.1.1 Fish Abundance and Access

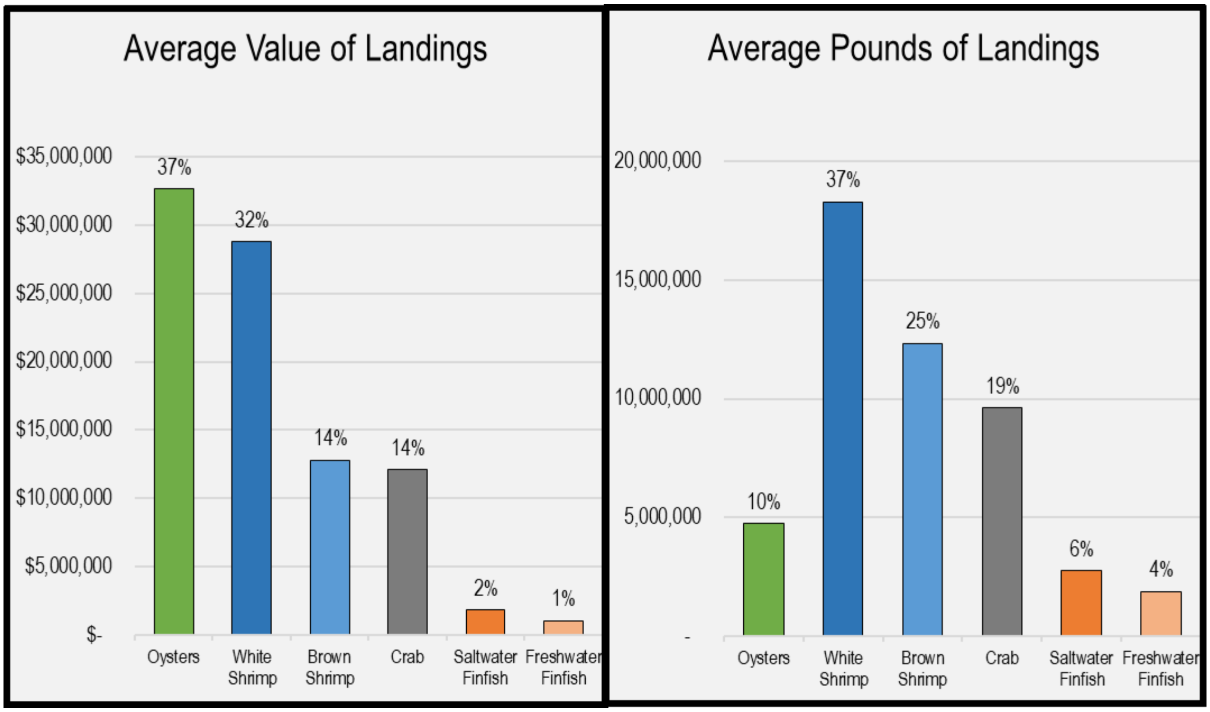
Under the No Action Alternative, gradual and continual increases in salinity and decreases in marsh habitat would affect habitat suitability for commercially targeted species in the Project area. As sea levels rise, salinity is expected to increase, impacting aquatic species (as described in detail in Section 4.10.4 Operational Impacts in Aquatic Resources) and marsh habitat is expected to decrease by approximately 82 percent (approximately 350,000 acres) in the basin and birdfoot delta by 2070, as described in detail in Section 4.6.5.1 Wetland Types and Extent in Wetland Resources and Waters of the U.S. These changes would affect the abundance and location of key species targeted commercially in the Project area, as described in detail in Section 4.10.4.5 Key Species in Aquatic Resources, which would adversely affect the commercial fishing industry (from negligible to major decreases in abundance over time, depending on the species). Adverse impacts may be partially offset by changes in fisher behavior (for example, changing fishing locations or equipment), but these adjustments would likely be accompanied by increased costs. The impact of these expected environmental changes under the No Action Alternative on the abundance of commercially targeted fish species is summarized in Table 4.14-1 below (see Section 4.10 Aquatic Resources for additional information about aquatic species abundance under the No Action Alternative).

Table 4.14-1
Expected Trends in Project Area Fish Abundance Under the No Action Alternative

Aquatic Species	Trend Over 50 Modeled Years
Brown Shrimp	Gradual but major decrease in abundance over time with largest decrease after 2050
White Shrimp	Gradual but major decrease in abundance over time with largest decrease after 2050
Blue Crab	Gradual decrease in abundance over time with largest decrease after 2050
Bay Anchovy	Negligible or no change over time
Gulf Menhaden	Negligible or no change over time
Spotted Seatrout	Slight decrease in abundance over time
Atlantic Croaker	Slight decrease in abundance over time
Southern Flounder	Negligible or no change over time
Largemouth Bass	Gradual but major decrease in abundance over time
Eastern Oyster	Gradual but major decrease in abundance over time with largest decrease after 2050
Source: Section 4.10 Aquatic Resources	

As described in Chapter 3, Section 3.14 Commercial Fisheries, shrimp and oysters account for the majority of landings in LDWF sub-basins in the Project area, both in terms of value and pounds, accounting for over 80 percent of annual value of landings and over 70 percent of landings by weight between 2014 and 2018 (see Figure 4.14-1 below; note that percentages exclude Gulf menhaden fishery). As shown in Figure 4.14-1 below, oysters landings represent a large portion of the total commercial landing value relative to oysters' landed weight.[75] Impacts on shrimp and oyster abundance would therefore have a relatively large impact on the commercial fishing industry in the Project area as well as the regional economy given that they represent over 80 percent of the value of landings as shown in Figure 4.14-1 (excluding Gulf menhaden).

[75] Recent increases in the dockside value of oysters per pound have amplified the effects of increases in volume (LDWF 2020f).



Source: LDWF 2019b

Notes: Calculations based on non-confidential monthly LDWF trip ticket information, summarized by species and area fished. Saltwater finfish excludes Gulf menhaden. Average annual shrimp value between 2014 and 2018 includes relatively high value of shrimp landings in 2014 that resulted from high import prices in that year due to shrimp disease in Asia (Reed and Royales 2014). In 2017 and 2018, oyster landings in the Project area had a higher value than shrimp landings.

Figure 4.14-1. Share of Commercial Landings by Species, Average Annual Value, and Pounds 2014 to 2018, for LDWF Sub-basins in the Project Area.

There could also be impacts on commercial fishing related to changes in commercial fishing access under the No Action Alternative. Under the No Action Alternative, gradual and continual sea-level rise and subsidence could increase the occurrence of storm surge and tidal flooding at fishing access points outside of federal levee systems (or roads leading to them) such as boat launches or marinas, making access to these sites increasingly more difficult over the 50-year analysis period (see Section 4.16 Recreation and Tourism, Table 4.16-1). These changes could impact commercial fishing by increasing travel distances to, or closure of, certain water access points or maritime storm refuge areas. When access points become difficult or impossible to access, commercial fishers would be expected to modify their behavior and either substitute to alternative locations or forego trips entirely. Over time, the reduction in accessibility may cause commercial fishers to exit the industry or substitute to areas outside the Project area.

4.14.4.1.2 Shrimp Fishery

Due to changing habitat conditions summarized above, abundance of both brown and white shrimp is expected to decrease under the No Action Alternative relative to current conditions. This decline in abundance would be gradual over the 50-year analysis period, with the highest decrease expected after 2050, when habitat suitability for juvenile shrimp is projected to have its steepest decline. Over time, these changes, in combination with other demographic and market-related factors, would likely result in permanent, major, adverse impacts on the shrimp fishery. Communities that have a high reliance on shrimp fishing activities would also be adversely affected. Note, while impacts over the entire 50-year analysis period are expected to be major, these impacts may be spread over time, which could allow for some adaptation by fishers to changing conditions. In particular, because changes are anticipated to occur slowly for the first decades of the analysis period, shrimp fishers may exit gradually out of the fishery as shrimp abundance declines; some of this exit may also be attributable to attrition as older fishermen exit the fishery and are not replaced.

As described in Chapter 3, Section 3.14 Commercial Fishing, from 2015 to 2018, Louisiana was the largest producer of shrimp in the United States in landings by weight and the second largest in terms of value, behind Texas (NOAA 2020e). Shrimp landings from the Project area make up approximately one-third of statewide shrimp landings. On average, shrimping was the largest commercial fishery by value and weight in the Project area between 2014 and 2018 (see Figure 4.14-1 above).[76] Between 2014 and 2018, an average of 1,147 fishers in the Barataria Basin and 258 fishers in the Mississippi River Basin landed an average 30.6 million pounds of shrimp worth an average of $41.6 million per year (LDWF 2019c).[77] Despite changes in market-related conditions, extreme weather events, and the DWH oil spill, among other factors, the overall volume of catch in the Project area has been relatively steady since 2000 (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-7). If the price of native brown shrimp increases as they become scarcer (particularly if consumers are willing to pay a premium for native shrimp versus imported or farmed shrimp), then the reduction in the weight of landings may decrease faster than the reduction in value (with fishers potentially able to obtain a higher price per pound). However, if shrimp prices continue to decline as global production and U.S. imports of farmed shrimp increase (LDWF 2020f; Sackton 2018), this could result in a faster reduction in value compared to the reduction in the weight of landings. Section 4.10 Aquatic Resources, Table 4.10-4 summarizes the effects on shrimp under the No Action Alternative.

As discussed in Section 4.10.4.5 in Aquatic Resources, decreases in marsh habitat are expected to reduce habitat suitability for brown and white shrimp over time, resulting in adverse impacts on shrimp abundance in the Project area in the long-term

[76] Average shrimp value between 2014 and 2018 includes relatively high value of shrimp landings in 2014 that resulted from high import prices in that year due to shrimp disease in Asia (Reed and Royales 2014). In 2017 and 2018, oyster landings in the Project area had a higher value than shrimp landings.

[77] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders across the two basins within a year.

under the No Action Alternative (see Section 4.10 Aquatic Resources for more information about impacts on aquatic species in the Project area).

4.14.4.1.2.1 Regional Economic Impacts and Community Impacts on Shrimp Fishery

The number of commercial fishing license holders for shrimp has been on a downward trend (see Chapter 3, Section 3.14 Commercial Fisheries, Figures 3.14-2 and 3.14-3). A look at the number of license holders entering and exiting the market supports this trend. While there is flow of new entrants (more than 20 percent of those landing shrimp from the Barataria Basin in 2017 had no landings in the previous year), the number of commercial fishing license holders exiting the market has been greater than the number of new entrants. As discussed in Appendix H, from 2000 to 2016, roughly 35 percent of those landing shrimp from the Barataria Basin in any year did not land shrimp from the basin the following year; more than 40 percent of those harvesting shrimp from the Barataria Basin in 2017 had not been active in the shrimp fishery in that area 5 years before (Isaacs 2018a). These license holder trends are likely to continue under the No Action Alternative although changes in market conditions that would influence the fishery are also expected under the No Action Alternative. These changes in market conditions include competition from international markets, but also other external factors affecting the fishery, such as domestic demand and fishing input costs (for example, fuel and nets).

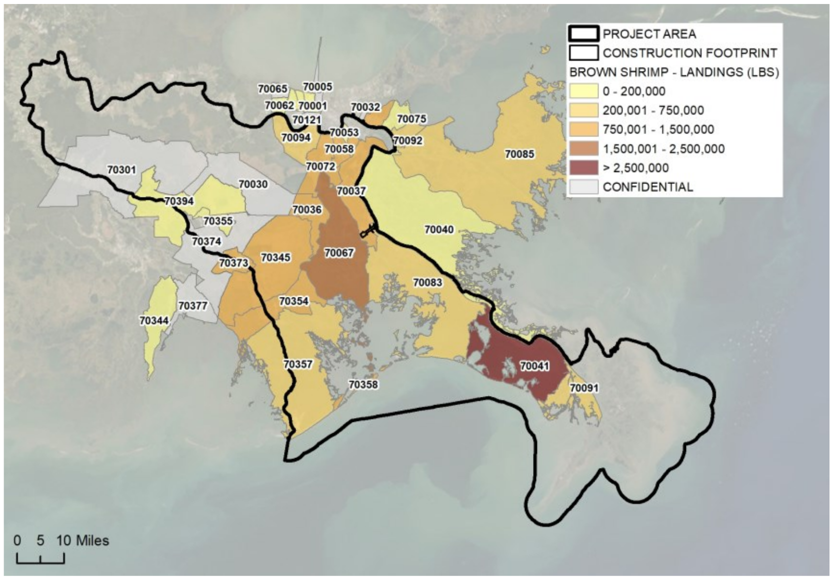
Over time, the average age among those landing shrimp has increased, with the median increasing faster than the mean, suggesting a higher proportion of relatively older fishers compared to the average. By 2017, the average age among those landing shrimp from the Barataria Basin was 50.9 and the median was 52 (Isaacs 2019a). This compares to a 2018 median age of 41 across all workers in all industries in Louisiana (U.S. Census Bureau 2019b). Thus, near-term employment impacts associated with reduced fishing opportunities could be exacerbated for older fishers. Age is a key indicator of social and demographic characteristics that influence social vulnerability (Hill and Cutter 2001). These fishers are less likely to invest in new skills and have less time to recoup the costs of acquiring or purchasing new equipment. However, as older fishers retire from the industry, and new entrants are fewer than exiting fishers, under the No Action Alternative, there would be fewer shrimp fishers in the industry over time. The age distribution of today's workforce implies that many of those harvesting shrimp today will have left the industry prior to the larger environmental changes anticipated later in the Project analysis period. Communities reliant on employment and expenditures associated with this industry would be adversely affected under the No Action Alternative.

Figures 4.14-2 and 4.14-3 show the percent of all commercial landings made up of brown and white shrimp landings by zip codes reported by fishers in 2018 in and around the Project area, as well as the total 2018 brown and white shrimp landings by zip code for context. The maps reflect licensed fishers' zip code of residence, but as discussed in Chapter 3, Section 3.14.2.3 in Commercial Fisheries, most shrimp in the Project area are caught in sub-basins 210 and 211, which are located within the Lower (southern) Barataria Basin (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-1 for locations of the LDWF fishing sub-basins). Communities with both high concentrations of shrimp landings and high total shrimp landings are particularly reliant on the species and would be most impacted by changes in shrimp abundance. As shown in Figures 4.14-2 and 4.14-3, these areas include much of the central and southern portion of the Project area (but are not representative of where the shrimp are caught).

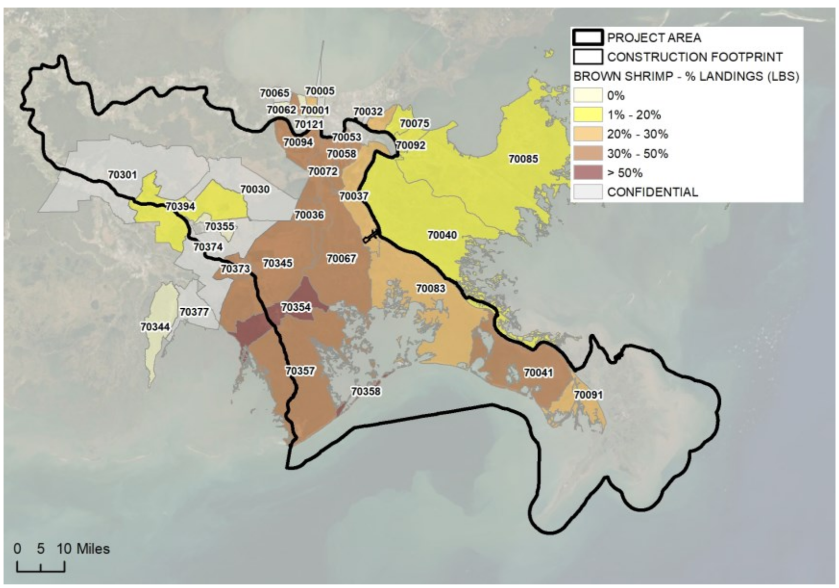
Areas that are particularly reliant on commercial shrimp fishing include seven communities (Lafitte, Grand Isle, Empire, Buras, Golden Meadow, Port Sulphur, and Venice) ranked by NOAA in its Social Indicators of Fishing Community Vulnerability and Resiliency study as having high reliance on and engagement in fishing per capita (for all species landed commercially; not specific to shrimp) (NOAA 2019a; see Chapter 3, Section 3.14.7 in Commercial Fisheries, for more details about this study). As stated above, communities with high reliance on shrimp landings would be more heavily impacted by reductions in shrimp abundance, while other communities would be less impacted. As shown in Figure 4.14-2, the Buras area (zip code 70041) and the Lafitte area (zip code 70067) had the highest recorded brown shrimp landings in 2018 of any area. The Buras area also had the highest recorded landings of white shrimp in 2018 (see Figure 4.14-3). In terms of the percent of total landings in each zip code, the Lafitte area was among the zip codes where shrimp made up the highest percent of total landings, with brown shrimp and white shrimp comprising two-thirds of all commercial landings. Grand Isle and Galliano also showed high dependency on brown shrimp catch (zip codes 70358 and 70354, respectively).

The reduction in marsh area indicates that a reduction in brown and white shrimp abundance is likely to occur under the No Action Alternative, which would likely lead to corresponding major, permanent, adverse impacts on commercial landings of shrimp in the Project area under the No Action Alternative. This projected decrease in brown and white shrimp landings is not likely to occur linearly over the 50-year analysis period for the Project, but instead would be concentrated after 2050, when relative sea-level rise and marsh loss are anticipated to accelerate. This timeline may provide fishers time to adapt to new conditions, such as acquiring new equipment or adjusting fishing locations, or otherwise to exit the industry when they are ready to retire, but would discourage new entrants into the industry. Depending on whether these fishers continue to fish or leave for other industries, communities that are currently reliant on shrimp fishing could experience economic hardships over time as the shrimp industry declines under the No Action Alternative. Over the longer term, as habitat becomes less suitable to shrimp in the basin under the No Action Alternative, shrimp from Louisiana would continue to be available to restaurants, potentially at higher prices. Restaurants willing to pay a premium for local seafood would likely do so, and additional importing would likely also occur.

Total Brown Shrimp Landings



Brown Shrimp Percent of Total Commercial Landings

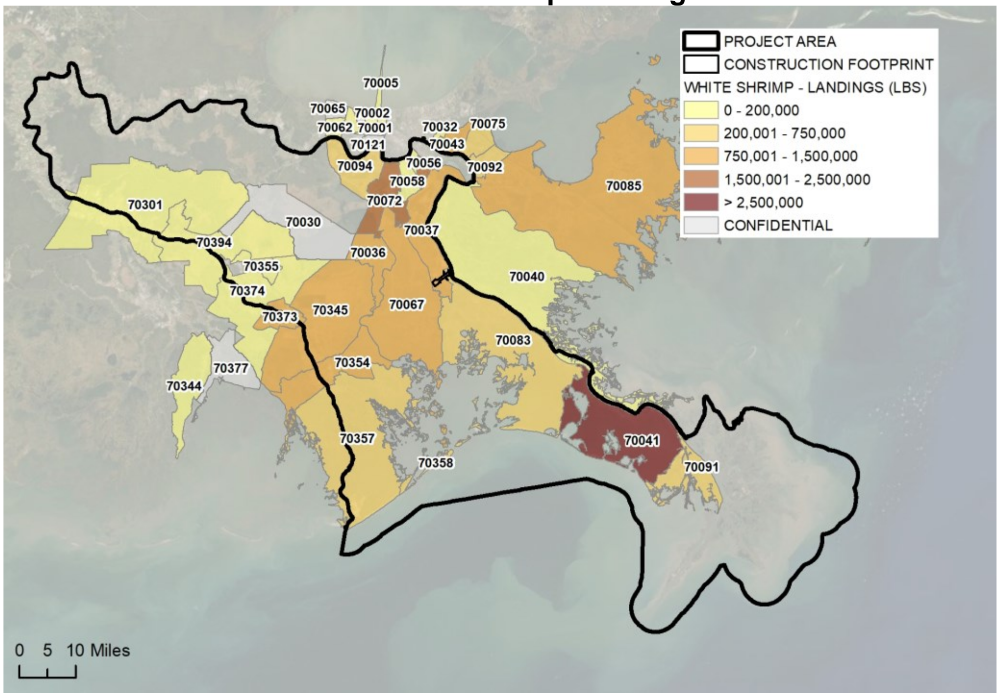


Source: LDWF 2019g.

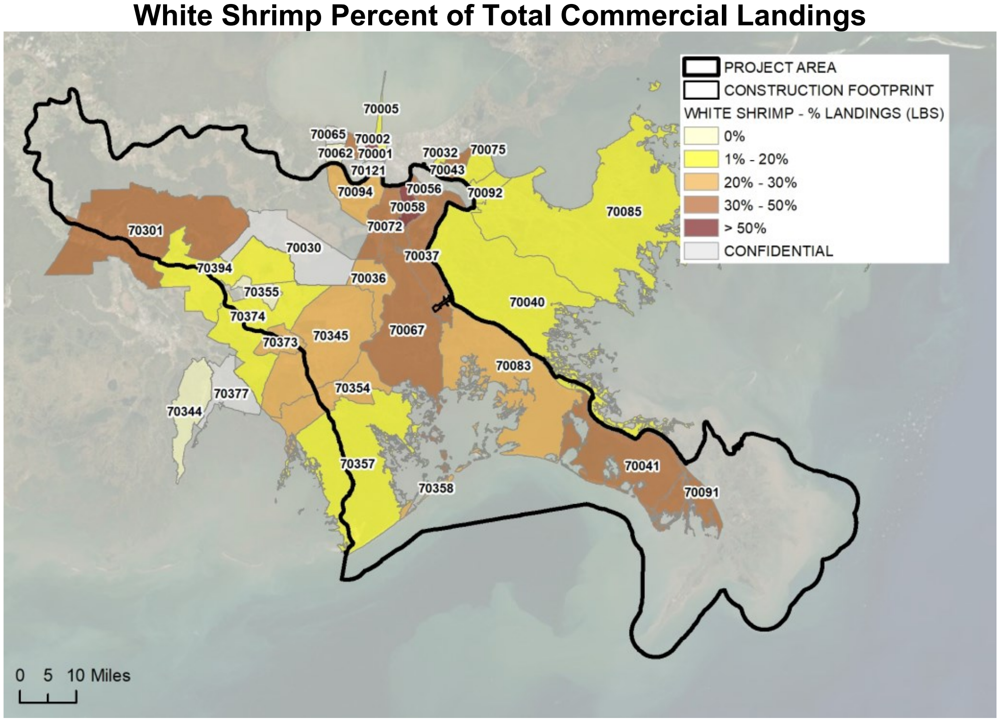
Note: Zip code landings data reflect fishers' addresses as they appear on the commercial fishing license and do not directly reflect the area fished.

Figure 4.14-2. Total Brown Shrimp Landings and Brown Shrimp Landings as a Percent of Commercial Landings in Project Area by Zip Code, (2018 Landings in Pounds).

Total White Shrimp Landings



White Shrimp Percent of Total Commercial Landings



Source: LDWF 2019g.

Note: Zip code landings data reflect locations of fishers' addresses as they appear on the commercial fishing license and do not directly reflect the area fished.

Figure 4.14-3. Total White Shrimp Landings and White Shrimp Landings as a Percent of Commercial Landings by Zip Code (2018 Landings in Pounds).

4.14.4.1.3 Eastern Oyster Fishery

The eastern oyster fishery is expected to decrease productivity under the No Action Alternative relative to current conditions, resulting in adverse impacts on commercial fishers targeting the species, as well as communities that have a high reliance on oyster fishing activities. This decline in oyster abundance would be gradual over the 50-year analysis period. Prior to 2050, minor shifts in average monthly salinity within currently suitable habitat would produce minor shifts in the spatial extent of suitable water quality conditions for oysters. These gradual shifts may allow for adaptability in cultch plant locations to optimize the placement of suitable substrate in areas with suitable water quality conditions. Further, because changes are anticipated to occur slowly for the first decades of the analysis period, oyster fishers may exit more gradually out of the fishery as oyster abundance declines. However, the largest decrease in oyster abundance is expected after 2050, when the most drastic changes in average monthly salinity are projected, leading to a steep decline in water quality suitability for oysters in a large portion of the currently suitable habitat.

4.14.4.1.3.1 Regional Economic Impacts and Community Impacts on Eastern Oyster Fishery

As stated in Chapter 3, Section 3.14.3 in Commercial Fisheries, the State of Louisiana is among the largest oyster producers in the United States. Between 2000 and 2014, the Louisiana oyster catch averaged over 11 million pounds annually, or 34 percent of the oysters harvested in the United States. Louisiana's commercial oyster industry accounts for almost 4,000 jobs and generates an economic impact (regional economic activity or sales) of $317 million annually (Louisiana Fisheries Forward 2017). Oyster activity in the Project area accounted for 36 percent of total Louisiana oyster landings by weight and 42 percent of total value from oyster landings in Louisiana.

Between 2014 and 2018, an average of 297 license holders in the Barataria Basin and 4 license holders in the Mississippi River Basin landed an average of 4.7 million pounds of oysters, worth an average of $32.7 million annually (LDWF 2019b; 2019f).[78] The number of active license holders in the Barataria Basin between 2000 and 2018 varied year-to-year, with a minimum of 81 license holders in 2002 and a maximum of 309 in 2017. However, between 2014 and 2018, the number of active license holders in the Barataria Basin was relatively stable, ranging between 278 and 309. Less than 10 active license holders landed oysters in the Mississippi River Basin each year between 2000 and 2018 (LDWF 2019h). Over time, the average age among those landing oysters had followed a gradually increasing pattern, but dropped notably in 2017 when the average age among those landing oysters from the Barataria Basin was 41.2 while the median was 40.5 (Isaacs 2019b). This is similar to the 2018 median age of 41 across all workers in Louisiana (U.S. Census Bureau 2019b). In addition to license holders, crew members employed by license holders may be impacted by changes in

[78] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders across the two basins within a year.

abundance under the No Action Alternative. The estimated crew size for trips landing oysters is 2.6, including the captain (Banks et al. 2016). However, some vessels may have multiple license holders, so this crew estimate provides an upper bound for the total number of fishers. These license holder trends are likely to continue under the No Action Alternative although changes in market conditions that would influence the fishery are also expected under the No Action Alternative. These changes in market conditions include competition from international markets, but also other external factors affecting the fishery, such as domestic demand and fishing input costs (for example, fuel and nets).

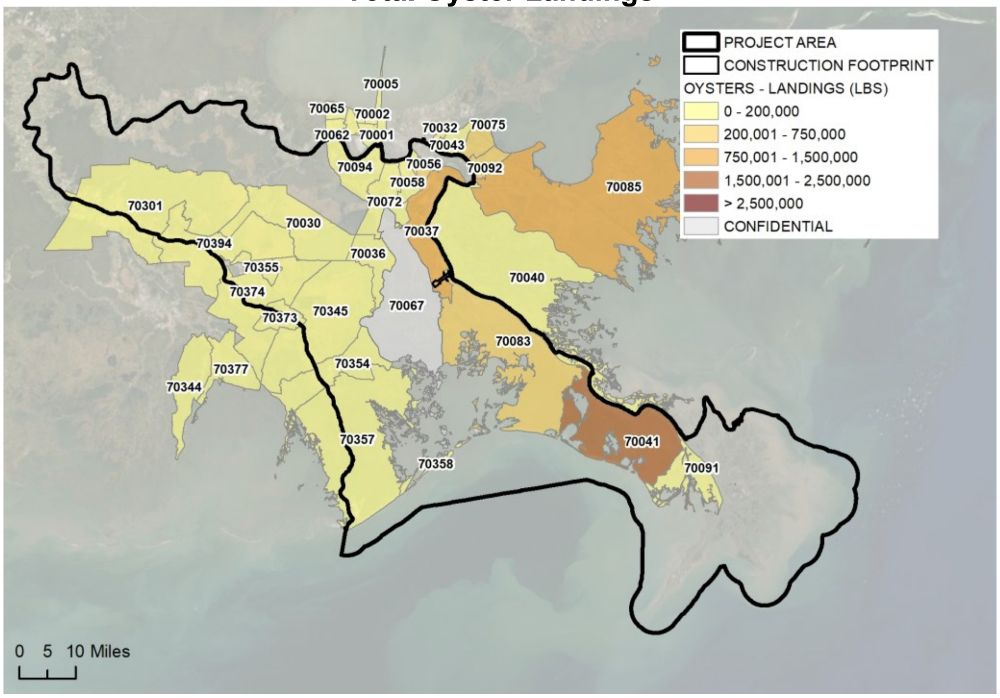
Figure 4.14-4 shows the percent of all commercial landings made up of oyster landings by zip codes reported by fishers in 2018 in and around the Project area, as well as the total 2018 oyster landings by zip code for context. As with the shrimp maps above, these maps reflect licensed fishers' zip code of residence, but between 2014 and 2018, about 90 percent of oysters were caught in sub-basin 210, which is located within the Lower Barataria Basin (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-1 for locations of the LDWF fishing sub-basins) (LDWF 2019b).[79] Communities with both high concentrations of oyster landings and high total oyster landings are particularly reliant on the species and most impacted by changes in abundance.

As shown in Figure 4.14-4, the Buras area (zip code 70041) has relatively high oyster landings in terms of weight and the Port Sulphur area (zip code 70083) has a relatively high percentage of oyster landings. As discussed above and in Chapter 3, Section 3.14.7 in Commercial Fisheries, Buras and Port Sulphur have a high reliance on and engagement in fishing per capita (for all species landed commercially; not specific to oysters) (NOAA 2019a; see Chapter 3, Section 3.14.7 in Commercial Fisheries for more details about this study).

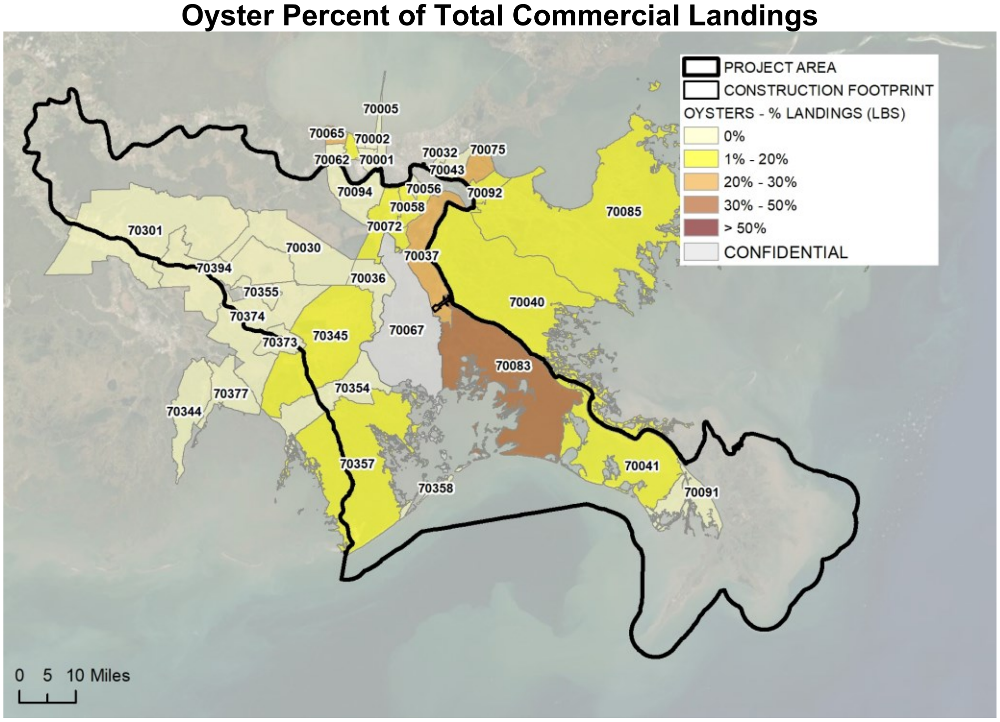
Depending on whether fishers continue to fish or leave for other industries, communities that are currently reliant on oyster fishing could experience economic hardships over time as this industry declines under the No Action Alternative if other industries are not developed in the area.

[79]Note that LDWF 2020f includes a different date range and area than is described in this EIS. Specifically, LDWF statistics cited in this EIS include 2018 data, while LDWF 2020f includes data from 2000 to 2017. Also, LDWF 2020f focuses on the Barataria Areas 209, 210, and 211, while this EIS also includes reported landings in the Mississippi River Basin in Areas 701, 702, and 703.

Total Oyster Landings



Oyster Percent of Total Commercial Landings



Source: LDWF 2019g.

Note: Zip code landings data reflect locations of fishers' addresses as they appear on the commercial fishing license and do not directly reflect the area fished.

Figure 4.14-4. Total Oyster Landings and Oyster Landings as a Percent of Commercial Landings by Zip Code (2018 Landings in Pounds).

4.14.4.1.4 Blue Crab Fishery

The blue crab fishery may experience moderate, permanent, adverse impacts under the No Action Alternative due to changes in habitat conditions over time that would affect species abundance.

Blue crab are targeted commercially throughout the central and southern regions of the Project area (primarily in LDWF fishing sub-basins 209, 211 and 704, see Chapter 3, Section 3.14.4 in Commercial Fisheries and Figure 3.14-1). As summarized in Figure 4.14-1, crab represented 19 percent of landings by weight and 14 percent of landings by value on average from 2014 to 2018 across all species groups in the Project area. Between 2014 and 2018, commercial fishers landed an average of 9.6 million pounds of crab worth $12.1 million annually in the Project area (LDWF 2019b).

4.14.4.1.4.1 Regional Economic Impacts and Community Impacts on Blue Crab Fishery

For context, Louisiana's blue crab fishery is the largest blue crab fishery in the United States. Commercial crab landings are dominated by blue crab, with a small amount of stone crab also landed in some areas. Blue crab supports a valuable commercial fishery in Louisiana, with landings of 38.8 million pounds and a dockside value of $51 million in 2013. Nearly 90 percent of crab landings from 2000 to 2013 were from the state's four estuarine basins: Barataria, Terrebonne, Lake Pontchartrain, and Atchafalaya/Vermilion/Teche Rivers. In the Barataria Basin, blue crab landings averaged 8.2 million pounds annually from 2000 to 2013 (Bourgeois et al. 2014). While blue crab landings have remained stable in recent years, the number of commercial license holders actively landing crab has declined from 586 in the Barataria Basin and 234 in the Mississippi River Basin in 2000 to just 248 in the Barataria Basin and 86 in the Mississippi River Basin in 2018 (see Chapter 3, Section 3.14 Commercial Fisheries, Figures 3.14-2 and 3.14-3) (LDWF 2019h, Barnes 2016).[80] In addition to license holders, crew members employed by license holders may be impacted by changes in abundance under the No Action Alternative.[81] These license holder trends are likely to continue under the No Action Alternative although changes in market conditions that would influence the fishery are also expected under the No Action Alternative. These changes in market conditions include competition from international markets, but also other external factors affecting the fishery, such as domestic demand and fishing input costs (for example, fuel and nets).

Generally, adverse impacts on crab populations under the No Action Alternative would likely lead to moderate, permanent adverse impacts on commercial catch of blue crab in the Project area under the No Action Alternative (see Section 4.10 Aquatic

[80] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders across the two basins within a year.

[81] The estimated crew size for trips landing crab is 1.4, including the captain (Isaacs 2015b).

Resources, Figure 4.10-11). Historically, areas fished with the highest concentration of crab catch were located in the middle and lower portions of the Barataria Basin and the Lower Mississippi River Basin surrounding the mouth of the river. In particular, sub-basin area 209 (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-1 for locations of the LDWF fishing sub-basins) has historically had the highest crab catch. Depending on whether these fishers continue to fish or leave for other industries, communities that are currently reliant on crab fishing could experience economic hardships over time as the crab industry declines under the No Action Alternative if other industries are not developed in the area. In particular, zip code landings data indicate that communities in zip codes that are generally north and east of the proposed diversion site are heavily reliant on crab fishing. The community of Gheens (zip code 70355), located north and west of the proposed diversion site is also heavily reliant on crab landings (LDWF 2019g).

Because habitat changes are expected to occur gradually under the No Action Alternative, crab fishers may exit out of the fishery as blue crab abundance declines; some of this exit may also be attributable to attrition as older fishermen exit the fishery and are not replaced. Substituting to different species may require investing in different gear and, in some cases, different vessels. Smaller boats that are often used in estuaries and bays in coastal Louisiana are often rigged for multiple purposes, such as crabbing and shrimping (Gramling and Hagelman 2005). Having this flexibility in boats and equipment would allow some fishers to adjust to changes in environmental conditions more quickly; however, the shrimp fishery in this area is also expected to decline, which would make options for substitution within the area more limited.

4.14.4.1.5 Finfish Fishery

A wide array of saltwater and freshwater finfish are targeted by commercial fishers in the Project area in modest numbers, while statewide finfish landings are dominated by Gulf menhaden, as described in Chapter 3, Section 3.14.5 in Commercial Fisheries. Because Gulf menhaden are caught primarily outside the Project area, this section focuses on other finfish species. However, as noted below, changes or improvements in their nursery habitats may impact the offshore fishery. Detailed aquatic species HSI modeling was conducted for a subset of these finfish (see Section 4.10 Aquatic Resources). For purposes of this analysis of commercial fisheries impacts, the analysis assumes the trends in habitat availability for target species provide a good proxy for likely trends in availability of commercially relevant finfish species.

Section 4.10.4.5 Key Species in Aquatic Resources provides detailed impact analyses for five commercially targeted saltwater finfish species (see Section 4.10 Aquatic Resources for more information about HSI results for aquatic species in the Project area): spotted seatrout, Atlantic croaker, bay anchovy, southern flounder, and Gulf menhaden.

Spotted Seatrout. Within the Project area, habitat suitability is projected to decrease under the No Action Alternative across the Barataria Basin and birdfoot delta due to decreased marsh habitat, which provides nursery habitat and supports prey for spotted seatrout. Given these expected adverse impacts, abundance of spotted seatrout would be expected to decrease over time. Given the anticipated decrease in species abundance over time, it appears likely that adverse impacts on commercial landings of spotted seatrout would occur under the No Action Alternative.

Atlantic croaker. Similar to spotted seatrout, adverse impacts on Atlantic croaker abundance would also be anticipated under the No Action Alternative due to increased salinity and water depth increases, which would reduce habitat suitability in the Project area and result in adverse impacts on fishers targeting Atlantic croaker.

Bay anchovy. Habitat suitability for bay anchovy would not be expected to change under the No Action Alternative. As such, impacts on commercial fishing conditions are not anticipated under the No Action Alternative.

Southern flounder. Habitat suitability for southern flounder would benefit from increased salinity in the basin over time, but the loss of marsh acreage would reduce prey availability under the No Action Alternative. Southern flounder habitat suitability is currently at or near optimum throughout the Barataria Basin, and the HSIs increase minimally over time for the No Action Alternative. As such, habitat-related impacts in the commercial harvest of southern flounder are not anticipated under the No Action Alternative.

Gulf menhaden. Gulf menhaden make up 97 percent of total finfish harvest in Louisiana (in pounds), but are mostly landed in nearshore Gulf waters outside the Project area (Louisiana Fisheries Forward 2018). As such, changes to Gulf menhaden that may occur under the No Action Alternative would result in no or negligible impacts on commercial fishing of this species in the Project area.

As discussed in Chapter 3, Section 3.14.5.3 in Commercial Fisheries, saltwater finfish catch in the Project area (excluding menhaden), was smaller than other commercially fished species groups discussed here between 2014 and 2018. Excluding menhaden, the average annual value of the 2.7 million pounds of saltwater finfish landed by commercial fishers in the Project area between 2014 and 2018 was $1.8 million (LDWF 2019b). During that time, an average of 130 fishers in the Barataria Basin and 133 fishers in the Mississippi River Basin targeted saltwater finfish each year (see Chapter 3, Section 3.14.5 in Commercial Fisheries) (LDWF 2019h).[82]

Largemouth bass, while not a commercial species, was selected as a proxy for general trends expected in freshwater fish species-habitat quality and abundance in this analysis. Under the No Action Alternative, increases in salinity and reductions in marsh cover would lead to decreases in HSI scores throughout most of the Project area. As such, to the extent that general patterns for largemouth bass are representative of

[82] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders across the two basins within a year.

patterns for freshwater fish more broadly, this suggests that potential adverse impacts on freshwater finfish commercial fishing under the No Action Alternative would occur.

4.14.4.1.5.1 Regional Economic Impacts and Community Impacts on Finfish Fishery

As discussed in Chapter 3, Section 3.14.5 in Commercial Fisheries, between 2014 and 2018, the average annual values of the 1.9 million pounds of freshwater finfish landed by commercial fishers was $1.0 million (LDWF 2019b). During that time, an average of 143 fishers in the Barataria Basin and 79 fishers in the Mississippi River Basin targeted freshwater finfish each year (LDWF 2019h).[83] The regional economy would also benefit from catch of adult menhaden caught offshore under the No Action Alternative.

Because salt and freshwater finfish (other than menhaden) comprise a small portion of the overall landings at most docks in the Project area, changes to the composition of this catch over time are not anticipated to have noticeable regional economic impacts or community impacts in the Project area. To the extent that finfish catch increases as other species declines over time under the No Action Alternative, communities could experience some regional economic benefits.

4.14.4.1.6 Alligator Hunting and Farming

LDWF manages wild alligator populations for hunting and issues specific tag allotments for each parish and marsh type, based on the quality of habitat and number of acres of suitable habitat. As discussed in Section 4.9 Terrestrial Wildlife and Habitat, major, permanent, direct and indirect, adverse impacts on alligator populations would be expected as alligators would expend higher amounts of energy to survive and thrive in sub-optimal habitats under the No Action Alternative. Due to ongoing wetland loss and increases in salinity and water depth, the abundance of alligators inhabiting fresher marshes is expected to decline under the No Action Alternative over time, which would adversely affect opportunities for commercial alligator hunters. Because tag allotments set by LDWF for alligator hunting are determined by the number of habitat acres available, a decrease in habitat availability would directly decrease the amount of alligator hunting available.

Commercial alligator farming/ranching is also overseen by LDWF. A wild-egg harvest program allows alligator ranchers to harvest eggs from the wild, but requires ranchers to return a quantity of juvenile alligators equal to 12 percent of the eggs hatched to the wild within 2 years. To the extent that ongoing wetland loss and increases in salinity and water depth decreasing habitat availability under the No Action Alternative, the availability of eggs and allowable quotas for alligator egg collection may

[83] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders across the two basins within a year. The estimated crew size, including the captain, was 1.4 for trips landing freshwater finfish, though some vessels may have had multiple license holders (Isaacs 2015d).

be reduced in the Project area, decreasing ranchers' ability to produce farm-raised alligators and eggs. However, the harvesting of wild alligator eggs is sometimes conducted in locations that are far removed from the alligator farm, so it may possible that substitute sources would be available outside the study area along the coast to support these farms.

4.14.4.1.6.1 Regional Economic Impacts and Community Impacts on Alligator Hunting and Farming

Under the No Action Alternative, alligator hunting opportunities and farming productivity may decline. However, given the limited number of farms in the Project area (one in Plaquemines Parish and three in Lafourche Parish in December 2016), regional and community level impacts would be negligible.

4.14.4.1.7 Aquaculture

The aquaculture industry is expected to remain relatively stable or grow in the Project area over the next 50 years, based on recent trends in the industry (LSU Ag Center 2018a) resulting in negligible impacts under the No Action Alternative.

While commercial harvesting of alligator, shrimp, oysters, and soft-shell crabs are sometimes categorized as aquaculture, impacts on shrimp, oyster and crab fisheries and alligator farming under the No Action Alternative are discussed separately in sections above. Other types of aquaculture activities include crawfish farming, fish bait, and turtles. Seventeen farms for "other aquaculture products" occur in Project area parishes (nine of these are in Jefferson, Lafourche and Plaquemines Parishes) (USDA 2012). Habitat impacts under the No Action Alternative would not be anticipated to substantially affect these aquaculture activities in the Project area, though it is possible that changing environmental conditions could affect a small number of operations. As such, given that existing trends of stability and growth would continue, impacts on aquaculture would be negligible in the Project area under the No Action Alternative.

4.14.4.1.7.1 Regional Economic Impacts and Community Impacts on Aquaculture

Under the No Action Alternative, aquaculture opportunities and productivity (excluding alligator, shrimp, oysters, and crabs, which are described separately above) may decline. However, given the limited number of farms in the Project area, changes in regional and community level impacts would be negligible.

4.14.4.2 Applicant's Preferred Alternative

4.14.4.2.1 Fish Abundance and Access

As explained further below, the Applicant's Preferred Alternative is expected to have both beneficial and adverse direct and indirect impacts on fish abundance in the Project area, which would have beneficial impacts on the commercial catch of some targeted species, and adverse impacts on the commercial catch of other targeted species.

Over time, the Applicant’s Preferred Alternative is expected to create and maintain marsh habitat, increase the coverage of SAV habitat, decrease salinity levels, supply nutrients that increase primary production, and increase shallow-water habitat compared to the No Action Alternative. Operations under the Applicant’s Preferred Alternative would affect salinity conditions, larval and juvenile transport, habitat availability, and prey availability, and in turn, abundance of some commercially important species in the Project area (see Section 4.10 Aquatic Resources for details about estimated Project impacts on aquatic species). The expected change to each target species is characterized qualitatively by the difference between the expected change under the Applicant’s Preferred Alternative and expected impacts under the No Action Alternative (see Table 4.14-2).

There could also be impacts on commercial fishing related to changes in access that could result from the Project. Under the Applicant’s Preferred Alternative, minor, permanent, adverse direct and indirect impacts on commercial fishing would occur as a result of increased tidal flooding of launch sites, sediment accretion in the Myrtle Grove area, or the expansion of thick mats of aquatic invasive plant species (see Section 4.20.4 Storm Surge and Flooding in Public Health and Safety, Including Flood and Storm Hazard Risk Reduction). This could impact commercial fishing by increasing travel distances to, or closure of, certain water access points. These accessibility impacts would be less adverse for smaller vessels, such as those used for recreational boating, which is addressed in Section 4.16 Recreation and Tourism. Project-induced sedimentation affecting some Barataria Basin navigation channels and marine infrastructure would result in permanent, moderate, adverse impacts on commercial fishing vessels using the affected channels and marinas if no mitigation efforts are taken to maintain channel depths. However, larger ports, including Port Sulphur, Venice, and Buras, would not be affected by increased tidal flooding or by sediment accretion related to the Applicant’s Preferred Alternative, resulting in an overall minor, permanent, adverse impact on commercial fishing.

Operation of the proposed Project could cause adverse impacts on commercial fishers originating from Jean Lafitte Launch or Jean Lafitte Harbor due to sedimentation in the Barataria Bay Waterway absent additional maintenance dredging (see Section 4.21 Navigation, Figure 4.21-2). Similarly, in the Wilkinson Canal, sedimentation would increase each decade during the 50-year analysis period (see Section 4.16 Recreation and Tourism, Figure 4.16-1). The alternative Myrtle Grove access channel would also experience increases in sedimentation over the analysis period as a result of the Applicant’s Preferred Alternative. The Hermitage Bayou would also experience some sedimentation, but impacts are expected to be negligible.

Table 4.14-2
Expected Trends in the Project Area Fisheries Under the Applicant's Preferred Alternative

Fishery/Aquatic Species	Adverse Impact Drivers Under Applicant's Preferred Alternative	Beneficial Impact Drivers Under Applicant's Preferred Alternative	Expected Impacts Under Applicant's Preferred Alternative Compared to No Action Alternative
Shrimp Fishery			
Brown Shrimp	Disruption of larval transport and juvenile settlement, decreased salinity	Increased marsh and primary production	Major, Permanent, Adverse – decreased abundance, accelerated impacts relative to No Action Alternative
White Shrimp	Disruption of larval transport/juvenile settlement	Increased marsh, SAV, and primary production	Negligible to Minor, Permanent, Beneficial
Oyster Fishery			
Eastern Oyster	Decreased salinity, increased siltation and turbidity	Decreased predation and disease	Major, Permanent, Adverse – accelerated impacts relative to No Action Alternative
Crab Fishery			
Blue Crab	Mating, disruption of megalopae transport, early juvenile settlement	Increased marsh, SAV, and primary production	Negligible to Minor, Permanent, Beneficial
Finfish Fishery			
Gulf Menhaden	Disruption of larval transport/juvenile disruption	Increased low salinity juvenile nursery habitat, increased prey biomass	Moderate, Permanent, Beneficial
Atlantic Croaker	Disruption of larval transport near outfall	Increased marsh, SAV, and primary production	Negligible
Bay Anchovy	Disruption of larval transport near outfall	Increased marsh, SAV, and primary production	Minor, Permanent, Beneficial
Southern Flounder	Reduced salinity	Increased marsh, SAV, and primary production	Negligible to Minor, Permanent, Adverse
Spotted Seatrout	Disruption of larval transport in outfall area, juvenile growth, and adult spawning activities	Increased marsh, SAV, and primary production	Minor, Permanent, Adverse
Largemouth Bass	Delayed spawning, early life stage flushing into unsuitable habitat, high flows at the outfall	Increased low salinity habitat, SAV, and prey	Moderate, Permanent, Beneficial
Freshwater Finfish[a]	Varies by species	Increased low salinity habitat	Moderate, permanent, beneficial

Source: Section 4.10 Aquatic Resources, see Table 4.10-5.

[a] Under the Applicant's Preferred Alternative, freshwater finfish in the Mississippi River could be transported to the Barataria Basin by the Project. These freshwater finfish were not analyzed under the No Action Alternative because no impacts on these aquatic species were expected under the No Action Alternative.

The sedimentation of channels such as the Barataria Bay Waterway and the Wilkinson Canal used to access fishing sites are expected to have permanent, moderate, adverse impacts on vessels using the canals if no mitigation efforts are taken to maintain channel depths or alternative routes. While the sedimentation is not expected to affect smaller recreational boats, as they can operate in depths as shallow as 2 feet in depth, some fishing vessels may be unable to operate in water under 3 feet in depth. As a result, without mitigation, there is likely to be an increase in maintenance dredging requirements in some parts of the channels and around other marine infrastructure that experience sedimentation. Commercial fishers who launch from these sites and use these waterways for commercial fishing transit may have to substitute to areas farther away to launch during this time. Fishers would be expected to take fewer trips if maintenance dredging is not performed to maintain navigability of the waterway.

The Applicant's Preferred Alternative could result in an increased potential for the introduction and expansion of invasive plant species in the Barataria Basin, which would clog canals and impede passage for some fishing vessels, representing minor, permanent, adverse impacts. Fishers have indicated in the past that water hyacinth and Eurasian watermilfoil, as well as other invasive aquatic plants, frequently clog canals and impede boat traffic around the Caernarvon Diversion (Kravitz et al. 2005). See Section 4.10 Aquatic Resources for more details about the potential spread of aquatic invasive species.

In addition to physical impacts on channels, habitat, and species abundance, the proposed Project would introduce additional uncertainty for commercial fishers about the future of the fisheries in which they operate. As noted in Louisiana's Seafood Future 2019 Findings Report, "Changes in and loss of habitats, uncertainty about future restoration efforts, and low commodity prices all affect how members of Louisiana's seafood industry face the future" (Louisiana Seafood Futures 2019). For example, local shrimpers have characterized the uncertainty of impacts that diversions could have on shrimp populations as a factor contributing to their inability to plan for future fishing income (Coalition to Restore Coastal Louisiana 2017).

4.14.4.2.2 Shrimp Fishery

The shrimp industry includes catch of both brown and white shrimp. Section 4.10 Aquatic Resources describes the effect of the Applicant's Preferred Alternative on white and brown shrimp. Under the Applicant's Preferred Alternative, brown shrimp are expected to experience major, permanent, adverse impacts earlier, while white shrimp are expected to experience negligible to minor, permanent, beneficial impacts, relative to the No Action Alternative. White shrimp accounted for an average of 60 percent of total shrimp landings (white and brown shrimp combined) in terms of weight and almost 70 percent of landed value between 2014 and 2018. However, because a number of the same commercial fishers catch both brown and white shrimp during different seasons, overall impacts on the shrimp industry as a whole (including brown and white shrimp) would be expected to be moderate to major, permanent, and adverse, with the potential for a substantial loss of income in some months due to the decreased abundance of brown shrimp. This section describes how the various changes induced by the Applicant's Preferred Alternative support this determination, including changes in shrimp abundance as well as anticipated response from the commercial shrimp industry.

Adverse impacts may be partially offset by changes in fisher behavior, but these adjustments could increase operating costs. Adverse impacts would further encourage fishers to exit the industry. Note that these potential impacts may be spread over time, which could allow for adaptation. If changes occur more slowly, then shrimp fishers who exit out of the fishery over time will reduce the impact of brown shrimp abundance declines; some of this exit may also be attributable to attrition as older fishermen exit the fishery and are not replaced; see discussion of ongoing trends in fisheries entry and exit in the discussion of the No Action Alternative above.

4.14.4.2.2.1 Regional Economic Impacts and Community Impacts on Shrimp Fishery

Communities reliant on employment and expenditures associated with the shrimp fishery would be adversely affected under the Applicant's Preferred Alternative as compared to the No Action Alternative if other industries are not developed in the area. Historically, areas fished located closest to the Gulf of Mexico were the predominant source of commercially landed shrimp, with sub-basins 210 and 211 in the southern Barataria Basin providing the highest quantity of shrimp landings. It should be noted that sub-basin 211 includes a significant area beyond the barrier islands and outside of the analysis area for assessing aquatic resource impacts. As such, a portion of shrimp reported as being caught in this sub-basin is likely caught offshore and would not be impacted by changes under the Applicant's Preferred Alternative. With a major decrease in brown shrimp abundance throughout the basin, including in areas where most landings currently occur, a decrease in commercial shrimp landings and their associated employment and expenditures would be expected.

As discussed in Section 4.14.4.1 and displayed in Figures 4.14-2 and 4.14-3, communities with high reliance on shrimp landings may be more heavily impacted by reductions in shrimp abundance, while other communities would be less impacted. As discussed in Section 4.14.4.1 above, several communities having high reliance on and engagement in fishing in general are also highly reliant on shrimp landings, including Empire, Venice, Buras, Grand Isle, Golden Meadow, Port Sulphur, and Lafitte. Further, adverse impacts on communities that depend on brown shrimp landings would be expected to be greater than those in areas targeting mostly white shrimp, due to the magnitude of the expected adverse impact on brown shrimp under the Applicant's Preferred Alternative. However, as discussed above, shrimpers often target both brown and white shrimp, landing whichever species is in peak season (LDWF 2014). Therefore, most shrimpers have some potential to be adversely impacted by declines in abundance of brown shrimp. Commercial fishermen who travel to Barataria Basin to fish for species that would be adversely affected, particularly shrimp and oysters, could also be adversely affected by the proposed Project.

As described above, under the No Action Alternative, changes in habitat conditions in the Project area would lead to declines in brown shrimp abundance over the long-term. The Applicant's Preferred Alternative would accelerate and increase the decline in brown shrimp abundance as compared to the No Action Alternative. While the total loss of commercial brown shrimp landings from the Barataria Basin is not anticipated, recent shrimp fishery landings data from LDWF provide an estimate of the value of brown shrimp subject to adverse impacts under the Applicant's Preferred Alternative. Between 2014 and 2018, an average of 12.3 million pounds of brown shrimp valued at $12.8 million was harvested annually in the Project area (LDWF 2019b).[84] In contrast, trends in white shrimp landings would be expected to continue as described under the No Action Alternative or increase slightly due to the expected negligible to minor beneficial impacts on white shrimp abundance. Between 2014 and 2018 fishers landed 18.3 million pounds of white shrimp valued at $28.8 million (LDWF 2019b). About 67 percent of shrimp landings (brown and white) in the Project area in terms of weight and 62 percent of shrimp landings in the Project area in terms of value are from sub-basins 210 and 211 between 2014 and 2018. Some of these landings are likely caught in the Gulf and would not be affected by the Applicant's Preferred Alternative (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-1 for locations of the LDWF fishing sub-basins).

A survey of shrimpers identified a range of potential responses that fishers would consider in response to a diversion project other than not fishing. Responses included investing in gear upgrades, converting to an offshore (deep water) vessel, increasing the geographic range (length) of fishing trips, and fishing other fisheries (substitution) (Coalition to Restore Coastal Louisiana 2017). Substitution to other species and areas, which include investments in new gear and vessels, are discussed below.

Substituting to different species may require investing in different gear and, in some cases, different vessels. Smaller boats that are often used in estuaries and bays in coastal Louisiana are often rigged for multiple purposes (Gramling and Hagelman, 2005). For example, it is not uncommon to see a boat with a skimmer or butterfly rigging that can also be set up to trawl or transport crab traps. Having this flexibility in boats and equipment would allow some fishers to adjust to changes in environmental conditions more quickly. Small boat owners also tend to buy a commercial license in order to shrimp part-time or only during the inshore season (Gramling and Hagelman, 2005). Shrimpers who are only relying on this activity part-time may have more flexibility to move in and out of the industry as environmental conditions change. For fishers using less flexible gear, the near-term impacts of the Applicant's Preferred Alternative may result in fishers deciding to retire equipment before the end of its useful life, for example, if fishers decide to invest in new equipment to enable them to fish further out where brown shrimp may be less affected. However, if changes occur more slowly, then the regular attrition of shrimp fishers exiting the fishery may coincide with reduced brown shrimp abundance in later years; some of this exit may also be

[84] Average shrimp value between 2014 and 2018 includes relatively high value of shrimp landings in 2014 that resulted from high import prices in that year due to shrimp disease in Asia (Reed and Royales 2014).

attributable to attrition as older fishermen exit the fishery and are not replaced. Similarly, potential new entrants into the shrimp fishery in the future may assess the market and decide to make the upfront investment in more flexible vessels/gear than they would have otherwise, or they may pursue alternative employment. Based on analysis of licensed shrimpers, only 40 percent of commercial fishers landing shrimp in 2017 had landed shrimp in the past 5 years; as such, many of the participants in the future could be new entrants.

As discussed in Section 4.14.4.1 above, the median age of fishers landing shrimp is higher than that of all workers in Louisiana. As such, short-term impacts may be more difficult to offset as older workers are less likely to invest in new skills and have less time to recoup the costs of acquiring or purchasing new equipment. These added costs may limit the effect of substitutions across species for current fishers, but may be more feasible for new entrants. Similarly, for younger fishers, they may more easily adapt to the need for new skills or equipment.

While substituting to different target species may help to lessen adverse impacts on fishers, the magnitude of the adverse impacts on brown shrimp, which accounted for about 25 percent of total landings and 14 percent of the total value of commercial landings in the Project area between 2014 and 2018 (see Figure 4.14-1), suggests that substitution would not fully offset the impacts of environmental changes. Further, shrimpers who currently land shrimp from May to late fall likely harvest brown shrimp in May and June, during its peak season, and white shrimp in the fall, when white shrimp landings are at their peak (LDWF 2014). The major adverse impacts on brown shrimp abundance may substantially reduce harvest in the spring, adversely impacting commercial fishers who depend on this income. However, harvest in the fall months would experience negligible to minor beneficial impacts as white shrimp abundance may increase slightly. As discussed above, these beneficial impacts are not expected to fully offset the adverse impacts on brown shrimp or offer opportunity for substitution as many shrimp fishers already target both species. While substituting to different target species such as crab may help to lessen adverse impacts on shrimpers, the magnitude of the adverse impacts on brown shrimp suggests that substitution may not fully offset the adverse impacts under the Applicant's Preferred Alternative. While some vessels may already be rigged for multiple purposes including crab, substituting to different species may require investing in different gear and vessels, which some shrimp fishers may not have the resources to do. Adaptation may be easier for the relatively large number of new entrants who would more easily be able to outfit with vessels and gear best suited for future conditions as they enter the industry.

If shrimp fishers choose to move fishing locations, including fishing in state waters offshore, rather than substituting to other species, additional gear and travel costs would be incurred. Currently, some commercial fishing participants operate in a relatively small geographic area while others travel across multiple basins (Barnes et al. 2017). Brown shrimp landings also occur in the Terrebonne Basin and Lake Pontchartrain as well as offshore in federal waters (LDWF 2019b). Area substitution may not be profitable for shrimp fishers depending on their location and distance from new fishing areas, especially considering the potential increased costs and gear requirements. Further, the ability of shrimpers to mitigate impacts by substituting to other areas would be limited by the abundance of species in the other areas and competition for that substitute resource.

Regardless of the impacts on species abundance or location, commercial fishers, and shrimpers in particular, may feel a high degree of uncertainty about the future impacts of the proposed diversion, which may lead them to be more likely to exit the industry. Shrimpers who do not exit the industry may invest in flexible vessels and gear to better adapt to changing conditions. The commercial fishing industry is faced with a great deal of uncertainty related to general economic factors such as fuel costs, prices, and consumer preference for seafood harvest from the region relative to imports and other consumer products. As stated above, local shrimpers have characterized the additional uncertainty of impacts that diversions could have on shrimp populations as a factor contributing to their inability to plan, which could lead to waiting to make investments or making more risky investments either of which could result in decreased effectiveness of adapting and continuing to shrimp successfully (Coalition to Restore Coastal Louisiana 2017). Similarly, Louisiana's Seafood Future 2019 Findings Report notes a variety of factors that contribute to uncertainty underlying the seafood industry, including loss of habitats and low commodity prices (Louisiana Seafood Futures 2019). As discussed above, exits have outpaced entrants over time. The major adverse impacts on brown shrimp abundance under the Applicant's Preferred Alternative, leading to moderate to major, permanent, adverse impacts on the overall shrimp industry in the Project area may exacerbate this trend. The uncertainty of diversion impacts also has the effect of discouraging future generations from entering the industry (Coalition to Restore Coastal Louisiana 2017).

Reductions in shrimp catch would have regional economic implications. First, the shrimp industry provides substantial employment opportunities in some coastal communities. There were 935 license holders actively landing shrimp in the Barataria Basin and 229 in the Mississippi River Basin in 2018 (LDWF 2019h).[85] In addition to license holders, crew members employed by license holders may be impacted by changes in shrimp abundance. As discussed above, the estimated crew size of commercial fishing trips targeting shrimp, including the captain, is 2.1 (Isaacs 2015a). However, these crew size estimates likely include some operations where the captain is the only license holder as well as some operations with multiple individuals holding a license on the same vessel. Therefore, multiplying estimates of the number of commercial license holders landing each species by the average crew size may overstate the total number of individuals engaged in the industry. Nonetheless, the data illustrate that direct and indirect impacts on the commercial shrimp industry extend beyond the commercial fishing license holder. Annual dockside sales support a broad set of economic activities. In addition to commercial fishing license holders and crew members, dealers, suppliers, and seafood processors would also be impacted by

[85] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders across the two basins within a year.

changes in shrimp catch in the Project area. Statewide in 2019, there were 1,763 wholesale seafood and retail seafood dealers, 87 percent of which were resident seafood dealers. In addition, there were 1,381 fresh products (direct-to-consumer) seafood dealers, of which 99 percent were resident dealers (LDWF 2019i). Recent statewide trip ticket-license data estimates that 180 dealers handled shrimp landings in 2018 in from the Project area (Draft Statewide Dealer Statistics 2019).[86] Some dealers handle multiple species, thus reducing their reliance on any one species. However, significant declines in brown shrimp landings within the Project area would also be expected to adversely impact dealers. There are approximately 350 wholesale seafood processors and distributors in Louisiana, although some of those businesses, such as restaurants and retail establishments, secure permits to support a small portion of their business (Commercial Seafood Program 2019). Nonetheless, the Applicant's Preferred Alternative would cause adverse, permanent impacts on the viability of those businesses that currently use shrimp landings from the Project area. While availability of shrimp from the basin would decrease, shrimp from Louisiana would continue to be available to restaurants, potentially at higher prices. Restaurants willing to pay a premium for local seafood would likely do so, and additional importing would likely also occur. Under both the Applicant's Preferred Alternative and the No Action Alternative, consumers in Louisiana would experience higher prices for locally caught seafood, or would consume additional imported shrimp over time. However,impacts due to decreased local shrimp availability would occur decades sooner under the Applicant's Preferred Alternative than under the No Action Alternative.

Overall, moderate to major, adverse, permanent direct and indirect impacts are anticipated on shrimp fisheries in the Project area due to expected negligible to minor, permanent, beneficial impacts on white shrimp, and major, permanent, adverse impacts on brown shrimp abundance (see Section 4.10.4.5 in Aquatic Resources), under the Applicant's Preferred Alternative relative to the No Action Alternative. While some substitution of targeted species may be possible, such substitution would require additional investment by individual fishers, which may or may not be financially feasible. Declines in shrimp abundance may also exacerbate trends in the aging workforce to leave the industry. Adverse impacts on brown shrimp abundance and subsequent adverse impacts on the overall shrimp fisheries would begin at the onset of operations and last permanently throughout the 50-year analysis period. Any benefits on shrimp abundance in the Project area associated with increased marsh habitat later in the analysis period would not substantially alter the stated impacts on the shrimping industry in the Project area.

4.14.4.2.3 Eastern Oyster Fishery

Overall, the eastern oyster fishery in the Project area is expected to experience major, permanent, adverse impacts under the Applicant's Preferred Alternative relative to the No Action Alternative, although it is possible that areas near the barrier islands

[86] Estimates include only wholesale/retail seafood dealer-business or wholesale/retail seafood dealer-vehicle licenses.

could be used as seed grounds and growing areas for adults when salinities are too low throughout the rest of the Barataria Basin. However, establishment of new reefs could take years to develop, including determining a suitable location for a new reef, establishing suitable substrate for oyster attachment and growth, and oyster growth to sack size (requiring about 18 months, or less if seed oysters are placed; see Chapter 3, Section 3.10.5.2.11 Eastern Oysters and Section 4.10.4.5.2.11 Eastern Oysters). This overall determination considers expected impacts on oyster abundance, potential increases in fecal coliform levels, as well as the anticipated response from commercial fishers.

As discussed in Section 4.10.4.5 in Aquatic Resources, major, permanent, adverse impacts on eastern oyster abundance in the Project area would occur under the Applicant's Preferred Alterative relative to the No Action Alternative (see Section 4.10 Aquatic Resources for more information about Project impacts on aquatic resources in the Project area).

In addition to direct species effects, impacts on water quality associated with the Project could also impair oyster harvests. In particular, as described in Section 4.5.5.8 Water Quality, increases in fecal coliform levels associated with increased Mississippi River input from the Project may result in additional temporary exceedances of allowable limits for shellfish harvest beyond what would have occurred under the No Action Alternative. Fecal coliform and other bacterial limits are established by the Office of Public Health (OPH) in collaboration with the National Shellfish Sanitation Program (NSSP) to prevent harvest of oysters that may contain unsuitable levels of fecal coliform or toxins harmful to human health. Under the NSSP, Louisiana Department of Health and Hospitals, OPH monitors fecal coliform levels and manages oyster harvest areas (LDH/OPH 2022). If fecal coliform levels rise above harvest standards due to the Project, the OPH may temporarily restrict or close some areas, further impairing oyster harvest.

Adverse impacts on oyster fishers due to changes in the availability of oyster harvest may be partially offset by behavioral adjustments that fishers could make, such as modifying fishing locations, distances traveled, or shifting to off-bottom aquaculture, but these adjustments would increase operating costs, which may result in fishers exiting the industry more quickly than would have been anticipated under the No Action Alternative. The off-bottom and hatchery components of the oyster fishery would not be affected by the Project, or may benefit from it. Specifically, the only significant off-bottom oyster fisheries in Barataria Basin occurs in the lower basin. As indicated in Section 3.14.6, the Mike Voisin Oyster Hatchery in Grand Isle is the only commercially available source of oyster larvae and seed. These areas could benefit from the Project.

While the total loss of commercial eastern oysters in the Project area and associated landings is not anticipated, recent fishery landings data from LDWF provide an estimate of the value of eastern oyster harvest that would be at risk for adverse impacts under the Applicant's Preferred Alternative. As discussed above, an average of 4.7 million pounds of oyster worth $32.7 million were landed annually in the Project area between 2014 and 2018, accounting for 10 percent of average annual Project area commercial fishing landings in terms of weight and 37 percent in terms of value (see Figure 4.14-1 above) (LDWF 2019b). Over 90 percent of eastern oyster landings within the Project area occurred in LDWF sub-basin 210.

4.14.4.2.3.1 Regional Economic Impacts and Community Impacts on Eastern Oyster Fishery

Reductions in eastern oyster landings in the Project area would have direct and indirect regional economic implications. Overall, major, permanent, adverse direct and indirect impacts are anticipated on eastern oyster fisheries in the Project area due to expected major, permanent, adverse impacts on oyster abundance under the Applicant's Preferred Alternative relative to the No Action Alternative. While changes in fisher behavior, such as substitution to other species or areas, may partially offset the adverse impacts, major adverse impacts are still anticipated in the Project area. Adverse impacts on oyster abundance and subsequent adverse impacts on oyster fisheries would begin at the onset of operations and last permanently throughout the 50-year analysis period.

As described above, most active license holders landing oysters in the Project area are in the Barataria Basin, with between 278 and 309 active license holders in the Barataria Basin between 2014 and 2018; largely from sub-basin 210 (LDWF 2019h). The Mississippi River Basin had less than 10 active license holders annually during this timeframe (LDWF 2019h). In addition to license holders, crew members employed by license holders would be impacted by changes in abundance under the Applicant's Preferred Alternative. As discussed above, the estimated crew size for trips landing oysters is 2.6, including the captain (Isaacs 2015b).

As summarized in Chapter 3, Section 3.14 Commercial Fishing, annual dockside sales support a broad set of economic activities. In addition to commercial fishing license holders and crew members, dealers, suppliers, and seafood processors would also be impacted by changes in oyster catch in the Project area. As discussed in the Shrimp Fishery section, there were 1,763 wholesale and retail seafood dealers, and 1,381 fresh products (direct-to-consumer) seafood dealers statewide in 2019 (LDWF 2019i). Recent statewide trip ticket-license data estimates that 70 dealers handled oyster landings in 2018 in from the Project area (Draft Statewide Dealer Statistics 2019).[87] Some dealers handle multiple species, thus reducing their reliance on any one species.

The major, permanent, adverse impacts on eastern oysters may cause fishers to exit the industry or substitute to different species or areas. While substituting to different target species may help to lessen adverse impacts on fishers, the magnitude of the adverse impacts on oysters suggests that substitution would not fully offset the adverse impacts of changes under the Applicant's Preferred Alternative. Further, substituting to different species would likely require investing in different gear and

[87] Estimates include only wholesale/retail seafood dealer-business or wholesale/retail seafood dealer-vehicle licenses.

vessels, which some oyster fishers may not have the resources to do, but may be more feasible for new entrants. These added costs may limit the viability of substitutions across species for current fishers, but may be more feasible for new entrants. However, unlike in other fisheries, the average age among those landing oysters from the Barataria Basin in 2017 was similar to the 2018 median age of all workers in Louisiana (Isaacs 2019b; U.S. Census Bureau 2019b). The relatively young age of oyster fishers may provide fishers more flexibility to invest in new skills and time to recoup the costs of acquiring or purchasing new equipment.

In addition to substitution to other species, fishers adversely impacted by loss of eastern oyster abundance may substitute to different locations outside of Barataria Bay. Another major source of eastern oyster landing is the Terrebonne Basin (Barnes et al. 2017). To the extent species abundance in the Terrebonne Basin can support additional fishers, fishers from the Barataria Basin may be able to substitute to this location. However, area substitution may not be profitable for oyster fishers depending on their location and distance from new fishing areas. Commercial fishermen who travel to Barataria Basin to fish for species that would be adversely affected, particularly shrimp and oysters, could also be adversely affected by the proposed Project.

4.14.4.2.4 Blue Crab Fishery

Overall, the blue crab fishery is expected to experience negligible to minor, permanent, beneficial impacts under the Applicant's Preferred Alternative relative to the No Action Alternative. This determination considers potential impacts on blue crab abundance as well as the anticipated response from the commercial fishing industry.

Blue crab abundance is expected to benefit from increased marsh area, SAV, and primary production in the vicinity of the Project area due to proposed Project operations (see Section 4.10 Aquatic Resources, Figure 4.10-14). These benefits are expected to offset the adverse impacts of the Project on larval transport, and early juvenile settlement, resulting in an overall negligible to minor, permanent, beneficial impact on blue crab abundance in the Project area relative to the No Action Alternative (see Section 4.10 Aquatic Resources for more information about Project impacts on aquatic resources in the Project area).

Recent crab fishery landings data provide context for the values of the crab fishery that could be beneficially affected under the Applicant's Preferred Alternative. As stated above, an average of 9.6 million pounds of crab worth $12.1 million were harvested annually between 2014 and 2018 in the Project area (LDWF 2019b). During that time, about 70 percent of crab landings in terms of value and weight occurred in four sub-basins: sub-basins 209 and 211 in the Barataria Basin and 703 and 704 in the Mississippi River Basin (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-1 for locations of the LDWF fishing sub-basins).

4.14.4.2.4.1 Regional Economic Impacts and Community Impacts on Blue Crab Fishery

Although not as large as the shrimp or oyster industry, increases in crab catch in the Project area would have direct and indirect regional economic implications. To the extent that changes under the Applicant's Preferred Alternative impact blue crab abundance, there is also potential for negligible to minor beneficial impacts on dealers, suppliers, and food processors that rely on blue crab landings for business.

Historically, areas fished with the highest concentration of crab landings were located in the middle and lower portions of the Barataria Basin and the Lower Mississippi River Basin surrounding the mouth of the river. In particular, sub-basin area 209 (see Chapter 3, Section 3.14 Commercial Fisheries, Figure 3.14-1 for locations of the LDWF fishing sub-basins) has historically had the highest crab landings. Anticipated negligible to minor beneficial impacts on blue crab abundance would be expected to result in negligible to minor, permanent, beneficial impacts on the blue crab commercial fishery. Communities reliant on employment and expenditures associated with this industry may also benefit, as expenditures associated with employment and support industries may be increased under this alternative.

4.14.4.2.5 Finfish Fishery

Impacts of the proposed Project on the abundance and commercial landings of saltwater and freshwater finfish would vary by species from beneficial to adverse when compared to the No Action Alternative. This determination considers potential impacts on finfish abundance as well as the anticipated response from the commercial fishing industry. The abundance of these species directly impacts commercial fishing for these species. Reductions in catch would discourage entrants into the fishery and encourage exits. For species where increases in abundance and catch would be anticipated, the converse would be true. Alternatively, adaptation may be more feasible for new entrants.

The primary commercial saltwater finfish fisheries in the Project area are for black drum, mullet-red roe, and sheepshead, with the dominant commercial fishery for menhaden occurring outside of the Barataria Basin in offshore or shelf waters. Refer to Section 4.10 Aquatic Resources for more information about Project impacts on aquatic species in the Project area.

Overall impacts of the Applicant's Preferred Alternative on the saltwater finfish commercial fishery would range from moderate, permanent, beneficial (Gulf menhaden), to minor, permanent, beneficial (bay anchovy) to negligible (Atlantic croaker), to negligible to minor, permanent, adverse (southern flounder), to minor, permanent adverse (spotted seatrout), relative to the No Action Alternative, as discussed in Section 4.10 Aquatic Resources.

Historical landings and estimated employment in this fishery provide insight into the value of the saltwater finfish industry subject to impacts under the Applicant's

Preferred Alternative. Excluding menhaden, which is largely caught in nearshore Gulf waters, the average annual value of the 2.7 million pounds of saltwater finfish landed by commercial fishers between 2014 and 2018 was $1.8 million (LDWF 2019b). Between 2014 and 2018, saltwater finfish, excluding menhaden, accounted for 5 percent of the total weight of landings in the Project area and 2 percent of the total value (see Figure 4.14-1 above). During that time, an average of 130 fishers targeted saltwater finfish in the Barataria Basin and 133 targeted saltwater finfish in the Mississippi River Basin each year (LDWF 2019h).[88] Menhaden make up the vast majority (97 percent) of total finfish landings in pounds (Louisiana Fisheries Forward 2018). As such, adverse impacts on other saltwater species have some potential to be offset by benefits to menhaden abundance and associated catch that would occur under the Applicant's Preferred Alternative. Adult menhaden caught offshore utilize estuaries such as the Barataria Basin during their juvenile stage. As a result, benefits from the Project on menhaden in the basin (moderate, beneficial) could improve this fishery offshore. However, only a small number of license holders produce a large majority of the menhaden catch. Further, the gear required to catch menhaden is different than that used to target other saltwater finfish species in the Project area, so offsetting reduced landings from other species with menhaden would require investment in new gear, which may deter fishers from this type of substitution. It is therefore uncertain whether commercial saltwater finfish fishers would offset any reductions in catch in the Project area with offshore menhaden catch.

The freshwater finfish fishery would also be impacted by changes under the Applicant's Preferred Alternative. Due to increased low salinity habitat under the Applicant's Preferred Alternative relative to the No Action Alternative, freshwater finfish species would be expected to experience moderate, permanent, beneficial impacts. The increased abundance of freshwater finfish species (such as catfish, freshwater drum, carp and buffalo fish) in the Project area would be expected to lead to moderate, permanent, beneficial impacts on commercial fishers targeting freshwater finfish.

Commercial fishers landed an annual average of 1.9 million pounds of freshwater finfish in the Project area, worth about $1.0 million between 2014 and 2018 (LDWF 2019b). Between 2014 and 2018, freshwater finfish landings accounted for 4 percent of total landings in the Project area by weight and only 1 percent of total value (see Figure 4.14-1 above). During that time, an average of 143 licensed fishers targeted freshwater finfish in the Barataria Basin annually and 79 targeted freshwater finfish in the Mississippi River Basin (LDWF 2019h).[89]

[88] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders across the two basins within a year.

[89] Some license holders may have landings from both the Barataria and Mississippi River Basins, causing the sum of both basins to overstate the number of unique license holders within a year.

4.14.4.2.5.1 Regional Economic Impacts and Community Impacts on Finfish Fishery

Given the small magnitude of the commercial finfish industry in the Project area, changes in finfish abundance would have very limited regional economic implications. The impacts of changes in finfish abundance would largely be felt by the individual fishers targeting those species. Fishers may have to substitute to different areas or species if historically targeted species are no longer abundant in the same places. This may require investment in new gear or increased travel costs that reduce profitability and may cause fishers to exit the finfish industry. Alternatively, potential new entrants into the finfish fishery in the future may assess the market and decide to make the upfront investment in more flexible vessels/gear than they would have otherwise, or they may pursue alternative employment. Based on analysis of commercial fishing licenses, only 35 percent of fishers harvesting saltwater finfish and 41 percent of fishers harvesting freshwater finfish in 2017 had landed saltwater or finfish respectively in the past 5 years; thus, many of the participants in the future could be new entrants to finfish fishing. Regardless of the impacts of the Applicant's Preferred Alternative on finfish species, fishers may feel a high degree of uncertainty surrounding operational changes in the Project area, further encouraging them to exit the industry. Alternatively, the increased abundance of some finfish species may encourage new entrants into the industry. These changes would impact license holders as well as crew members, dealers, suppliers, and food processors.

4.14.4.2.6 Alligator Hunting and Farming

Operational impacts on commercial alligator hunting and farming under the Applicant's Preferred Alternative are based on expected impacts on alligators as discussed in Section 4.9 Terrestrial Wildlife and Habitat.

As compared to the No Action Alternative, the Applicant's Preferred Alternative is expected to result in minor, permanent, beneficial, direct and indirect impacts on alligator populations in the Project area due to the retention of suitable habitat near the outfall. This increase in habitat would likely result in a small increase in the number of tag allotments for commercial alligator hunting and quotas for egg collection as compared to the No Action Alternative. Further, although alligator nests are subject to flooding events, females generally select nest sites in June or July, such that diversion flows would already be high or decreasing in a typical water year, thereby limiting the potential for nest flooding.

4.14.4.2.6.1 Regional Economic Impacts and Community Impacts on Alligator Hunting and Farming

Under the Applicant's Preferred Alternative, alligator hunting and farming opportunities may increase slightly relative to the No Action Alternative. However, given the limited number of farms in the Project area (one in Plaquemines Parish and four in Lafourche Parish in December 2018) (LDWF 2019j), regional and community level impacts would not be expected.

4.14.4.2.7 Aquaculture

This analysis anticipates negligible impacts on the aquaculture industry from the Applicant's Preferred Alternative relative to the No Action Alternative. While commercial harvesting of alligator, shrimp, oysters and soft-shell crabs are sometimes categorized as aquaculture, impacts on shrimp, oyster and crab fisheries and alligator farming and hunting are discussed separately in sections above. Other types of aquaculture activities include crawfish farming, fish bait, and turtles. Aquaculture activities located throughout the Project area should be relatively unaffected by increased tidal flooding impacts that result from the proposed Project. Increased sediment accretion would be unlikely to markedly affect these operations, though it is possible that a small number of operations may need to be relocated. As such, the trend of relative stability with some growth in the aquaculture industry (excluding alligator, shrimp, oyster and soft-shell crab farming) in the Project area would not be anticipated to be different under the Applicant's Preferred Alternative than under the No Action Alternative.

4.14.4.2.7.1 Regional Economic Impacts and Community Impacts on Aquaculture

As trends in the aquaculture industry (excluding alligator, shrimp, oyster and soft-shell crab farming) in the Project area would not be anticipated to be different under the Applicant's Preferred Alternative than under the No Action Alternative, negligible regional economic impacts or community impacts are anticipated.

4.14.4.3 Other Alternatives

4.14.4.3.1.1 50,000 cfs Alternatives

Similar to the impacts of the Applicant's Preferred Alternative, the 50,000 cfs Alternative is expected to result in the following impacts on commercial fisheries in the Project area as compared to the No Action Alternative:

- Moderate to major permanent adverse impacts on shrimp fishery;
- Major, permanent, adverse impacts on the oyster fishery;
- Negligible to minor, permanent, beneficial impacts on the blue crab fishery; and
- A range of negligible to moderate, beneficial and adverse impacts on finfish fisheries depending on the species, as detailed above and summarized in Table 4.14-3 below.

As compared to the Applicant's Preferred Alternative, the 50,000 cfs Alternatives would result in less marsh creation, but also would disrupt larval transport in a smaller area. Overall impacts of the 50,000 cfs Alternative on commercial fisheries would be somewhat less intense than the Applicant's Preferred Alternative.

4.14.4.3.1.2 150,000 cfs Alternative

Similar to the impacts of the Applicant's Preferred Alternative, the 150,000 cfs Alternative is expected to result in the following impacts on commercial fisheries in the Project area as compared to the No Action Alternative:

- Moderate to major, permanent, adverse impacts on shrimp fishery;
- Major, permanent, adverse impacts on the oyster fishery; and
- Negligible to minor, permanent, beneficial impacts on the blue crab fishery.

A range of negligible to moderate, beneficial and adverse impacts would occur on finfish fisheries depending on the species, as detailed above and summarized in Table 4.14-3 below. In addition, under the 150,000 cfs Alternative, there would be increased marsh creation and incremental adverse impacts from the expansion of the area in which larval transport would be disrupted as compared to the Applicant's Preferred Alternative. When compared to No Action Alternative conditions, Project-induced sedimentation affecting some Barataria Basin navigation channels and marine infrastructure would result in moderate, permanent, adverse impacts on commercial fishing vessels using the affected channels and marinas if some channels become inaccessible to larger commercial fishing vessels if no mitigation efforts are taken to maintain channel depths. These impacts may be slightly increased under the 150,000 cfs Alternatives relative to the Applicant's Preferred Alternative. Overall impacts of the 150,000 cfs Alternative on commercial fisheries would be somewhat more intense than the Applicant's Preferred Alternative.

4.14.4.3.1.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on commercial fisheries similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.14.5 Summary of Potential Impacts

Table 4.14-3 below summarizes the construction and operational impacts of the No Action Alternative and action alternatives on commercial fisheries. Commercial fisheries that target species with expected increases in abundance would be expected to benefit from the action alternatives, while commercial fisheries that target species with expected decreases in abundance would be adversely affected (see Section 4.10 Aquatic Resources for more information about Project impacts on aquatic species in the Project area). Changes in the location and/or extent of commercial fishing activities may also have impacts on the regional economy, and communities reliant on these activities.

Table 4.14-3
Summary of Potential Impacts on Commercial Fisheries from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on commercial fisheries from construction of the proposed Project would occur. Ongoing trends in commercial fishing conditions and activities would continue.
Operational Impacts	• Adverse impacts on the commercial shrimp fishery due to decrease in shrimp abundance from reduced marsh habitat and increased salinity over time as compared to existing conditions. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Adverse impacts on the commercial oyster industry due to salinity shift over time, particularly after 2050 as compared to existing conditions. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Adverse impacts on commercial crab fishery due to decrease in blue crab abundance from reduced marsh habitat over time as compared to existing conditions. • Finfish (as compared to existing conditions): o Adverse impacts on commercial fisheries for spotted seatrout, Atlantic croaker, and largemouth bass (proxy for freshwater species) as abundance declines in the long-term due to reduced marsh habitat and increased salinity and water depth; and o No or negligible impacts anticipated for southern flounder, Gulf menhaden, and bay anchovy commercial fisheries due to negligible impacts on species abundance over time.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Potential for highway or waterway traffic congestion, which may contribute to minor, adverse, temporary impacts on commercial fishing due to delays in accessing areas used for fishing as compared to No Action Alternative.
Operational Impacts	• Moderate to major, permanent, adverse impacts on shrimp fisheries in the Project area would be anticipated associated with major adverse impacts on brown shrimp abundance over time as compared to No Action Alternative. Negligible to minor, permanent, and beneficial impacts for white shrimp. Adverse impacts may be partially offset by changes in fisher behavior, especially given that the greatest impacts may be occurring later in the analysis period, but these adjustments would increase operating costs. Impacts could further encourage fishers to exit from the industry. Potential new entrants may adapt more easily by investing in more flexible vessels/gear than they would have otherwise, or they may pursue alternative employment. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Major, permanent, adverse impacts on eastern oyster fisheries in the Project area would be anticipated due to adverse impacts on eastern oyster abundance as compared to No Action Alternative. Adverse impacts may be partially offset by changes in fisher behavior, but these adjustments would increase operating costs. Impacts would encourage fishers to exit from the industry. Potential new entrants may adapt more easily by investing in more flexible vessels/gear than they would have otherwise, or they may pursue alternative employment. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Negligible to minor, permanent, beneficial impacts on blue crab fishery would be anticipated due to changes in species abundance as compared to No Action Alternative. • A range of impacts on finfish fisheries would be expected. Decreases in species abundance in the Project area would cause direct reductions in commercial catch, discourage entrants into the fishery, and encourage exits, while the converse would

Table 4.14-3
Summary of Potential Impacts on Commercial Fisheries from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	be true where increases in abundance and catch would be anticipated. Specifically, as compared to the No Action Alternative: ○ Moderate, permanent, beneficial impacts on Gulf menhaden; ○ Minor, permanent, beneficial impacts on bay anchovy; ○ Negligible impacts on Atlantic croaker; ○ Negligible to minor, permanent, adverse impacts on southern flounder; ○ Minor, permanent, adverse impacts on spotted seatrout; and ○ Moderate, permanent, beneficial impacts on freshwater finfish fisheries.
50,000 cfs Alternative	
Construction Impacts	• Potential for highway or waterway traffic congestion, which may contribute to minor, adverse, temporary impacts on commercial fishing due to delays in accessing areas used for fishing as compared to the No Action Alternative. Impacts may be slightly lower than those anticipated under the Applicant Preferred or the 150,000 cfs Alternatives.
Operational Impacts	• Moderate to major, permanent, adverse impacts on shrimp fisheries in the Project area would be anticipated associated with adverse impacts on brown shrimp abundance over time as compared to No Action Alternative. Negligible to minor, permanent, and beneficial impacts for white shrimp are anticipated. Adverse impacts may be partially offset by changes in fisher behavior, especially given that the greatest impacts may be occurring later in the analysis period, but these adjustments would increase operating costs. Impacts could further encourage fishers to exit from the industry. Potential new entrants may adapt more easily by investing in more flexible vessels/gear than they would have otherwise, or they may pursue alternative employment. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Major, permanent, adverse impacts on eastern oyster fisheries would be anticipated due to adverse impacts on eastern oyster abundance as compared to the No Action Alternative. Adverse impacts may be partially offset by changes in fisher behavior, but these adjustments would increase operating costs. Impacts would encourage fishers to exit from the industry, but may be more feasible for new entrants. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Negligible to minor, permanent, beneficial impacts on blue crab fishery would be anticipated due to changes in species abundance as compared to the No Action Alternative. • A range of impacts on finfish fisheries would be expected. Decreases in species abundance would cause direct reductions in commercial catch, discourage entrants into the fishery, and encourage exits, while the converse would be true where increases in abundance and catch would be anticipated. Specifically, as compared to the No Action Alternative: ○ Moderate, permanent, beneficial impacts on Gulf menhaden; ○ Minor permanent, beneficial impacts on bay anchovy; ○ Negligible impacts on Atlantic croaker; ○ Negligible to minor, permanent, adverse impacts on southern flounder; ○ Minor, permanent, adverse impacts on spotted seatrout; ○ Moderate, permanent, beneficial impacts on freshwater finfish fisheries. • As compared to the Applicant's Preferred Alternative, this alternative would result in less marsh creation but also would disrupt larval transport in a smaller area. Overall impacts of this alternative on commercial fisheries would be somewhat less intense than the Applicant's Preferred Alternative.
150,000 cfs Alternative	
Construction Impacts	• Potential for highway or waterway traffic congestion, which may contribute to minor, adverse, temporary impacts on commercial fishing due to delays in accessing areas

Table 4.14-3
Summary of Potential Impacts on Commercial Fisheries from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	used for fishing as compared to the No Action Alternative. Effects may be slightly higher than those anticipated under the 50,000 or 75,000 cfs Alternatives.
Operational Impacts	• Moderate to major, permanent, adverse impacts on shrimp fisheries in the Project area would be anticipated associated with adverse impacts on brown shrimp abundance over time as compared to No Action Alternative. Negligible to minor, permanent, and beneficial impacts for white shrimp are anticipated. Adverse impacts may be partially offset by changes in fisher behavior, especially given that the greatest impacts may be occurring later in the analysis period, but these adjustments would increase operating costs. Impacts could further encourage fishers to exit from the industry. Potential new entrants may adapt more easily by investing in more flexible vessels/gear than they would have otherwise, or they may pursue alternative employment. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Major, permanent, adverse impacts on eastern oyster fisheries would be anticipated due to adverse impacts on eastern oyster abundance as compared to the No Action Alternative. Adverse impacts may be partially offset by changes in fisher behavior, but these adjustments would increase operating costs. Impacts would encourage fishers to exit from the industry. Communities reliant on employment and expenditures associated with this industry would be adversely affected. • Negligible to minor, permanent, beneficial impacts on blue crab fishery would be anticipated due to changes in species abundance as compared to the No Action Alternative. • A range of impacts on finfish fisheries would be expected. Decreases in species abundance would cause direct reductions in commercial catch, discourage entrants into the fishery, and encourage exits, while the converse would be true where increases in abundance and catch would be anticipated. Specifically, as compared to the No Action Alternative: o Moderate, permanent, beneficial impacts on Gulf menhaden; o Minor permanent, beneficial impacts on bay anchovy; o Negligible impacts on Atlantic croaker; o Negligible to minor, permanent, adverse impacts on southern flounder; o Minor, permanent, adverse impacts on spotted seatrout; and o Moderate, permanent, beneficial impacts on freshwater finfish fisheries. • As compared to the Applicant's Preferred Alternative, this alternative would result in more marsh creation but also would disrupt larval transport in a larger area. Overall impacts of this alternative on commercial fisheries would be somewhat more intense than the Applicant's Preferred Alternative.
Terrace Alternatives	
Construction Impacts	• The three terrace alternatives would have the same construction impacts as those described above under the corresponding flow capacity alternatives without terraces. • The additional impacts on commercial fisheries due to the construction of terraces would be negligible.
Operational Impacts	• The three terrace alternatives would have impacts on the commercial fishing activities that would be similar to those anticipated under the corresponding flow capacity alternatives without terraces. • Any additional impacts on commercial fisheries due to the presence of terraces during Project operations would be negligible.

4.15 ENVIRONMENTAL JUSTICE

EO No. 12898 (1994), Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, and EO No. 14008 (2021), Tackling the Climate Crisis at Home and Abroad, direct federal agencies to identify and address disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts of their activities on minority and low-income populations. EO No. 12898 and EO No. 14008 direct federal agencies to make achieving environmental justice part of their missions by identifying and addressing the impacts of programs, policies, and activities on minority and low-income populations. The fundamental principles of the EOs are as follows:

- Ensure full and fair participation by potentially affected communities in the decision-making process.
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority or low-income populations.
- Avoid, minimize, or mitigate disproportionately high and adverse human health, environmental, climate-related, and other cumulative impacts, on minority populations and low-income populations.
- Encourage meaningful community representation in the NEPA process through the use of effective public participation strategies and special efforts to reach out to minority and low-income populations.
- Identify mitigation measures that address the needs of affected low-income and minority populations.

Environmental justice analyses identify and address, when appropriate, disproportionately high and adverse impacts of federal agency actions on minority populations, low-income populations, and Tribal Nations (see Chapter 1, Section 1.6 Scope of the EIS, Chapter 1, Section 1.7 Public Involvement Summary and Chapter 1, Section 1.8 Agency Roles and Responsibilities, which describe the NEPA process and steps taken by USACE to involve the public and coordinate with Tribal Nations). Of primary concern is whether adverse impacts fall disproportionately on minority and/or low-income members of the community compared to the larger community and, if so, whether those community members are “disproportionately high and adversely” affected by the Project. “Context” and “intensity,” evaluated during the consideration of an impact’s significance, may be factors that can (as appropriate) inform an agency’s determination whether an impact is disproportionately high and adverse. Definitions of impact context and intensity established for environmental justice are presented below. Another factor that aids in determining whether impacts are disproportionately high and adverse is the distribution of adverse and beneficial impacts of the Project alternatives between the general population and low-income and minority populations.

If disproportionately high and adverse impacts are identified, guidance from the NEPA Committee and Federal Interagency Working Group on Environmental Justice (EJ IWG 2016) and the U.S. Environmental Protection Agency (USEPA 1998) advises federal agencies to initiate consideration of alternatives and mitigation actions in coordination with meaningful community engagement. Consistent with EO No. 12898, EO No. 14008, and the Federal Interagency Working Group on Environmental Justice guidance (EJ IWG 2016), this section describes the approach taken to identify low-income and minority populations in the Project area and evaluate environmental consequences of the proposed Project with respect to these populations.

4.15.1 Area of Potential Impact

The EJ analysis first identified relevant portions of the proposed Project area where impacts of the Project would occur based on other resource analyses, including Section 4.2 Geology and Soils, Section 4.4 Surface Water and Coastal Processes, Section 4.13 Socioeconomics, Section 4.14 Commercial Fisheries, Section 4.16 Recreation and Tourism, and Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction. Following the guidance provided in EJ IWG (2016), the area of potential impacts for the environmental justice analysis was then refined from the 10 parishes included in the Project area identified in Chapter 3 Section 3.1. In particular, identification of the area of potential impact considered the "ecological, aesthetic, historic, cultural, economic, social or health consequences" to minority and low-income populations identified in other modeling or impact analyses (for example, Delft3D Basinwide Model results, aquatics, public health and safety) that may be caused by the Project (EJ IWG 2016). This includes populations and communities that are located in close proximity to the Project and/or are dependent on industries that could be impacted by the Project (for example, commercial fishing). The analysis also considered public comments provided in the proposed Project's scoping process, comments received during the public comment period for the Draft EIS, relevant literature, and recent news articles related to EJ concerns in the Project area. As discussed below, impacts are primarily anticipated in portions of Plaquemines and Jefferson Parishes, which were consequently determined to be the area of focus for the EJ analysis.

The area of potential impact varies for construction impacts versus operational impacts. For Project construction impacts, the EJ analysis primarily focuses on low-income and minority populations that live and work within the immediate vicinity (about 0.5-mile) of the Project construction footprint, including the community of Ironton.

For operational impacts, including changes to coastal land loss, tidal flooding, and storm hazards, the area of potential impacts focuses on areas most likely to experience adverse impacts, which are south of the diversion in southern Plaquemines and Jefferson Parishes. For fishing (including commercial, recreational, and subsistence), the area of potential impact was defined as the Barataria Basin. For recreational and subsistence hunting, impacts could occur throughout the Project area.

The analysis subsequently identified low-income and minority populations within the area of potential effect through a "no threshold" analysis (CEQ 1997, EJ IWG 2016). Where cities or towns were incorporated, U.S. Census data were used to identify low-income and minority populations. Census data used to identify low-income and minority populations residing outside of incorporated places varied according to Census designation. For Census Designated Places (CDPs), community level CDP data were used to identify minority and low-income populations within the Project area. For non-CDP communities, block group- and block-level data were used.

4.15.2 Guidelines for Environmental Justice Impact Determinations

Impact intensities for EJ are based on the definitions provided in Section 4.1 and the following socioeconomic-specific indicators for negligible, minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on minority and low-income populations would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: impacts on minority and low-income populations would be small and localized. These impacts are not expected to substantively alter social and/or economic conditions. Actions would not disproportionately affect minority and low-income populations;
- moderate: impacts would be readily apparent and detectable in local and adjacent areas and would have a noticeable effect on social and/or economic conditions in the Project area. Actions could disproportionately affect minority and low-income populations; and this impact could be temporary and localized; and
- major: impacts on minority and low-income populations would be readily detectable and observed, and would have a substantial influence on social and/or economic conditions within a particular community or over a widespread area. Actions could disproportionately affect minority and low-income populations, and this impact could be permanent and widespread.

Impacts on minority and low-income populations are considered disproportionately high and adverse if they would "significantly … and adversely" affect a low-income or minority population and would "appreciably exceed or [be] likely to appreciably exceed" impacts on the general population or another appropriate comparison group (CEQ 1997). Impacts are evaluated on the basis of whether they would be disproportionately high and adverse, rather than by population size. That is, a very small low-income or minority population within a given community or area could experience disproportionately high and adverse impacts.

The NEPA Committee and Federal Interagency Working Group on Environmental Justice (EJ IWG 2016) identifies factors that may amplify identified project impacts on low-income and minority populations. These factors include the presence of vulnerable groups, such as children and elderly populations, within larger populations; unique exposure pathways, including subsistence fishing, hunting, or gathering; inadequate housing, roads, or water supplies; and chronic stress related to environmental or socioeconomic impacts.

Note that impact durations also are considered. Some of the expected operational impacts are considered long-term or permanent, in that they continue for more than several years, up to the 50-year analysis period. Long-term or permanent impacts and benefits offer a different scenario in terms of adaptation than short-term impacts or benefits. For short-term impacts (that is, impacts that continue for approximately 3 years following construction), adaptation can be quick and focused, whereas for long-term impacts, planned adaptation may have to be modified as scenarios change over time and predicted outcomes may change.

4.15.3 Construction Impacts

4.15.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur; as such, no EJ impacts from the Project would occur. Low-income and minority populations would continue to be affected by and potentially adapt to changes in environmental conditions under the No Action Alternative in the short-term. Ongoing trends of sea-level rise, tidal flooding, and storm hazards would continue, but only limited changes to low-income and minority populations are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project).

In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the construction area of the proposed Project may be developed for industrial or commercial purposes that would likely have some adverse effect on nearby low-income and minority populations, such as increased noise, fugitive dust, and traffic delays from construction vehicles and activities. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws and regulations.

4.15.3.2 Applicant's Preferred Alternative

Construction of the proposed Project under the Applicant's Preferred Alternative is expected to have minor to moderate, temporary, adverse impacts on low-income and minority populations that live, work, and fish within 0.5-mile of the construction footprint.

The community anticipated to be most impacted by construction impacts is Ironton, located 0.5-mile from the construction footprint (see Figure 4.15-1).

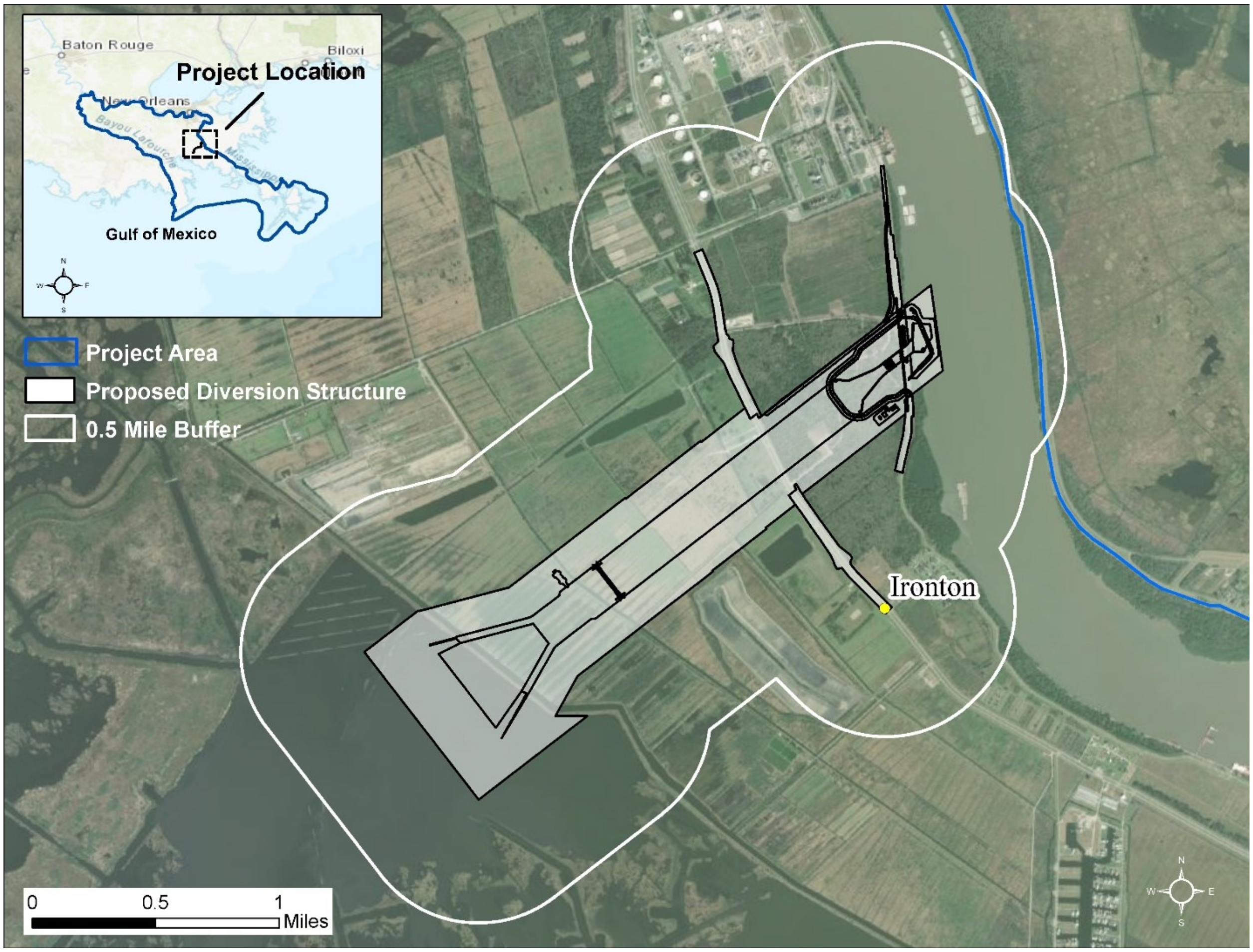


Figure 4.15-1. Mid-Barataria Sediment Diversion Project Construction Footprint and Buffer Area.

Populations in Ironton would experience minor to moderate, temporary, adverse impacts due to increased noise levels, dust, and transportation delays during the approximately 5-year construction period. As discussed in Section 4.7 Air Quality, temporary, direct, minor to moderate, adverse impacts on air quality would occur during construction of the proposed Project due to increased fugitive dust and other pollutants from the use of combustion-powered equipment and vehicles, earthwork, aggregate and material handling (including concrete batching), and wind erosion of exposed piles of dredged and excavated material. In addition, while tree cover can improve air quality via uptake of pollutants, the proposed Project would require clearing of some of the forest areas between the nearby community of Ironton and existing sources of air pollution in the Project vicinity.[90] However, as depicted in Chapter 4, Section 4.18 Land

[90] In November 2021, Phillips 66 announced plans to terminate operation of its Alliance refinery and convert that facility to terminal storage and loading.

Use and Land Cover, Figure 4.18-1, forest vegetation would remain on either side of the diversion structure and would continue to provide some buffer to air emissions from the other operations in the area and dust from the grain terminal for the community of Ironton. Further, construction of the Project is not expected to cause a change in air quality sufficient to affect compliance with the NAAQS. During construction, sound levels would increase above the existing ambient sound levels presented in Chapter 3, Section 3.8.3.1 in Noise in the immediate vicinity (within 0.5-mile) of each work area, resulting in adverse impacts ranging from minor to moderate. Pile driving is anticipated to be the greatest single noise source during construction of the proposed Project. In Ironton, noise generated from pile driving is expected to attenuate to levels that meet the recommended hourly L_{eq} for residential land (67 dBA), which is the sound level established for annoyance by USEPA (FHWA 2006). Pile driving would occur periodically over about 2.5 years. Additionally, temporary, moderate, adverse impacts on users of LA 23 due to construction of the proposed Project include potential delays from increased traffic levels and reduced roadway capacity, with the majority of construction traffic occurring during the first 3.5 years of Project construction. LA 23 is the only roadway access in and out of western Plaquemines Parish. Northbound traffic would utilize the two existing southbound lanes, maintaining the existing two-lane capacity. Southbound traffic would utilize the shoulder, reducing southbound roadway capacity from two lanes to one. This reduction in capacity may cause delays for southbound traffic over the duration of the construction period. CPRA would implement measures to minimize impacts from air and noise emissions and traffic congestion during construction (see Sections 4.7 Air Quality, 4.8 Noise, and 4.22 Land-Based Transportation for more details about construction impacts and CPRA's proposed actions to minimize these impacts).

Low-income and minority populations, due to unique vulnerabilities, may experience increases in respiratory illness or episodes of asthma as a result of these temporary impacts associated with construction of the proposed Project (Zahran et al. 2018). Intermittent increases in noise levels during Project construction may also have adverse impacts on low-income and minority populations living within 0.5-mile of the construction footprint. Given that the minority population of Ironton makes up 90 percent of its total population – a higher proportion than any other community evaluated – construction impacts on minority and low-income populations could be disproportionately high and adverse depending on whether the population experiences unique vulnerabilities.

Individuals who access the Barataria Basin using navigation channels located within 0.5-mile of the construction footprint for fishing activities may also experience minor, temporary, adverse impacts. Increased traffic on Bayou Dupont to transport equipment and materials to construct the diversion may cause impacts on subsistence fishers and recreators using the same channel to access the basin. Impacts may include longer travel times to fishing areas or fishing restrictions in some areas due to construction activities.

Construction of the Applicant's Preferred Alternative may also have minor, temporary, beneficial impacts on low-income and minority populations within the Project area by providing additional construction jobs and income. However, approximately 75 percent of workers across all industries in Plaquemines Parish commute from other areas (U.S. Census Bureau 2015, The Data Center 2014). While most construction workers are thus expected to reside outside the proposed Project area, some additional construction jobs would likely be filled by low-income and minority populations residing in the Project area. Low-income and minority populations within the Project area may also benefit from jobs or income derived from increased demand for goods and services in the area near the Project footprint during the construction period.

4.15.3.3 Other Alternatives

As compared to the No Action Alternative, the other alternatives are also expected to have minor to moderate, temporary, adverse impacts on low-income and minority populations during the construction period, including individuals who live, work, and fish within 0.5-mile of the construction footprint. Adverse impacts would include increased noise, dust, and traffic congestion on LA 23 and local roadways. As compared with the Applicant's Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition feature would be wider and construction timeframes several months longer for alternatives with 150,000 cfs flow volumes, while these features would be narrower and construction timeframes shorter for alternatives with 50,000 cfs flow volumes. Therefore, the duration and intensity of minor to moderate, temporary, adverse impacts on low-income and minority populations associated with noise, dust, and traffic congestion caused by construction activities would be somewhat increased or reduced, respectively, as compared with the Applicant's Preferred Alternative under these flow capacity alternatives. The presence of terraces in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on the low-income and minority populations that would be similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.15.4 Operational Impacts

4.15.4.1 No Action Alternative

The No Action Alternative may result in major, permanent, adverse impacts on low-income and minority populations. The same environmental changes that would impact other populations throughout the Project area would also impact low-income and minority populations under the No Action Alternative, including tidal flooding and storm hazards. In addition, low-income and minority populations would be impacted by anticipated declines in natural resource industries, such as commercial fishing, that would accompany changes in environmental conditions in the Project area such as increases in storm surge and flooding caused by sea-level rise, land subsidence, and the continued loss of wetlands (see Chapter 3, Section 3.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction and Section 4.14 Commercial Fisheries for more information). Impacts on low-income and minority populations under the No Action Alternative (as compared to existing conditions) are discussed below for the following topics:

- water surface elevations leading to tidal flooding;
- storm surge and inundation associated with storm events (storm hazards);
- commercial fishing;
- subsistence fishing and hunting; and
- recreational fishing and hunting.

4.15.4.1.1 Tidal Flooding

Under the No Action Alternative, low-income and minority populations in communities located within approximately 20 miles of the proposed Project and outside of the federal levee system – including Lafitte, Myrtle Grove, Woodpark, Suzie Bayou, Hermitage, Grand Bayou, and Happy Jack (see Section 4.13 Socioeconomics, Figure 4.13-1) – would experience nearly year-round tidal flooding by 2070.[91] A list of these communities presenting demographic and socioeconomic data along with distance to the proposed Project is provided in Chapter 3, Section 3.15 Environmental Justice, Tables 3.15-5 and 3.15-6. In some communities, tidal flooding would occur more than half of the year by 2040 (see Table 4.20-1 in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction).

As stated in the Fourth National Climate Assessment, "people and communities are differentially exposed to hazards and disproportionately affected by climate-related health risks. Populations experiencing greater health risks include children, older adults, low-income communities, and some communities of color (SGCRP 2018)". Impacts on low-income and minority groups may be more intense than those experienced by other populations for several reasons. As stated in the Fourth National Climate Assessment, "populations with increased health and social vulnerability typically have less access to information, resources, institutions, and other factors to prepare for and avoid the health risks of climate change. Some of these communities include poor people in high-income regions, minority groups, women, pregnant women, those experiencing discrimination, children under five, persons with physical and mental illness, persons with physical and cognitive disabilities, the homeless, those living alone, Indigenous people, people displaced because of weather and climate, the socially isolated, poorly planned communities, the disenfranchised, those with less access to healthcare, the uninsured and underinsured, those living in inadequate housing, and those with limited financial resources to rebound from disasters" (SGCRP 2018). Under the No Action Alternative, environmental change and changes in tidal flooding may have a differential impact on population and migration depending on the community and its

[91] For the Water Institute study (Water Institute 2019) of tidal flooding, three communities (Myrtle Grove, Grand Bayou, and Lafitte) were chosen as being generally representative of the other communities in the basin, as well as representing varying levels of exposure to historic tidal flooding. For example, Grand Bayou has no structural protection and would experience similar tidal flooding as other unprotected communities, such as Hermitage and Happy Jack.

residents. In coastal Louisiana, socially vulnerable families may reside in sub-standard housing, have limited access to information about emergencies and hazard responses, and lack the resources to evacuate, find housing, commute to coastal jobs, or rebuild following a storm event (SGCRP 2018). They may also be less able to afford flood insurance rates or homeowners and automobile insurance rates that are likely to increase as environmental conditions worsen over time.

Among low-income and minority populations, elderly residents and others with emotional or spiritual ties to traditional lands and lifeways have been resistant to migration, while younger residents have been migrating northward and inland for decades (Colten et al. 2018). This selective outmigration of younger adults leaves an older, poorer, and more vulnerable population behind. However, younger adults who have moved inland often provide monetary support to elderly family members who have not moved and may offer alternative living space when needed. As such, migration of younger adults may provide a supplementary source of income and social links to inland locales for those populations remaining in vulnerable locations (Colten et al. 2018).

4.15.4.1.2 Storm Hazards

As discussed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, under the No Action Alternative, storm surge and wave heights would substantially increase and intensify over the next 50 years in the Project area. The ADCIRC model results consistently show an increase in projected surge elevation in the Project area for all modeled storm events over time under the No Action Alternative. Under the No Action Alternative, storm surge in the Barataria Basin about 10 to 15 miles south of the location proposed for the diversion is projected to reach heights of 14.1 feet in 2070 during 1 percent AEP (100-year) storms (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction). Increases in sea-level rise and diminished wetland-provided protection from storm hazards are expected to continue under the No Action Alternative, increasing the risk of damage to private and public infrastructure from flooding throughout the Project area.

As described in Section 4.13.5.3 Housing and Property Values, federally-backed flood insurance is anticipated to remain available for all residents of NFIP-participating communities under the No Action Alternative. In 7 of the 10 parishes in the Project area, average policy premiums already exceed 1 percent of household income, which is one metric of affordability (FEMA 2022b, U.S. Census Bureau 2020). As such, changes (see Table 3.13-4 in Section 3.13.3 Housing and Property Values) in flood insurance rates for low-income households in the Project area due to FEMA's revised risk policy (Risk Rating 2.0) may be financially burdensome under the No Action Alternative. Under the No Action Alternative, increases in storm hazards over the next 50 years may have substantial impacts on low-income and minority populations living in the Project area due to unique vulnerabilities of these populations, for reasons similar to those described above for tidal flooding impacts.

4.15.4.1.3 Commercial Fishing, and Subsistence Fishing and Hunting

Because many low-income and minority populations depend on fishing for income and for subsistence activities, these populations would be highly impacted by changes in fisheries expected over time under the No Action Alternative (see Section 4.14 Commercial Fisheries). Commercial shrimp, oyster, blue crab, spotted seatrout, Atlantic croaker, and largemouth bass fisheries are expected to decline due to reduced marsh habitat and increased salinity under the No Action Alternative. Activities supporting these fisheries would also be expected to decline, which would impact individuals and communities that depend economically on these commercial fisheries (Lindstedt 2005). Adverse impacts on subsistence fishing activities related to these species would also be expected in the long-term under the No Action Alternative. Because of a lack of data correlating the fisheries harvest with specific low-income and minority populations, the precise extent to which impacts on fisheries would affect these populations cannot be determined. However, to the extent that low-income and minority populations depend on oysters or brown shrimp either for commercial or subsistence fishing, these populations may experience impacts from changes in abundance to these species due to unique vulnerabilities of the low-income and minority populations.

Further, to the extent that low-income and minority populations depend on finfish either for commercial or subsistence fishing, these populations may experience impacts from changes in abundance to finfish species (both beneficial and adverse depending on the species). Low-income and minority populations may be less likely or able to adapt to changing environmental conditions, because switching to other industries is difficult due to economic challenges, age, educational or training background, and cultural or language barriers. These populations may also be less likely or able to relocate to other geographic areas for alternative employment opportunities due to economic or cultural reasons (Austin et al. 2014b, pp. 178-181). Further, low-income populations may be more vulnerable to changes in natural resource availability as they may be likely to turn to subsistence fishing, hunting, and trapping during economic downturns (Chiasson 2018).

4.15.4.1.4 Recreational Fishing and Hunting

The No Action Alternative is expected to have minor, adverse impacts on spotted seatrout and negligible impacts on red drum, the two species most commonly targeted by recreational anglers (see Section 4.16 Recreation and Tourism). To the extent that participants in recreational fishing and hunting are low-income or minority, under the No Action Alternative, minor adverse impacts on low-income and minority populations could occur. To the extent that reduced availability of spotted seatrout would require low-income anglers to travel to alternative locations to fish, these anglers could be impacted by these changes.

4.15.4.2 Applicant's Preferred Alternative

As described in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, the Applicant's Preferred Alternative could lead to minor to major, long-term, adverse impacts, primarily on communities not protected by federal levees from acceleration of increases in tidal flooding and storm hazards, and moderate to major permanent adverse impacts on commercial fisheries (see Section 4.14 Commercial Fisheries) and subsistence fisheries as compared to the No Action Alternative. These impacts could be disproportionately high and adverse on some low-income and minority populations in the Project area as compared to the No Action Alternative. These impacts would result from acceleration of changes in the frequency of tidal flooding and the severity of storm hazards relative to the No Action Alternative, particularly in the first two decades of operation. Impacts could occur on low-income and minority populations within the communities of Myrtle Grove, Woodpark, Hermitage, Suzie Bayou, Grand Bayou, and Happy Jack, to the extent that affected populations lack resources to avoid or otherwise respond to the impacts. To a lesser extent, tidal flooding could increase in the Lafitte area, which includes multiple communities with varying levels of existing non-federal flood protection. Because it is within the federal levee system, Ironton is not expected to be impacted by increases in frequency and duration of tidal flooding due to Project operations. However, the increased risk of levee overtopping during certain 1 percent storm events gulfward of the immediate outfall area following delta formation (after approximately 20 years of operations) could result in disproportionately high and adverse impacts on low-income and minority populations in Ironton to the extent that overtopping leads to flooding in that community. In addition, disproportionately high and adverse impacts on low-income and minority populations could occur in some communities where reductions in abundance of oysters, brown shrimp, and certain finfish species are anticipated as a result of the proposed Project to the extent that affected populations engage in or are heavily reliant on commercial and subsistence fishing for these species. Impacts would vary according to levels of engagement and dependence.

For low-income or minority populations located in areas farther than approximately 10 miles to the north or 20 miles to the south (gulfward) of the immediate outfall area, impacts from increased tidal flooding and storm surge caused by operation of the Project are expected to be negligible. For low-income or minority populations located in areas north of the diversion, the proposed Project is expected to have some beneficial impacts related to additional protection from storm hazards due to reduced storm surge and wave heights as a result of land building.

Operation of the proposed Project under the Applicant's Preferred Alternative may impact low-income and minority populations as a result of impacts on the following:

- water surface elevations leading to tidal flooding;
- storm surge and inundation associated with storm events (storm hazards);
- commercial fishing;
- subsistence fishing and hunting; and
- recreational fishing and hunting.

Each of these types of potential impacts is discussed below. Table 4.15-1 describes demographic information for communities where low-income and minority populations may be impacted by Project operations and summarizes the potential adverse impacts on those populations.

4.15.4.2.1 Tidal Flooding

Increased tidal flooding caused by operation of the proposed Project under the Applicant's Preferred Alternative could have minor to major, long-term, adverse impacts on communities located near the immediate outfall area (within approximately 10 miles north and 20 miles south) and outside of the federal levee system. Impacts could be disproportionately high and adverse on some low-income and minority populations in the Project area as compared to the No Action Alternative. Affected populations include those within the communities of Myrtle Grove, Woodpark, Suzie Bayou, Hermitage, Grand Bayou, and Happy Jack (see Figure 3.15-4). To a lesser extent, tidal flooding could increase in the Lafitte area, which includes multiple communities with varying levels of existing non-federal flood protection. While all populations in these communities outside of federal flood protection would experience tidal flooding impacts (which are expected to range from minor to major, depending on decade and location; see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for details), impacts on low-income and minority populations in these communities have the potential to be disproportionately high and adverse due to unique vulnerabilities of these populations. This applies particularly to the first and second decades of operations, when increased tidal flooding frequencies would be substantial relative to the No Action Alternative. Such vulnerabilities include residing in sub-standard housing, having limited access to information about emergencies and hazard responses, as well as economic and social obstacles to relocating, finding housing, commuting to employment opportunities, or responding to environmental damage to homes and businesses (SGCRP 2018). The prevalence and severity of these vulnerabilities may vary among low-income and minority populations. Impacts on low-income and minority populations may be disproportionately high and adverse to the extent and degree that such populations are subject to these vulnerabilities, such as residing in sub-standard housing that is more subjected to regular flooding due to the Project. Tidal flooding is not expected to increase due to Project operations in populated areas protected by federal levees; as such, impacts on low-income or minority populations located in these areas are expected to be negligible.

Table 4.15-1
Summary of Communities where the Applicant's Preferred Alternative Could Impact Low-income and Minority Populations

Parish	Community	Demographics[a]			Outside Federal Flood Protection	Potential Adverse Impacts			
		Total Population	% Minority	% Below Poverty Level		Tidal Flooding	Storm Hazards	Commercial Fishing	Subsistence Activities
Plaquemines (35% minority; 19% living below poverty level)	Belle Chasse[b]	13,490	19%	11%				●	●
	Live Oak[c]	2,575	26%	17%				●	●
	Ironton[d]	125-153[e]	89-90%[e]	18%[f]			●	●	●
	Myrtle Grove[di]	108-136[e]	11-29%[e]	18%[f]	Yes	●	●	●	●
	Grand Bayou[d]	25	72%	18%[f]	Yes	●	●	●	●
	Suzie Bayou[d, e]	40-157	22-35%	18% [f]	Yes	●	●	●	●
	Port Sulphur[b]	2,175	83%	53%				●	●
	Empire[b]	1,060	61%	40%				●	●
	Buras[b]	907	24%	23%				●	●
	Venice[b]	245	4%	11%				●	●
	Hermitage[d]	62	63%	18%[f]	Yes	●	●	●	●
	Happy Jack[d]	16	25%	18%[f]	Yes	●	●	●	●
	West Pointe A La Hache[d]	32	75%	18%[f]				●	●
Jefferson (47% minority; 16% living below poverty level)	Crown Point[d]	781	32%	10%	Yes	m		●	●
	Jean Lafitte (town)	1,971	11%	16%	Yes[g]	m		●	●
	Barataria[b]	979	18%	5%	Yes	m		●	●
	Lafitte[b]	990	4%	34%	Yes[g]	●		●	●
	Grand Isle[b]	757	1%	22%	Yes[h]			●	●
Lafourche (23% minority; 16% living below poverty level)	Galliano[b]	7,131	26%	17%				●	●
	Golden Meadow[b]	2,023	16%	21%					●
	Leeville[d]	58	22%	18%[f]	Yes			●	●
	Port Fourchon[d]	42	33%	28%[f]	Yes			●	●

Table 4.15-1
Summary of Communities where the Applicant's Preferred Alternative Could Impact Low-income and Minority Populations

Parish	Community	Demographics[a]			Outside Federal Flood Protection	Potential Adverse Impacts			
		Total Population	% Minority	% Below Poverty Level		Tidal Flooding	Storm Hazards	Commercial Fishing	Subsistence Activities

Note: the communities listed in this table have been identified as communities where Project impacts could potentially affect low-income and minority populations; this may not be a complete subset of all potentially affected low-income and minority populations.

m = modeling insufficient to be certain how tidal flooding would affect these communities.

[a] Data sources: For incorporated places, CDPs, and block groups, the source is American Community Survey (ACS) 5-Year Estimates, 2014-2018 (U.S. Census Bureau, 2020). While 2020 ACS data was recently released, some data quality concerns exist regarding this data, which continues to be released as of this Final EIS (for example, see U.S. Census Bureau 2021a). For block-level data, which is used here to report demographics of very small communities, the source is U.S. Census Bureau Decennial Census 2020. The Draft EIS reported 2010 Decennial Census data for block-level data, which has been updated in the Final EIS to 2020 Decennial Census data. Poverty data is unavailable at the block level. Because Decennial Census and ACS data collection methods differ, data issues related to COVID-19 have a more limited impact on the Decennial Census (U.S. Census Bureau 2021b). However, the adoption of differential privacy measures in data reporting for the 2020 Census introduces greater uncertainties related to data reported at the smallest geographic scales than were present in data reporting for the 2010 Decennial Census (U.S. Census Bureau 2021c). Because these communities are important to the EIS evaluation and received public comment, and because the updated data represent much more recent data, the block level Decennial Census data have been updated in the Final EIS.

[b] Non-incorporated area, CDP

[c] Non-incorporated area, non-CDP. Block group level data used for demographic analysis.

[d] Non-incorporated area, non-CDP. Block-level data used for demographic analysis.

[e] For the 2020 Census, portions of both Ironton and Myrtle Grove fall within Census Block 1031 (Block Group 1, Census Tract 504, Plaquemines Parish). Consequently, exact population totals, including minority populations, for Ironton and Myrtle Grove cannot be determined. To account for uncertainty, the lower bound estimate for Ironton excludes all populations counted in Block 1031, while the upper bound estimate includes all populations counted in Block 1031. Similarly, the lower bound estimate for Myrtle Grove excludes all populations counted in Block 1031, while the upper bound estimate includes all populations counted in Block 1031. In addition, portions of Suzie Bayou and Myrtle Grove fall within Census Block 1076 and portions of Suzie Bayou and Hermitage fall within Census Block 1099 (Block Group 1, Census Tract 504, Plaquemines Parish). The lower bound estimate for Suzie Bayou excludes all of the populations in the two blocks, while the upper bound includes all populations in the two blocks.

[f] Unlike racial demographic data, poverty data are not available at the block level from the ACS. Poverty data for communities in non-incorporated, non-CDP areas are taken from the corresponding census tract. For Ironton, Myrtle Grove, Suzie Bayou, Grand Bayou, Hermitage, Happy Jack, and West Pointe A La Hache, poverty data are presented for Census Tract 504, Plaquemines Parish; for Crown Point: Tract 280, Jefferson Parish; for Leeville: Tract 212, Lafourche Parish; and for Port Fourchon: Tract 211.01, Lafourche Parish.

[g] Local/non-federal levee system only

[h] Seaward side only

[i] The community of Woodpark is included in a census block that overlaps Myrtle Grove and as such is combined with Myrtle Grove in this table, Census Block 1076 (Block Group 1, Census Tract 504, Plaquemines Parish).

Analyses of tidal flooding impacts and increased water surface elevations associated with the proposed Project were focused on three communities that were considered to be generally representative of the other communities in the basin, representing the reasonable minimum and maximum impacts on communities to the south (Grand Bayou); north (Lafitte); and closest to the immediate outfall area (Myrtle Grove). These communities were located within approximately 10 miles north and 20 miles south of the immediate outfall area and outside of levee protection (Water Institute 2019, Marino 2019; see Appendix P); it is expected that tidal flooding impacts in areas inside the federal levee system or farther than 20 miles from the immediate outfall area would be negligible. In earlier decades of operation, Project operations would cause an increase in the projected annual days when the inundation threshold elevation would be exceeded, causing increases in tidal flooding relative to the No Action Alternative (see Table 4.20-2 in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction). For example, at Grand Bayou, proposed Project operations are projected to increase the number of days flooded above the inundation threshold annually by 45 days in 2030 and by 5 days in 2050 relative to the No Action Alternative assuming a high, late spring Mississippi River flood flow (2011 hydrograph). At Lafitte, proposed Project operations are projected to increase the number of days flooded above the inundation threshold annually by 13 days in 2030, increasing to 15 days in 2040 and to 30 days in 2050 relative to the No Action Alternative assuming a high, late spring Mississippi River flood flow (2011 hydrograph). At Myrtle Grove, proposed Project operations are projected to increase the number of days flooded above the inundation threshold annually by 111 days in 2030 and by 67 days in 2040 relative to the No Action Alternative assuming a high, late spring Mississippi River flood flow (2011 hydrograph). In the 2060s through 2070s, impacts associated with increases in periodic, tidal flooding caused by the proposed Project are expected to be minor in the three communities studied (Lafitte, Myrtle Grove, Grand Bayou) as compared to the No Action Alternative since sea-level rise and subsidence would have overtaken the Project as the cause of flooding by that time.

Based on the increases in frequency and duration of tidal flooding for these communities, Project operations would be expected to result in moderate to major tidal flooding impacts in decades 2020s through 2030s in communities with low-income or minority populations located within approximately 10 miles north and 20 miles south of the immediate outfall area and outside of the federal levee system, including Myrtle Grove, Woodpark, Suzie Bayou, Hermitage, Grand Bayou, and Happy Jack (Plaquemines Parish). Impacts may affect some of these small communities in their entirety, resulting in a more severe impact than other areas. To a lesser extent, tidal flooding could increase in the Lafitte area, which includes multiple communities with varying levels of existing non-federal flood protection (see Section 4.13 Socioeconomics, Figure 4.13-1), as compared to the No Action Alternative. As flooding due to sea-level rise and subsidence increases across the basin in later decades, the Applicant’s Preferred Alternative would result in minor impacts due to increases in tidal flooding in these communities relative to the No Action Alternative. Impacts would vary depending on the location; areas further from the diversion or with higher inundation threshold elevations would have less severe impacts in all decades.

Low-income and minority residents in the impacted communities outside of flood protection could experience disproportionately high and adverse impacts related to tidal flooding increases in the 2020s through 2050s (see Section 4.13.3 in Socioeconomics). Low-income and minority populations may be uniquely vulnerable to tidal flooding impacts due to factors such as inadequate housing or infrastructure, a lack of resources to make investments to improve resiliency, a reduction in social capital (for example, family and community support networks), and inability or lack of resources to relocate to other areas (Colten et al. 2018, Spina 2017, SGCRP 2018). While this lack of social capital may be somewhat tempered by income diversification as younger people move from the coastal parishes, low-income homeowners could be less able to relocate if higher insurance rates make it difficult to sell, and if they cannot afford a second mortgage or rent inland (Colten et al. 2018). Disproportionately high and adverse impacts on low-income and minority populations could occur to the extent that such populations are uniquely vulnerable to tidal flooding impacts and/or uniquely tied to traditional lands.

In communities where increases in tidal flooding frequency would occur due to the Applicant's Preferred Alternative, such increases would further encourage outmigration under the Applicant's Preferred Alternative relative to the No Action Alternative (see Section 4.13.5.2 in Socioeconomics). However, low-income and elderly populations, as well as populations with emotional and/or spiritual ties to traditional lands, may be less able or willing to migrate (Colten et al. 2018). Some low-income and minority populations in these communities have adapted to changes in the frequency and impacts of tidal flooding events in the past, and may be able to continue adapting to impacts of the proposed Project. For example, many structures have been elevated in these communities, which are typically small and located in unincorporated areas. However, increased tidal flooding due to the Applicant's Preferred Alternative may result in an acceleration of damage to infrastructure such as roads, water supply, and wastewater systems as inundation effects are felt sooner than under the No Action Alternative (see Chapter 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, Table 4.20-2). These impacts may require an accelerated investment in the infrastructure needed to maintain the functionality of residences and businesses in areas affected by increased tidal flooding under the Applicant's Preferred Alternative. See Section 4.27 Mitigation Summary and the Mitigation and Stewardship Plan (see Appendix R1) for details about minimization measures CPRA would implement during operation of the proposed Project, including potential EJ mitigation measures to address the disproportionately high and adverse tidal flooding impacts discussed in this section.

4.15.4.2.2 Storm Hazards

In areas south of the proposed Project that are outside of federal flood protection, increases in storm hazards caused by operation of the Applicant's Preferred Alternative may have disproportionately high and adverse impacts on low-income and minority populations living in these areas due to unique vulnerabilities of these populations. In addition, negligible to minor increases in the risk of levee overtopping during certain 1 percent storm events gulfward of the immediate outfall area following delta formation (after approximately 20 years of Project operations) may contribute to effects in communities inside levees, with the greatest increases in communities within the NOV-NFL Levee system closest to the proposed Project. Vulnerabilities of low-income and minority populations in these areas may include inadequate housing or infrastructure, a lack of resources to make investments to improve resiliency, and inability or lack of resources to relocate to other areas (Colten et al. 2018, Spina 2017). The prevalence and severity of these vulnerabilities may vary among different low-income and minority populations. Impacts on low-income and minority populations may be disproportionately high and adverse to the extent and degree that such populations are subject to these vulnerabilities. For low-income or minority populations located in areas north of the diversion and inside of federal flood protection, the proposed Project is expected to have some beneficial impacts related to additional protection from storm hazards due to reduced storm surge and wave heights as a result of land building.

ADCIRC modeling results forecast that during storm events, Project operations would reduce storm surge in areas inland of the diversion and increase storm surge in areas immediately gulfward of the diversion (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more information about flooding and storm surge impacts and ADCIRC modeling). Figure 4.15-2 shows the location of stations that provided data for ADCIRC modeling and their geographic relationship with communities analyzed in this section. Table 4.15-2 indicates the distance between ADCIRC stations and adjacent communities. Based on ADCIRC modeling results for stations in the Barataria Basin, Project-induced increases in storm surge heights as compared to the No Action Alternative may impact low-income and minority populations living in and near communities outside federal flood protection south of the diversion, including populations within Myrtle Grove, Woodpark, Suzie Bayou, Hermitage, Grand Bayou, and Happy Jack. In addition, negligible to minor increases in the risk of levee overtopping could affect the community of Ironton inside the NOV-NFL system. Depending on the extent to which overtopping causes flooding in Ironton, impacts could be disproportionately high and adverse on low-income and minority populations in that community. While demographic data do not provide precise statistics on low-income and minority populations in these communities, such populations are present in potentially impacted communities (see Table 4.15-1).

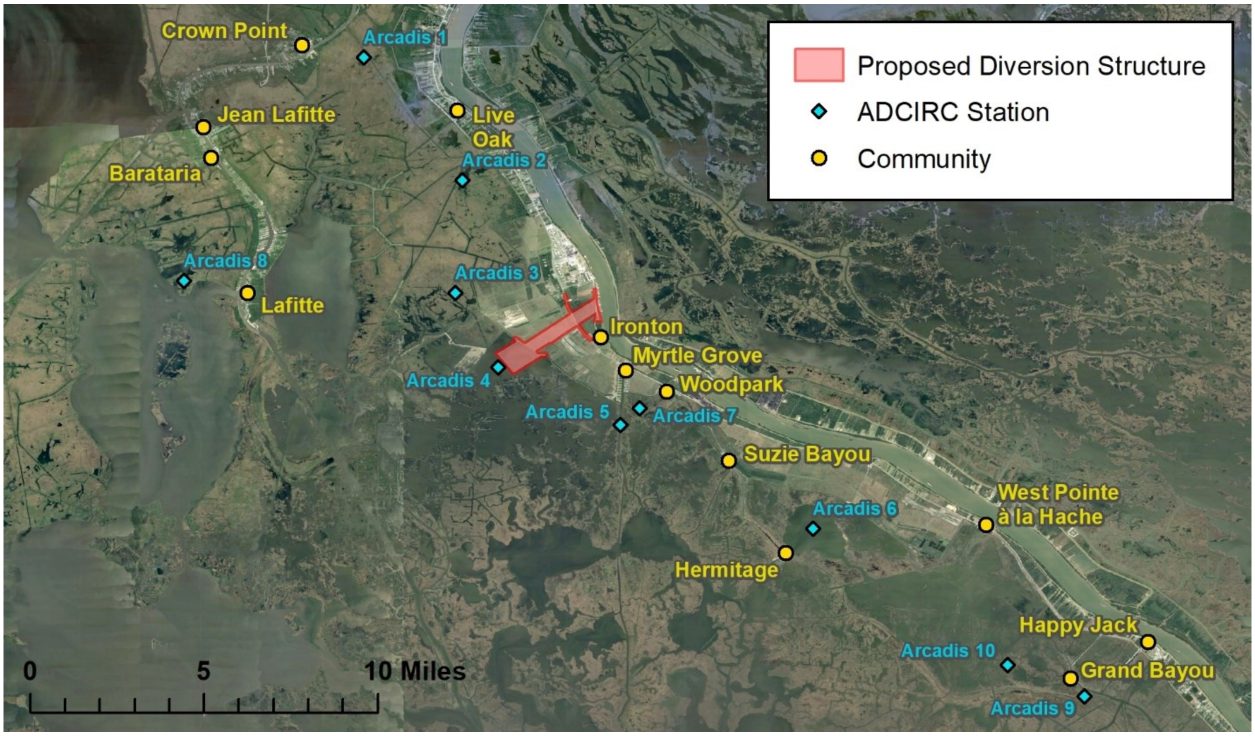


Figure 4.15-2. ADCIRC Stations and Adjacent Communities.

Table 4.15-2
Projected Maximum Surge Elevation Differences at the NOV-NFL Levee between the No Action Alternative and Applicant's Preferred Alternative for 1 Percent AEP (100-Year) Storms in 2040 and 2070[a]

ADCIRC Station	Distance between Station and Nearest Portion of Community (mi)	No Action Alternative: Maximum Surge Elevation in 2040 (feet)	Surge Elevation in 2040: Applicant's Preferred Alternative less No Action Alternative (feet)	No Action Alternative: Maximum Surge Elevation in 2070 (feet)	Change in Surge Elevation in 2070: Applicant's Preferred Alternative less No Action Alternative (feet)
Arcadis 1	Crown Point (1.5)	11.0	-0.4	14.4	-0.6
Arcadis 2	Live Oak (0.9)	11.4	-0.5	14.3	-0.6
Arcadis 3	Live Oak (3.0)	11.1	-0.6	13.7	-0.7
Arcadis 4	Ironton (2.5)	11.5	-0.2	14.1	0.0
Arcadis 5	Myrtle Grove (0.7)	12.0	0.7	14.5	1.6
Arcadis 6	Hermitage (0.8)	12.3	0.4	14.6	0.9
Arcadis 7	Myrtle Grove (0.5)	12.3	0.7	14.9	1.7
Arcadis 8	Lafitte (1.3)	9.7	-0.4	11.9	-0.6
Arcadis 9	Grand Bayou (0.1) Happy Jack (1.0)	11.7	0.2	13.4	0.4
Arcadis 10	Grand Bayou (1.3)	11.8	0.3	13.7	0.5

[a] Negative values indicate a decrease in surge elevations.
[b] See Figure 4.15-2 for locations of these stations and communities.
[c] Although Arcadis 4 is the closest output station to Ironton, it is not representative of the potential impacts on the community.

Adverse storm surge impacts from proposed Project operations would be greatest at communities located near the immediate outfall area, with impacts decreasing with distance from the outfall. For example, during 1 percent AEP (100-year) storm events, at the NOV-NFL Levee about 0.5-mile south of the diversion structure near the community of Myrtle Grove (station Arcadis 7), the proposed Project would increase storm surge heights by up to 1.7 feet by year 2070 (see Table 4.15-2 and Figure 4.15-2). Although the community of Ironton is closest to Arcadis 4, this station is not necessarily representative of potential impacts on the communities behind the portion of the NOV-NFL system between Arcadis 4 and Arcadis 5. Arcadis 4 is located at the mouth of the diversion outfall and therefore does not show the increased storm surge that is projected following delta formation (after approximately 20 years of Project operations) along this reach of the NOV-NFL Levee, as reflected in the increased storm surge projected by Arcadis 5. Over time as the delta forms in the outfall area, communities located within this portion of the NOV-NFL system could be vulnerable to flooding caused by overtopping anywhere along this portion of the levee system. Near the community of Hermitage about 8.5 miles south of the immediate outfall area, storm surge is projected to increase by 0.9 foot, and at Grand Bayou 16.0 miles southeast of the diversion structure by up to 0.5 foot by year 2070. The Applicant's Preferred Alternative is projected to increase surge heights by only up to 0.2 and 0.1 foot at Empire and Grand Isle, respectively, relative to the No Action Alternative. Changes in storm surge due to the proposed Project would be expected to be experienced differently by various populations. As noted under the No Action Alternative, socially vulnerable families may reside in sub-standard housing, have limited access to information about emergencies and hazard responses, and lack the resources to evacuate, find housing, commute to coastal jobs, or rebuild following a storm event (SGCRP 2018). As such, the inability of these populations to respond to increases in storm surge may disproportionately impact minority and low-income populations to the extent that they are subject to unique vulnerabilities such as a lack of resources to adapt to increases in storm surge events. See Section 4.27 Mitigation Summary and the Mitigation and Stewardship Plan (see Appendix R1) for details about potential EJ measures to address the disproportionately high and adverse storm hazard impacts discussed in this section.

As described in Section 4.13.5.3 Housing and Property Values, federally-backed flood insurance is anticipated to remain available for all residents of NFIP-participating communities under the Applicant's Preferred Alternative. If FEMA were to revise the estimated flood risk of properties in the Project area due to effects of the Applicant's Preferred Alternative, flood insurance rates could increase relative to the No Action Alternative. In communities impacted by increases in tidal inundation due to Project operations, any differences in insurance rates relative to the No Action Alternative would likely occur in the earlier years of the Project, and decline over time as sea-level rise becomes the driver in the degree of tidal flooding in the long term (post 2050). However, the magnitude of any difference in insurance rates is uncertain. Any increases in flood insurance rates for low-income households in the Project area due to increased flooding and storm surge risk may be financially burdensome under the Applicant's Preferred Alternative.

4.15.4.2.3 Commercial Fishing

Operation of the Applicant's Preferred Alternative may have a major, permanent, adverse impact relative to the No Action Alternative on fishers who depend on shrimp and oysters from sub-basins south of the diversion. Because of a lack of data correlating the fisheries harvest with specific low-income and minority populations, the precise extent to which impacts on shrimp and oyster fisheries would affect these populations cannot be determined. However, to the extent that low-income and minority populations depend on commercial fishing of shrimp and oysters, these populations may experience disproportionately high and adverse impacts from changes in brown shrimp and oyster abundance in impacted sub-basins due to unique vulnerabilities. Further, to the extent that low-income and minority populations depend on finfish for commercial fishing, these populations may experience impacts from changes in abundance to finfish species (both positive and negative depending on the species). Low-income and minority populations may be less likely or able to adapt to changing environmental conditions, because switching to other industries is difficult due to economic challenges, age, educational or training background, and cultural or language barriers. These populations may also be less likely or able to relocate to other geographic areas for alternative employment opportunities due to economic or cultural reasons (Austin et al. 2014b, pp. 178-181). Based on analysis of areas that are economically dependent on shrimp and oyster fishing, affected low-income and minority populations may include those in the communities of Grand Isle, Galliano, the Lafitte area, Barataria, Belle Chasse, Live Oak, West Pointe A La Hache, Ironton, Grand Bayou, and Port Sulphur. Impacts on low-income and minority fishers who do not rely on shrimp and oysters in affected sub-basins are generally expected to be negligible.

Commercial fishing activities would be affected by changes in species abundance under the operation of the Applicant's Preferred Alternative (see Section 4.14 Commercial Fisheries). Major, permanent, adverse impacts on brown shrimp and oyster populations are expected relative to the No Action Alternative due to reductions in salinity, especially in LDWF-designated sub-basins of the Barataria Basin south of the diversion (sub-basins 209, 210, and 211). Abundance of southern flounder and spotted seatrout are also expected to decline. As discussed below, some low-income and minority communities in the Project area in which fishers that target these species reside have substantial landings of potentially affected species.

Communities located in these sub-basins of the Barataria Basin have been shown to be relatively dependent on shrimp and oysters. These areas include the seven communities (Lafitte, Grand Isle, Empire, Buras, Golden Meadow, Port Sulphur, and Venice) ranked by NOAA in its Social Indicators of Fishing Community Vulnerability and Resiliency study as having high reliance on and engagement in fishing per capita in 2017, over all species (NOAA Fisheries SERO Social Indicator Database 2019a; see Chapter 3 Section 3.14 Commercial Fisheries for more details about this study). As shown in Section 4.14 Commercial Fisheries, Figure 4.14-2, the Buras area (zip code 70041) and the Lafitte area (zip code 70067) had the highest recorded brown shrimp landings in 2018 among all zip codes in the Project area. In terms of the percent of total landings in each zip code, Grand Isle, Galliano, and the Lafitte area were among the zip codes where shrimp made up the highest percent of total landings, with brown shrimp comprising 56 percent, 55 percent, and 48 percent of all commercial landings, respectively.

Declines in the abundance of brown shrimp may affect low-income and minority populations in zip codes where more than 50 percent of catch is attributable to this species (including the communities of Grand Isle and Galliano). However, because of a lack of data correlating the fisheries harvest with low-income or minority populations, the precise extent to which the impact on the brown shrimp fishery would affect those populations cannot be determined. In addition, some shrimp are caught offshore and would not be impacted by changes under the Applicant's Preferred Alternative. Adverse impacts may also occur to low-income and minority populations in communities in southern Plaquemines Parish, such as Empire, Port Sulphur, Venice, and Buras, because they have very high levels of engagement and reliance on commercial fishing as an economic activity in general (see Chapter 3 Section 3.14 Commercial Fisheries). There are a number of other fishing communities identified by NOAA in the Project area, including Golden Meadow, Leeville, and Port Fourchon in Lafourche Parish (Impact Assessment 2005); low-income or minority populations in these communities may be adversely affected if they are reliant on fishing for brown shrimp or oysters in the Barataria Basin.

Other species are expected to benefit from the Applicant's Preferred Alternative. In particular, red drum, Gulf menhaden, and some freshwater finfish, including largemouth bass, are expected to increase in abundance relative to the No Action Alternative. To the extent that low-income and minority populations fish for these species, these changes may beneficially impact these populations.

In summary, adverse impacts on low-income and minority populations would vary depending on species fished and the circumstances of individual fishers. For those whose livelihoods depend on shrimp and oysters, the impacts would be more acute. For others who do not depend on these species, or who can adapt to changing environmental conditions caused by the Applicant's Preferred Alternative by substituting to other areas (for example, Terrebonne Basin, offshore) or other species, impacts could be minor. However, substitution that requires traveling long distances or investing in expensive new equipment adds costs that may be challenging for low-income and minority fishers. As a result, impacts of the Applicant's Preferred Alternative on fishing conditions relative to the No Action Alternative would likely represent a disproportionately high and adverse impact on low-income and minority fishers who currently depend on shrimp and oysters. See Section 4.27 Mitigation Summary and the Mitigation and Stewardship Plan (see Appendix R1) for details about potential EJ measures to address the disproportionately high and adverse commercial fishing impacts discussed in this section.

4.15.4.2.4 Subsistence Fishing and Hunting

Operation of the Applicant's Preferred Alternative may have major, permanent, adverse impacts on low-income and minority populations that depend on shrimp and oysters from the Barataria Basin for subsistence fishing. While a lack of demographic data characterizing subsistence fishing in the Project area prevents a precise determination, low-income and minority subsistence fishers may experience disproportionately high and adverse impacts from changes in brown shrimp and oyster abundance, especially in affected LDWF-designated sub-basins of the Barataria Basin south of the diversion (sub-basins 209, 210, and 211). While fishing for domestic consumption is common in southern Louisiana, including in the Project area, low-income and minority populations may depend more highly on subsistence fishing than the general public. For these populations, subsistence fishing may also play essential social and cultural roles that differ from the general public. Such impacts could include difficulties meeting dietary needs; reduced access to fresh, healthy, and valued foods; weakening of social ties based on sharing foods with family, friends, and coworkers; and challenges to senses of identity derived from subsistence fishing activities (Austin et al. 2014a, 2014b).

Wetlands have historically provided an important environment for subsistence activities participated in by low-income and minority populations around the Barataria Basin, including Houma Indians (Hemmerling et al. 2004), the Atakapa-Ishak/Chawasha tribal community residing in Grand Bayou Village (Marshall 2016), and members of the Chitimacha Tribe of Louisiana. In particular, traditional subsistence ways of life are dependent on healthy wetland habitat to sustain viable wildlife populations, as well as places important for social, cultural and spiritual purposes (Hemmerling et al. 2004). The benefits of the Applicant's Preferred Alternative on wetlands may lead to some minor beneficial impacts on some low-income and minority populations in the Project area (see Section 4.6 Wetland Resources and Waters of the U.S.). While operation of the proposed Project would reduce wetland losses in the Barataria Basin overall relative to the No Action Alternative, wetland losses in the birdfoot delta would be somewhat greater under the Applicant's Preferred Alternative than under the No Action Alternative. This could have some minor adverse impacts on availability of natural resources dependent on these wetlands. To the extent that tribal populations engage in subsistence fishing and hunting in the birdfoot delta, they may experience minor adverse impacts as a result of decreased natural resource availability. See Section 4.27 Mitigation Summary and the Mitigation and Stewardship Plan (see Appendix R1) for details about potential EJ measures to address the disproportionately high and adverse subsistence fishing impacts discussed in this section.

Some fish species are expected to benefit from the Applicant's Preferred Alternative. Some freshwater finfish, including catfish, carp, and largemouth bass, are expected to increase in abundance relative to the No Action Alternative. To the extent that low-income and minority populations rely on these species for subsistence fishing, these changes may beneficially impact these populations.

4.15.4.2.5 Recreational Fishing and Hunting

Impacts on fish and wildlife species targeted by recreational anglers and hunters caused by operation of the Applicant's Preferred Alternative are expected to have minor to moderate, long-term to permanent, adverse impacts on low-income and minority populations, in parallel with impacts on general recreators. While recreational fishing and hunting is a popular activity for low-income and minority recreators,[122] impacts would be similar to those experienced by the general population and low-income and minority populations would not be disproportionately affected. The Applicant's Preferred Alternative is expected to beneficially affect species abundance for red drum, and to have a minor adverse impact on spotted seatrout, the two species most commonly targeted by recreational anglers (see Section 4.16 Recreation and Tourism).

4.15.4.3 Other Alternatives

4.15.4.3.1 50,000 cfs Alternative

Operational impacts of the proposed Project under the 50,000 cfs Alternative is expected to be similar to the Applicant's Preferred Alternative, which may result in disproportionately high and adverse impacts on low-income and minority populations in the long-term in communities outside of flood protection in areas immediately south of the diversion (within 20 miles) due to increases in tidal flooding and storm hazards, and permanent impacts on low-income and minority populations that depend on commercial and subsistence fishing of shrimp and oysters in the Barataria Basin. Disproportionately high and adverse impacts on low-income and minority populations from these impacts would be slightly smaller under the 50,000 cfs Alternative.

4.15.4.3.2 150,000 cfs Alternative

Operational impacts of the proposed Project under the 150,000 cfs Alternative are expected to be similar to the Applicant's Preferred Alternative. The 150,000 cfs Alternative may result in disproportionately high and adverse impacts on low-income and minority populations in the long-term in communities outside of flood protection in areas immediately south of the diversion (within 20 miles) due to increases in tidal flooding and storm hazards, and disproportionately high and adverse permanent impacts on low-income and minority populations that depend on commercial and subsistence fishing of shrimp and oysters in the Barataria Basin. Disproportionately high and adverse impacts on low-income and minority populations from these impacts would be slightly greater under the 150,000 cfs Alternative.

4.15.4.3.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on the low-income and minority populations that be similar to those anticipated under the corresponding flow capacity alternatives without terraces.

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[122] A survey of recreators in 2012 through 2013 found that approximately 67 percent of shoreline recreational trips and 28 percent of boating trips to the Barataria Basin were made by lower income (defined as having a household income below the State median) or minority recreators. (USDOI 2020a and USDOI 2020b).

4.15.5 Summary of Potential Impacts

Table 4.15-3 summarizes the potential impacts on communities with environmental justice concerns for each alternative. Details are provided in Sections 4.15.2 through 4.15.4 above. In response to public comments, this section also provides a summary of the construction and operational impacts on the community of Ironton under the Applicant's Preferred Alternative in order to provide a cohesive summary of impacts on that community.

Table 4.15-3
Summary of Potential Impacts on Environmental Justice from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts from construction of the proposed Project would occur. Ongoing trends in vulnerable communities would continue.
Operational Impacts	• Major, permanent, adverse impacts on low-income and minority populations. Environmental changes may impact low-income and minority populations more intensely than general population due to social and economic vulnerabilities, ties to traditional lands and lifeways, and dependence on commercial and subsistence fisheries that would be expected to decline over time.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Minor to moderate, temporary, adverse impacts on low-income and minority populations within 0.5-mile of the construction footprint due to additional increases in traffic, noise, and dust as compared to the No Action Alternative. Construction impacts on minority and low-income populations, including the population of Ironton, could be disproportionately high and adverse depending on the unique vulnerabilities of those populations. • Minor, temporary, beneficial impacts on low-income and minority populations within the Project area by providing additional construction jobs and income.
Operational Impacts	• Minor to major, long-term, adverse impacts on low-income and minority populations near (within approximately 10 miles north and 20 miles south) the immediate outfall area and outside levee protection from increases in tidal flooding and storm hazards as compared to the No Action Alternative. In addition, negligible to minor increase in risk of levee overtopping in communities gulfward of the immediate outfall area may occur which may contribute to effects in communities inside levees, with the greatest increases in communities within the NOV-NFL Levee system depending on the extent to which overtopping causes flooding. • May have disproportionately high and adverse, long-term impacts on some low-income and minority populations in communities located near the immediate outfall area (within approximately 10 miles north and 20 miles south) and outside of federal levee protection including populations within Myrtle Grove, Woodpark, Suzie Bayou, Hermitage, Grand Bayou, and Happy Jack due to increased tidal flooding and storm hazards, to the extent that such populations are uniquely vulnerable to tidal flooding and storm hazard impacts. In addition, the increased risk of levee overtopping during certain 1 percent storm events gulfward of the immediate outfall area could result in disproportionately high and adverse impacts on low-income and minority populations in Ironton to the extent that overtopping leads to flooding in that community. To a lesser extent, tidal flooding could increase in the Lafitte area, which includes multiple communities with varying levels of existing non-federal flood protection. The impacts would be most pronounced in operational years before 2030, after which time, impacts would be more minor as compared to the No Action Alternative. • For low-income or minority populations located in areas inside the federal levee system, or farther than 20 miles from the immediate outfall area, impacts from

Table 4.15-3 Summary of Potential Impacts on Environmental Justice from Each Alternative	
Impact Type	**Impact Description (as Compared to No Action Alternative unless Otherwise Stated)**
	increased tidal flooding and storm surge caused by operation of the Project are expected to be negligible. Impacts on low-income and minority populations in these areas would not be disproportionate. For low-income or minority populations located in areas north of the diversion, some beneficial impacts related to additional protection from storm hazards due to reduced storm surge and wave heights as a result of land building may occur relative to the No Action Alternative. • Negligible to major, permanent, adverse impacts on commercial fisheries and subsistence fisheries, depending on species, as compared to the No Action Alternative. • Disproportionately high and adverse impacts on low-income and minority populations engaged in commercial and subsistence fishing and dependent on adversely impacted fisheries in the Barataria Basin could occur; disproportionate impacts may vary according to levels of engagement and dependence. To the extent that low-income and minority populations rely on fish species that are expected to benefit from the Project (including catfish, carp, and largemouth bass) for subsistence fishing, these changes may beneficially impact these populations.
50,000 cfs Alternative	
Construction Impacts	• Some minor to moderate, short-term, adverse impacts on low-income populations within 0.5-mile of the construction footprint due to additional increases in traffic, noise, and dust as compared to the No Action Alternative. Impacts would be somewhat less than impacts of the Applicant's Preferred Alternative due to a shorter duration of construction as compared to the Applicant's Preferred Alternative.
Operational Impacts	• Minor to major, long-term, permanent adverse impacts on some populations could occur in communities located near the immediate outfall area (within 10 miles north and 20 miles south) and outside of federal levee protection from changes in tidal flooding, storm hazards, commercial fisheries, and subsistence fisheries as compared to the No Action Alternative. Impacts would be slightly smaller than under the Applicant's Preferred Alternative, but could remain disproportionately high and adverse for those low-income and minority populations specified in the 75,000 cfs Alternative summary above. • For low-income or minority populations located in areas north of the diversion and inside of federal flood protection, some beneficial impacts related to additional protection from storm hazards due to reduced storm surge and wave heights as a result of land building may occur relative to the No Action Alternative. These benefits would be slightly lower than under the Applicant's Preferred Alternative.
150,000 cfs Alternative	
Construction Impacts	• Some minor to moderate, short-term adverse impacts on low-income populations within 0.5-mile of the construction footprint due to additional increases in traffic, noise, and dust as compared to the No Action Alternative. Impacts would be somewhat higher than impacts of the Applicant's Preferred Alternative due to a longer duration of construction as compared to the Applicant's Preferred Alternative.
Operational Impacts	• Minor to major, long-term, adverse impacts on some populations could occur in communities located near the immediate outfall area (within 10 miles north and 20 miles south) and outside of federal levee protection, from changes in tidal flooding, storm hazards, commercial fisheries, and subsistence fisheries as compared to the No Action Alternative. Impacts could be disproportionately high and adverse for those low-income and minority populations specified in the 75,000 cfs Alternative summary above, and slightly greater compared to Applicant's Preferred Alternative. • For low-income or minority populations located in areas north of the diversion and inside of federal flood protection, some beneficial impacts related to additional protection from storm hazards due to reduced storm surge and wave heights as a result of land building may occur relative to the No Action Alternative. These benefits would be slightly higher than under the Applicant's Preferred Alternative.

Table 4.15-3
Summary of Potential Impacts on Environmental Justice from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Terrace Alternatives	
Construction Impacts	• The three terrace alternatives would have impacts on the low-income and minority populations that would be similar to those anticipated under the corresponding flow capacity alternatives without terraces. • Any additional impacts on low-income and minority populations due to the construction of terraces would be negligible.
Operational Impacts	• The three terrace alternatives would have impacts on the low-income and minority populations that would be similar to those anticipated under the corresponding flow capacity alternatives without terraces. • Any additional impacts on low-income and minority populations due to the presence of terraces during Project operations would be negligible.

4.15.5.1 Summary of Impacts on the Community of Ironton under the Applicant's Preferred Alternative

Ironton is a majority-Black community that has resided for generations on a former plantation site within 0.5-mile of the Project construction footprint in Plaquemines Parish. Currently, Ironton has a population of approximately 120 to 150 individuals, many of whom descend from the community's founders, formerly enslaved laborers on the nearby St. Rosalie Plantation (U.S. Census Bureau 2021d, Parker 2021). This community was flooded during Hurricane Ida in August 2021 and sustained substantial damages to structures that temporarily displaced many community residents (Parker 2021). As the community located closest to the proposed Project (see Figure 4.15-3), Ironton is expected to experience a unique array of impacts due to Project construction and operation relative to the No Action Alternative.

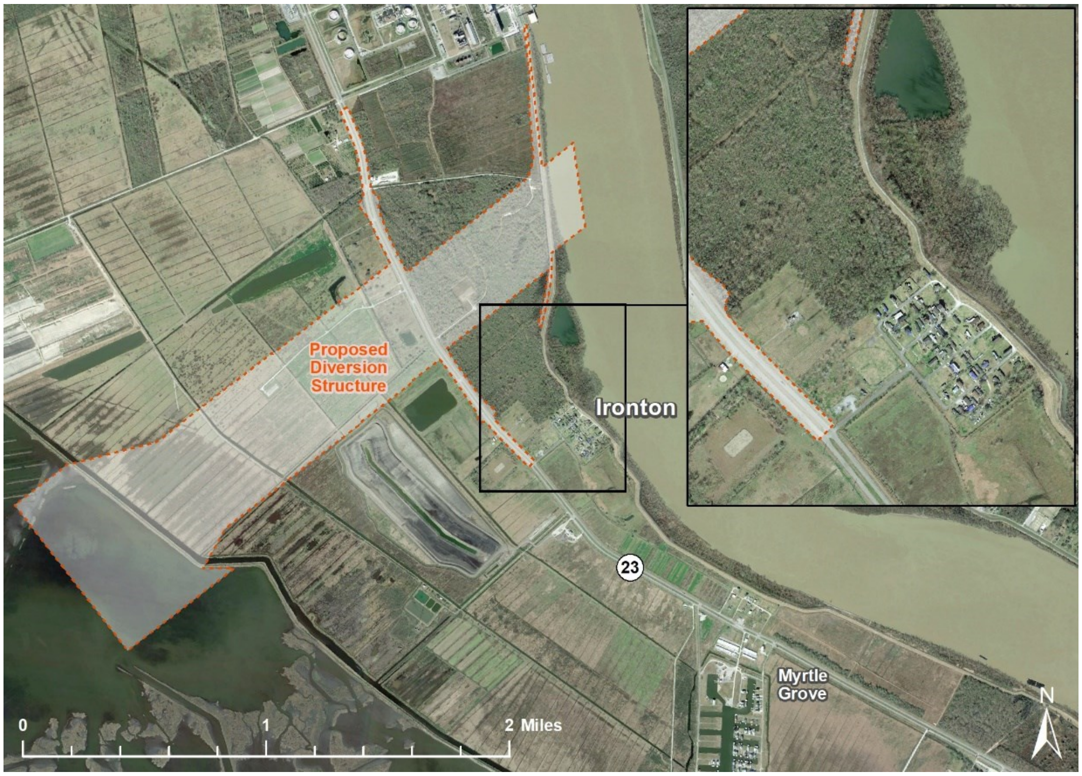


Figure 4.15-3. Map of Ironton and the Project construction footprint.

4.15.5.1.1 Construction Impacts

In the near term (up to 5 years), construction of the proposed Project is expected to have minor to moderate, adverse impacts on air quality for residents of Ironton due to fugitive dust and other airborne pollutants (see Section 4.7 Air Quality). Trucking associated with Project construction would also release pollutant emissions from combustion engines and fugitive dust from construction materials. Construction activities and related transportation (trucking, in particular) would also result in increased noise in Ironton, causing minor to moderate, adverse impacts (see Section 4.8 Noise). Most significantly, pile driving would periodically produce noise levels up to 67 dBA for about 2.5 years (see Section 4.8 Noise).

For 3.5 to 5 years, Ironton residents are likely to experience transportation delays and congestion, resulting in temporary, moderate, adverse impacts, primarily in the first 3.5 years of construction of the Project (see Section 4.22 Land-Based Transportation). Traffic on LA 23 would increase due to construction-related trucking and commuting construction workers. During construction of the proposed LA 23 modifications, two-way traffic would be maintained. Northbound traffic would utilize the two existing southbound lanes, maintaining the existing two-lane capacity. Southbound traffic would utilize the shoulder, reducing southbound roadway capacity from two lanes to one. This reduction in capacity may cause delays for southbound traffic over a 1.5-year period during the duration of construction. Impacts on transportation could affect children in Ironton who travel to attend school or access services elsewhere (see Section 4.13

Socioeconomics). Residents of Ironton may experience increased travel times to work or to recreate, including reduction/elimination of some travel routes for pedestrians or bicycles. They could also experience added minor delays if required to evacuate in the case of natural disasters or other emergencies due to evacuating traffic navigating through roadway construction. If the construction timeframes of reasonably foreseeable future actions overlap with construction of the Project, current existing traffic on LA 23 may double in volume (see Section 4.25 Cumulative Impacts).

To the extent that low-income and minority populations in Ironton engage in recreational fishing, hunting, wildlife watching, and recreational boating activities near the construction area, these populations would likely experience temporary, minor, adverse direct impacts due to construction-related traffic and noise impacts (see Section 4.16 Recreation and Tourism). Construction activities would increase shipping traffic through Bayou Dupont, potentially restricting or delaying access to subsistence and recreational fishers from Ironton who use Bayou Dupont to access resources, leading to minor, temporary, adverse impacts (see Section 4.16 Recreation and Tourism).

Overall, both beneficial and adverse economic impacts on Ironton are expected in the short term due to Project construction. For some residents of Ironton, construction of the proposed Project may offer additional construction jobs and income, leading to potential temporary, minor, beneficial impacts (see Section 4.13 Socioeconomics). At the same time, the combination of air quality, noise, and transportation impacts may cause minor, short-term, adverse indirect impacts on property values for residential and commercial properties in Ironton for 2.5 to 5 years, and possibly beyond (see Section 4.13 Socioeconomics). The same construction-related noise, air quality, and transportation impacts may have minor, short-term, adverse indirect impacts on businesses in Ironton (Section 4.13 Socioeconomics). However, these impacts are not expected to lead to changes in community cohesion in Ironton (see Section 4.13 Socioeconomics).

4.15.5.1.2 Operational Impacts

Beyond the near-term impacts of construction, operation of the Applicant's Preferred Alternative may have several impacts on Ironton. Because it is within the federal levee system, Ironton is not expected to be impacted by increases in frequency and duration of tidal flooding due to Project operations (see Section 4.20 Public Health and Safety). However, negligible to minor increases in the risk of overtopping of the NOV-NFL Levee due to storm surge south of the immediate outfall area following delta formation in the outfall area (after approximately 20 years of Project operations) could result in disproportionately high and adverse impacts on low-income and minority populations within Ironton, depending on the extent to which overtopping causes flooding in Ironton.

The Applicant's Preferred Alternative is projected to cause an increase in surge elevation gulfward of the immediate outfall area including in the vicinity of the NOV-NFL Levee adjacent to Ironton. The Applicant's Preferred Alternative is projected to decrease wave heights within the delta formation area, and slightly increase surge elevation gulfward of the delta formation area, with the changes increasing in magnitude and spatial extent over time as the size of the delta increases. Areas adjacent to the delta formation area gulfward of the immediate outfall area, including Ironton, would be at an increased risk of inundation, as the reduction in wave height within the delta formation area is generally not projected to eliminate the increased risk associated with increased storm surge elevation. The intensity of these impacts would decrease with distance from the immediate outfall area; minor impacts would occur near the immediate outfall area and would be reduced to negligible in areas farther from the immediate outfall area.

Similar to other communities, any increases in flood insurance rates for low-income households in Ironton due to increased flooding and storm surge risk may be financially burdensome under the Applicant's Preferred Alternative (see Section 4.13.5.3 Housing and Property Values).

Major, permanent, adverse impacts on shrimp and oyster fisheries would be expected to impact employment and income for Ironton residents to the extent that Ironton residents depend on these fisheries for employment and income (see Section 4.14 Commercial Fisheries). In addition, to the extent that low-income and minority populations in Ironton depend on finfish for commercial fishing, these populations may experience impacts from changes in abundance to finfish species (both positive and negative depending on the species). However, given a lack of data to correlate the fisheries harvest with specific low-income and minority populations, including those residing in Ironton, the precise extent to which these impacts would be experienced in Ironton cannot be determined. Impacts on subsistence fisheries for minority and low-income populations in Ironton may be adverse or beneficial, depending on the fishery. Similar to Ironton's commercial fishing participation, there is a lack of data to characterize the precise extent to which these impacts would be experienced by populations in Ironton.

Finally, the replacement of a segment of LA 23 with a bridge will result in the elimination of two existing median cross-overs (see Section 4.22 Land-Based Transportation). Ironton residents who currently use these cross-overs may experience permanent, minor, adverse impacts due to longer travel routes. The proposed Project would also alter a portion of the Mississippi River Levee, which would eliminate pedestrian access along the portion of the levee that will be replaced with the diversion conveyance channel and guide levees. The new LA 23 bridge would not have a pedestrian/bicycle lane although it would have shoulders on both the north- and south-bound lanes. The bridge is expected to reduce wildlife access to LA 23, potentially resulting in permanent, minor, beneficial impacts due to reduced frequency of wildlife-related vehicle accidents. In addition, the existing NOGC Railway track will be extended 600 feet closer to Ironton from its current termination point 0.5 miles away. However, the noise and air quality impacts of the railroad extension on residents of Ironton are expected to be negligible (see Section 4.22 Land-Based Transportation).

In summary, given that the minority population of Ironton makes up approximately 90 percent of its total population – a higher proportion than any other community evaluated – construction impacts on minority and low-income populations could be disproportionately high and adverse. No impacts due to tidal flooding are expected in Ironton; however, negligible to minor increases in risk of overtopping of the NOV-NFL Levee due to storm surge gulfward of the immediate outfall area following delta formation (after approximately 20 years of Project operations) may cause disproportionately high and adverse impacts on low-income and minority populations within Ironton, depending on the extent to which overtopping causes flooding in Ironton. Impacts of Project operations on commercial and subsistence fisheries may cause disproportionately high and adverse impacts on minority and low-income populations in Ironton, to the extent that those populations depend on shrimp, oyster, and specific finfish fisheries. Other impacts of Project operations would not be expected to be disproportionately high and adverse for minority and low-income populations in Ironton.

4.16 RECREATION AND TOURISM

4.16.1 Area of Potential Impacts

Construction impacts on recreation and tourism would likely be primarily constrained within and immediately adjacent to (within 0.5 mile) the proposed construction footprint (see Figure 2.8-1 in Chapter 2). During Project operations, the proposed Project would have the potential to impact recreation and tourism throughout the Barataria Basin and the Mississippi River birdfoot delta. The area of potential direct and indirect impacts on the regional economy include the 10 parishes that are located within or partially within the Barataria Basin and the birdfoot delta including (listed from largest to smallest percentage of the Project area): Lafourche, Plaquemines, Jefferson, St. Charles, St. James, Assumption, St. John the Baptist, Orleans, Ascension, and St. Bernard Parishes (see Chapter 3, Section 3.1 for further details about the boundaries and composition of the Project area).

4.16.2 Overview of Methodology and Sources for Analysis

The analysis in this section addresses potential direct and indirect impacts on recreational visitation and experiences in the Project area with respect to recreational fishing, hunting, wildlife viewing, boating, and visitation to non-governmental recreation areas (including the Lafitte Woods Preserve, the Edward Wisner Donation Trust, and Grand Isle Fee) under the No Action Alternative and each action alternative. Further details are provided in Appendix H.

Three sources of recreational use data were used to estimate impacts on recreational use in the Project area under the No Acton Alternative and action alternatives: the *Deepwater Horizon* (DWH) Boating Valuation Survey (U.S. Department of the Interior 2020a), the DWH Shoreline Valuation Use Survey (U.S. Department of the Interior 2020b), and the LDWF LA Creel Survey (LDWF 2019a). Additional information about these sources is provided in Chapter 3, Section 3.16, Recreation and Tourism and Appendix H. Information regarding potential Project impacts on public lands (for example, state and federal parks) in the Project area is provided in Section 4.17 Public Lands.

The estimates presented by these surveys are assumed to represent annual recreational use into the near future (approximately 2020 to 2029) for all alternatives. Recreational use in the longer term is expected to be influenced by changes in population, environmental conditions, climate change, land loss, site quality, general recreational preferences, and other factors. It is difficult to predict how some of these factors, particularly recreational preferences, would change in the future and impact recreational use. As a result, impact determinations are qualitative and based on best available information and professional judgment. See Appendix H for a more quantitative discussion of factors that impact recreational use.

This section evaluates how changes in the environment under the No Action Alternative and other action alternatives could impact the recreational visitation summarized in Chapter 3, Section 3.16 Recreation and Tourism and the associated regional economic benefits of tourism in the study area. Changes in environmental conditions that would impact site accessibility and conditions for fishing, hunting, wildlife viewing, boating, and visitation to non-governmental recreation areas are summarized for the No Action Alternative and other action alternatives below. Because the estimated changes in environmental conditions are assessed qualitatively (using the categories negligible, minor, moderate, or major) rather than quantitative (for example, a change in the abundance of a particular fish species over time), the recreation and tourism analysis is also mostly qualitative. Appendix H presents quantitative scenario analyses that use a range of assumed quantitative changes in environmental conditions to assess potential impacts of the proposed Project on recreation. The findings in Appendix H are generally consistent with the qualitative findings presented in this section.

Further, this section characterizes impacts on recreation and tourism at a broad geographic scale, reflecting the limited geographic specificity of the anticipated environmental conditions at recreation sites under the No Action Alternative and other action alternatives. In some cases, impacts are characterized for specific recreational sites or areas in the basin.

4.16.3 Guidelines for Recreation and Tourism Impact Determinations

The intensity of the impacts for recreation and tourism are based on the definitions presented in Section 4.1 and the following provide specific definitions of no impact, negligible, minor, moderate, and major for use in evaluating impacts on recreation and tourism:

- no impact: no discernible or measurable impact;
- negligible: impacts on recreation and tourism would be at the lowest levels of detection, barely measurable, with no perceptible consequences;

- minor: impacts would be detectable and/or would only affect some recreators. Users would likely be aware of the action, but impacts in use would be slight. Impacts would be local. There would be a change in local recreational opportunities; however, it would affect relatively few visitors or would not affect any related recreational activities;

- moderate: impacts would be readily apparent and/or would affect many recreators locally and in adjacent areas. Users would be aware of the action. Some users would choose to pursue activities in other available local or regional areas; and

- major: impacts would affect most recreators over a widespread area. Users would be highly aware of the action. Users would choose to pursue activities in other available regional areas.

4.16.4 Construction Impacts

4.16.4.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. Recreation and tourism in the Project area would continue as described in Chapter 3, Section 3.16 Recreation and Tourism. Ongoing trends of relative sea-level rise and increasing salinities would continue. Only limited impacts on recreational fishing, hunting, wildlife watching, recreational boating, and visitation to privately managed recreation areas in the Project area are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that may have some adverse impact on local recreational sites or activities. However, it would be speculative to project what exactly those future developments might be (but see Section 4.25 Cumulative Impacts, for more details about reasonably foreseeable projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal water quality standards.

4.16.4.2 Applicant's Preferred Alternative

Under the Applicant's Preferred Alternative, there would likely be temporary, minor, adverse direct impacts on recreational fishing, hunting, wildlife watching, and recreational boating activities near the construction area due to construction-related traffic and noise impacts (see Chapter 2, Figure 2.8-1 for a map of the proposed construction area).

Due to the mobilization of crews and equipment, construction activities under the Applicant's Preferred Alternative may cause traffic congestion during the 5-year construction period, which may contribute to delays in accessing recreation sites, particularly in southern Plaquemines Parish. Construction activities are not expected to result in road closures; however, southbound roadway capacity on LA 23 would be reduced at times. In particular, as described in Section 4.22 Land-Based Transportation, land-based transportation impacts would occur within the construction footprint of the proposed Project, which includes a 1.5-mile section of LA 23 and an approximately 0.7-mile section of the NOGC Railway between Ravenna Road and the town of Ironton. Impacts may also occur on LA 23 and local roads south of New Orleans outside of the defined Project construction footprint due to increases in roadway and railroad traffic for construction deliveries and worker commutes. LA 23 is the only road to and from recreation sites south of the diversion structure (see Chapter 3, Section 3.16 Recreation and Tourism, Figure 3.16-1) and Project-induced traffic congestion on LA 23 would be moderate and adverse. This would cause temporary, minor, adverse impacts on recreation users traveling this stretch of LA 23 to access recreation sites south of the proposed Project construction site. Construction along LA 23 would not impact recreation sites accessed via Highway 1, including the Edward Wisner Donation Trust, Lafitte Woods Preserve, and Grand Isle Fee (see Chapter 3, Section 3.16 Recreation and Tourism, Figure 3.16-1).

Use of open water within the Mississippi River and the Barataria Basin associated with construction of the diversion complex and auxiliary features would include minor increases in water-based traffic. Construction equipment and materials would be barged in from vendors north and south of the proposed Project site, causing minor increases in marine traffic in the Lower Mississippi River, Harvey Canal, GIWW, Barataria Bay Waterway, and Bayou Dupont, causing minor reductions in access for recreational users when Project vessels are in transit through these waterbodies. These minor, adverse impacts would be temporary, occurring over the 5-year construction period, and intermittent, based on the expected number and frequency of construction vessels, as described in Section 4.21 Navigation. Additionally, temporary, minor, adverse impacts from construction noise and dust could occur on recreators transiting LA 23, the Mississippi River, and the Barataria Basin near the Project construction site during construction (see Sections 4.7 Air Quality and 4.8 Noise for additional information about potential impacts on air and noise from the proposed Project).

4.16.4.3 Other Alternatives

Construction impacts on recreational activities in the Project area from the other action alternatives would be similar (temporary, minor, and adverse) to the Applicant's Preferred Alternative.

As compared with the Applicant's Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition feature of the proposed diversion structure would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes, and the overall construction footprint of all action alternatives would be similar. Additionally, construction timeframes for the 150,000 cfs Alternatives would be longer by several months and for the 50,000 cfs Alternatives shorter by several months as compared to the Applicant's Preferred

Alternative. As such, the duration of potential temporary, minor, adverse impacts due to traffic delays and construction noise and dust would be longer or shorter, respectively, than the Applicant's Preferred Alternative.

The construction of terraces in the basin under the three terrace alternatives would add minor, localized, temporary, adverse impacts on water-based recreational activities in the immediate outfall area due to increased noise from the use of construction equipment in the basin. Additional, minor increases in water-based traffic when construction vessels are in transit through the basin to construct the terraces would also lead to minor, temporary, adverse impacts. Recreators may choose to avoid these areas during construction.

4.16.5 Operational Impacts

4.16.5.1 No Action Alternative

4.16.5.1.1 Site Accessibility

Under the No Action Alternative, sea-level rise and subsidence would increase the occurrence of tidal flooding at recreational access points outside of federal levee systems such as boat launches, marinas, wildlife and bird watching sites, and roads leading to these access points, making access to these sites increasingly more difficult throughout the Barataria Basin over the 50-year analysis period, with major decreases in site accessibility due to flooding occurring by 2070 (see Table 4.16-1 and Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more information about projected flooding in the Project area under the No Action Alternative). Inundation at recreation sites not protected by federal levee systems may occur acutely during storm events initially and worsen over time with sea-level rise increases, resulting in permanent closures of some sites by 2070 if no measures are taken to address these effects (see Appendix H and Chapter 3, Section 3.13 Socioeconomics). When accessing recreational sites becomes difficult or impossible, recreational users would be expected to modify their behavior and either substitute to alternative locations or forego recreational trips entirely. However, the State of Louisiana would likely make efforts to maintain access to these sites through road elevation, beach nourishment, or other mitigation efforts as explained in the State Coastal Master Plan (CPRA 2017a).

Table 4.16-1
Modeled Percent of Days of Restricted Access Due to Tidal Flooding

Boating Access Point Nearest Town[a]	2020 to 2029	2030 to 2049	2050 to 2070
Lafitte	1%	24%	78%
Myrtle Grove	26%	74%	97%
Leeville	14%	77%	100%
Grand Bayou	33%	88%	98%
Buras	12%	62%	100%
Venice	0%	11%	89%
Grand Isle	14%	77%	100%

[a] See Chapter 3, Section 3.16 Recreation and Tourism, Table 3.16-2 for a list of boating access points for each town listed here.

Note: This assumes no adaptation or mitigation to changes in tidal flooding and represents a worst-case scenario.

4.16.5.1.2 Recreational Boating Activities

Under the No Action Alternative, depending on location, there would be negligible impacts on recreational boating activities (such as touring) initially, but impacts would increase over time, with major, permanent declines throughout the basin due to increased flooding at recreational access points outside of federal levee systems, as explained above. The occurrence of flooding is expected to be similar to current conditions from 2020 to 2030, with major increases in occurrence from 2040 to 2070.

Recreational boating activities would also continue to be adversely impacted by the continued spread of aquatic invasive plant species in the basin. Aquatic invasive species such as water hyacinth, hydrilla and Eurasian watermilfoil, each of which are known to occur in Louisiana estuaries, can form thick mats that impede boat traffic and swimming. These plants thrive in fresh water. As explained in Section 3.10 Aquatic Resources, in 2017, public waterways within the Barataria Basin included approximately 33,500 acres of nuisance aquatic vegetation, primarily water hyacinth (22,000 acres). The ongoing trends of sea-level rise and saltwater intrusion may result in less suitable habitat for freshwater invasive species, which are more prevalent than marine invasive species in the Project area (see Chapter 3, Section 3.10 Aquatic Resources).

4.16.5.1.3 Recreational Fishing

While it is not possible to precisely predict how catch rates or sightings of species would change through 2070 under the No Action Alternative, there is sufficient information to generally describe how populations of recreationally important fish species would generally increase, decrease, or remain approximately the same due to anticipated trends in water flow (velocity and direction), salinity, temperature, turbidity, sedimentation, nutrient input and primary productivity (for fueling the food web), amount of marsh vegetation, bottom substrates, and dissolved oxygen. For example, some species, including largemouth bass, are more prevalent in lower-salinity environments. Other species, such as spotted seatrout, are more prevalent in higher-salinity environments. Others, including southern flounder, Atlantic croaker, red drum, and blue crab, can tolerate wide ranges in salinity and are most impacted by the availability of marsh-dependent food. Expected population trends in key fish species under the No Action Alternative are discussed in more detail in Section 4.10 Aquatic Resources.

As described in Chapter 3, Section 3.16 Recreation and Tourism, the LDWF LA Creel Survey (2019) surveys anglers at recreation access points to record information on species caught and targeted. Table 4.16-2 presents the percentage of angler trips in the basin where a range of species were caught or targeted between 2014 and 2018. As shown in Table 4.16-2 below, spotted seatrout and red drum are widely targeted by recreational anglers, while fewer anglers target other species.

Table 4.16-2
Percentage of Angler Trips in the Barataria Basin Reporting Fish Species as Caught or Targeted, 2014 to 2018

Aquatic Species	Caught	Primary Target	Secondary Target
Spotted Seatrout	36.9%	46.8%	39.8%
Red Drum	35.7%	40.5%	52.6%
Southern Flounder	2.7%	0.3%	0.9%
Largemouth Bass	1.3%	0.3%	1.6%
Atlantic Croaker	0.9%	0%	0.2%
Blue Crab	0.6%	<0.1%	0%
Bay Anchovy	0%	0%	0%
Eastern Oyster	0%	0%	0%
Brown Shrimp	<0.1%	0%	0%
White Shrimp	<0.1%	0%	0%
Gulf Menhaden	<0.1%	0%	0%
No Target Species	NA	10.6%	0.8%
Other	21.9%[a]	1.5%	4.1%

Source: LA Creel data provided by LDWF (2019)

[a] Other species caught include sheepshead (6.0%), black drum (5.0%), sand seatrout (3.7%), and gafftopsail catfish (1.1%). The remaining 6.1% of other species includes a range of types caught on very few (1%) of trips.

Under the No Action Alternative, there would be permanent, minor, adverse decreases in the abundance of spotted seatrout and red drum, the two species most targeted by recreational anglers, resulting in a decrease in the abundance and recreational fishing of these species throughout the basin, primarily because of decreases in marsh habitat. Adverse and beneficial impacts on recreational fishing of other fish species would likely be negligible because they are targeted by less than 2 percent of anglers in the Project area. To the extent that recreational anglers divert to alternative sites outside of the Project area to fish for spotted seatrout, the communities in the Project area would experience some degree of reduced tourist expenditures. The recreation impact analysis in Appendix H suggests that boating recreators may substitute away from sites in Plaquemines, Jefferson, and Lafourche Parishes. A small fraction of those recreators may substitute to sites in St. Charles Parish, while the remaining trips would leave the Project area. See Section 4.10 Aquatic Resources for more information about projected fish species abundance under the No Action

Alternative. Boat-based recreational fishing would also be affected by the same site accessibility impacts described above.

4.16.5.1.4 Hunting and Wildlife Watching, Including Birding

Expected trends in hunting and wildlife watching under the No Action Alternative are based on anticipated trends in bird and alligator populations, which are detailed in Section 4.9 Terrestrial Wildlife and Habitat. Due to ongoing wetland loss and increases in salinity and water depth, the abundance of alligators and those birds inhabiting fresher marshes is expected to decline under the No Action Alternative over time, which would adversely impact opportunities for hunters and wildlife watching. Because tag allotments for alligator hunting are determined by the number of habitat acres available, a decrease in habitat availability would directly decrease the amount of alligator hunting available. For waterfowl hunting, a decrease in habitat may result in fewer birds and potentially lower species diversity, which could decrease the number of days spent hunting or wildlife/bird watching throughout the Project area under the No Action Alternative (see Table 4.16-2). These adverse impacts could reduce the number of birder and hunting visitation days and associated expenditures in the region under the No Action Alternative. While regional population growth may lead to an increase in visitation days and associated expenditures, the net impact is uncertain.

4.16.5.1.5 Visitation to Privately Managed Recreation Areas

Due to ongoing wetland loss and increases in salinity, the abundance of birds and alligators is expected to decline under the No Action Alternative over time, which would adversely impact opportunities for hunting and wildlife watching in the three non-governmental or privately owned recreational areas in the Project area: the Edward Wisner Donation Trust, Grand Isle Fee, and the Lafitte Woods Preserve (see Chapter 3, Section 3.16 Recreation and Tourism, Figure 3.16-1).

Under the No Action Alternative, Delft3D Basinwide Modeling indicates that the Edward Wisner Donation Trust would lose all of its 1,395 acres of wetlands by 2070 (see Table 4.16-3) and the Lafitte Woods Preserve would lose all but 1 acre by 2070. This loss of wetlands would have adverse impacts on hunting and wildlife viewing of terrestrial wildlife and birds that thrive in wetland habitat. This would represent a permanent, minor decrease in wetland habitat in the Edward Wisner Donation Trust because existing wetlands represent a small portion of its acreage (approximately 10 percent), and a permanent, major decrease in wetland habitat in the Lafitte Woods Preserve because most of the existing site is comprised of wetlands that would be almost completely lost by 2070. Expected increases in tidal flooding due to projected sea-level rise would also substantially decrease access and visitation to these sites over the 50-year analysis period under the No Action Alternative (see Site Accessibility section above).

Table 4.16-3
Comparison of Delft3D Basinwide-Modeled Wetland Acreages between the No Action Alternative and the Action Alternatives[a] in Privately Managed Recreation Areas

Recreation Area	No Action Alternative (NAA)	75,000 cfs Alternative (Applicant's Preferred)	75,000 cfs Alternative Difference Relative to NAA	50,000 cfs Alternative	50,000 cfs Alternative Difference Relative to NAA	150,000 cfs Alternative	150,000 cfs Alternative Difference Relative to NAA
Edward Wisner Donation Trust							
2030	1,325	1,325	0	1,325	0	1,325	0
2040	557	620	63	620	63	651	94
2050	84	88	4	88	4	88	4
2060	0	0	0	0	0	0	0
2070	0	0	0	0	0	0	0
Grand Isle Fee							
2030	2	2	0	2	0	0	-2
2040	2	2	0	2	0	2	0
2050	1	1	0	1	0	1	0
2060	1	1	0	1	0	1	0
2070	1	1	0	1	0	1	0
Lafitte Woods Preserve							
2030	7	7	0	7	0	1	-6
2040	7	7	0	7	0	7	0
2050	1	1	0	1	0	1	0
2060	1	1	0	1	0	1	0
2070	1	1	0	1	0	1	0

[a] Wetland acreages of the three terrace alternatives were identical to their non-terrace alternative counterparts.

4.16.5.1.6 Regional Economic Impacts

Recreators traveling to the Barataria Basin and birdfoot delta to participate in recreational activities directly and indirectly support the local and regional (10 parishes within or partially within the Project area) tourism industry. As part of their recreational trips, they spend money on food (at restaurants and grocery stores), lodging, fuel, equipment, guided tours, and at gift shops. These expenditures translate into jobs, income, and tax revenue for those businesses providing the goods and services in demand by travelers to the region. Direct and indirect impacts on recreational use are expected to affect tourism spending and the regional (10-parish) economy.

Under the No Action Alternative, increased storm hazards and tidal flooding, as well as impacts on fish and wildlife abundance are assumed to adversely impact future recreational visitation and associated expenditures. A reduction in expenditures would lead to adverse impacts on the regional economy associated with recreational visitation. With respect to tourist expenditures in restaurants in the region, over the longer term, as habitat becomes less suitable to shrimp and oysters in the basin under the No Action Alternative, shrimp from Louisiana would continue to be available to consumers in restaurants, potentially at higher prices. Restaurants willing to pay a premium for local seafood would likely do so, and additional importing would likely also occur, while consumers could decide to consume more imported shrimp and fewer shrimp/oysters overall.

4.16.5.2 Applicant's Preferred Alternative

Relative to the No Action Alternative, the Applicant's Preferred Alternative would decrease salinity throughout the basin, with the greatest impacts in the immediate outfall area and during the period of peak diversion flow, by bringing in fresh water from the Mississippi River. The Mississippi River is generally cooler than water in the basin and thus diversion flows would also decrease water temperatures, again primarily in the immediate outfall area during peak flows in the late winter and early spring (see Section 4.5 Surface Water and Sediment Quality, Section 4.5.5.2 Water Temperature). Impacts on aquatic and terrestrial species are described in the sections below as they pertain to recreation activities they support. Impacts on site accessibility are discussed further here as these impacts could affect all types of recreational activities.

4.16.5.2.1 Site Accessibility

As compared to the No Action Alternative, the Applicant's Preferred Alternative is expected to cause long-term, minor to moderate, adverse direct and indirect impacts on site accessibility due to increased tidal flooding at recreation sites (or roads leading to those sites) and permanent, moderate, adverse direct and indirect impacts due to sedimentation in some of the Project-area navigation channels used to access recreation sites unless additional dredging is undertaken in federal and non-federal navigation channels (see Section 4.21 Navigation for additional information about Project impacts on sedimentation and dredging in navigation channels in the Barataria Basin).

The Applicant's Preferred Alternative would increase tidal flooding relative to the No Action Alternative near the immediate outfall area (within approximately 10 miles to the north and 20 miles to the south), causing major, long-term, adverse impacts at the Myrtle Grove Marina and minor to moderate, long-term, adverse impacts around Lafitte and Grand Bayou (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, Table 4.20-2). Because some boating access sites would likely remain accessible, increases in tidal flooding would result in minor to moderate impacts on recreation site accessibility in these areas. Inundation frequency would increase in 2020 through 2050 in these areas relative to the No Action Alternative, but the difference in inundation frequency between the Applicant's Preferred Alternative and the No Action Alternative would decline and become minor to negligible from 2060 to 2070 as the influence of sea-level rise and subsidence on water levels increases (see Figure 4.20-4 in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction). While the Myrtle Grove Marina and Lafitte access points currently support over 20,000 and 50,000 boating user days per year, respectively (see Chapter 3, Section 3.16 Recreation and Tourism, Table 3.16-1), recreational user days around Grand Bayou are unknown due to data limitations, but are likely to be fewer given the limited infrastructure present to support recreational use.

Permanent, moderate, adverse impacts on boat-based recreation (for example, fishing, hunting, wildlife viewing, boating) may occur where sedimentation from proposed Project operations accumulates to the extent that water depths decrease and restrict access to deeper-draft vessels. The nearest major recreational access point to the proposed Project is the Myrtle Grove Marina. Due to its proximity to the Project outfall, access to the basin from this site may be impaired due to sedimentation if the Wilkinson Canal and Myrtle Grove area are not periodically dredged or otherwise maintained to allow recreational boat passage, though boaters may use alternative routes, which could mitigate this impact. Recreators currently using the Myrtle Grove Marina and the surrounding canals would be expected to take fewer trips to this area if accessibility and navigation impacts are not mitigated. Operation of the proposed Project could also cause permanent, moderate, adverse impacts on recreators transiting to or from the Jean Lafitte Launch or Jean Lafitte Harbor due to projected sedimentation in the Barataria Bay Waterway if maintenance dredging is not performed to maintain navigability of the channel (see Figure 4.21-2 in Section 4.21 Navigation). Recreational boaters who launch from these sites and use the Barataria Bay Waterway to access the southern portion of the basin would be expected to take fewer trips if maintenance dredging is not performed to maintain navigability of the waterway, though boaters may use alternative routes, which could mitigate this impact. The location of these channels is illustrated in Figure 4.16-1 below.

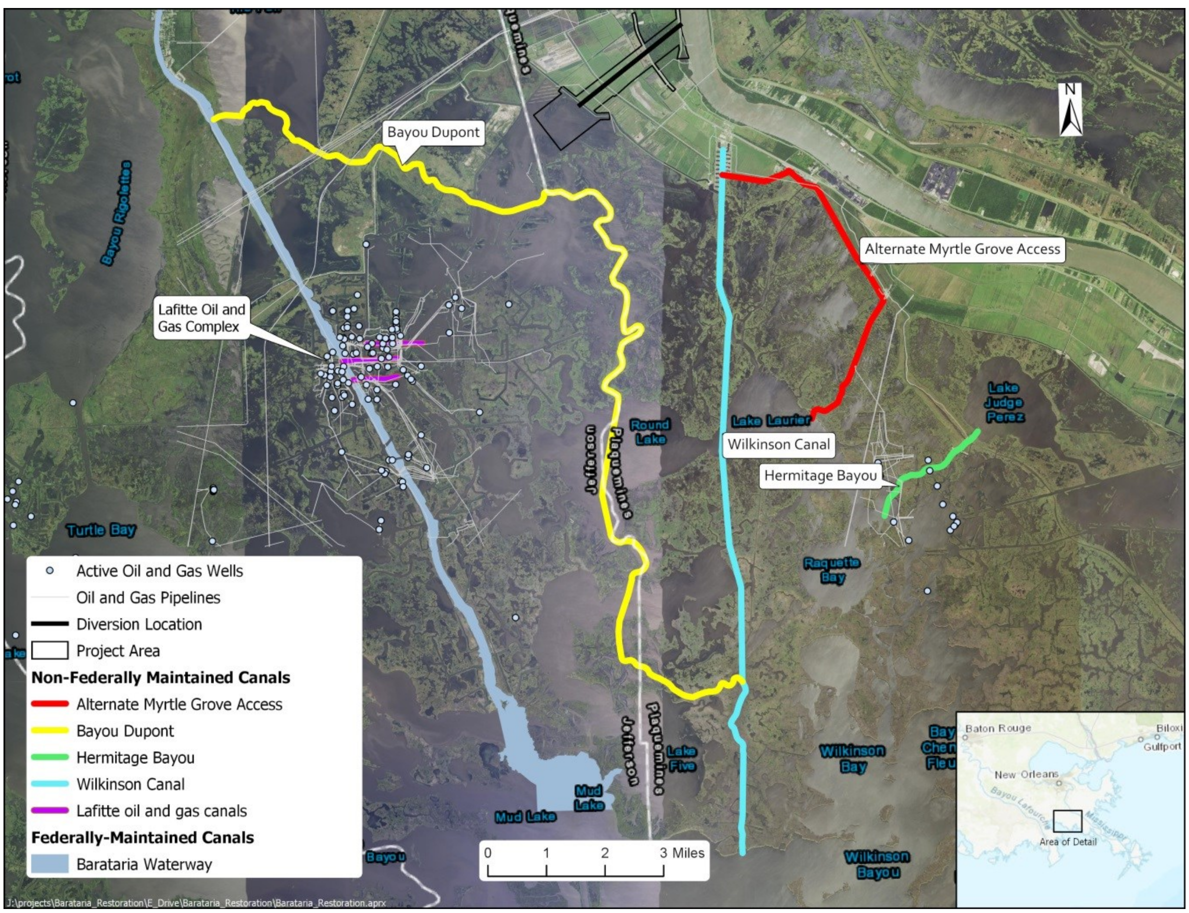


Figure 4.16-1. Navigation Channels Near the Proposed Project.

4.16.5.2.2 Recreational Boating Activities

Recreational boating would be impacted by the Applicant's Preferred Alternative due to expected site accessibility impacts described above. As compared to the No Action Alternative, the Applicant's Preferred Alternative would have long-term, minor to moderate, adverse direct and indirect impacts on recreational boating due to increased tidal flooding in the Barataria Basin at access points located outside of federal levees within approximately 10 miles north and 20 miles south of the immediate outfall area, and permanent, moderate, adverse direct and indirect impacts due to sedimentation in some of the navigation channels in the basin outfall area (see Figure 4.16-1). See Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction and Section 4.21 Navigation for more information about flooding and sedimentation impacts of the proposed Project in the basin.

The Applicant's Preferred Alternative would result in an increased potential for the introduction and expansion of invasive plant species that prefer slower moving fresh waters in the Barataria Basin. Invasive plant species would continue to clog canals and impede recreational boating activities, representing moderate (readily apparent and impacting many recreators locally), permanent, adverse impacts. Anglers have indicated in the past that water hyacinth and Eurasian watermilfoil, as well as other invasive aquatic plants, frequently clog canals and impede boat traffic around the Caernarvon Diversion (Kravitz et al. 2005). See Section 4.10 Aquatic Resources for more information on aquatic invasive species in the Barataria Basin.

4.16.5.2.3 Recreational Fishing

Relative to the No Action Alternative, the Applicant's Preferred Alternative would cause minor, permanent, adverse impacts on recreational fishing for spotted seatrout and moderate, permanent, beneficial impacts on recreational fishing for red drum, as described further below. Spotted seatrout and red drum are the most targeted species by recreational anglers in the basin (targeted in 87 percent of angler trips between 2014 and 2018). Boat-based recreational fishing would also be impacted by the same site accessibility impacts described above for recreational boating activities, representing long-term to permanent, minor to moderate, adverse impacts on accessibility to recreational access points.

Operations under the Applicant's Preferred Alternative would have direct and indirect impacts on salinity conditions, larval transport, habitat availability, water flow, availability of prey for recreationally important species, and other environmental conditions in the basin relative to the No Action Alternative. These impacts would affect the key fish species analyzed in Section 4.10 Aquatic Resources, some of which are targeted by recreational anglers in the basin including blue crab, red drum, spotted seatrout, Atlantic croaker, southern flounder, and largemouth bass (see Table 4.16-2).

While it is not possible to precisely predict future impacts in catch rates or abundance of species through 2070, there is sufficient information to characterize how populations of recreationally important species would respond to impacts in environmental conditions. Red drum and spotted seatrout are widely targeted by recreational anglers and very few anglers target other species (see Table 4.16-2). Impacts on these key species under the Applicant's Preferred Alternative are summarized in Table 4.16-4. Impacts on other species are described in Section 4.10 Aquatic Resources and are expected to have a negligible impact on recreational fishing, with the exception of freshwater species such as largemouth bass that currently exist in the Barataria Basin, or species such as catfish and carp that may be introduced into the basin through the diversion. While few anglers currently target such species in the basin, the percentage of anglers which target freshwater species as freshwater habitat and species abundance increases under the Applicant's Preferred Alternative.

Table 4.16-4
Expected Trends in the Barataria Basin Fish Abundance Under the Applicant's Preferred Alternative Compared to the No Action Alternative

Aquatic Species	Trend Over 50 Modeled Years
Red Drum	Moderate, permanent, beneficial impact due to increased marsh (particularly in the Project outfall region), SAV biomass throughout the basin, and primary production. Benefits may result in a slight increase in species abundance over time. The beneficial primary productivity impacts are expected to begin at the onset of operations and last through the analysis period, whereas the benefits associated with new and sustained marsh and SAV biomass would be realized later in the analysis period.
Spotted Seatrout	Minor, permanent, adverse impact due to disruption of larval transport, juvenile growth, and adult spawning activities. Major impacts in species location or abundance would not be expected. Adverse impacts are expected to begin at the onset of operations and last through the analysis period.
Source: Section 4.10 Aquatic Resources	

Minor, permanent, adverse impacts on recreational fishing for spotted seatrout, the most targeted species by recreational anglers in the basin, are expected due to Project operations' minor disruption of larval transport, juvenile growth, and adult spawning activities (see Table 4.16-4). Moderate, permanent, beneficial impacts on recreational fishing for red drum are expected due to the Project operations' beneficial impact on increased marsh and primary production. This could increase catch rates for red drum, possibly improving the recreational experience for these anglers or attracting new recreational fishing trips. Some recreational fishers may need to modify their traditional fishing locations to target specific species that may modify habitat use (either temporarily or permanently) based on changing salinities.

4.16.5.2.4 Hunting and Wildlife Watching, Including Birding

Operational impacts on hunting under the Applicant's Preferred Alternative are based on anticipated direct and indirect impacts on birds and alligators from Section 4.9 Terrestrial Wildlife and Habitat. As compared to the No Action Alternative, the Applicant's Preferred Alternative is expected to result in an increase in wetlands, which provide habitat for both birds and alligators. This would increase the number of tag allotments for recreational alligator hunting in brackish and freshwater wetlands. For waterfowl hunting, an increase in habitat may result in more birds and potentially greater species diversity, which could increase the number of days that individual hunters spent hunting throughout the basin.

An increase in wetland habitat that would be created under the Applicant's Preferred Alternative relative to the No Action Alternative may result in increased opportunities for bird nesting and bird watching in some areas of the Barataria Basin (see Section 4.6 Wetland Resources and Waters of the U.S., Figures 4.6-9 through 4.6-14 for locations of Project-induced wetland creation). However, the Applicant's Preferred Alternative would accelerate wetland loss in other areas such as in the birdfoot delta as compared to the No Action Alternative. A decrease in wetland habitat may result in decreased opportunities for bird nesting and bird watching, though recreational access and visitation in the birdfoot delta are more limited than in other parts of the basin. Overall, the benefit to birdwatching activity that may occur following Project implementation due to wetland creation is anticipated to be minor to moderate and permanent.

4.16.5.2.5 Visitation to Privately Managed Recreation Areas

The differences between the Applicant's Preferred Alternative and the No Action Alternative on visitation to privately owned recreation areas would be negligible due to similar declines in the abundance of birds and alligators for bird watching and hunting due to wetland loss. Under the Applicant's Preferred Alternative, Delft3D Basinwide Modeling wetlands relative to the No Action Alternative in 2040, but by 2060, the wetland acreage at this preserve would be the same as the No Action Alternative (0.0 acres; see Table 4.16-3). The wetland acreage in the small Lafitte Woods Preserve would not differ between the Applicant's Preferred Alternative and the No Action Alternative. Tidal flooding increases under the Applicant's Preferred Alternative would be similar to the No Action Alternative. Information regarding potential Project impacts on public lands and recreation areas (for example, state and federal parks) in the Project area is provided in Section 4.17 Public Lands.

4.16.5.2.6 Regional Economic Impacts

There would be minor, permanent, adverse as well as minor, permanent, beneficial direct and indirect impacts on the regional economy associated with recreational expenditures in the region under the Applicant's Preferred Alternative relative to the No Action Alternative. Reduced access to some sites outside of flood protection due to increased sedimentation and tidal flooding caused by the proposed Project, particularly at and around the Jean Lafitte Launch, Jean Lafitte Harbor, Myrtle Grove Marina, and around Grand Bayou would cause minor, permanent, adverse impacts on the regional economy because visitation to these sites represents a small share of total recreation in the 10-parish region, and recreators may substitute to other sites within the Project area or, alternatively, outside of the region. In addition, the potential decrease in abundance of spotted seatrout in the basin, a popular recreational fishing target species, would result in permanent, minor, adverse impacts on the regional economy. Conversely, some permanent, minor, beneficial impacts on the regional economy would also be associated with the potential increase in abundance of red drum in the basin. The net result of these impacts is unclear, although distributional impacts are likely as recreators substitute away from sites with reduced accessibility and quality and toward sites with improved conditions. This would lead to some areas seeing relative increases in visitation and spending, while others see reductions.

With respect to tourist expenditures in restaurants in the region, while availability of shrimp and oysters from the basin would decrease with the Project, shrimp and oysters from Louisiana would continue to be available to restaurants, potentially at higher prices. Restaurants willing to pay a premium for local seafood would likely do so, and additional importing would likely also occur. Under both the Applicant's Preferred Alternative and the No Action Alternative, consumers in Louisiana would experience higher prices for locally caught seafood, or would consume additional imported shrimp over time. However, the impacts of decreased local shrimp and oyster availability and increased local shrimp and oyster prices would occur decades sooner under the Applicant's Preferred Alternative than under the No Action Alternative.

4.16.5.3 Other Alternatives

4.16.5.3.1 Site Accessibility

4.16.5.3.1.1 <u>50,000 cfs Alternative</u>

Impacts on site accessibility under the 50,000 cfs Alternative are expected to be similar to those described under the Applicant's Preferred Alternative.

The 50,000 cfs Alternative would have long-term, minor to moderate, adverse direct and indirect impacts on recreation site accessibility due to increased tidal flooding in the basin outside of federal levee protection and permanent, moderate, adverse direct and indirect impacts due to sedimentation in some of the Project-area navigation channels used to access recreation sites. See Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction and Section 4.21 Navigation for more information about Project-induced impacts on tidal flooding and sedimentation in navigation canals, respectively. Similar to the Applicant's Preferred Alternative, the 50,000 cfs Alternative would increase tidal flooding relative to the No Action Alternative near the Project site, causing minor to moderate, long-term, adverse impacts on site accessibility at the Myrtle Grove Marina and minor to moderate, long-term, adverse impacts around Lafitte and Grand Bayou. Inundation frequency would increase in 2030 through 2050 in these areas relative to the No Action Alternative, but the difference in inundation frequency between the other action alternatives and the No Action Alternative would decline and become negligible by 2070 as the influence of sea-level rise on water levels increases.

The 50,000 cfs Alternative would also cause permanent, moderate, adverse impacts on boat-based recreation (for example, fishing, hunting, wildlife viewing, boating) where sedimentation from proposed Project operations would accumulate in channels near the Project site, to the extent that water depths decrease and affect passage of deeper-draft vessels. The 50,000 cfs Alternative would differ in the volume of sedimentation in navigation channels (see Section 4.2 Geology and Soils, Table 4.2-4, which presents the differences in sediment volume by alternative), but these differences on recreational site access from the impacts expected under the Applicant's Preferred Alternative would be negligible.

4.16.5.3.1.2 150,000 cfs Alternative

Impacts on site accessibility under the 150,000 cfs Alternative are expected to be similar to those described under the Applicant's Preferred Alternative.

The 150,000 cfs Alternative would have long-term, minor to moderate, adverse direct and indirect impacts on recreation site accessibility due to increased tidal flooding in the basin outside of federal levee protection and permanent, moderate, adverse direct and indirect impacts due to sedimentation in some of the Project-area navigation channels used to access recreation sites. See Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction and Section 4.21 Navigation for more information about Project-induced impacts on tidal flooding and sedimentation in navigation canals, respectively. Similar to the Applicant's Preferred Alternative, the 150,000 cfs Alternative would increase tidal flooding relative to the No Action Alternative near the immediate outfall area, causing minor to moderate, long-term, adverse impacts on site accessibility at the Myrtle Grove Marina and minor to moderate, long-term, adverse impacts around Lafitte and Grand Bayou. Inundation frequency would increase in 2030 through 2050 in these areas relative to the No Action Alternative, but the difference in inundation frequency between the other action alternatives and the No Action Alternative would decline and become negligible by 2070 as the influence of sea-level rise on water levels increases.

The 150,000 cfs Alternative would also cause permanent, moderate, adverse impacts on boat-based recreation (for example, fishing, hunting, wildlife viewing, boating) where sedimentation from proposed Project operations would accumulate in channels near the immediate outfall area, to the extent that water depths decrease and affect passage of deeper-draft vessels. The 150,000 cfs Alternative would differ in the volume of sedimentation in navigation channels (see Section 4.2 Geology and Soils, Table 4.2-4, which presents the differences in sediment volume by alternative), but these differences on recreational site access from the impacts expected under the Applicant's Preferred Alternative would be negligible.

4.16.5.3.1.3 Terrace Alternatives

The addition of marsh terrace features in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on site accessibility similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.16.5.3.2 Recreational Boating Activities

4.16.5.3.2.1 50,000 cfs Alternative

Recreational boating activities under the 50,000 cfs Alternative would be impacted by the site accessibility impacts described above. As compared to the No Action Alternative, the 50,000 cfs Alternative would have long-term, minor to moderate, adverse direct and indirect impacts on recreational boating due to increased tidal flooding at access points in Lafitte, Myrtle Grove, and Grand Bayou and permanent, moderate, adverse direct and indirect impacts due to sedimentation in some of the Project-area navigation channels (see Figure 4.16-1). The 50,000 cfs Alternative would also result in an increased potential for the introduction and expansion of invasive plant species in the basin, which would clog canals and impede recreational boating activities, representing moderate (readily apparent and impacting many recreators locally), permanent, adverse impacts.

4.16.5.3.2.2 150,000 cfs Alternative

Recreational boating activities under the 150,000 cfs Alternative would be impacted by the site accessibility impacts described above. As compared to the No Action Alternative, the 150,000 cfs Alternative would have long-term, minor to moderate, adverse direct and indirect impacts on recreational boating due to increased tidal flooding at access points in Lafitte, Myrtle Grove, and Grand Bayou and permanent, moderate, adverse direct and indirect impacts due to sedimentation in some of the Project-area navigation channels (see Figure 4.16-1). The 150,000 cfs Alternative would also result in an increased potential for the introduction and expansion of invasive plant species in the basin, which would clog canals and impede recreational boating activities, representing moderate (readily apparent and impacting many recreators locally), permanent, adverse impacts.

4.16.5.3.2.3 Terrace Alternative

The addition of marsh terrace features in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on recreational boating similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.16.5.3.3 Recreational Fishing

4.16.5.3.3.1 50,000 cfs Alternative

The other 50,000 cfs Alternative generally would not result in impacts on key recreational fish species different from those described in the Applicant’s Preferred Alternative. Under the 50,000 cfs Alternative, there would be minor, permanent, adverse impacts on recreational fishing for spotted seatrout and minor, permanent, beneficial impacts on recreational fishing for red drum. Boat-based recreational fishing would also be impacted by the same site accessibility impacts described above for recreational boating. As compared to the No Action Alternative, the 50,000 cfs

Alternative would cause long-term, minor to moderate, adverse direct and indirect impacts on accessibility to recreational access points (boat launches and marines) outside of major levee systems due to increased tidal flooding and permanent, moderate, adverse direct and indirect impacts on site accessibility due to sedimentation in some of the Project-area navigation channels used to access recreation sites. Additionally, the 50,000 cfs Alternative would increase the potential for the introduction and expansion of invasive plant species in the basin, which would clog canals and impede recreational boating activities, representing moderate, permanent, adverse impacts on recreational fishing.

4.16.5.3.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative generally would not result in impacts on key recreational fish species different from those described in the Applicant's Preferred Alternative. Under the 150,000 cfs Alternative, there would be minor, permanent, adverse impacts on recreational fishing for spotted seatrout and minor, permanent, beneficial impacts on recreational fishing for red drum. Boat-based recreational fishing would also be impacted by the same site accessibility impacts described above for recreational boating. As compared to the No Action Alternative, the 150,000 cfs Alternative would cause long-term, minor to moderate, adverse direct and indirect impacts on accessibility to recreational access points (boat launches and marinas) outside of major levee systems due to increased tidal flooding and permanent, moderate, adverse direct and indirect impacts on site accessibility due to sedimentation in some of the Project-area navigation channels used to access recreation sites. Additionally, the 150,000 cfs Alternative would increase the potential for the introduction and expansion of invasive plant species in the basin, which would clog canals and impede recreational boating activities, representing moderate, permanent, adverse impacts on recreational fishing.

4.16.5.3.3.3 Terrace Alternatives

The addition of marsh terrace features in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on recreational fishing similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.16.5.3.4 Hunting and Wildlife Watching, Including Birding

4.16.5.3.4.1 50,000 cfs Alternative

As compared to the No Action Alternative, the 50,000 cfs Alternative is expected to result in wetland gains that provide increased habitat for both birds and alligators to differing degrees (see Section 4.9.4.3 in Terrestrial Wildlife and Habitat for details regarding wildlife impacts and HSI scores) resulting in minor to moderate, permanent beneficial impacts. This would increase the number of tag allotments for recreational alligator hunting in brackish and freshwater wetlands, the number of days spent waterfowl hunting, and the opportunities for bird watching within the areas of increased marsh, as compared to the No Action Alternative. As the magnitude of increased habitat near the immediate outfall area is similar between the 50,000 cfs Alternative and the Applicant's Preferred Alternative, the difference between these two alternatives is negligible.

4.16.5.3.4.2 150,000 cfs Alternative

As compared to the No Action Alternative, the 150,000 cfs Alternative is expected to result in wetland gains that provide increased habitat for both birds and alligators to differing degrees (see Section 4.9.4.3 in Terrestrial Wildlife and Habitat for details regarding wildlife impacts and HSI scores) resulting in minor to moderate, permanent beneficial impacts. This would increase the number of tag allotments for recreational alligator hunting in brackish and freshwater wetlands, the number of days spent waterfowl hunting, and the opportunities for bird watching within the areas of increased marsh, as compared to the No Action Alternative. The 150,000 cfs Alternative would likely result in a greater increase in these recreational activities than the Applicant's Preferred Alternative, given the magnitude of increased habitat associated with the 150,000 cfs Alternative.

4.16.5.3.4.3 Terrace Alternative

The presence of terraces in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on these activities similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.16.5.3.5 Visitation to Privately Managed Recreation Areas

4.16.5.3.5.1 50,000 cfs Alternative

The differences in impacts on recreational use at privately managed recreation areas between the No Action Alternative and the 50,000 cfs Alternative would be negligible. Therefore, the 50,000 cfs Alternative would not measurably alleviate or worsen the permanent, major, adverse impacts on these sites expected under the No Action Alternative due to expected increases in tidal flooding (see Appendix H and Section 4.16.5.1 above).

4.16.5.3.5.2 150,000 cfs Alternative

The differences in impacts on recreational use at privately managed recreation areas between the No Action Alternative and the 150,000 cfs Alternative would be negligible. Therefore, the 150,000 cfs Alternative would not measurably alleviate or worsen the permanent, major, adverse impacts on these sites expected under the No Action Alternative due to expected increases in tidal flooding (see Appendix H and Section 4.16.5.1 above).

4.16.5.3.5.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on these activities similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.16.5.3.6 Regional Economic Impacts

4.16.5.3.6.1 50,000 cfs Alternative

Consistent with the Applicant's Preferred Alternative, there would be minor, permanent, adverse as well as minor, permanent beneficial direct and indirect impacts on the regional economy associated with recreational expenditures in the region under the 50,000 cfs Alternative relative to the No Action Alternative.

4.16.5.3.6.2 150,000 cfs Alternative

Consistent with the Applicant's Preferred Alternative, there would be minor, permanent, adverse as well as minor, permanent beneficial direct and indirect impacts on the regional economy associated with recreational expenditures in the region under the 150,000 cfs Alternatives relative to the No Action Alternative.

4.16.5.3.6.3 Terrace Alternatives

The presence of terraces in the basin within the immediate outfall area associated with the three terrace alternatives would have impacts on the regional economy similar to those anticipated under the corresponding flow capacity alternatives without terraces.

4.16.6 Summary of Potential Impacts

Table 4.16-5 summarizes the potential impacts on recreation and tourism for each alternative. Details are provided in Sections 4.16.4 and 4.16.5 above.

Table 4.16-5
Summary of Potential Impacts on Recreation and Tourism from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on recreation and tourism from construction of the proposed Project would occur. Ongoing trends would continue.
Operational Impacts	• Negligible (early decades) to major (later decades) declines in recreation site accessibility due to increased flooding from sea-level rise. • Major, permanent decreases in recreational boating due to decreases in site accessibility over time due to increased flooding at recreational access points outside of federal levee systems.

Table 4.16-5
Summary of Potential Impacts on Recreation and Tourism from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	• Minor, permanent decreases in the abundance and recreational fishing of spotted seatrout and red drum, the most targeted species by recreational anglers, primarily due to decreases in wetland habitat. • Adverse impacts on hunting and wildlife watching due to wetland loss and increases in salinity and water depth. • Visitation to privately managed recreation areas would be impacted by major, permanent, and adverse increases in tidal flooding and sea-level rise leading to restricted access. • Recreational expenditures in the region and the associated economic impacts would decrease over time in concert with any impacts that occur on recreational visitation due to increased storm hazards and tidal flooding, as well as impacts on fish and wildlife abundance.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Temporary, minor, localized, adverse impacts from construction of the proposed Project would occur due to traffic, increased dust, and noise impacts as compared to the No Action Alternative. LA 23 is the only road to and from the recreation sites south of the diversion structure and adverse traffic congestion on LA 23 would occur, which may contribute to delays in accessing sites. Water-based construction traffic in the Mississippi River and Barataria Basin may also have minor impacts on recreational site access for recreational users.
Operational Impacts	• As compared to the No Action Alternative, long-term, minor to major, adverse impacts on site accessibility, recreational boating, and boat-based recreational fishing due to increased tidal flooding at access points in Lafitte, Myrtle Grove, and Grand Bayou and permanent, moderate, adverse impacts on site accessibility, recreational boating, and boat-based recreational fishing due to sedimentation in some of the Project-area navigation channels used to access recreation sites. • Moderate, permanent, adverse impacts on recreational boating and boat-based recreational fishing as compared to the No Action Alternative due to increase in the introduction and expansion of invasive plant species in the basin, which would clog canals and impede boating. • Minor, permanent, adverse impacts on recreational fishing for spotted seatrout as compared to the No Action Alternative. No major change in species location or abundance is expected for spotted seatrout. Moderate, permanent, beneficial impacts on recreational fishing for red drum are expected due to the Project operations' beneficial impact on increased marsh and primary production. Spotted seatrout and red drum are the most targeted species by recreational anglers in the basin. Some recreational fishers may need to modify their traditional fishing locations to target specific species that may modify habitat use (either temporarily or permanently) based on changing salinities. • Beneficial impacts on hunting and wildlife watching due to an increase in wetland habitat in some areas of the Barataria Basin compared to No Action Alternative; adverse impacts due to wetland loss in other areas such as in the birdfoot delta. Overall benefit to these activities is anticipated to be minor to moderate and permanent. • Negligible impacts on privately owned recreation areas as compared to No Action Alternative. • Minor, permanent, adverse or beneficial impacts on the regional economy associated with recreational expenditures in the region as compared to the No Action Alternative. Adverse impacts associated with localized site accessibility impacts and potential decrease in

Table 4.16-5
Summary of Potential Impacts on Recreation and Tourism from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	abundance of spotted seatrout. Beneficial impacts associated with potential increase in abundance of red drum.
50,000 cfs Alternative	
Construction Impacts	• Temporary, minor, adverse impacts from construction of the proposed Project would occur due to traffic, increased dust, and noise impacts as compared to the No Action Alternative. Water-based construction traffic in the Mississippi River and Barataria Basin may also have minor impacts on recreational site access for recreational users. • The duration of impacts due to traffic delays and construction noise and dust would be shorter than the Applicant's Preferred Alternative.
Operational Impacts	• As compared to the No Action Alternative, long-term, minor to moderate, adverse impacts on site accessibility, recreational boating, and boat-based recreational fishing due to increased tidal flooding at access points in Lafitte, Myrtle Grove, and Grand Bayou and permanent, moderate, adverse impacts on site accessibility, recreational boating, and boat-based recreational fishing due to sedimentation in some of the Project-area navigation channels used to access recreation sites. The 50,000 cfs Alternative would differ in the volume of sedimentation in navigation channels, but these differences on recreational site access from the impacts expected under the Applicant's Preferred Alternative would be negligible. • Moderate, permanent, adverse impacts on recreational boating and boat-based recreational fishing as compared to the No Action Alternative due to increase in the introduction and expansion of invasive plant species in the basin, which would clog canals and impede boating. • Minor, permanent, adverse impacts on recreational fishing for spotted seatrout as compared to the No Action Alternative. No major change in species location or abundance is expected for spotted seatrout due to an expected decrease in abundance. Moderate, permanent, beneficial impacts on recreational fishing for red drum. • Beneficial impacts on hunting and wildlife watching due to an increase in wetland habitat in some areas of the Barataria Basin compared to No Action Alternative; adverse impacts due to wetland loss in other areas such as in the birdfoot delta. Overall benefit to these activities is anticipated to be minor to moderate and permanent. As the magnitude of increased habitat near the immediate outfall area is similar between the 50,000 cfs Alternative and the Applicant's Preferred Alternative, the difference between these two alternatives is negligible. • Negligible impacts on privately owned recreation areas as compared to No Action Alternative. • Minor, permanent, adverse or beneficial impacts on the regional economy associated with recreational expenditures in the region as compared to the No Action Alternative. Adverse impacts associated with localized site accessibility impacts and potential decrease in abundance of spotted seatrout. Beneficial impacts associated with potential increase in abundance of red drum.
150,000 cfs Alternative	
Construction Impacts	• Temporary, minor, adverse impacts from construction of the proposed Project would occur due to traffic, increased dust, and noise impacts as compared to the No Action Alternative. Water-based construction traffic in the Mississippi River and Barataria Basin may also have minor impacts on recreational site access for recreational users.

Table 4.16-5
Summary of Potential Impacts on Recreation and Tourism from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	• The duration of impacts due to traffic delays and construction noise and dust would be longer than the Applicant's Preferred Alternative.
Operational Impacts	• As compared to the No Action Alternative, long-term, minor to moderate, adverse impacts on site accessibility, recreational boating, and boat-based recreational fishing due to increased tidal flooding at access points in Lafitte, Myrtle Grove, and Grand Bayou and permanent, moderate, adverse impacts on site accessibility, recreational boating, and boat-based recreational fishing due to sedimentation in some of the Project-area navigation channels used to access recreation sites. The 150,000 cfs Alternative would differ in the volume of sedimentation in navigation channels, but these differences on recreational site access from the impacts expected under the Applicant's Preferred Alternative would be negligible. • Moderate, permanent, adverse impacts on recreational boating and boat-based recreational fishing as compared to the No Action Alternative due to increase in the introduction and expansion of invasive plant species in the basin, which would clog canals and impede boating. • Minor, permanent, adverse impacts on recreational fishing for spotted seatrout as compared to the No Action Alternative. No major change in species location or abundance is expected for spotted seatrout due to an expected decrease in abundance. Moderate, permanent, beneficial impacts on recreational fishing for red drum. • Beneficial impacts on hunting and wildlife watching due to an increase in wetland habitat in some areas of the Barataria Basin compared to No Action Alternative; adverse impacts due to wetland loss in other areas such as in the birdfoot delta. Overall benefit to these activities is anticipated to be minor to moderate and permanent. The 150,000 cfs Alternative would likely result in a greater increase in these recreational activities than the Applicant's Preferred Alternative, given the magnitude of increased habitat associated with the 150,000 cfs Alternative. • Negligible impacts on privately owned recreation areas as compared to No Action Alternative. • Minor, permanent, adverse or beneficial impacts on the regional economy associated with recreational expenditures in the region as compared to the No Action Alternative. Adverse impacts associated with localized site accessibility impacts and potential decrease in abundance of spotted seatrout. Beneficial impacts associated with potential increase in abundance of red drum.
Terrace Alternatives	
Construction Impacts	• The three terrace alternatives would have the same construction impacts as those described under the 75,000 cfs, 50,000 cfs, and 150,000 cfs alternatives. • The construction of terraces in the basin near the proposed diversion structure would have negligible impacts on recreation beyond those anticipated under the corresponding flow capacity action alternatives without terraces listed above.
Operational Impacts	• The three terrace alternatives would have the same operational impacts as those described under the 75,000 cfs, 50,000 cfs, and 150,000 cfs alternatives. • The presence of terraces in the basin near the proposed diversion structure would have negligible impacts on recreation beyond those

Table 4.16-5 Summary of Potential Impacts on Recreation and Tourism from Each Alternative	
Impact Type	**Impact Description (as Compared to No Action Alternative unless Otherwise Stated)**
	anticipated under the corresponding flow capacity action alternatives without terraces listed above.

4.17 PUBLIC LANDS

4.17.1 Area of Potential Impacts

During construction, direct impacts on public lands would occur in the immediate vicinity (within 0.5-mile) of the Project construction footprint from increased turbidity and suspended sediment in surface waters from in-water activities or runoff from adjacent work zones. Indirect construction impacts on public lands would occur on LA 23 in the vicinity of and extending south of the proposed construction footprint due to potential traffic delays for visitors accessing public lands via LA 23. During operations, the area of potential impacts on public lands would include the designated public lands themselves, which are located throughout the Barataria Basin and the birdfoot delta (see Chapter 3, Section 3.16 Recreation and Tourism, Figure 3.16-1 for locations of these public lands).

4.17.2 Guidelines for Public Lands Impact Determinations

Impact intensities for public lands are based on the definitions provided in Section 4.1 and the following public land specific indicators for negligible, minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on public lands would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: the same site capacity and visitor experience would remain unchanged after construction. The impact would be detectable. Users would likely be aware of the action but changes in use could be slight. Impacts would affect relatively few visitors or have localized habitat effects in protected areas. A small impact on the size, integrity, or connectivity of the wetland habitats could occur; however, restoration of wetland habitat could occur if left alone;
- moderate: impacts would be readily apparent and/or would affect visitation locally and in adjacent areas. Users would be aware of the action. Some users would choose to pursue activities in other available local or regional areas. Wetland functions would only be permanently altered in limited areas; and

- major: impacts would affect visitation over a widespread area. Users would be highly aware of the action. Users would choose to pursue activities in other available regional areas. The action would cause a permanent loss or gain of wetlands across a widespread area. The character of the wetlands would be changed so that the functions typically provided by the wetland would be permanently lost.

4.17.3 Construction Impacts

4.17.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The visitation to and management of public lands in the Mississippi River, Barataria Basin, and birdfoot delta would continue as described in Chapter 3, Section 3.17 Public Lands. Ongoing trends of relative sea-level rise and increasing salinities would continue, but only limited impacts on wetland habitat and recreational visitation to public lands in the Project area are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project) (see Chapter 3, Section 3.6 Wetland Resources and Waters of the U.S. for more information about causes of wetland loss in the Project area).

In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that may have some adverse impact on local recreational sites or activities. However, it would be speculative to project what exactly those future developments might be (but see Section 4.25 Cumulative Impacts for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws and regulations.

4.17.3.2 Applicant's Preferred Alternative

No public lands are located within 0.5-mile of the proposed diversion complex footprint. Therefore, there would be no direct construction impacts on public lands. Due to the mobilization of crews and equipment, construction activities under the Applicant's Preferred Alternative may cause traffic congestion during the 5-year construction period, which may indirectly contribute to delays in accessing public lands, particularly in southern Plaquemines Parish. Construction activities are not expected to result in road closures; however, southbound roadway capacity on LA 23 would be reduced at times. LA 23 is the only road to and from public lands south of the diversion structure (see Chapter 3, Section 3.16 Recreation and Tourism, Figure 3.16-1) and Project-induced traffic congestion on LA 23 would be moderate and adverse. This would cause temporary, minor, adverse indirect impacts on recreation users traveling this stretch of LA 23 to access public lands south of the location proposed for the Project construction site. Construction along LA 23 would not impact public lands accessed via Highway 1, including the Elmer's Island Wildlife Refuge and Grand Isle State Park (see Chapter 3, Section 3.17 Public Lands).

4.17.3.3 Other Alternatives

Construction impacts on public lands in the Project area from the other action alternatives would be similar (temporary, minor, and adverse) to the Applicant's Preferred Alternative. As compared with the Applicant's Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition feature of the proposed diversion structure would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes, but the overall construction footprint of all action alternatives would be similar. Additionally, construction timeframes for the 150,000 cfs Alternatives would be longer by several months and for the 50,000 cfs alternatives shorter by several months as compared to the Applicant's Preferred Alternative. As such, the duration of potential temporary, minor, adverse impacts on access to public lands along LA 23 due to traffic delays would be longer or shorter, respectively, than the Applicant's Preferred Alternative. The construction of terraces in the basin under the three terrace alternatives would have no impacts on public lands.

4.17.4 Operational Impacts

4.17.4.1 No Action Alternative

Under the No Action Alternative, ongoing wetland loss would adversely impact public lands over time. As projected by the Delft3D Basinwide Model, approximately 298,235 acres (80.4 percent) and 52,525 (89.1 percent) of wetlands would be lost over a 50-year period (2020 to 2070) in the Barataria Basin and birdfoot delta, respectively (see Section 4.6 Wetland Resources and Waters of the U.S. for additional information about wetland loss in the Project area under the No Action Alternative). The Delft3D Basinwide Model projects that between 2030 and 2070, public lands in the Project area would sustain major, adverse, permanent losses of wetland acreages (see Table 4.17-1). This expected trend would represent permanent, major, adverse impacts on the ability of state and federal agencies managing these public lands to meet conservation goals. Further, ongoing wetland loss would cause declines in the abundance of birds and alligators (see Section 4.9 Terrestrial Wildlife and Habitat), which would adversely impact opportunities for hunting and wildlife watching in public lands that allow these activities.

Table 4.17-1
Comparison of Delft3D Basinwide-Modeled Wetland Acreages between the No Action Alternative (NAA) and the Action Alternatives in Public Lands[a,b]

Recreation Area / Decade	NAA	50,000 cfs Alt.	50,000 cfs Alt. Difference Relative to NAA	75,000 cfs Alt. (Applicant's Preferred)	75,000 cfs Alt. Difference Relative to NAA	150,000 cfs Alt.	150,000 cfs Alt. Difference Relative to NAA
Barataria Basin							
Jean Lafitte National Historical Park and Preserve – Barataria Preserve							
2030	13,000	13,000	0	13,000	0	13,000	0
2040	12,000	12,000	-34	12,000	-68	12,000	-68
2050	6,630	6,630	0	6,630	0	6,700	67
2060	1,730	1,730	0	1,730	0	1,730	0
2070	798	798	0	798	0	798	0
Salvador Wildlife Management Area							
2030	27,700	27,700	0	27,700	0	27,700	0
2040	25,400	25,400	0	25,400	0	25,400	0
2050	21,000	21,000	0	21,000	0	20,900	-34
2060	10,700	10,700	-34	10,700	-34	10,700	-68
2070	2,070	2,040	-35	2,040	-35	2,040	-35
Timken Wildlife Management Area							
2030	2,210	2,210	0	2,210	0	2,210	0
2040	2,110	2,140	34	2,110	0	2,110	0
2050	1,610	1,610	0	1,610	0	1,610	0
2060	256	256	0	256	0	290	34
2070	16	16	0	16	0	16	0
Bayou des Allemands Natural and Scenic River							
2030	57	57	0	57	0	57	0
2040	54	54	0	54	0	54	0
2050	49	48	-1	48	-1	48	-1
2060	30	30	0	30	0	30	0
2070	0	0	0	0	0	0	0
Elmer's Island Wildlife Refuge							
2030	631	617	-14	617	-14	558	-73
2040	457	457	0	457	0	457	0
2050	432	432	0	432	0	432	0
2060	10	10	0	10	0	10	0
2070	10	10	0	10	0	10	0
Grand Isle State Park							
2030	188	188	0	188	0	24	-164
2040	144	144	0	144	0	144	0
2050	143	143	0	143	0	143	0

Table 4.17-1
Comparison of Delft3D Basinwide-Modeled Wetland Acreages between the No Action Alternative (NAA) and the Action Alternatives in Public Lands[a,b]

Recreation Area / Decade	NAA	50,000 cfs Alt.	50,000 cfs Alt. Difference Relative to NAA	75,000 cfs Alt. (Applicant's Preferred)	75,000 cfs Alt. Difference Relative to NAA	150,000 cfs Alt.	150,000 cfs Alt. Difference Relative to NAA
2060	58	58	0	58	0	58	0
2070	28	28	0	28	0	28	0
E.A. Maier Family Donation							
2030	147	147	0	147	0	153	6
2040	73	92	19	92	19	151	78
2050	0	25	25	25	25	68	68
2060	0	0	0	0	0	0	0
2070	0	0	0	0	0	0	0
Birdfoot Delta							
Delta National Wildlife Refuge							
2030	9,350	8,940	-407	8,860	-493	8,290	-1,060
2040	5,990	5,840	-147	5,600	-396	5,040	-952
2050	4,280	4,220	-53	4,400	120	3,960	-321
2060	2,610	2,400	-211	2,530	-80	2,010	-601
2070	1,400	558	-846	477	-926	545	-858
Pass A Loutre Wildlife Management Area							
2030	8,910	8,770	-146	8,780	-133	8,580	-334
2040	3,320	3,380	61	3,390	75	3,370	59
2050	1,520	1,530	13	1,590	69	1,510	-10
2060	602	585	-17	618	16	570	-32
2070	361	327	-34	324	-37	308	-53

[a] Lake Boeuf WMA and Bayou Segnette State Park are in the Project area but outside of the Delft3D Basinwide Model domain and are therefore not included in this table. See Appendix E for more information about the model domain.

[b] Modeled wetland acreages have been rounded to three significant digits.

Under the No Action Alternative, sea-level rise and subsidence would increase the occurrence of tidal flooding on public land access points outside of federal levee systems such as boat launches, marinas, and roads leading to these access points. This would make access to these sites increasingly more difficult throughout the Barataria Basin and birdfoot delta over the 50-year analysis period, with major decreases in site accessibility due to flooding occurring by 2070 (see Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more information about projected flooding in the Project area under the No Action Alternative). Inundation at state and federal lands not protected by federal levee systems may occur acutely during storm events initially and worsen over time with sea-level rise increases, resulting in permanent closures of some sites by 2070 if flood and storm hazard measures are not implemented or are not feasible. When accessing public lands becomes difficult or impossible, recreational users would be expected to modify their behavior and either substitute to alternative locations or forego recreational trips entirely. However, the State of Louisiana would likely make efforts to maintain access to these sites through road elevation, beach nourishment, or other flood and storm hazard mitigation efforts as explained in the State Coastal Master Plan (CPRA 2017a).

4.17.4.2 Applicant's Preferred Alternative

4.17.4.2.1 Barataria Basin

As compared to the No Action Alternative, the Applicant's Preferred Alternative would have negligible to minor, adverse, permanent impacts on public lands in the Barataria Basin due to negligible to minor, adverse, permanent impacts on wetland habitat at these sites (see Table 4.17-1). Because wetlands provide critical ecosystem services including habitat and forage for wildlife and aquatic species, impacts on wetlands directly correlate with impacts on the ability of state and federal agencies to meet conservation objectives on public lands (see Sections 4.9.2 and 4.10.2 for Project-related impacts on Terrestrial Wildlife and Habitat and Aquatic Resources, respectively).

As explained further in Section 4.6 Wetland Resources and Waters of the U.S., the Applicant's Preferred Alternative is anticipated to have major, permanent, beneficial impacts on wetlands in the Barataria Basin where wetlands are sustained and created by the diversion of sediment and fresh water. However, by the end of the 50-year analysis period, any Project-induced wetland benefits on public lands in the Barataria Basin would be overcome by sea-level rise and disappear. As compared to the No Action Alternative, by 2070, the Applicant's Preferred Alternative would result in 0 acres of wetland gains or losses in the Jean Lafitte National Historical Park and Preserve-Barataria Preserve, Timkin WMA, Bayou des Allemands Natural and Scenic River, Elmer's Island Wildlife Refuge, E.A. Maier Family Donation, and Grand Isle State Park; and 35 acres of wetland loss in the Salvadore WMA, representing minor, permanent, adverse wetland impacts (see Table 4.17-1).

The Applicant's Preferred Alternative is expected to cause long-term, minor to moderate, adverse direct and indirect impacts on site accessibility due to increased tidal flooding on public lands in the Project area (or roads leading to those lands) (see Section 4.16 Recreation and Tourism for more information on Project impacts on accessibility to public lands and recreation sites).

Actions to be taken to minimize or provide compensatory mitigation for adverse impacts on public lands are described in Section 4.27 Mitigation Summary.

4.17.4.2.2 Birdfoot Delta

The Applicant's Preferred Alternative is anticipated to have minor to moderate, adverse, permanent impacts on the two state and federal public lands located in the birdfoot delta due to projected decreases in wetlands and the critical ecosystem services they provide, including habitat and forage for wildlife and aquatic species. As compared to the No Action Alternative, the Applicant's Preferred Alternative would result in a net loss of 926 acres and 37 acres, respectively, in the Delta NWR and the Pass A Loutre WMA (see Table 4.17-1). This decline is due to Project-induced reductions in sediment that would be delivered to the birdfoot delta via the Mississippi River and changes in water flow in the river due to Project operations over the 50-year analysis period.

As part of its responsibilities under the Fish and Wildlife Coordination Act (FWCA) and as operator of the Delta NWR, the USFWS recommended the creation of crevasses to build land in the birdfoot delta to offset MBSD Project-induced wetland losses of 926 acres in the Delta NWR and 37 acres in the Pass A Loutre WMA (see Appendix T USFWS Coordination Act Report [FWCAR] of the Final EIS). In response to the FWCAR Recommendation, CPRA agreed that, "Within 5 years of the commencement of Project operations, CPRA or the LA TIG will provide $10,000,000 of additional funding for wetland preservation and restoration work in the Delta NWR and the PAL [Pass A Loutre] WMA to offset modeled acres of indirect wetland losses in those areas. That funding may be accomplished through additional funding through the CWPPRA program, through additional restoration work sponsored by the LA TIG (for example, construction of the Engineering and Design work discussed in the DWH LA TIG's Restoration Plan and Environmental Assessment #7), or through a direct contribution for additional work. The funding will be proportioned between the Delta NWR and the PAL WMA based on the magnitude of the predicted wetland loss in each area" (Final EIS, Appendix R1 Mitigation and Stewardship Plan, Section 4.6 Fish and Wildlife Coordination Act).

4.17.4.3 Other Alternatives

The differences in impacts on public lands with respect to visitation and the ability of managers to meet conservation objectives would be negligible between the Applicant's Preferred Alternative and the other action alternatives. Therefore, the other action alternatives would result in negligible to minor, adverse and beneficial, permanent impacts on public lands in the Barataria Basin and minor to moderate, adverse, permanent impacts on public lands in the birdfoot delta due to wetland impacts and access difficulties associated with tidal flooding (see Section 4.16 Recreation and Tourism).

4.17.4.3.1 50,000 cfs Alternative

The differences in impacts on public lands with respect to visitation and the ability of managers to meet conservation objectives would be negligible between the Applicant's Preferred Alternative and the 50,000 cfs Alternative. As compared to the No Action Alternative, the 50,000 cfs Alternative would result in negligible to minor, adverse and beneficial, permanent impacts on public lands in the Barataria Basin and minor to moderate, adverse, permanent impacts on public lands in the birdfoot delta due to wetland impacts and access difficulties associated with tidal flooding (see Section 4.16 Recreation and Tourism).

4.17.4.3.2 150,000 cfs Alternative

The differences in impacts on public lands with respect to visitation and the ability of managers to meet conservation objectives would be negligible between the Applicant's Preferred Alternative and the 150,000 cfs Alternative. As compared to the No Action Alternative, the 150,000 cfs Alternative would result in negligible to minor, adverse and beneficial, permanent impacts on public lands in the Barataria Basin and minor to moderate, adverse, permanent impacts on public lands in the birdfoot delta due to wetland impacts and access difficulties associated with tidal flooding (see Section 4.16 Recreation and Tourism).

4.17.4.3.3 Terrace Alternatives

The presence of terraces in the immediate outfall area would not have incremental impacts on public lands in the Project area. Therefore, the three terrace alternatives would have impacts similar to those anticipated under the corresponding flow capacity alternatives without terraces, with negligible to minor, adverse and beneficial, permanent impacts on public lands in the Barataria Basin and minor to moderate, adverse, permanent impacts on public lands in the birdfoot delta due to wetland impacts and access difficulties associated with tidal flooding.

4.17.5 Summary of Potential Impacts

Table 4.17-2 summarizes the potential impacts on public lands for each alternative. Details are provided in Sections 4.17.2 through 4.17.4 above.

Table 4.17-2
Summary of Potential Impacts on Public Lands from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No construction impacts on public lands.
Operational Impacts	• Major, permanent, and adverse impacts on public lands due to decreases in wetland habitat availability for fish and wildlife and adverse impacts on visitation accessibility.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Temporary, minor, adverse impacts from construction due to temporary and localized traffic congestion from the mobilization of crews and equipment, which may contribute to delays in accessing public lands.
Operational Impacts	• Negligible to minor, adverse, permanent impacts on public lands in the Barataria Basin due to negligible to minor, adverse impacts on wetland habitat at these sites. • Minor to moderate, adverse, permanent impacts on the Pass A Loutre WMA and Delta NWR in the birdfoot delta due to projected decreases in wetland habitat. • Long-term, minor to moderate, adverse direct and indirect impacts on site accessibility due to increased tidal flooding at public lands and private recreation sites (or roads leading to those sites).

Table 4.17-2
Summary of Potential Impacts on Public Lands from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
50,000 cfs Alternative	
Construction Impacts	• Temporary, minor, adverse impacts from construction due to temporary and localized traffic congestion from the mobilization of crews and equipment, which may contribute to delays in accessing public lands.
Operational Impacts	• Negligible to minor, adverse, permanent impacts on public lands in the Barataria Basin due to negligible to minor, adverse impacts on wetland habitat at these sites. • Minor to moderate, adverse, permanent impacts on the Pass A Loutre WMA and Delta NWR in the birdfoot delta due to projected decreases in wetland habitat. • Long-term, minor to moderate, adverse direct and indirect impacts on site accessibility due to increased tidal flooding at public lands and private recreation sites (or roads leading to those sites).
150,000 cfs Alternative	
Construction Impacts	• Temporary, minor, adverse impacts from construction due to temporary and localized traffic congestion from the mobilization of crews and equipment, which may contribute to delays in accessing public lands.
Operational Impacts	• Negligible to minor, adverse, permanent impacts on public lands in the Barataria Basin due to negligible to minor, adverse impacts on wetland habitat at these sites. • Minor to moderate, adverse, permanent impacts on the Pass A Loutre and Delta NWR in the birdfoot delta due to projected decreases in wetland habitat. • Long-term, minor to moderate, adverse direct and indirect impacts on site accessibility due to increased tidal flooding at public lands and private recreation sites (or roads leading to those sites).
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on public lands as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on public lands due to the construction of terraces would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on public lands as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on public lands due to the presence of terraces during Project operations would be negligible.

4.18 LAND USE AND LAND COVER

4.18.1 Area of Potential Impacts

During construction, the majority of impacts on land use and land cover would occur in the immediate vicinity of the Project construction footprint, generally within 0.5 mile. During operations, the area of potential land use and land cover impacts would extend throughout the Barataria Basin and the birdfoot delta due to gradual erosion and aggradation resulting in changes in land mass.

4.18.2 Guidelines for Land Use/Land Cover Impact Determinations

Impact intensities for land use/land cover are based on the definitions provided in Section 4.1 and the following resource-specific indicators for negligible, minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on land use/land cover would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: the action would require a variance or zoning change or an amendment to a land use, area comprehensive, or management plan, but would not affect overall use and management beyond the local area;
- moderate: the action would require a variance or zoning change or an amendment to a land use, area comprehensive, or management plan, and would affect overall land use and management in local and adjacent areas; and
- major: the action would cause permanent changes to and conflict with land uses or management plans over a widespread area.

4.18.3 Construction Impacts

4.18.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The existing land use and land cover in the Project area would continue as described in Chapter 3, Section 3.18 Land Use and Land Cover. Ongoing trends including sea-level rise, erosion, subsidence, flooding, wave activity, saltwater intrusion, and damaging wind during storm events are expected to continue, but only limited changes to land use and land cover are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project); therefore, there would likely be only negligible impacts on land use during that timeframe.

In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes, and in particular the areas classified such that commercial and industrial uses are allowed (see Chapter 3, Section 3.18.3 in Land Use and Land Cover). However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.18.3.2 Applicant's Preferred Alternative

A mix of temporary and short-term, moderate, adverse impacts (affecting overall land use in the construction footprint but not requiring a zoning change) on existing land use would occur during construction of the proposed Project, as compared to the No Action Alternative. These impacts are due to land-based construction of the diversion complex, auxiliary structures, and outfall features, which would require vegetation clearing, ground disturbance, and fill placement, as well as the movement of construction personnel and equipment in both land and water.

The conversion of agricultural, open, and forested land to developed land would be a direct, moderate, permanent adverse impact on land use and land cover in the Project area. Construction of the proposed Project would impact a total of approximately 1,376.0 acres of uplands, wetlands, and open water in Jefferson and Plaquemines Parishes (see Table 4.18-1 and Figure 4.18-1), with the majority of impacts occurring in uplands (see Section 4.2 Geology and Soils, Table 4.2-1 for Project component acreages). The upland portion of the construction footprint would impact a mix of agricultural (which may be actively tilled or fallow land), forest land, developed, and open land. These land use types are defined in Chapter 3, Section 3.18.2 in Land Use and Land Cover and depicted in Figure 4.18-1. Water-based construction activities would occur in the Mississippi River for installation of diversion complex features such as the cofferdam, intake system, and river trestle dock. Water-based construction activities in the Barataria Basin outfall area would include dredging operations for the outfall transition feature and access routes for barge deliveries of construction materials. Excavation and pile-driving activities for construction of the diversion complex features may also occur from the basin. See Chapter 3, Section 3.18.2 in Land Use and Land Cover for definitions of each land use type.

In addition to the 1,376.0 acres impacted by construction shown in Table 4.18-1, dredged material may be placed in the basin near the proposed outfall transition feature in designated beneficial use areas that would be comprised predominately of open water (375 acres) but also include 92 acres of emergent herbaceous wetlands.

Table 4.18-1
Land Use Types Impacted by Project Construction Footprint[a]

Land Use Type	Diversion Complex and Associated Construction Components[b]		Access Channels[c]	
	Acres	Percentage	Acres	Percentage
Uplands				
Cultivated Crops	4.4	0.4%	0.0	0.0%
Deciduous Forest	119.2	11.4%	0.0	0.0%
Developed, Low Intensity	36.7	3.5%	0.0	0.0%
Developed, Medium Intensity	6.0	0.6%	0.0	0.0%
Developed, High Intensity	0.2	0.0%	0.0	0.0%
Shrub/Scrub	6.9	0.7%	0.0	0.0%
Mixed Forest	30.7	2.9%	0.0	0.0%
Pasture/Hay	458.1	43.9%	0.0	0.0%
Grassland/herbaceous	32.9	3.2%	0.9	0.3%
Barren Land (Rock/Sand/Clay)	83.6	8.0%	0.0	0.0%
Developed, Open Space	4.7	0.5%	0.0	0.0%
Evergreen Forest	1.8	0.4%	0.0	0.0%
Subtotal	785.2	75.2%	0.9	0.3%
Open Water and Wetlands[d]				
Open Water	204.4	19.6%	266.7	80.3%
Emergent Herbaceous Wetlands	38.7	3.7%	64.7	19.5%
Woody Wetlands	15.3	1.5%	0.0	0.0%
Subtotal	258.4	24.8%	331.4	99.7%
Total Acres	1,043.6	100.0%	332.3	100.0%
Total Acres of Diversion Complex + Access Channels	**1,376.0 acres**			

Source: MRLC 2019

[a] The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends. Further, certain Project features overlap; however, the overlap has been accounted for in this table to avoid double counting. Therefore, acreages presented in this table are not equated to component acreages presented in Chapter 2, Table 2.8.2.

[b] This includes the outfall transition feature in the basin where dredging would occur. It also includes associated Project components like the river trestle dock, haul roads, disposal areas, and construction contractor yards that would not be maintained during Project operations.

[c] This includes adjacent stockpile/disposal sites that would not be required for operation of the Project.

[d] These data are based on land use data and therefore differ from wetland acreages presented in Section 4.6 Wetland Resources and Waters of the U.S., as well as the forested acreage presented in Sections 4.9 and 4.12, which are based on field surveys as well as desktop delineations that were coordinated with CEMVN.

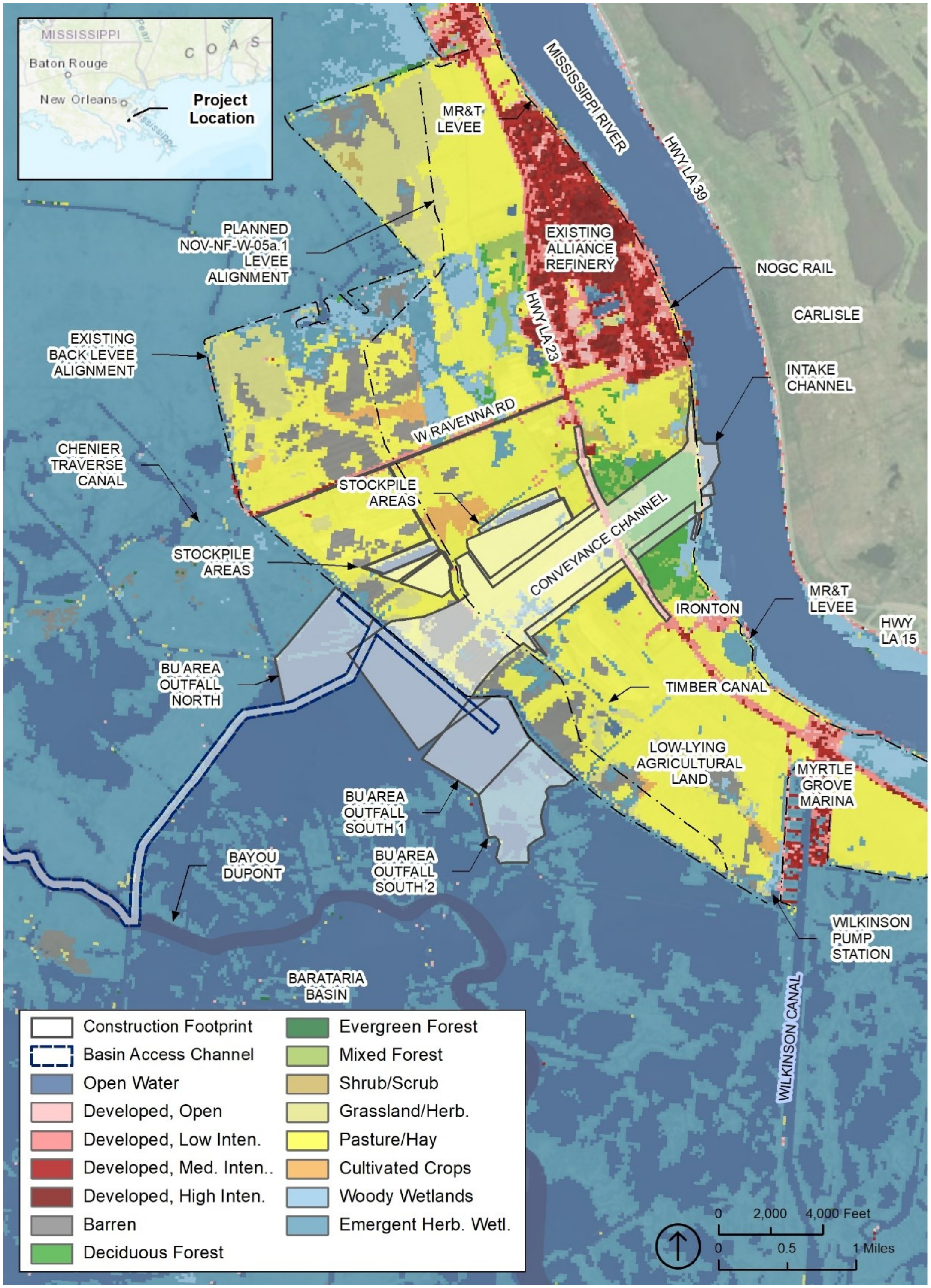


Figure 4.18-1. Land Use and Land Cover in Project Construction Footprint, 2019.

Construction impacts in the immediate outfall area associated with dredging the outfall transition feature and barge access channels would eventually be filled in with sediment to create new wetlands during Project operations. Impacts on wetlands associated with beneficial use areas would result in beneficial impacts on wetland resources, and are discussed in detail in Section 4.6 Wetland Resources and Waters of the U.S.

No buildings are currently present within the footprint of the proposed diversion complex. However, portions of LA-23, the NOGC Railroad, and the MR&T and NOV-NFL Levees, as well as existing utilities within the Project area, would be modified or relocated. The closest residences are in Ironton, about 0.5 mile south-southeast of the proposed diversion complex. As described in Chapter 3, Section 3.18.3 in Land Use and Land Cover, the portion of the diversion complex located in Jefferson Parish would be on land zoned as unrestricted rural, while the portion located in Plaquemines Parish would be within a floodplain district that allows certain uses, including industrial, subject to approval. It is expected that re-zoning of the site would not be required.

Direct impacts would occur on lands where active construction occurs as well as any exclusion areas established by the installation of safety fencing. Minor, temporary adverse, indirect impacts could occur on adjacent lands, including nearby residences and businesses, from construction noise and dust; disturbance or removal of lawns, trees, landscaped shrubs, or similar vegetation; and the relocation of existing infrastructure within the Project area. Use of open water within the Mississippi River and Barataria Basin associated with construction of the diversion complex and auxiliary structures would include minor increases in water-based traffic and minor reductions in access for commercial and recreational users when Project vessels are in transit through these waterbodies. These minor, adverse impacts would be temporary, occurring over the 5-year construction period, and intermittent, based on the expected number and frequency of construction vessels, as described in Section 4.21 Navigation. Impacts on recreational and commercial use of the river and basin are described in Sections 4.16 Recreation and Tourism and Section 4.21 Navigation, respectively.

4.18.3.3 Other Alternatives

All action alternatives would have a similar construction footprint as that of the Applicant's Preferred Alternative, except for the width of the intake and conveyance channels. The 50,000 cfs Alternatives would require a narrower intake and conveyance channel width, as compared to the 75,000 cfs Alternatives, while the 150,000 cfs Alternatives would require the widest intake and conveyance channel widths. The direct and indirect impacts from construction of these other action alternatives on land use and land cover would be a mix of temporary and short-term, moderate, adverse impacts as compared to the No Action Alternative, and similar to those described above for the Applicant's Preferred Alternative. The conversion of agricultural, open land, forest land, and wetlands to developed land would be a direct, moderate, permanent impact on land use and land cover in the Project area. Incremental impacts on land use from the construction of terraces would be negligible, as compared to the Applicant's Preferred Alternative. Therefore, all three terrace alternatives, as compared to the No Action Alternative would cause the same construction impacts as described above for the Applicant's Preferred Alternative.

4.18.4 Operational Impacts

4.18.4.1 No Action Alternative

In the long-term, without Project implementation, the existing land use and land cover in the immediate vicinity (within 0.5-mile) of the proposed diversion complex would likely change due to future land use management, as discussed in Chapter 3, Section 3.18.4 in Land Use and Land Cover. Similarly, land use and land cover within the basin and the birdfoot delta would change as a result of ongoing processes, including sea-level rise, erosion, subsidence, flooding, wave activity, saltwater intrusion, and damaging wind during storm events. See Section 4.2 Geology and Soils and Section 4.4 Surface Water and Coastal Processes for details on these ongoing processes. Wetland losses would be persistent over the next 50 years, converting a greater percentage of the basin into open water. In the birdfoot delta, while wetland losses would be less than under the action alternatives, the loss of wetlands would continue. See Section 4.6.2.1 in Wetland Resources and Waters of the U.S. above for details. These changes would result in major, permanent, adverse impacts on land use and land cover.

Certain water-based users of the basin could experience minor, beneficial impacts given the larger amount of surface water available for fishing, boating, wildlife viewing, and other water-based tourism; however, these benefits could be offset by adverse impacts from marsh loss on associated resources (see Sections 4.14 Commercial Fisheries and 4.16 Recreation and Tourism). Under the No Action Alternative, the goals set forth by the state and parishes in their respective plans described in Chapter 3, Section 3.18.4.1 in Land Use and Land Cover would not be met. Specifically, coastline restoration and flood protection benefits associated with construction of the proposed Project would not be achieved, which could discourage investment in the Project area. Refer to Section 4.2 Geology and Soils for details about modeled land loss rates associated with the No Action Alternative.

4.18.4.2 Applicant's Preferred Alternative

Operation of the proposed Project would have permanent, moderate, adverse and permanent, major, beneficial impacts on existing land use in the Project area as compared to the No Action Alternative. Whether these changes in land use types are adverse or beneficial depends on the particular use or user in question. For example, as discussed in Section 4.16 Recreation and Tourism, the creation of wetlands within the basin would be beneficial for certain uses such as hunting of waterfowl. Alternatively, impacts would be considered adverse for other water-based users where open water is more desirable.

Certain Project components like the river trestle dock, haul roads, disposal sites, and construction contractor yards would not be maintained for operation. Also, the temporary cofferdam in the Mississippi River would be removed upon completion of construction of the diversion complex. Therefore, the operational, permanent footprint required for the diversion complex and auxiliary structures would be about 793 acres.

After commencement of operations, the access channels in the immediate outfall area in the basin would fill in with sediment. As previously discussed, about 151.7 acres of forest land (deciduous, mixed, and evergreen forest) would be disturbed during construction of the diversion complex and auxiliary facilities, all of which would be maintained for operation of the Project facilities. Further, in addition to 131.2 acres of land classified as developed or barren, about 462.5 acres of agricultural land (most of which is not actively cultivated), 204.4 acres of open water, 39.8 acres of open land (shrubland and herbaceous lands), and 54.0 acres of wetlands (woody wetlands and emergent herbaceous wetlands) within the operational footprint would be permanently converted to developed land and would not be available for development by others during the Project analysis period. This would result in moderate, permanent, adverse impacts on existing land use as compared to the No Action Alternative. Although land currently classified as developed would not result in a conversion of land type, the Applicant's use of the land would be different than the current industrial or commercial use.

Based on the results of Delft3D Basinwide Modeling, new land would be created from operation of the proposed Project within the Barataria Basin, and land loss would occur in the birdfoot delta as compared to the No Action Alternative (see Section 4.2 Geology and Soils, Tables 4.2-3 and 4.2-4). Changes in land use and land cover (specifically wetlands and open water) within the Barataria Basin and the birdfoot delta, as well as changes in use (for example, fishing, recreation, and tourism; as discussed in Chapter 3 Section 3.16 and in 4.16 Recreation and Tourism) would be considered direct impacts, while impacts such as these that occur on adjacent lands outside of the basin and birdfoot delta are considered indirect impacts. During the 50-year analysis period, the total acres created by the Project in the Barataria Basin is greatest in 2050; however, at that time the difference in land area relative to the No Action Alternative is about 9 percent. Alternatively, by 2070 the Applicant's Preferred Alternative is outperforming the No Action Alternative, generating 26 percent more land area as compared to the No Action Alternative (see Section 4.2 Geology and Soils, Table 4.2-4). Land area loss within the birdfoot delta as compared to the No Action Alternative is greater, a trend that peaks in year 2070, with about 45 percent more land area loss occurring under the Applicant's Preferred Alternative as compared to the No Action Alternative. The expected land gains and losses under the No Action Alternative are presented in Section 4.2 Geology and Soils, Table 4.2-3. The overall trend of land area gained in the Barataria Basin and lost in the birdfoot delta under the Applicant's Preferred Alternative as compared to the No Action Alternative applies to the creation or loss of wetlands, as discussed further in Section 4.6 Wetland Resources and Waters of the U.S.

Land gains in the Barataria Basin would have permanent, major, beneficial impacts on certain uses through the creation of wetland habitat that supports fishing, wildlife viewing, and other tourism activities as discussed in Section 4.16 Recreation and Tourism. Under the Applicant's Preferred Alternative, the creation of wetlands in the Barataria Basin would aid in achieving the goals set forth by the state and parishes' respective plans, such as coastline restoration and flood protection, which could induce investment in the Project area. Future issues and needs identified by Plaquemines

Parish in its 2020 master plan focus on the lower delta (Plaquemines Parish 2020). The loss of wetlands expected in the birdfoot delta would have permanent, moderate, impacts on land use; land loss in the birdfoot delta would increase under the Applicant's Preferred Alternative as compared with the No Action Alternative. Whether this loss is perceived as beneficial or adverse depends on the perspective of the user, in terms of land- versus water-based users, as discussed above.

Indirect impacts from the proposed Project could result in changes to land use in areas adjacent to the basin and birdfoot delta. Changes in use could be from displacement of fishing, recreation, and other tourism activities from the basin or birdfoot delta to the adjacent areas, or vice versa, as discussed above.

Ongoing maintenance activities, such as dredging and mowing of vegetation at the diversion complex permanent rights-of-way and on the Mississippi River Levee would occur periodically. These activities would occur intermittently and would be consistent with other periodic vegetation maintenance activities in the area of potential impacts, such as the mowing of roadside vegetation and lawns on developed land.

4.18.4.3 Other Alternatives

Like the Applicant's Preferred Alternative, changes in land use and land cover (specifically wetlands and open water) within the Barataria Basin and the birdfoot delta, as well as changes in use (for example, fishing, recreation, and tourism) would occur with the other alternatives. The other action alternatives would result in land gains, specifically wetlands, in the Barataria Basin that would have permanent, major, beneficial impacts as compared to the No Action Alternative on certain uses (for example, fishing, wildlife viewing, and other tourism) through the creation of supporting habitat. See Section 4.16 Recreation and Tourism for additional discussion about impacts on recreational resources. Expected land loss in the birdfoot delta would have similar impacts on wetlands and open water as the No Action Alternative, specifically, increasing the surface area of open water for users, the benefit of which could be offset by permanent, moderate, adverse impacts from wetland loss on associated resources. The wetland creation in the Barataria Basin resulting from the action alternatives would also aid in achieving the goals set forth by the state and parishes' respective plans, including coastline restoration and flood protection, which could induce investment in the Project area. A comparison of the action alternatives' direct impacts on land gain and loss is summarized below.

Changes in land use and land cover (specifically wetlands and open water) within the Barataria Basin and the birdfoot delta, as well as changes in use (for example, fishing, recreation, and tourism) would be considered direct impacts, while impacts such as these that occur on adjacent lands outside of the basin and birdfoot delta are considered indirect impacts.

4.18.4.3.1 50,000 cfs Alternative

The direct impacts from operation and maintenance of the 50,000 cfs Alternative on land use and land cover would be slightly less than the Applicant's Preferred Alternative. Based on the results of Delft3D Basinwide Modeling, land creation within the Barataria Basin from operation of this alternative would result in a cumulative net land gain of 9,660 acres in the Barataria Basin and a cumulative net land loss of 2,820 acres in the birdfoot delta with respect to the No Action Alternative in 2070 (see Section 4.2 Geology and Soils, Table 4.2-4).

4.18.4.3.2 150,000 cfs Alternative

The direct impacts from operation and maintenance of the 150,000 cfs Alternative on land use and land cover would result in substantially greater land gains in the Barataria Basin and slightly less land loss in the birdfoot delta as compared to the Applicant's Preferred Alternative. Land creation within the Barataria Basin in 2070 under the 150,000 cfs Alternative would result in a cumulative net land gain of 29,200 acres in the Barataria Basin as compared to the No Action Alternative. A cumulative net land loss of about 2,820 acres in year 2070 would occur in the birdfoot delta under this alternative (see Section 4.2 Geology and Soils, Table 4.2-4).

4.18.4.3.3 Terrace Alternatives

While the gains and losses of land area and wetlands vary over time, as shown in Section 4.2 Geology and Soils, Tables 4.2-4 and 4.2-6, by year 2070, each of the terrace alternatives would result in the same percent change in land area in the Barataria Basin, as compared to the corresponding non-terrace alternatives (26 percent, 19 percent, and 56 percent; see Table 4.2-4). Results of the percent change in land in the birdfoot delta by 2070 are generally the same under the with- and without-terrace alternatives, with the greatest difference being under the 150,000 cfs Alternative with terraces (38 percent) as compared to the 150,000 cfs Alternative without terraces (42 percent). Focusing on the creation or loss of wetlands, by 2070 the terrace alternatives would result in generally the same percent change as under the corresponding capacity alternatives without terraces, with the greatest difference being under the 150,000 cfs terrace alternative (35.4 percent gains in the basin and 42.1 percent loss in the birdfoot delta) as compared to the 150,000 cfs Alternative without terraces (36.3 percent gains in the basin and 38.0 percent loss in the birdfoot delta) (see Table 4.6-4 in Section 4.6 Wetland Resources and Waters of the U.S.). Overall, the incremental impacts due to the presence of terraces would be negligible. With minor differences, the presence of terraces, as compared to the No Action Alternative, would have the same operational impacts on land use and land cover to those anticipated under the respective non-terraced flow capacity alternatives.

4.18.5 Summary of Potential Impacts

Table 4.18-2 summarizes the potential impacts on land use and land cover for each alternative. Details are provided in Sections 4.18.2 through 4.18.3 above.

Table 4.18-2
Summary of Potential Impacts on Land Use and Land Cover from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on land use from construction of the proposed Project would occur. • Any future impacts would be required to comply with applicable permits and laws.
Operational Impacts	• Major, permanent, adverse impacts due to continued land loss in the Barataria Basin and birdfoot delta.
75,000 cfs Alternative (Applicant's Preferred Alternative)	
Construction Impacts	• Moderate, temporary, and short-term, adverse impacts due to vegetation clearing, ground disturbance, and fill placement. • The conversion of agricultural, open, and forested land to developed land would be a moderate, permanent, adverse impact on land use and land cover in the Project area. • Minor, temporary, adverse impacts on adjacent lands due to noise and dust during active construction. • Minor, temporary, adverse impacts on commercial and recreation water-based users from waters where active construction occurs and marine construction traffic during construction.
Operational Impacts	• Moderate, permanent impacts on existing land use; whether these changes in land use types are adverse or beneficial depends on the particular use or user in question. Agricultural, forests, and open land would be permanently converted to developed land for the operational, permanent footprint required for the diversion complex and auxiliary structures. Land currently classified as developed would not result in a conversion of land type, however the Applicant's use of the land would be different than the current industrial or commercial use. • Major, permanent, beneficial impacts in the Barataria Basin due to lands that are sustained or created (13,400 acres by year 2070) by the diversion of sediment, fresh water and nutrients, and enhanced habitat that supports fishing, boating, wildlife viewing, and other water-based tourism in the Barataria Basin. • Land loss in the form of wetlands in the birdfoot delta would have moderate, permanent, adverse or beneficial (depending on the user) impacts on land use. While land loss would occur in the birdfoot delta under the No Action Alternative, it would increase with the Applicant's Preferred Alternative (an additional 3,000 acres would be lost by 2070).
50,000 cfs Alternative	
Construction Impacts	• Moderate, temporary, and short-term, adverse impacts due to vegetation clearing, ground disturbance, and fill placement. • The conversion of agricultural, open, and forested land to developed land would be a moderate, permanent, adverse impact on land use and land cover in the Project area. • Minor, temporary, adverse impacts on adjacent lands due to noise and dust during active construction. • Minor, temporary, adverse impacts on commercial and recreation water-based users from waters where active construction occurs and marine construction traffic during construction.

Table 4.18-2
Summary of Potential Impacts on Land Use and Land Cover from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• Moderate, permanent impacts on existing land use; whether these changes in land use types are adverse or beneficial depends on the particular use or user in question. Agricultural, forest, and open land would be permanently converted to developed land for the operational, permanent footprint required for the diversion complex and auxiliary structures. • Major, permanent, beneficial impacts in the Barataria Basin due to lands that are sustained or created (9,660 acres by year 2070) by the diversion of sediment, fresh water and nutrients, and enhanced habitat that supports fishing, boating, wildlife viewing, and other water-based tourism in the Barataria Basin. • Land loss in the form of wetlands in the birdfoot delta would have the moderate, permanent, adverse or beneficial (depending on the user) impacts on land use; under this alternative, land loss in the birdfoot delta would be increased as compared with the No Action Alternative (an additional 2,820 acres would be lost by 2070).
150,000 cfs Alternative	
Construction Impacts	• Moderate, temporary and short-term, adverse impacts due to vegetation clearing, ground disturbance, and fill placement. • The conversion of agricultural, open, and forested land to developed land would be a moderate, permanent, adverse impact on land use and land cover in the Project area. • Minor, temporary, adverse impacts on adjacent lands due to noise and dust during active construction. • Minor, temporary, adverse impacts on commercial and recreation users from waters where active construction occurs and marine construction traffic during construction.
Operational Impacts	• Moderate, permanent impacts on existing land use; whether these changes in land use types are adverse or beneficial depends on the particular use or user in question. Agricultural, forest, and open land would be permanently converted to developed land for the operational, permanent footprint required for the diversion complex and auxiliary structures. • Major, permanent, beneficial impacts in the Project area due to lands that are sustained or created (29,200 acres by year 2070) by the diversion of sediment and fresh water and enhanced habitat that supports fishing, boating, wildlife viewing, and other water-based tourism in the Barataria Basin. • Land loss in the form of wetlands in the birdfoot delta would have the moderate, permanent, adverse or beneficial (depending on the user) impacts on land use; under this alternative, land loss in the birdfoot delta would be increased as compared with the No Action Alternative (an additional 2,820 acres would be lost by 2070).
Terrace Alternatives	
Construction Impacts	• The construction of terraces in the outfall area would not impact existing land use; as compared to the Applicant's Preferred Alternative, the incremental impacts on land use from the construction of terraces would be negligible. • Therefore, as compared to the No Action Alternative, all three terrace alternatives would cause the same construction impacts as listed above for the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives. Any additional impacts on land use due to the construction of terraces would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would cause generally the same operational impacts as listed above for the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives. The incremental impacts due to the presence of terraces would be negligible.

4.19 AESTHETIC AND VISUAL RESOURCES

4.19.1 Area of Potential Impacts

During construction, the area of potential impacts on aesthetic and visual resources is considered to be the distance from which active construction areas would be visible. Based on the types of construction equipment and topography of the construction footprint, construction activities could be visible to visual receptors within about 0.25 mile of the construction footprint. Impacts during construction would also occur for visual receptors along the road and waterways that would be used to transport equipment, construction personnel, and dredged material to and from the construction sites. Collectively, these areas compose the viewshed for the analysis of construction impacts.

During operations, the area of potential impacts would be the viewshed from which the built structures associated with the diversion complex and their lighting are visible to residents and visitors, as well as the delta formation area in the basin. For any one structure, the distance would be based on the specific facility design, including color scheme and dimensions.

4.19.2 Guidelines for Aesthetic and Visual Resources Impact Determinations

Impact intensities for visual and aesthetic resources are based on the definitions provided in Section 4.1 and the following resource-specific indicators for negligible, minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on visual resources would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[123]
- minor: there would be a change in the viewshed that is readily apparent but would not attract attention, dominate the view, or detract from current user activities or experiences;
- moderate: there would be a change in the viewshed that is readily apparent and attracts attention. Changes would not dominate the viewscape, although they could detract from the current user activities or experiences; and
- major: changes to the characteristic views would dominate and detract from current user activities or experiences.

[123] The term "negligible" will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

4.19.3 Construction Impacts

4.19.3.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. The existing viewshed in the Project area would remain as described in Chapter 3, Section 3.19 Aesthetic and Visual Resources. Ongoing trends of sea-level rise and increasing salinities would continue, but only limited changes to the area's viewshed are expected to occur under the No Action Alternative during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project); therefore, there would likely be negligible impacts on aesthetic and visual resources during that timeframe.

In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area may be developed for industrial or commercial purposes. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.19.3.2 Applicant's Preferred Alternative

Temporary, minor, adverse impacts on visual resources would occur during construction of the proposed Project. Land-based construction would require ground disturbance and the removal of existing vegetation associated with installation of the built structures, relocation of portions of LA 23 and the NOGC Railroad, as well as alteration to portions of the MR&T and NOV-NFL Levees. These construction activities could generate dust, which may be a nuisance to visual receptors, and could generally diminish the quality of the existing viewshed.

Water-based construction activities in the Barataria Basin immediate outfall area would include dredging operations for the outfall transition feature and conveyance channel, access routes for barge deliveries of construction materials, and placement of dredged material at designated beneficial use areas. Excavation and pile-driving activities for construction of the diversion complex features would also occur in the basin. Water-based construction activities would also occur in the Mississippi River for installation of diversion complex features such as the cofferdam and intake channel structure. In addition, land- and water-based traffic would increase in the Project area to accommodate the delivery of construction materials, equipment, and personnel to and from the Project construction footprint. These activities would occur during the 5-year construction period for the proposed Project and would affect the views of people at nearby residences and businesses, motorists on transportation corridors, and people engaging in water-based activities on the Mississippi River and in the Barataria Basin. Impacts on a specific visual receptor would vary based on the viewer's location, the adjacent land use type, and the specific construction activity occurring at that time. The increase in construction-related water-based traffic would have a minor impact on the viewshed because the vessels would be consistent with current use and the visual character of these waterways.

As discussed in Chapter 3, Section 3.8 Noise, several residences are located near areas of active construction (see Table 3.8-3). Construction activities such as the movement of equipment and associated dust plumes, and earthwork (such as land clearing and ground excavation) could affect the views for these residences. The Applicant would minimize dust generated by construction as discussed in Section 4.7 Air Quality. Given the distance between the residences and the construction footprint (ranging from 0.4 to 1.3 miles), as well as the presence of existing industrial infrastructure within the viewshed, these changes would be temporary and minor. The Applicant would also minimize construction-related impacts on nearby residents by limiting construction to daytime hours, to the extent practicable.

4.19.3.3 Other Alternatives

All action alternatives would have a similar construction footprint as that of the Applicant's Preferred Alternative. As such, the direct and indirect impacts from construction of all other action alternatives on visual resources would be temporary, minor, and adverse as compared to the No Action Alternative and similar to those described above for the Applicant's Preferred Alternative. As compared with the Applicant's Preferred Alternative, CPRA estimates that the intake channel, conveyance channel, and outfall transition feature would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes. The overall construction footprint of all action alternatives would be similar. Additionally, construction timeframes for the 150,000 cfs Alternatives would be longer by several months and for the 50,000 cfs Alternatives would be shorter by several months as compared to the Applicant's Preferred Alternative. As such, the duration of potential temporary impacts on aesthetic and visual resources would be longer or shorter, respectively, than the Applicant's Preferred Alternative.

Incremental impacts on visual receptors associated with the construction of terraces would be negligible; as compared to the Applicant's Preferred Alternative, the construction-related water-based activities and associated vessels would be similar to current uses and the visual character of the basin. Therefore, all three terrace alternatives, as compared to the No Action Alternative would cause the same construction impacts as described above for the Applicant's Preferred Alternative.

4.19.4 Operational Impacts

4.19.4.1 No Action Alternative

Under the No Action Alternative, in the long-term, the existing viewshed would likely evolve as a result of natural processes and from future land use management, as discussed in Chapter 3, Section 3.18 Land Use and Land Cover. The impact of these changes could result in minor to major, adverse or beneficial impacts on aesthetic and visual resources depending on the type and amount of development that occurs.

Similarly, the viewshed within the basin and the birdfoot delta would change as a result of ongoing processes, including sea-level rise, erosion, subsidence, flooding, wave activity, saltwater intrusion, and damaging wind during storm events. These changes would be gradual and over time, in areas where visual receptors are present only intermittently (for example, fishermen, boaters, hunters); as such, impacts on the viewshed for these visual receptors would be minor. Whether the changes in the viewshed are perceived as beneficial or adverse, would depend on the perspective of the individual receptor and his/her use or interactions within the Project area.

4.19.4.2 Applicant's Preferred Alternative

Permanent, moderate, adverse impacts on visual resources would result from operation of the proposed Project due to the presence of aboveground structures, as compared to the No Action Alternative. The most prominent visual feature of the proposed Project would be the diversion complex. While the diversion complex would be about 793 acres, including the outfall transition feature in the basin where dredging would occur, it would have a low physical profile, thereby minimizing its impact on the viewshed. Project structures (for example, the levees, administrative buildings, and diversion control structure) would generally range from 20 to 25 feet in height. The tallest Project structure would be the machine rooms on top of the gated control structure at about 41 feet, which would consist of three 45-foot wide steel gates with an invert elevation of 40 feet and a top-of-wall elevation of 16.4 feet.

Other visible structures within the diversion complex would include the portions of LA 23 and the NOGC Railroad rights-of-way that would be raised and relocated over the conveyance channel. The relocation of LA 23 would occur via a bridge that would be approximately 34 feet in height. The relocated segment of railroad would be achieved through construction of a bridge over the proposed conveyance channel with a bottom elevation of 16.4 feet and track elevation of 20.4 feet.

In accordance with federal safety regulations, facilities would be illuminated at night. The Applicant would implement measures that would reduce night time visibility of the aboveground facilities, including light reduction techniques such as limiting the amount of outdoor lighting installed, dimming lights at night, and directing light downward.

Mowing and other vegetation maintenance would also be conducted in vegetated areas at the diversion complex. These activities would occur intermittently and would be consistent with other periodic vegetation maintenance activities at other existing facilities and maintained rights-of-way in the Project area, such as the mowing of roadside vegetation, the Mississippi River Levee, and lawns on developed land.

While the built structures for the proposed Project would represent new aboveground facilities, which would permanently change the viewshed for nearby receptors, the Project would be consistent with existing development in the general area. To further minimize impacts on visual resources from operation of the proposed

Project, the Applicant would limit the height of structures to the extent practicable and utilize a color scheme that is harmonious with the natural landscape.

During operations, permanent, minor impacts on the existing viewshed within the Barataria Basin would occur from wetland creation and restoration. The 13,400-acre increase in land mass would be gradual and occur over the 50-year analysis period in areas where visual receptors are present only intermittently (for example, fishermen, boaters, hunters); as such, impacts on the viewshed for these visual receptors would be minor. Whether this impact on the viewshed is beneficial or adverse would depend on the perspective of the individual receptor; for example, the increase in wetlands may be perceived as beneficial for those individuals participating in wildlife viewing, where water-based users may find the loss of open water to be adverse.

New and restored marsh areas within the basin would represent new permanent impacts on the viewshed for nearby receptors, but would be consistent with historical views in the basin. The restored wetlands are expected to provide additional habitat for wildlife and plant species, which would result in long-term enhancement of the natural character of the viewshed. Dredging may be conducted on an as-needed basis to allow the proposed Project to function as designed. These activities would be similar to other maintenance dredging within the viewshed of the Project area.

Expected land loss in the birdfoot delta under the Applicant's Preferred Alternative would be gradual and occur over the 50-year analysis period in areas where visual receptors are present only intermittently (for example, fishermen, boaters, hunters); as such, impacts on the viewshed for these visual receptors would be minor, and either beneficial or adverse depending on the individual's perspective as discussed above for the basin.

4.19.4.3 Other Alternatives

Like the Applicant's Preferred Alternative, the other action alternatives would result in land gains in the Barataria Basin that would enhance the viewshed for visual receptors associated with certain uses (for example wildlife viewing; see Section 4.16 Recreation and Tourism for additional discussion about impacts on recreational resources) through the creation of supporting habitat. These benefits could be offset for visual receptors who live in proximity to the built structures for the proposed Project that would represent new aboveground facilities and would permanently change the viewshed. Expected land loss in the birdfoot delta under the alternatives would have similar impacts on visual resources as the Applicant's Preferred Alternative, specifically, increasing the surface water areas, which could result in negative impacts on visual receptors associated with wildlife viewing whereas this change could be beneficial for water-based recreation. A comparison of the action alternatives' impacts on visual resources is summarized below.

4.19.4.3.1 50,000 cfs Alternative

The direct and indirect impacts from operation and maintenance of the 50,000 cfs Alternative on visual resources would be permanent, moderate, and adverse as compared to the No Action Alternative, and would be similar to the Applicant's Preferred Alternative including the built structures, which would represent new aboveground facilities resulting in a permanent change to the viewshed for nearby receptors. During operations, permanent, minor, beneficial impacts on the existing viewshed within the Barataria Basin would occur from wetland creation and restoration. The 9,660-acre increase in land mass would be gradual and occur over the 50-year analysis period in areas where visual receptors are present only intermittently (for example, fishermen, boaters, hunters); as such, impacts on the viewshed for these visual receptors would be minor.

4.19.4.3.2 150,000 cfs Alternative

The direct and indirect impacts from operation and maintenance of the 150,000 cfs Alternative on visual resources would be permanent, moderate, and adverse as compared to the No Action Alternative, and would be similar to the Applicant's Preferred Alternative including the built structures, which would represent new aboveground facilities resulting in a permanent change to the viewshed for nearby receptors. During operations, permanent, minor, beneficial impacts on the existing viewshed within the Barataria Basin would occur from wetland creation and restoration. The 29,200-acre increases in land mass would be gradual and occur over the 50-year analysis period in areas where visual receptors are present only intermittently (for example, fishermen, boaters, hunters); as such, impacts on the viewshed for these visual receptors would be minor.

4.19.4.3.3 Terrace Alternatives

The direct and indirect impacts from operation and maintenance of the three terrace alternatives on visual resources would be permanent, moderate, and adverse impacts as compared to the No Action Alternative and would be similar to the corresponding capacity alternatives without terraces. The predicted changes in land mass for these alternatives (see Section 4.2 Geology and Soils) would be gradual and occur over the 50-year analysis period in areas where visual receptors are present only intermittently (for example, fishermen, boaters, hunters); as such, impacts on the viewshed for these visual receptors would be minor, permanent, and either beneficial or adverse depending on the perspective of the individual. Over time, the presence of terrace as-built features would permanently change the viewshed for nearby receptors, as the sediments increase and marsh and associated vegetation emerge from the water; however, the incremental impacts on visual receptors associated with the terraces would be negligible, as compared to the corresponding capacity alternatives without terraces. Therefore, all three terrace alternatives, as compared to the No Action Alternative, would have impacts on visual resources similar to those anticipated under the corresponding flow capacity alternatives, including the Applicant's Preferred Alternative.

4.19.5 Summary of Potential Impacts

Table 4.19-1 summarizes the potential impacts on aesthetic and visual resources for each alternative. Details are provided in Sections 4.19.2 through 4.19.4 above.

Table 4.19-1
Summary of Potential Impacts on Aesthetic and Visual Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• Negligible impacts on aesthetic and visual resources from construction of the proposed Project would occur. • Any future impacts would be required to comply with applicable permits and laws.
Operational Impacts	• Minor to major, adverse or beneficial, permanent impacts on aesthetic and visual resources depending on type and scope of potential future development.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Temporary, minor, adverse impacts on visual resources would occur due to land- and water-based construction associated with installation of the built structures, relocation of portions of LA 23 and the NOGC Railroad, as well as alteration to portions of the MR&T and NOV-NFL Levees along with dredging and pile-driving activities.
Operational Impacts	• Permanent, moderate, adverse impacts on visual resources would result from operation of the proposed Project due to the presence of aboveground structures. Permanent, minor, beneficial or adverse impacts, depending on the individual's perspective, in the existing viewshed within the Barataria Basin would occur from wetland creation and restoration.
50,000 cfs Alternative	
Construction Impacts	• The direct and indirect impacts from construction of the 50,000 cfs Alternative on visual resources would be similar to those described for the Applicant's Preferred Alternative and considered temporary, minor, and adverse.
Operational Impacts	• The direct and indirect impacts from operation and maintenance of the 50,000 cfs Alternative on visual resources would be permanent, moderate, and adverse, similar to the Applicant's Preferred Alternative. Permanent, minor, beneficial or adverse impacts, depending on the individual's perspective, in the existing viewshed within the Barataria Basin would occur from wetland creation and restoration.
150,000 cfs Alternative	
Construction Impacts	• The direct and indirect impacts from construction of the 150,000 cfs Alternative on visual resources would be similar to those described for the Applicant's Preferred Alternative and considered temporary, minor, and adverse.
Operational Impacts	• The direct and indirect impacts from operation and maintenance of the 150,000 cfs Alternative on visual resources would be permanent, moderate, and adverse, similar to the Applicant's Preferred Alternative. Permanent, minor, beneficial or adverse impacts, depending on the individual's perspective, in the existing viewshed within the Barataria Basin would occur from wetland creation and restoration.
Terrace Alternatives	
Construction Impacts	• The construction of terraces in the immediate outfall area would not change the viewshed for nearby receptors; as compared to the corresponding flow alternatives without terraces, the incremental impacts on visual receptors associated with the construction of terraces would be negligible. ○ As compared to the No Action Alternative, all three terrace alternatives would cause substantially similar construction impacts as listed above for the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives.

Table 4.19-1
Summary of Potential Impacts on Aesthetic and Visual Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would cause substantially similar operational impacts as listed above for the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives. • The presence of terraces as-built features would permanently change the viewshed for nearby receptors; however, the incremental impacts on visual receptors associated with the terraces would be negligible.

4.20 PUBLIC HEALTH AND SAFETY, INCLUDING FLOOD AND STORM HAZARD RISK REDUCTION

4.20.1 Area of Potential Impacts

Direct impacts on public health and safety from construction could hypothetically occur within the construction footprint of the proposed Project (see Figure 2.8-1 in Chapter 2); however, no direct impacts on public health and safety from construction are anticipated under any alternative. Indirect impacts from construction (such as migration of released fuel from construction equipment into populated areas) could occur outside of the construction footprint within adjacent populated areas within the portion of Plaquemines Parish currently afforded flood risk reduction by the NOV-NFL system on the west bank of the Mississippi River. The location of federal levee systems within the Project area are shown in Chapter 3, Figure 3.4-11 in Surface Water and Coastal Processes.

Direct and indirect impacts on public health and safety from the operation of the diversion would occur within the populated areas of the Project area.

4.20.2 Guidelines for Public Health and Safety Impact Determinations

Impact intensities for public health and safety are based on the definitions provided in Section 4.1 Approach to Evaluation of Environmental Consequences and the following public health and safety-specific indicators for minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: the impact on public health and safety would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[124]

[124] The term "negligible" will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

- minor: measurable increased or decreased risk of potential hazards (for example, increased or decreased likelihood of storm surge impacts on populated areas) could be localized and/or of limited consequence;
- moderate: increased or decreased risk of potential hazards to populated areas could be sufficient to cause a permanent change in use patterns and area avoidance in local and adjacent areas; and
- major: increased or decreased risk of potential hazards to populated areas could be substantial and could cause permanent changes in use patterns and area avoidance over a widespread area.

4.20.3 Overview of Model for Impact Analysis

Water levels and land change projected in the Barataria Basin and birdfoot delta through Delft3D Basinwide Model were used in conjunction with topography analysis to quantify existing tidal flood risk within the Project area, and to project potential impacts on such risk associated with the Project alternatives, including the No Action Alternative. In addition, the coupled ADCIRC and Simulating WAves Nearshore (SWAN) high fidelity models (referred to as ADCIRC in this section) were used to quantify existing coastal storm hazards (surge and wave height magnitude) in the Project area, and to project potential impacts on storm surge and wave height magnitude associated with the Project alternatives, including the No Action Alternative (see Section 4.1 Approach to Evaluation of Environmental Consequences for an overview of Delft3D Basinwide and ADCIRC modeling and Appendix P for more details about ADCIRC model parameters and storm simulations). Storm surge refers to the increase in sea level during a storm event, caused primarily from wind, measured as the height above water above the normal predicted astronomical tide. Wave height refers to the height of a wave between its crest (top) and trough (bottom). Waves can occur over and above the surge elevation during a storm event.

Storm simulations were conducted for the analysis period (2020 to 2070) to project the impacts of the No Action Alternative and Project-induced landscape changes (as projected through the Delft3D Basinwide Modeling efforts) on storm surge and waves within the Project area. The ADCIRC and SWAN models used a subset of FEMA's synthetic, or hypothetical, storm suite for coastal Louisiana (USACE 2008a-c) that included a total of 11 storms (six 25-year storms and five 100-year storms) with various tracks for the No Action Alternative, Applicant's Preferred Alternative, 50,000 cfs Alternative and 150,000 cfs Alternative. To model the impact of terraces on storm surge and wave height, four of the 11 storms were simulated (two 25-year storms and two 100-year storms). A 25-year storm is defined as a storm with a size and intensity that has a 4 percent chance of occurring in a given year, otherwise known as a 4 percent AEP. A 100-year storm is defined as a storm with a size and intensity that has a 1 percent chance of occurring in a given year, or 1 percent AEP. To understand how these changes in storm surge and wave height magnitude would impact flood risk, these changes were compared to local topography and levee heights adjacent to populated areas, as described in Section 4.20.4 below. See Appendix P for more information about the ADCIRC modeling conducted for the proposed Project.

To understand the tidal flood hazards under the various alternatives, the Water Institute compared Delft3D Basinwide Model water levels and water surface elevation thresholds for inundation at three communities in the Project area that are located outside of the federal levee system and expected to experience inundation between 2020 and 2070 (Lafitte, Grand Bayou, and Myrtle Grove; see Appendix P). The Water Institute used the 2011 hydrograph to project a “worst case” scenario in these communities. The 2011 hydrograph has a high peak and a long duration of high flows in the spring (see Section 4.1, Table 4.1-2). As explained in Section 4.4.4 Hydrology and Hydrodynamics, the increase in water levels anticipated under the historical representative hydrographs (1970, 1975, 1985, 2002, and 2008) are generally lower than those used by the Water Institute for this tidal flooding analysis. These three communities were chosen for in-depth analysis because they were considered to be generally representative of the other communities in the basin, representing the reasonable minimum and maximum impacts on communities to the south (Grand Bayou); north (Lafitte); and closest to the immediate outfall area of the diversion (Myrtle Grove). As such, the selected communities were considered representative of varying levels of exposure to tidal flooding. For example, Grand Bayou has no structural protection and would experience similar nuisance flooding as other unprotected communities, such as Hermitage, Suzie Bayou, and Happy Jack. The Myrtle Grove impacts would also be similar to the neighboring community of Woodpark.

The “elevation threshold for inundation” refers to the lowest elevations under which non-storm, tidal flooding is assumed to occur in these communities based on their current topography. Details on the estimation of inundation threshold elevations for each community can be found in Appendix P, but in general, the elevations were determined through synthesis of LiDAR elevation data, survey elevation data, recent flood mapping products, and published literature. The inundation threshold elevations used in the analysis were +2.5 feet, +1.75 feet, and +1.5 feet NAVD88 for Lafitte, Myrtle Grove, and Grand Bayou, respectively.

The projected number of days of threshold exceedance discussed for each alternative is based on a fixed inundation threshold elevation, meaning the selected threshold elevation for each community was held constant throughout the 50-year analysis period. The fixed inundation threshold constitutes the elevation at which the community currently experiences inundation. In reality, these communities would continue to experience local subsidence. Thus, the actual frequency of flooding events could exceed the frequencies projected in this section. However, as the intent of this analysis is to project the relative difference between the No Action and action alternatives, the use of a fixed (current day) inundation threshold elevation provides adequate comparison between alternatives. The cumulative local subsidence estimates and threshold elevation changes over decadal periods are provided in Appendix P for site comparisons.

4.20.4 Storm Surge and Flooding

As described in Chapter 3, hurricanes and storm events can cause substantial losses of life and property depending on their intensity, size, orientation, and landfall. Coastal storm hazards can be described as extreme storm responses such as water level, wind, and waves which are the primary contributors to flooding. Flooding is a function of storm surge, depth and tide, and to an extent, waves. Storm surge is defined as the abnormal change in sea level that may accompany a hurricane or other strong wind system. Storm surge depends on the wind speed, the storm size (often defined by the radius to maximum winds), the storm track (and hence point of landfall), the storm's forward speed, the direction from which the storm makes landfall, its central pressure, the width and slope of the adjacent continental shelf, and the local land topography (for example, Rego and Li 2009, Weisberg and Zheng 2006).

The majority of this section analyzes the potential impacts on public health and safety associated with the risk of flooding in populated areas within the Project area. Two types of flooding are considered in this analysis: 1) tidal flooding, which is caused by the natural ebb and flow of the tidal cycle and local wind patterns causing water levels that exceed the height of local topography and/or tidal levees; and 2) storm hazard flooding, which is caused by storm events or hurricane-related increases in water levels, in the form of storm surge or waves, exceeding the height of local topography and/or hurricane and storm damage risk reduction systems (such as levees).

4.20.4.1 Construction Impacts

4.20.4.1.1 Floodplains and Tidal Flooding

4.20.4.1.1.1 <u>No Action Alternative</u>

Under the No Action Alternative, the proposed Project would not be constructed, and therefore no impacts from construction would occur. The proposed construction footprint would continue to be comprised of 100-year and 500-year floodplains (see Chapter 3, Section 3.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more information about existing floodplains in the Project footprint). Ongoing trends of sea-level rise and subsidence, which are likely to increase the intensity of tides, could result in minor tidal flooding impacts on the floodplain area outside of federal levees under the No Action Alternative during the 5-year construction timeframe with corresponding minor impacts on public health and safety.

In consideration of current, ongoing, and planned developments in the area, it is predictable that at some future point the proposed Project construction footprint and vicinity may be developed for industrial or commercial purposes. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable projects in the Project area). It is reasonable to anticipate that any future development impacting floodplains would be required to comply with all applicable local, state, and federal regulations, such as Floodplain Management Regulations of Plaquemines Parish (Plaquemines Parish Ord. No. 08-211).

4.20.4.1.1.2 Applicant's Preferred Alternative

Approximately 793 acres of the 100-year floodplain would be altered by the proposed construction footprint. Figure 4.20-1 provides an overview of the location of these alterations in relation to the FEMA floodplain classifications. This alteration of the floodplain would not be expected to directly or indirectly impact public health and safety during construction, as the alteration would include maintenance of the authorized or designed level of flood risk reduction for the populated areas within the MR&T and NOV-NFL Levee system within the construction footprint. Reference to the NOV-NFL system throughout this section assumes and includes the completion of all authorized and funded improvements, relocations, and incorporation of Plaquemines Parish non-federal levees into the NOV federal levee system, including construction of the NOV-NF-W-05a.1 levee reach between La Reussite and Myrtle Grove. Floodplain alteration caused by construction of the portion of the Project outside the levee system would not directly impact populated areas, and therefore would have no direct impact on public health and safety.

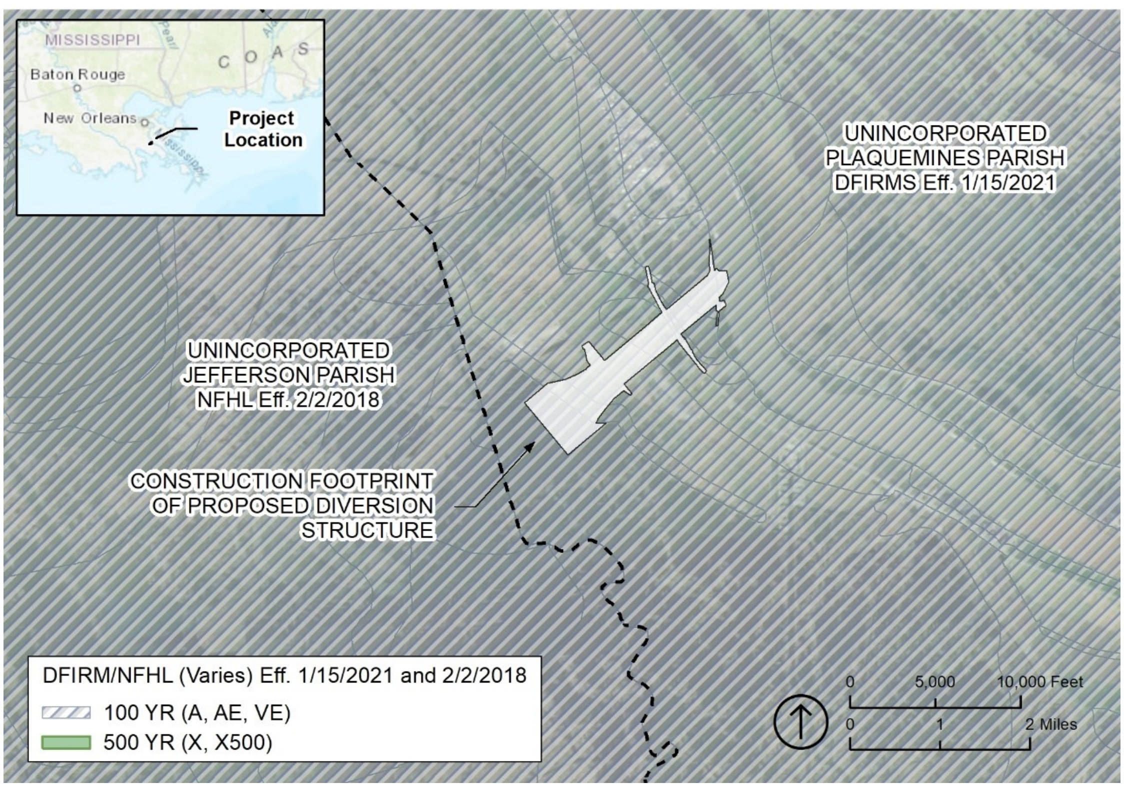


Figure 4.20-1. Construction Footprint in Relation to 100-year Floodplain.

Although stormwater management and drainage would be altered during the construction of the Applicant's Preferred Alternative, this alteration would not be expected to cause an impact on the risk of flooding or current floodplain function (as per EO No. 11988[125]), or an impact on public health and safety, as the existing level of drainage would be maintained throughout construction of the proposed Project. New levees would be constructed paralleling the conveyance channel, which would require rerouting stormwater channels to the Wilkinson Canal Pump Station (see Chapter 2 for more information about proposed Project designs). Watershed drainage would be redirected through a siphon constructed under the proposed conveyance channel. This siphon would carry drainage flow under the conveyance channel to the southeast and then down to the Wilkinson Canal Pump Station. The siphon would be constructed in advance of the conveyance channel construction to maintain water flow during construction of the levees. Because both the existing level of drainage and federal flood risk reduction would be maintained, there would be no anticipated change to the FEMA FIRM designation or base flood elevations due to the construction of the diversion.

Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) within the construction footprint and its vicinity. The intensity and spatial extent of any impact on public health and safety from inadvertent releases of contaminants would depend upon the nature of the release. Minor spills such as fuel leakage during equipment refueling would be more easily contained and mitigated, would not likely impact areas outside of the construction footprint, and thus would not be expected to have an impact on public health and safety. A larger accidental release could potentially migrate outside of the construction footprint, particularly if it were to occur near or within water, which could cause minor (barely detectable, localized) to moderate (readily detectable, localized), temporary, adverse impacts on water quality and public health and safety. Actions would be taken to avoid, minimize, or contain potential contaminants during construction, including adhering to a Project-specific SPCC Plan. Implementation of these plans was assumed in this impact analysis. See Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for further discussion about actions CPRA would undertake to minimize Project impacts on public health and safety, and Section 4.5 Surface Water and Sediment Quality for further discussion about potential Project impacts on water quality.

4.20.4.1.1.3 Other Alternatives

As compared with the Applicant's Preferred Alternative, the size of the intake channel and conveyance channel would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes. Even though

[125] In accordance with EO No. 11988 and 33 CFR 320.4(l), USACE considers floodplain management as part of its public interest review. Particular factors considered include: Project water-dependency; availability of practicable alternatives inside and outside the floodplain; avoidance and mitigation of adverse impacts on floodplain functions; preservation and restoration of floodplain values; avoidance and minimization of flooding risks to human health, safety, and welfare; and the findings and certifications of other agencies with jurisdiction over floodplain concerns.

construction would occur within a similar construction footprint for all alternatives, the volume of material excavated and placed for construction of the conveyance channel berms, guide levees, and outfall transition feature would be greater for alternatives with 150,000 cfs flow volumes and smaller for alternatives with 50,000 cfs flow volumes. Alternatives with higher-flow volumes would have construction times several months longer, and those with lower-flow volumes would have construction times several months shorter.

These alternatives would alter the same approximate acreages of 100-year and 500-year floodplain within the construction footprint, with the exception of the alternatives that include construction of terraces adjacent to the outfall transition feature. Construction of the terraces would alter approximately 88 additional acres of 100-year floodplain. The differences in the size of the conveyance channel between alternatives would not have a differential impact on public health and safety, because these alterations of the floodplain include maintenance of the current level of flood risk reduction for the populated areas within the MR&T and NOV-NFL Levee system throughout and after construction. The impacts on stormwater management and drainage for these alternatives would be the same as for the Applicant's Preferred Alternative.

The duration of risk of potential impacts from construction, such as construction-related contamination, would endure for longer or shorter timeframes depending upon the alternative. Potential inadvertent releases of contaminants (fuel, oil, and other construction materials) pose the same level of risk to public health and safety as described for the Applicant's Preferred Alternative, and CPRA would implement the same preventative plans to reduce the risk of such impacts.

Impacts on floodplains and stormwater management and drainage from construction would not be expected to directly or indirectly impact public health and safety, for the reasons described under the Applicant's Preferred Alternative.

4.20.4.1.2 Storm Hazards

4.20.4.1.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed, and therefore no impacts from construction would occur. Because of its low elevation and proximity to coastal lakes, bays, and the Gulf of Mexico, the proposed Project construction footprint would continue to be vulnerable to storm surge and flooding caused by the landfall of storm events and hurricanes (see Chapter 3, Section 3.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction, for more information about storm hazards in the Project footprint). Only limited changes to the area's susceptibility to coastal inundation due to sea-level rise and subsidence are expected to occur under the No Action Alternative during the 5 years construction timeframe; therefore, there would likely be no substantial change in storm hazard susceptibility that would subsequently impact public health and safety.

In consideration of current, ongoing, and planned developments in the area, it is predictable that at some future point the proposed Project construction footprint and vicinity may be developed for industrial or commercial purposes. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.20.4.1.2.2 Applicant's Preferred Alternative

The construction period for the Applicant's Preferred Alternative would span 5 years. Construction activities would occur during yearly hurricane seasons and would have the potential to produce minor to moderate, short-term, adverse safety-related impacts on public health and safety. These impacts would be similar in nature to those described above regarding impacts within the floodplain under non-storm event conditions; storm events could increase the intensity of such impacts if they were to occur. If storm event- or hurricane-related surge or rainfall were to inundate the construction site, construction-related debris or liquids such as fuel could be transported outside of the construction footprint, which could, depending upon the nature of the transported material, pose a risk to public health and safety. Large equipment and building supplies within the construction site, if not properly secured, could become mobilized due to high wind conditions, causing serious damage to the surrounding homes and properties, and increasing risks to public health and safety. As described in Section 4.27 Mitigation Summary, CPRA would implement an SPCC Plan, SWPPP, and a Site Safety and Health Accident Prevention Plan during construction to reduce the risk of construction-related contamination, which would minimize the risk of these impacts on public health and safety during construction. Additionally, as part of the Site Safety and Health Accident Prevention Plan, if large equipment were moved from the construction site and construction materials secured on-site, the potential public health and safety risk from mobilization of equipment during storm events could be reduced (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for details about minimization measures CPRA would implement during construction of the proposed Project).

The alteration of the MR&T and NOV-NFL Levee system during construction would include measures to maintain their respective current levels of hurricane and river flood risk reduction for the populated areas within these levee systems throughout and after construction, and would therefore have no direct or indirect impacts on public health and safety.

4.20.4.1.2.3 Other Alternatives

As compared with the Applicant's Preferred Alternative, the size of the intake channel and conveyance channel would be wider for alternatives with 150,000 cfs flow volumes, and narrower for alternatives with 50,000 cfs flow volumes. Even though construction would occur within a similar construction footprint for all alternatives, the volume of material excavated and placed for construction of the conveyance channel berms, guide levees, and outfall transition feature would be greater for alternatives with 150,000 cfs flow volumes and smaller for alternatives with 50,000 cfs flow volumes. Alternatives with higher-flow volumes would have construction times several months longer, and those with lower-flow volumes would have construction times several months shorter.

The risks to public health and safety associated with storm hazards during construction of the 50,000 cfs, 150,000 cfs, and terrace alternatives would be the same as those described for the Applicant's Preferred Alternative. However, as alternatives with higher-flow volumes would have construction times several months longer and those with lower-flow volumes would have construction times several months shorter, the duration of exposure to these risks would endure for longer or shorter timeframes accordingly. As with the Applicant's Preferred Alternative, CPRA would implement preventative plans during construction to reduce the risk of construction-related contamination and minimize the risk of these impacts on public health and safety during construction (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan).

4.20.4.1.3 Risk Reduction Levees

4.20.4.1.3.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be constructed, and therefore no impacts from construction would occur. Risk reduction levees in the proposed construction footprint, including the MR&T and NOV-NFL Levees, would continue to exist and provide flood risk reduction, and ongoing projects for modifying and repairing these levees would continue (see Chapter 3, Section 3.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction for more information about risk reduction levees in the Project footprint). Only limited changes to risk reduction levees due to ongoing trends of land subsidence and sea-level rise are expected to occur under the No Action Alternative during the 5-year construction timeframe; therefore, there would likely be no substantial change in the level of risk reduction afforded by these levees that would subsequently impact public health and safety.

In consideration of current, ongoing, and planned developments in the area, it is predictable that at some future point the proposed Project construction footprint and vicinity may be developed for industrial or commercial purposes. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.20.4.1.3.2 Applicant's Preferred Alternative

Construction of the Applicant's Preferred Alternative would require the provision of interim flood risk reduction features that would temporarily replace the risk reduction afforded by the portions of the MR&T and NOV-NFL Levee systems falling within the construction footprint. For example, in order to construct the intake system of the diversion on the Mississippi River, a temporary cofferdam and interim levee would be built prior to removal of the portion of the MR&T within the construction footprint, providing redundant protection from riverine flooding during construction. Two parallel levees would be constructed along the proposed conveyance channel that would tie-in to the NOV-NFL Levee. These proposed Project levees would be built to provide a 2 percent AEP (50-year) level of risk reduction. This portion of the NOV-NFL Levee will be constructed up to a 4 percent AEP (25-year) level of risk reduction. Additional details regarding interim risk reduction features to be built under the Applicant's Preferred Alternative are provided in Chapter 2. Interim risk reduction measures would be designed and built to provide the same level of risk reduction currently provided by the NOV-NFL and MR&T Levee systems, and would remain in place until the construction of the Applicant's Preferred Alternative is completed to the point that it provides the same level of risk reduction as the existing USACE projects. Because the interim flood risk reduction measures would be designed and built to provide the same level of flood risk reduction as the existing system, impacts on risk reduction levees within the construction footprint during construction would have no impact on public health and safety.

4.20.4.1.3.3 Other Alternatives

Construction of all action alternatives would require the provision of interim flood risk reduction features that would temporarily replace the risk reduction afforded by the portions of the MR&T and NOV-NFL Levee systems falling within the construction footprint. Because the interim flood risk reduction measures would be designed and built to provide the same level of flood risk reduction as the existing system, impacts on risk reduction levees within the construction footprint during construction would have no impact on public health and safety.

4.20.4.2 Operational Impacts

4.20.4.2.1 Floodplains and Tidal Flooding

4.20.4.2.1.1 No Action Alternative

The floodplains within the Project area would continue to be subject to storm and non-storm-related flooding, as described in Chapter 3, Section 3.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction. Water levels within the Barataria Basin are projected to follow an upward trend over the next 50 years due to sea-level rise and an increased tidal influence farther north in the basin associated with sea-level rise and land loss (see Section 4.4 Surface Water and Coastal Processes for details regarding these projected hydrologic changes based on Delft3D Basinwide Modeling efforts; see Section 4.2 Geology and Soils and Section 4.6 Wetland Resources and Waters of the U.S. for details regarding land loss).

Increased water levels would be expected to increase the frequency and severity of tidal flooding (not related to a storm event) in populated areas outside of federal levee systems, causing minor to major, permanent, adverse impacts on the health and safety of the public inhabiting these areas. NOAA tide gauges along the U.S. coastline have shown a rapid change in annual frequencies of tidal flooding over the last several decades (non-linearly increasing), and several studies have concluded that high-tide flood frequencies, duration, and extent would continue to rise in the future (Sweet et al. 2014, Sweet et al. 2018, Karegar et al. 2017). Although tidal flooding is not normally associated with the direct loss of life or other direct impacts on public health and safety, repeated tidal flooding can damage homes and infrastructure such as roadways, water supply systems, wastewater treatment facilities, and stormwater management systems. This can cause indirect adverse impacts on public health and safety, which based on the frequency, duration, and intensity of flooding, can range from minor to major (Hummel et al. 2018, Allen et al. 2018). The level of public health and safety impacts from inundation also depends on the nature of the structures and facilities subject to flooding. For example, repeated flooding of recreational marina facilities would have negligible to minor and short-term impacts on public health and safety as temporary loss or damage would interrupt the use of marina facilities for recreation; whereas repeated inundation of roads used for hurricane evacuations could slow or restrict traffic, representing minor to major, adverse impacts on public health and safety. As the frequency of tidal flooding increases within the floodplain outside of the federal or tidal protection levee systems, the impact of flooding on public health and safety would be adverse, and would increase from minor to major, and from temporary to permanent.

It is projected that over the 50-year Delft3D Basinwide Model simulations, under the No Action Alternative, the water surface elevations in the vicinity of these communities would increasingly exceed the estimated elevation threshold for inundation (flooding) over time due to sea-level rise and subsidence. Table 4.20-1 shows an upward trend in the number of days each community is projected to be inundated in future decades. As noted above, the historical hydrograph chosen for this analysis was 2011 because it included a high, late spring flood flow and thus, the diversion would be expected to operate at or near maximum capacity (75,000 cfs) for an extended period during the modeled year (see Section 4.1 Overview of Delft3D Basinwide Model for Impact Analysis; Table 4.1-2 and Figure 4.1-2 for more details about how long the diversion is projected to operate at or near maximum capacity for the 2011 hydrograph). However, because water levels within the Barataria Basin are influenced by forces other than just Mississippi River flows such as winds, tides, sea-level rise, and subsidence, the Mississippi River hydrograph chosen for the analysis does not produce major differences in the maximum water level increase when the diversion is operating at maximum capacity, while the hydrograph does affect the number of days/duration of exceedance, as compared to the other historical hydrographs discussed in Section 4.4 Surface Water and Coastal Processes.

Table 4.20-1
Projected Days of Water Surface Elevation Exceeding Inundation Threshold Elevation under the No Action Alternative (2011 hydrograph [high, late spring flood flow])

Simulated Year	Lafitte	Myrtle Grove	Grand Bayou
2020	1	62	68
2030	9	128	176
2040	50	219	297
2050	122	322	343
2060	283	353	358
2070	346	357	362
Source: Water Institute 2019, Appendix P			

Figure 4.20-2 shows the projected trend of increased periods of flooding for these three communities. While the Lafitte area is not projected to see as rapid of an increase in the frequency and duration of inundation as Myrtle Grove and Grand Bayou, all three communities are projected to experience near-constant inundation at the end of the 50-year analysis period due primarily to sea-level rise.

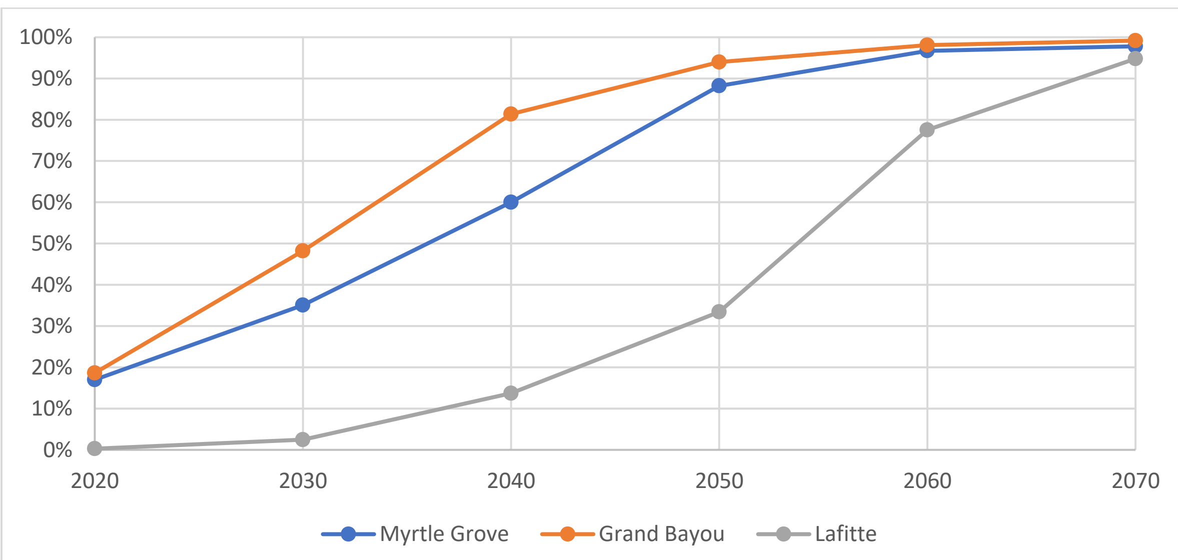


Figure 4.20-2. Projected Percent Days of Water Surface Elevation Exceeding Inundation Threshold Elevation under the No Action Alternative for the 2011 Hydrograph (high, late spring flood flow).

As described in more detail in Appendix E, a different sea-level rise rate assumption would change modeled inundation frequency and depth, strength of tidal forcing, and erosional impacts such that a higher rate of sea-level rise would result in an increased rate of inundation threshold exceedance and a lower rate of sea-level rise would result in a decreased rate of inundation threshold exceedance.

The socioeconomic impact of the increased public health and safety risk of inundation, including possible permanent relocation of certain residences or subdivisions, is discussed in Section 4.13 Socioeconomics.

Areas inside of the levee systems would be expected to experience increased pumping demands to remove rainwater from interior drainage systems, as sea-level rise could create the need for greater capacity, increased horsepower, and/or more frequent pump operation to overcome the increased head outside the levee system from rising sea levels, potentially leading to less efficient water drainage that leads to increased rain-induced flooding. This increased flooding could have similar indirect impacts on public health and safety as the indirect impacts of tidal flooding, including interruption of water supply, sanitation and wastewater infrastructure, and release of contaminants that could be injurious to public health and safety. These impacts would be adverse, intermittent but permanent, and would range from minor to major depending on the infrastructure impacted.

4.20.4.2.1.2 Applicant's Preferred Alternative

The Applicant's Preferred Alternative would cause minor to major, adverse, long-term direct and indirect impacts on public health and safety due to increased tidal flooding in the Barataria Basin communities not protected by federal levees. Impacts on public health and safety in Project area communities within federal levee systems would be negligible.

Under the Applicant's Preferred Alternative, the portion of the Project area outside of levee systems would experience changes in bathymetry and topography as sediment entering the basin through the diversion settles into areas of open water and existing marsh. As described in Section 4.6 Wetland Resources and Waters of the U.S., the Applicant's Preferred Alternative would sustain and create wetlands within Barataria Basin outside of federal levee systems; however, ongoing subsidence and sea-level rise would ultimately lead to a net loss of wetland acreage in the Project area over the 50-year analysis period. Floodplains within the Project area would continue to be subject to the projected hydrologic changes associated with relative sea-level rise as described in Section 4.4 Surface Water and Coastal Processes, leading to increased water levels throughout the basin, regardless of the implementation of the Applicant's Preferred Alternative. Thus, populated areas outside of federal levee systems within the Project area would continue to be susceptible to the adverse, long-term, and minor to major indirect public health and safety impacts associated with tidal flooding, as described for the No Action Alternative.

Land building within the basin under the Applicant's Preferred Alternative would slightly reduce the increased northern tidal propagation expected under the No Action Alternative, but only for the portion of the basin to the north and east of the Project-induced sediment deposition area, representing a negligible impact on public health and safety given that no communities outside of the federal levee systems are located within this region (see Section 4.2 Geology and Soils for additional information about Project-induced sediment deposition). The closest such community is Lafitte, which, according to the Delft3D Basinwide Model analysis for 2040 and 2070, is projected to experience no appreciable difference in tidal signal under the Applicant's Preferred Alternative as compared to the No Action Alternative during periods that the diversion is operating at baseflow (see Section 4.4.3 in Surface Water and Coastal Processes for further information about Project impacts on hydrology and water levels in the Project area).

Increased water levels due to diversion operations would cause an increased risk to public health and safety in populated areas outside of federal levee systems, specifically within areas approximately 10 miles to the north of the immediate outfall area and 20 miles to the south of the immediate outfall area, as communities in these areas could experience an increased percentage of annual days of inundation due to tidal flooding when the diversion is operating above base flow. Table 4.20-2 and Figure 4.20-3 show the projected number and percentage of days, respectively, that inundation would be experienced in each of the three example communities under the Applicant's Preferred Alternative and the No Action Alternative over the 50-year analysis period. These projections are based on the 2011 Mississippi River hydrograph (high, late spring flood flow), which represents a year of high river flows in which the proposed Project could be operated at its maximum capacity for an extended period of time during the year. Lower-flow years are projected to result in a lower impact on inundation frequency or duration of inundation, particularly in areas farther from the immediate outfall area.

Table 4.20-2
Number of Annual Days of Tidal Flooding Under the Applicant's Preferred Alternative Relative to the No Action Alternative[a]

Community	Alternative	2020	2030	2040	2050	2060	2070
Lafitte	No Action	1	9	50	122	283	346
	Applicant's Preferred	5	22	65	152	304	347
	Change	4	13	15	30	21	1
Myrtle Grove	No Action	62	128	219	322	353	357
	Applicant's Preferred	181	239	286	362	362	362
	Change	119	111	67	40	9	5
Grand Bayou	No Action	68	176	297	343	358	362
	Applicant's Preferred	124	221	318	348	357	362
	Change	56	45	21	5	-1	0

[a] Fixed thresholds for Grand Bayou, Myrtle Grove, and Lafitte are 1.5 feet (45.7 centimeters), 1.75 feet (53.3 centimeters), and 2.5 feet (76.2 centimeters), respectively. Based on Hydrograph year 2011 (high, late spring flood flow).

Source: Water Institute (2019).

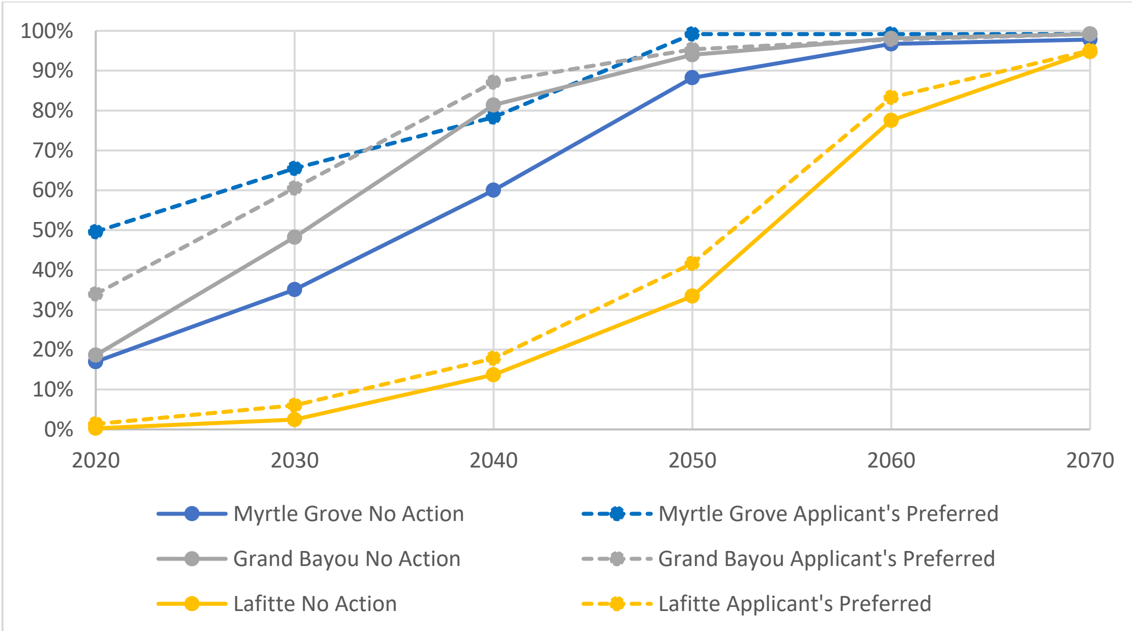


Figure 4.20-3. Projected Percent Days of Water Surface Elevation Exceeding Inundation Threshold Elevation under Applicant's Preferred Alternative and the No Action Alternative (2011 Hydrograph [high, late spring flood flow]).

There are approximately 532 residential parcels in the six communities within 20 miles south of the immediate outfall area. See Table 4.13-5 in Section 4.13 Socioeconomics for a list of the communities, parcels, and assessed values of the residential parcels in these communities. The largest impact on inundation frequency due to the diversion is projected to occur in Myrtle Grove, as this is the community closest to the immediate outfall area of the proposed diversion structure and thus would see the greatest increase in water levels. As shown in Figure 4.20-3, over time, the impact of the diversion on inundation frequency is projected to become less dominant, particularly in Myrtle Grove and Grand Bayou, as sea-level rise increasingly drives water levels throughout the basin. This trend is also shown in Figures 4.20-4 through 4.20-6, which project that the difference in days of inundation between the Applicant's Preferred Alternative and the No Action Alternative during periods of diversion operation above base flow would decrease over time as the influence of sea-level rise on water levels increases.

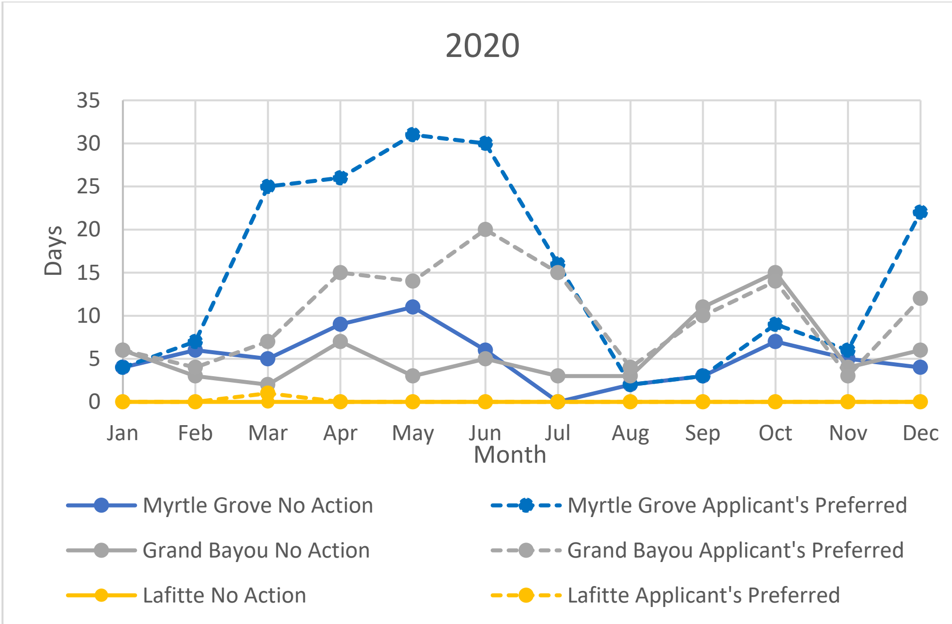


Figure 4.20-4. Projected Days per Month in Year 2020 of Water Surface Elevation Exceeding Inundation Threshold Elevation under Applicant's Preferred Alternative and the No Action Alternative (2011 Hydrograph [high, late spring flood flow]).

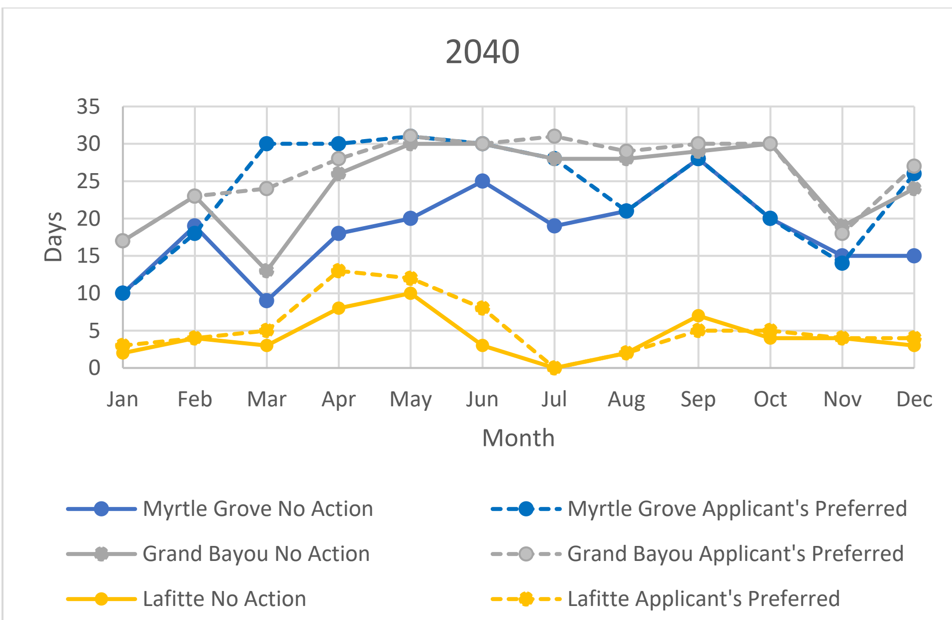


Figure 4.20-5. Projected Days per Month in Year 2040 of Water Surface Elevation Exceeding Inundation Threshold Elevation under Applicant's Preferred Alternative and the No Action Alternative (2011 Hydrograph [high, late spring flood flow]).

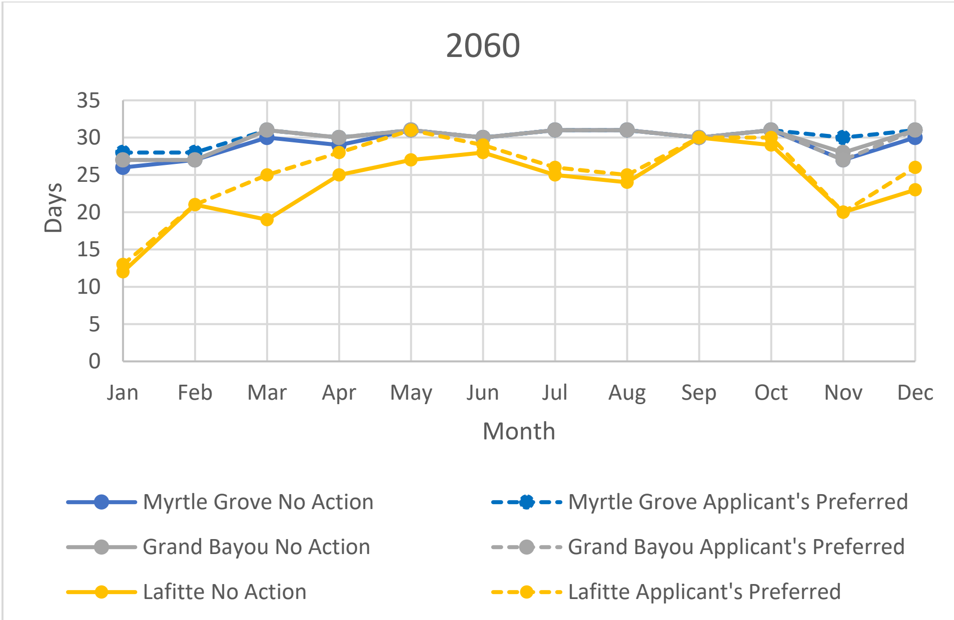


Figure 4.20-6. Projected Days per Month in Year 2060 of Water Surface Elevation Exceeding Inundation Threshold Elevation under Applicant's Preferred Alternative and the No Action Alternative (2011 Hydrograph [high, late spring flood flow]).

Under the Applicant's Preferred Alternative, water levels within the basin outside of federal levees would be higher than under the No Action Alternative, with the highest increases occurring primarily when the diversion is operating at or near maximum capacity during high river flows. The seasonal increase in water levels outside of the federal levees due to proposed diversion operations would be minor to major depending on community location, diversion flow rate, and Mississippi River flows. As described earlier, Mississippi River flows would influence the number of days or duration of exceedance, such that the intensity of impact from tidal flooding could be reduced during years that Lower Mississippi River flows lead to lower diversion flows. Secondly, impacts on water levels would be highest during periods of maximum diversion discharge and would decrease with reduced discharge.

Impacts on water levels in the basin would, in general, be highest near the immediate outfall area and would decrease with increasing distance from the immediate outfall area. But the topography of communities (represented by inundation thresholds in this analysis) also plays a role in the intensity of projected impacts, demonstrated by communities with higher inundation thresholds generally having lesser impacts than those with lower inundation thresholds.

Water level increases projected for the 2011 Mississippi River hydrograph would have major impacts in communities in the basin near the immediate outfall area of the proposed Project such as Myrtle Grove, which is projected to have approximately three times as many days of threshold exceedance under the Applicant's Preferred Alternative in the first decade of operation and twice as many in the second decade of operation as compared to the No Action Alternative. Given the similar location in the basin and assuming a similar topography, Woodpark would be expected to have a similar intensity of impact as Myrtle Grove. Moderate impacts are projected in communities such as Grand Bayou, which is the farthest community from the immediate outfall area but has the lowest inundation threshold of the three communities analyzed, resulting in approximately twice as many days of projected threshold exceedance under the Applicant's Preferred Alternative in the first decade of operation and an approximate 25 percent increase in the second decade of operation, as compared to the No Action Alternative. Nearby communities such as Suzie Bayou, Hermitage and Happy Jack would likely experience impacts similar to Grand Bayou, based on their location and assumed topography. Minor impacts are projected in communities in the Lafitte area, which is closer to the immediate outfall area than Grand Bayou but has a higher inundation threshold. Although Lafitte is projected to experience an increase in the number of days of threshold exceedance similar in proportion to the other communities, the resulting total days of inundation is relatively low compared to the other communities analyzed. For purposes of this analysis, the Lafitte area includes multiple communities with varying levels of existing non-federal flood protection.

All tidal flooding impacts would be reduced to minor by the end of the 50-year analysis period, when the dominant driver of tidal flooding would be relative to sea-level rise. Therefore, the Applicant's Preferred Alternative would cause adverse, long-term, but minor to major indirect impacts on public health and safety in these areas.

In recognition of this potential for increased flooding impacts due to the diversion operation, CPRA is considering acquiring servitudes on those properties that are projected to experience increased flooding due to diversion operations. More details regarding these potential actions are set forth in the Mitigation and Monitoring and Adaptive Management Plan and environmental review thereof, Appendix R.

4.20.4.2.1.3 Other Alternatives

The magnitude of increase in the projected tidal flooding inundation frequency in communities outside of the federal levee system when the diversion is operating is projected to increase with the magnitude of diversion flow and over time. This increase is more pronounced in areas closer to the immediate outfall area of the proposed diversion structure for all action alternatives. Differences in frequency of inundation due to tidal flooding between alternatives are discussed below.

4.20.4.2.1.3.1 50,000 cfs Alternative

Operation of the 50,000 cfs Alternative would have an adverse, long-term, and minor to negligible impact on public health and safety. This alternative would increase water levels less than the Applicant's Preferred Alternative would, and increased water levels would not propagate as far west or south in the basin as the Applicant's Preferred Alternative. As such, tidal flooding inundation frequency is projected to be lower in communities outside of the federal levee system when the diversion is operating as compared to the Applicant's Preferred Alternative, particularly in the immediate outfall area of the diversion structure (see Figures 4.20-7 through 4.20-9). However, operation of the 50,000 cfs Alternative would have a minor impact on public health and safety as compared to the No Action Alternative, as the 50,000 cfs Alternative would increase the frequency of tidal flooding inundation in the three communities analyzed. Similar to the Applicant's Preferred Alternative, water levels in the basin become less driven by diversion operation after the first 20 years as the dominant influence over water levels in the basin shifts toward sea-level rise rather than diversion operation after 2040, after which the tidal flooding inundation frequency between the 50,000 cfs and Applicant's Preferred Alternative becomes negligible. By the end of the 50-year analysis period, the difference between the 50,000 cfs and No Action Alternative is negligible.

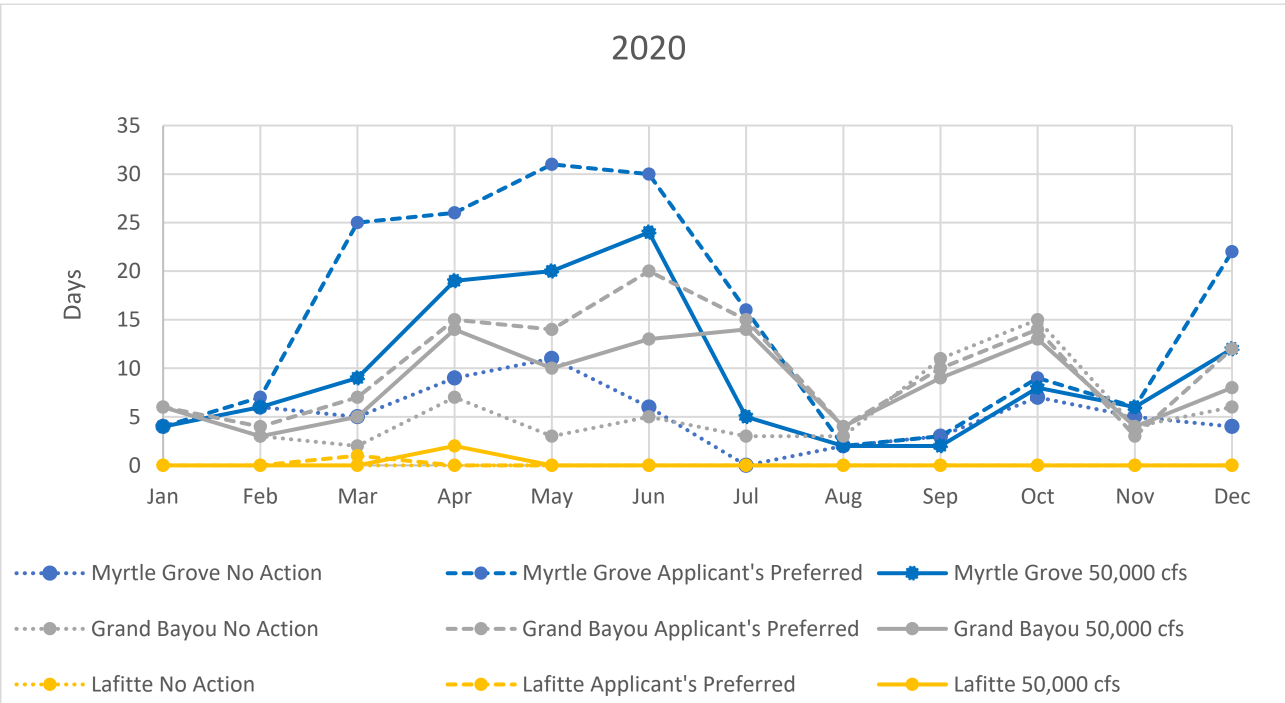


Figure 4.20-7. Projected Days per Month in Year 2020 of Water Surface Elevation Exceeding Inundation Threshold Elevation Under 50,000 cfs Alternative and Applicant's Preferred Alternative (2011 Hydrograph [high, late spring flood flow]).

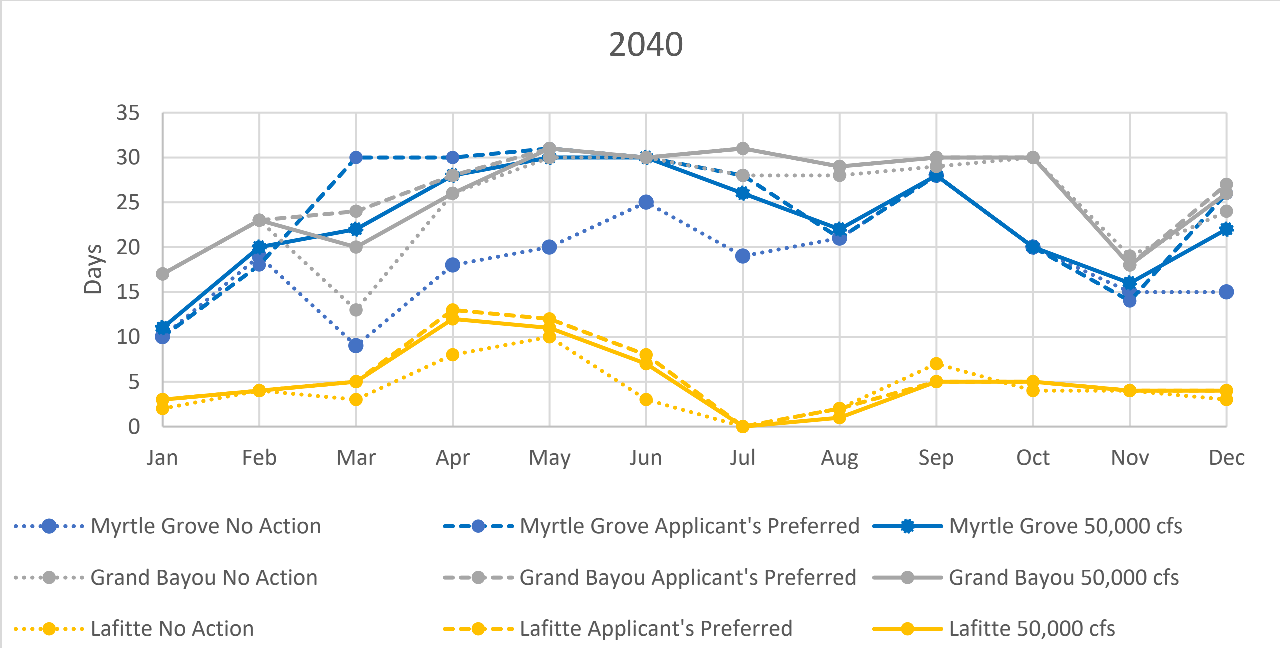


Figure 4.20-8. Projected Days per Month in Year 2040 of Water Surface Elevation Exceeding Inundation Threshold Elevation Under 50,000 cfs Alternative and Applicant's Preferred Alternative (2011 Hydrograph [high, late spring flood flow]).

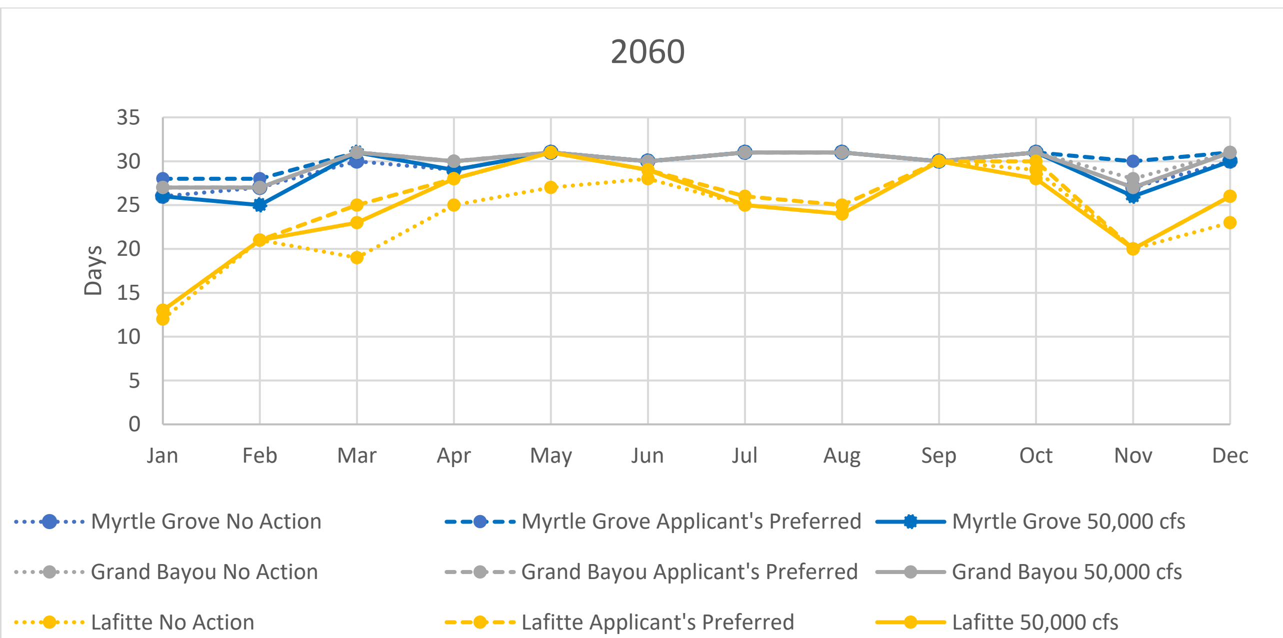


Figure 4.20-9. Projected Days per Month in Year 2060 of Water Surface Elevation Exceeding Inundation Threshold Elevation Under 50,000 cfs Alternative and Applicant's Preferred Alternative (2011 Hydrograph [high, late spring flood flow]).

Within the federal levee system, communities would be subject to the same increased pumping demands as under the No Action Alternative to remove rainwater from interior drainage systems due to sea-level rise, creating less efficient water drainage; however, this impact would be due to sea-level rise and not the proposed

Project. As in the No Action Alternative and Applicant's Preferred Alternative, still water levels are not expected to exceed authorized levee heights for federal levee systems within the Project area during periods when the diversion is operating up to maximum capacity.

4.20.4.2.1.3.2 150,000 cfs Alternative

Under the 150,000 cfs Alternative, the Project area would continue to be subject to the projected hydrologic changes associated with relative sea-level rise as described in Section 4.4 Surface Water and Coastal Processes, leading to increased water levels throughout the basin and subjecting populated areas to the adverse, long-term, and minor to major indirect public health and safety impacts associated with tidal flooding, as described for the No Action Alternative and depending on the populated area and decade being considered. Because water levels in the basin would generally be higher under the 150,000 cfs Alternative than under the Applicant's Preferred Alternative, tidal flooding inundation frequency is projected to increase in communities outside of the federal levee system when the diversion is operating. This increase is more pronounced in areas closer to the immediate outfall area of the proposed diversion structure (that is, Myrtle Grove), causing major, long-term, adverse impacts in this community. The impact of the diversion on communities farther from the immediate outfall area, such as Lafitte, would be reduced to minor in comparison to the No Action Alternative. Similar to the Applicant's Preferred Alternative, water levels within the basin become less driven by the diversion operation than by sea-level rise over time, thus leading to less of a difference in inundation frequency between the Applicant's Preferred Alternative and the 150,000 cfs Alternative over time, and reducing the impact of this alternative on public health and safety from major to minor. These trends are seen in Figures 4.20-10 through 4.20-12. Therefore, this alternative would have a greater indirect impact on public health and safety than the Applicant's Preferred Alternative during the first 20 years of the analysis period, particularly in communities outside the federal levee system closer to the immediate outfall area.

Within the federal levee system, communities would be subject to the same increased pumping demands as under the No Action Alternative to remove rainwater from interior drainage systems, due to sea-level rise creating less efficient water drainage; however, this impact would be due to sea-level rise and not the 150,000 cfs Alternative. As in the No Action Alternative and Applicant's Preferred Alternative, still water levels are not expected to exceed authorized levee heights for federal levee systems within the Project area during periods when the diversion is operating up to maximum capacity.

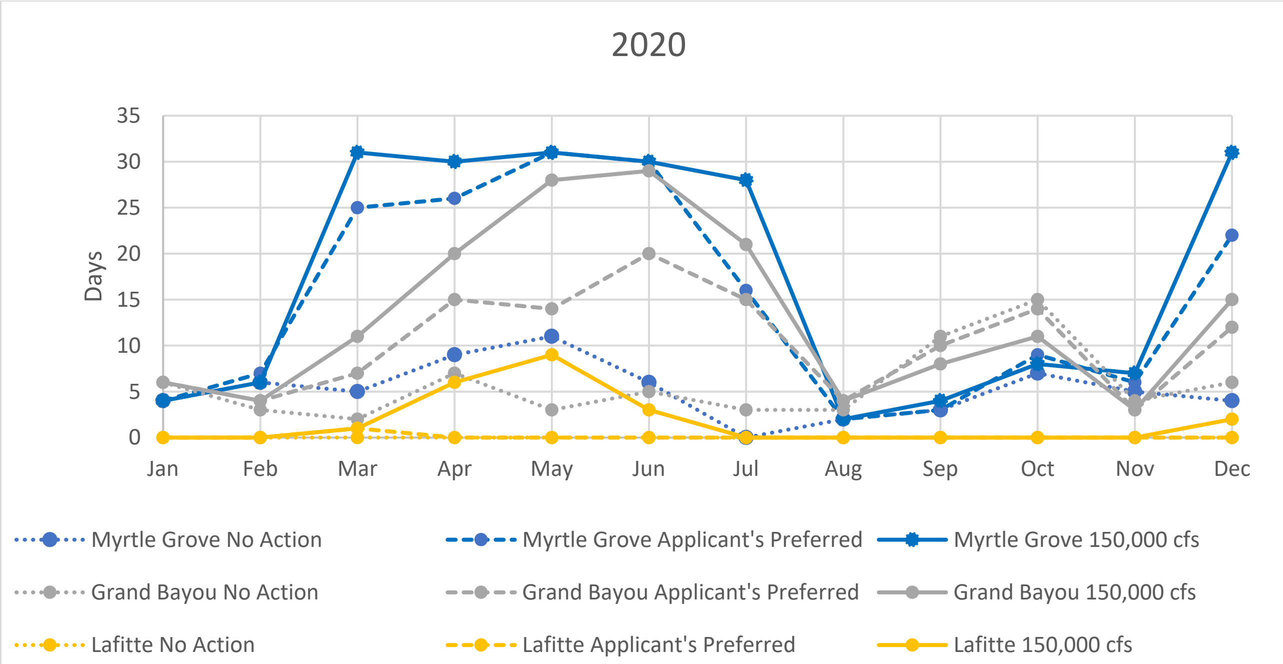


Figure 4.20-10. Projected Days per Month in Year 2020 of Water Surface Elevation Exceeding Inundation Threshold Elevation Under 150,000 cfs Alternative and Applicant's Preferred Alternative (2011 Hydrograph [high, late spring flood flow]).

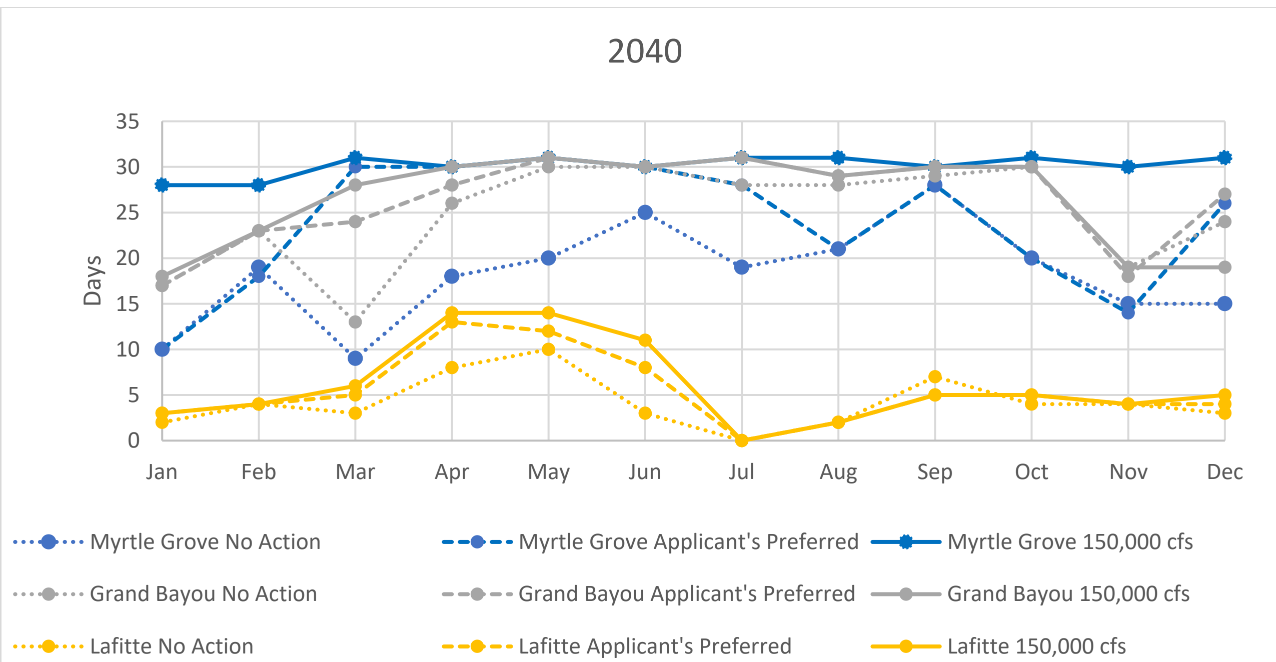


Figure 4.20-11. Projected Days per Month in Year 2040 of Water Surface Elevation Exceeding Inundation Threshold Elevation Under 150,000 cfs Alternative and Applicant's Preferred Alternative (2011 Hydrograph [high, late spring flood flow]).

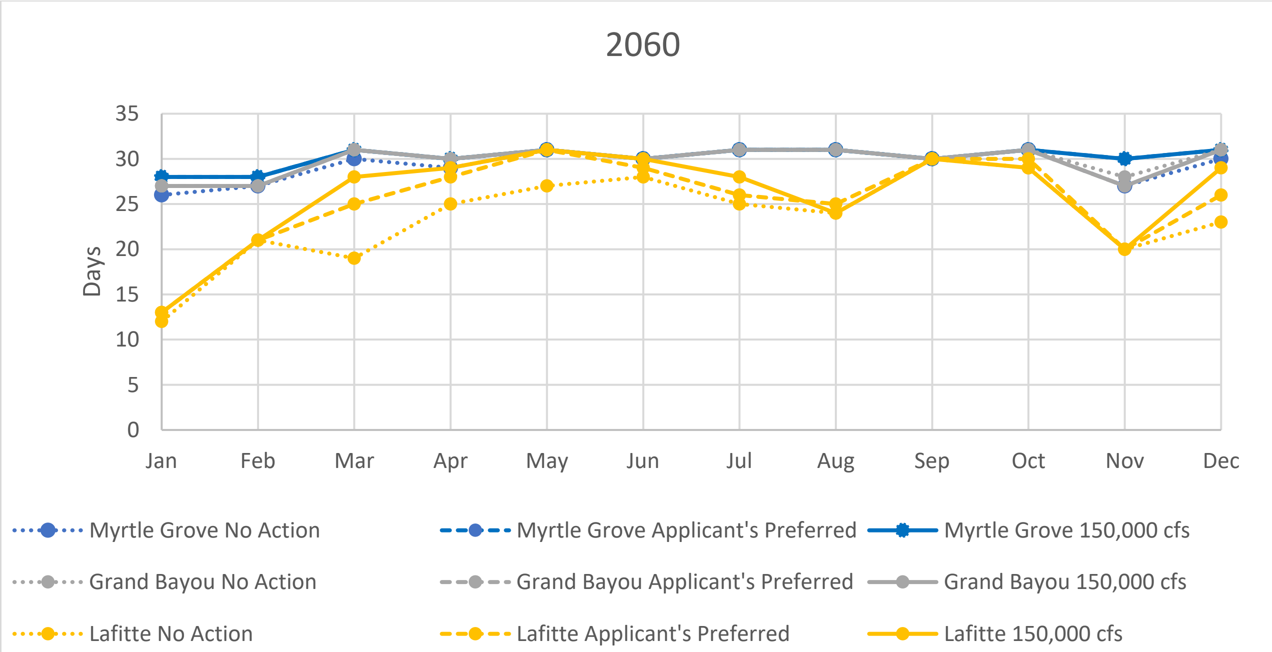


Figure 4.20-12. Projected Days per Month in Year 2060 of Water Surface Elevation Exceeding Inundation Threshold Elevation Under 150,000 cfs Alternative and Applicant's Preferred Alternative (2011 Hydrograph [high, late spring flood flow]).

4.20.4.2.1.3.3 Terrace Alternatives

The addition of terrace features to the 50,000 cfs, 75,000 cfs, and 150,000 cfs Alternatives is expected to have a negligible impact on tidal flooding inundation frequencies, since water level differences between the terrace and non-terrace alternatives are projected to be on the order of +/– 0.08 foot (2.4 centimeters) (see Section 4.4 Surface Water and Coastal Processes), and primarily in the vicinity of the immediate outfall area of the proposed diversion structure and terraces. While the terraces would deflect the diversion flow farther to the west and southwest across the outfall area, this impact to flow direction would not be substantial enough to result in a difference in projected maximum monthly average water levels in the vicinity of Lafitte under the terrace and non-terrace alternatives, demonstrating the localized nature of the water level increase. Thus, the presence of terraces in the basin in the immediate outfall area associated with the three terrace alternatives would be expected to have the same general intensity and duration of impacts on public health and safety from tidal flooding as anticipated under the flow capacity alternatives without terraces.

4.20.4.2.2 Storm Hazards

4.20.4.2.2.1 No Action Alternative

Under the No Action Alternative, the proposed Project would not be built or operated; consequently, there would be no impacts on public health and safety due to storm hazards as a result of the proposed Project. However, as projected by the ADCIRC results and supported by published studies in southeast Louisiana and the

Northern Gulf of Mexico (Smith et al. 2009, Woodruff 2013, Roberts and Cobell 2016), the Project area is projected to become increasingly susceptible to coastal inundation primarily due to sea-level rise and subsidence. The No Action Alternative would likely have permanent, major, adverse impacts on public health and safety due to the increased risk of storm hazard-related inundation. Storm surge events would continue to result in substantial water depth increases throughout the Barataria Basin, which would cause an increased risk to public health and safety from inundation impacts. The ADCIRC model results consistently show an increase in projected surge elevation in the Project area and vicinity for all modeled storm events over time. The model projected that, as compared to modeled year 2020, storm surge elevation would increase by a maximum of 2.3 feet (70.1 centimeters) and 7.3 feet (222.5 centimeters) by years 2040 and 2070, respectively. This is the maximum increase in surge elevation under the No Action Alternative for all storms analyzed. Using year 2020 as a baseline, surge elevation increases are projected to range from a minimum of 5 percent to a maximum of 30 percent by year 2040 and a minimum of 20 percent to a maximum of 80 percent by year 2070, depending on the storm simulated and the location within the basin where surge is measured. The main drivers for surge increase projections are subsidence and sea-level rise, and associated wetland loss in the Project area. The ADCIRC results are consistent with the Wamsley et al. (2007) study, which suggests that coastal wetland loss without any restorative efforts along the Louisiana coast would result in increased storm surge.

Tables 4.20-3 and 4.20-4 provide the minimum and maximum differences in storm surge elevation and wave heights in modeled years 2040 and 2070 relative to year 2020 under the No Action Alternative for the combined suite of simulated 1 percent AEP storms at federal levee systems and several communities outside these levee systems in the Project area (see Figure 4.20-13 for data stations analyzed in the analysis). These levee systems and communities include the NOV-NFL Levees, the NOV federal levees, the WBV Levees, and the LGM Levees. Communities located outside of levee systems for which data are provided include Lafitte, Grand Isle, Des Allemands/Bayou Gauche, and Grand Bayou. Because this table provides projected minimums and maximums for all of the simulated 1 percent AEP storms, the minimum and maximum increases in water levels do not necessarily result from the same storm or correspond to the same location along a given levee reach or community.

Table 4.20-3
Projected Minimum and Maximum Storm Surge Elevation Increases for Year 2040 and 2070 Relative to Year 2020 for All Simulated 1 Percent AEP Storms[a] under the No Action Alternative (feet)

Levee System[b] or Community	2040		2070	
	Minimum Increase	Maximum Increase	Minimum Increase	Maximum Increase
WBV	1.3	2.3	3.5	7.3
Des Allemands/Bayou Gauche	0.8	1.3	3.7	5.3
Lafitte	1.1	1.7	2.3	4.7
NOV-NFL	0.5	2.1	2.0	5.6
LGM	0.6	2.1	1.4	5.4
Grand Bayou	0.6	0.9	2.1	2.8
NOV	0.5	1.0	1.6	2.6
Grand Isle	0.5	1.2	2.0	3.7

[a] Includes five 1 percent AEP storms (1 percent change of occurring in a given year) with various tracks.
[b] WBV: West Bank and Vicinity
NOV-NFL: New Orleans to Venice Non-Federal Levees
LGM: Larose to Golden Meadow
NOV: New Orleans to Venice

Table 4.20-4
Projected Minimum and Maximum Wave Height Increases for Year 2040 and 2070 relative to Year 2020 for All Simulated 1 Percent AEP Storms[a] under the No Action Alternative(feet)[b]

Levee System[c] or Community	2040		2070	
	Minimum Increase	Maximum Increase	Minimum Increase	Maximum Increase
WBV	-0.1	0.8	0.1	2.7
Des Allemands/Bayou Gauche	0	0.6	0.1	2
Lafitte	0.5	0.7	1.1	1.8
NOV-NFL	0.1	1	1	2.9
LGM	0.1	0.5	0.4	1.5
Grand Bayou	0.5	0.6	1.3	1.6
NOV	0.2	0.6	-0.1	1.5
Grand Isle	0.2	0.5	0.8	1.6

[a] Includes five 1 percent AEP storms (1 percent change of occurring in a given year) with various tracks.
[b] Negative values indicate a reduction in wave heights.
[c] WBV: West Bank and Vicinity
NOV-NFL: New Orleans to Venice Non-Federal Levees
LGM: Larose to Golden Meadow
NOV: New Orleans to Venice

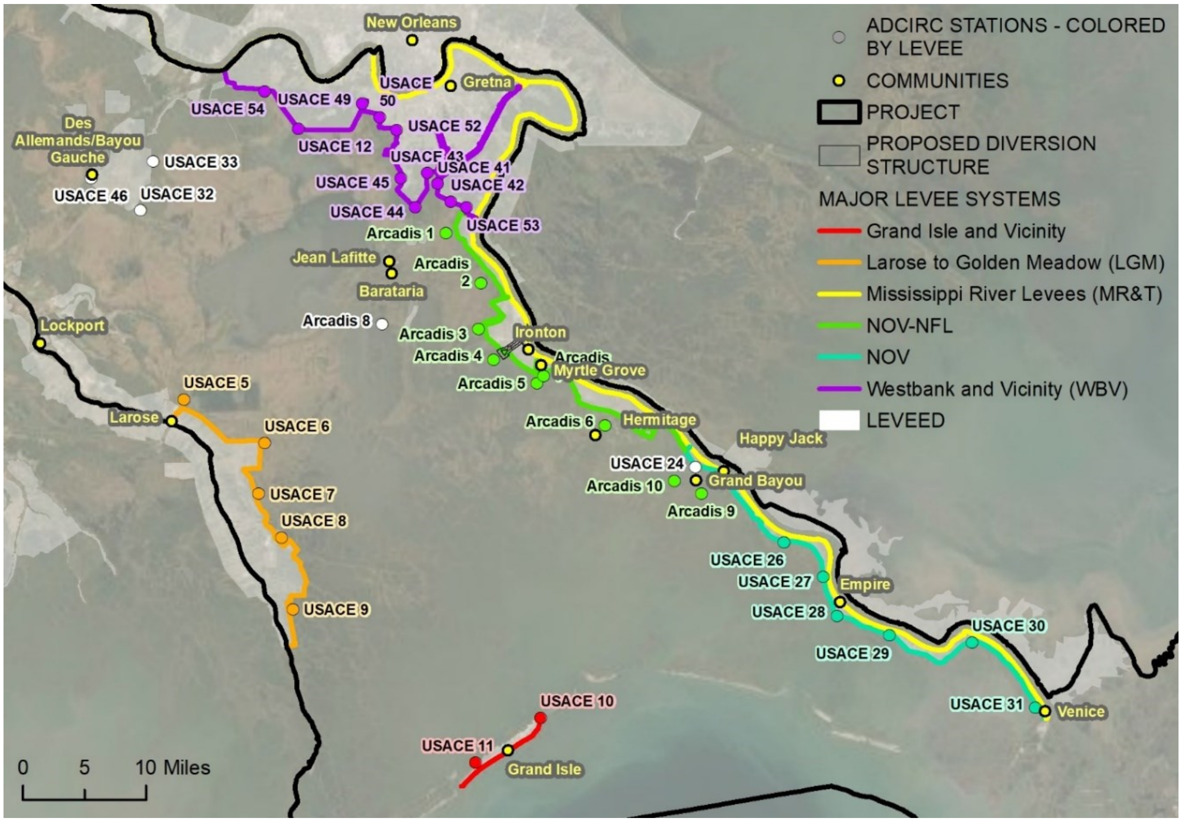


Figure 4.20-13. ADCIRC Data Stations Used for Storm Surge Elevation and Wave Height Analysis.

Tables 4.20-5 and 4.20-6 provide the maximum storm surge elevation and wave height for a representative 1 percent AEP storm (storm 009) at select levee system and communities, along with the minimum and maximum increases in storm surge elevation and wave height over time relative to year 2020 under the No Action Alternative.

To provide context to the water levels in these tables, the public health and safety impacts associated with these water levels depend in part on the elevation of the populated areas impacted. As noted earlier in this section, the elevation threshold for inundation based on area topography is estimated to be 2.5 feet (76.2 centimeters) and 1.5 feet (45.7 centimeters) (NAVD88) for Lafitte and Grand Bayou, respectively. The average ground elevation of Grand Isle is estimated to be approximately 2.5 feet (76.2 centimeters). Des Allemands and Bayou Gauche are estimated to be -1.3 feet (-39.6 centimeters) and -3 feet (-91.4 centimeters) respectively, but are surrounded by a local levee of elevation 3 feet (91.4 centimeters) (NAVD88) (NOAA 2019a). The public health and safety impact of these water levels on populated areas inside federal levee systems depends upon the height of the levees compared to the adjacent water levels, which is discussed in detail in Section 4.20.4 below. Appendix P provides additional details regarding these surge and wave elevations throughout the basin.

Table 4.20-5
Maximum Storm Surge Elevation and Projected Minimum and Maximum Storm Surge Elevation Increases from 2020 Elevation for Representative 1 Percent AEP Storm[a] under the No Action Alternative

Levee System[b] or Community	2020	2040		2070	
	Maximum Surge Elevation (feet)	Minimum Increase (feet)	Maximum Increase (feet)	Minimum Increase (feet)	Maximum Increase (feet)
WBV	8.1	1.6	1.8	4.1	5.4
Des Allemands/ Bayou Gauche	6.5	0.9	1.2	4.7	5.1
Lafitte	7.6	1.3	1.3	3.3	3.3
NOV-NFL	8.8	0.6	1.6	2.0	3.9
LGM	10.2	0.6	1.0	1.4	3.2
Grand Bayou	8.0	0.7	0.7	2.1	2.1
NOV	7.0	0.7	0.8	1.9	2.2
Grand Isle	6.1	0.7	0.9	2.1	2.9

[a] Storm 009 chosen as representative 1 percent AEP storm (see Appendix P for more information).
[b] WBV: West Bank and Vicinity
NOV-NFL: New Orleans to Venice Non-Federal Levees
LGM: Larose to Golden Meadow
NOV: New Orleans to Venice

Table 4.20-6
Maximum Wave Height and Projected Minimum and Maximum Wave Height Increases from 2020 Elevation for Representative 1 Percent AEP Storm[a] under the No Action Alternative

Levee System[b] or Community	2020	2040		2070	
	Maximum Wave Height (feet)	Minimum Increase (feet)	Maximum Increase (feet)	Minimum Increase (feet)	Maximum Increase (feet)
WBV	2.1	-0.1	0.7	0.1	2.0
Des Allemands/ Bayou Gauche	2.1	0.1	0.4	0.3	1.7
Lafitte	2.6	0.6	0.6	1.4	1.4
NOV-NFL	3.6	0.2	0.6	1.1	2.1
LGM	3.8	0.2	0.4	0.7	1.0
Grand Bayou	2.4	0.5	0.5	1.3	1.3
NOV	2.8	0.2	0.5	0.3	1.4
Grand Isle	5.5	0.3	0.5	0.8	1.4

[a] Storm 009 chosen as representative 1 percent AEP storm (see Appendix P for more information).
[b] WBV: West Bank and Vicinity
NOV-NFL: New Orleans to Venice Non-Federal Levees
LGM: Larose to Golden Meadow
NOV: New Orleans to Venice

Under the ADCIRC simulations near the NOV-NFL Levee system for the No Action Alternative, the simulated 1 percent AEP storm (storm 009) is projected to produce a maximum surge elevation of 8.8 feet (2.7 meters) and a maximum wave height of 3.6 feet (1.1 meters) in 2020 (see Figure 4.20-13 and Tables 4.20-5 and 4.20-6). Surge elevations are projected to increase by up to 44 percent and wave heights by up to 58 percent in 2070 in this area as compared to 2020. Along the NOV Levee system from St. Jude south to the town of Venice, the 1 percent AEP storm is projected to produce a maximum surge elevation of 7.0 feet (2.1 meters) and a maximum wave height of 2.8 feet (0.9 meter) in 2020. Surge elevations are projected to increase up to 31 percent, and wave heights up to 50 percent in 2070 as compared to 2020. Along the WBV Levee system in year 2020, the simulated 1 percent AEP storm is projected to produce a maximum surge elevation of 8.1 feet (2.5 meters) in 2020, and increase up to 22 percent and 66 percent in years 2040 and 2070, respectively. While some wave height increases over time are projected to be negligible, wave height increases in some areas of the WBV system are projected to double in height by 2070, as compared to 2020 (see Table 4.20-5). It should be noted that waves reaching the northern portion of the Project area, such as at the WBV system, are likely to include locally generated (within the Barataria Basin) waves and breaking waves (in shallow water areas), rather than offshore-generated waves.

As shown in Tables 4.20-5, under the No Action Alternative, the representative 1 percent AEP storm is projected to produce a maximum surge elevation of 10.2 feet (3.1 meters) in the LGM Levee area in year 2020 (see Figure 4.20-13). The communities near Golden Meadow, at the southern end of the levee system, are projected to experience higher surge elevations due to their proximity to the Gulf of Mexico as compared to the Larose area; surge elevations are projected to increase by as much as 31 percent by year 2070. The increase in surge elevations in the LGM Levee area would also induce some increases in wave heights in the magnitude of 26 percent by 2070, as compared to 2020. In the Grand Isle area, the 1 percent AEP storm is projected to produce a maximum surge elevation of 6.1 feet (1.9 meters) and wave heights of 5.5 feet (1.7 meters) on the bay side of the Grand Isle area in year 2020. The surge elevations and wave heights are projected to increase up to approximately 48 and 25 percent, respectively, in year 2070 as compared to 2020.

At the community of Lafitte, under the No Action Alternative, the 1 percent AEP storm is projected to produce a maximum surge elevation of 7.6 feet (2.3 meters) and maximum wave height of 2.6 feet (0.8 meter) in year 2020, which are projected to increase 43 percent and 54 percent, respectively, by 2070 (see Tables 4.20-5 and 4.20-6). While maximum surge elevations farther north in the basin near Des Allemands/Bayou Gauche (see Figure 4.20-13) are among the lowest projected in the Project area in 2020, the Des Allemands/Bayou Gauche area's maximum surge elevation of 6.5 feet (2.0 meters) in 2020 is projected to increase by a maximum of over 75 percent in 2070. Grand Bayou is projected to have a maximum surge elevation of 8.0 feet (2.4 meters) in 2020. In 2040, the surge elevation here is projected to increase less than 1.0 foot (0.3 meter), but in 2070 is projected to increase up to 25 percent compared to 2020 elevations. Wave heights are projected to increase by over 50 percent by year 2070 in the Grand Bayou area (see Tables 4.20-5 and 4.20-6).

Due to the combined effect of land subsidence, sea-level rise, and an increase in the frequency and strength of storms in the future, the risk of flooding and associated public health and safety concerns in the Project area would increase over time under the No Action Alternative, as described above for floodplain impacts (Webster et al. 2005, NOAA GFDL 2019c). Smith et al. (2009) showed that wetland areas are highly sensitive to relative sea-level rise and that surge does not increase linearly with relative sea-level rise. Bilskie et al. (2016) came to the same conclusion using several different hydrodynamic models. Deeper water depths and the degradation of wetlands were found to increase the surge propagation speed and allow for greater inundation (Wamsley 2009). The permanent loss of wetlands and modification of wetland hydrology associated with sea-level rise and subsidence would lead to increased storm surge farther north in the Barataria Basin, increasing flood risk and its associated adverse impacts on public health and safety over time. Thus, the No Action Alternative would likely have permanent, major, adverse impacts on public health and safety due to the increased risk of storm hazard-related inundation.

4.20.4.2.2.2 Applicant's Preferred Alternative

Operation of the Applicant's Preferred Alternative would have permanent (lasting throughout the 50-year analysis period), minor to moderate, beneficial and permanent, minor to moderate, adverse impacts on public health and safety risks associated with storm hazards in communities outside of federal levee systems. Whether a community experiences greater or lesser risks to public health and safety depends on its location as explained below. See the Risk Reduction Levees section below for more information on how storm hazard impacts would impact populated areas inside federal levee systems.

Operation of the proposed Project is anticipated to result in substantial increases in topographic elevations primarily within the delta formation area and result in the net creation of about 13,400 acres of land by modeled year 2070 in the Barataria Basin (see Section 4.2 Geology and Soils, Table 4.2-7 and Figure 4.2-14 for the spatial extent of projected sediment deposition). These increases in topography and land acreage would induce hydraulic friction and resistance, reducing the inland extent of storm surge and limiting the height of waves while increasing the elevation of storm surge in some areas gulfward of the delta formation area. Figures 4.20-14 and 4.20-15 provide simplified illustrations of the impact of land building on storm surge elevation and wave heights within the Project area, using a generalized example of a 1 percent AEP storm.

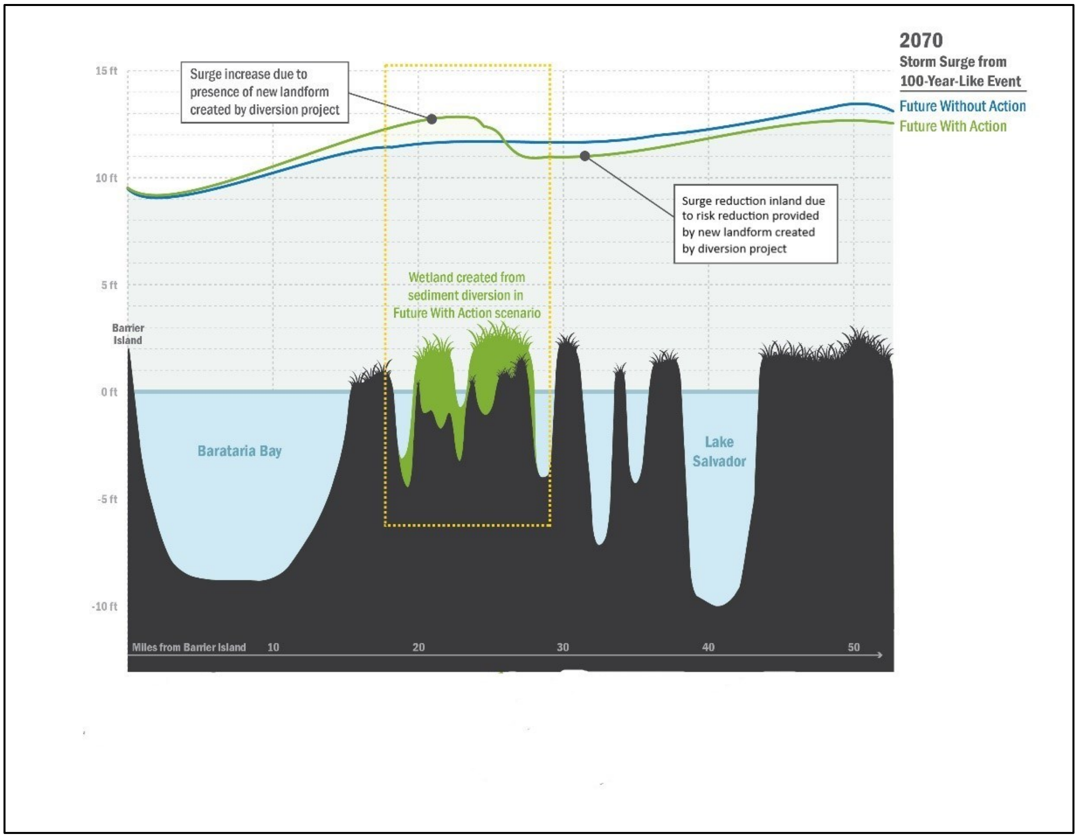


Figure 4.20-14. Simplified illustration of how increases in topography and land acreage in the delta formation area under the Applicant's Preferred Alternative influence storm surge elevation along a 50-mile cross-section of the Project area, as compared to No Action Alternative. Storm surge elevations are based on a generalized 1 percent AEP storm.

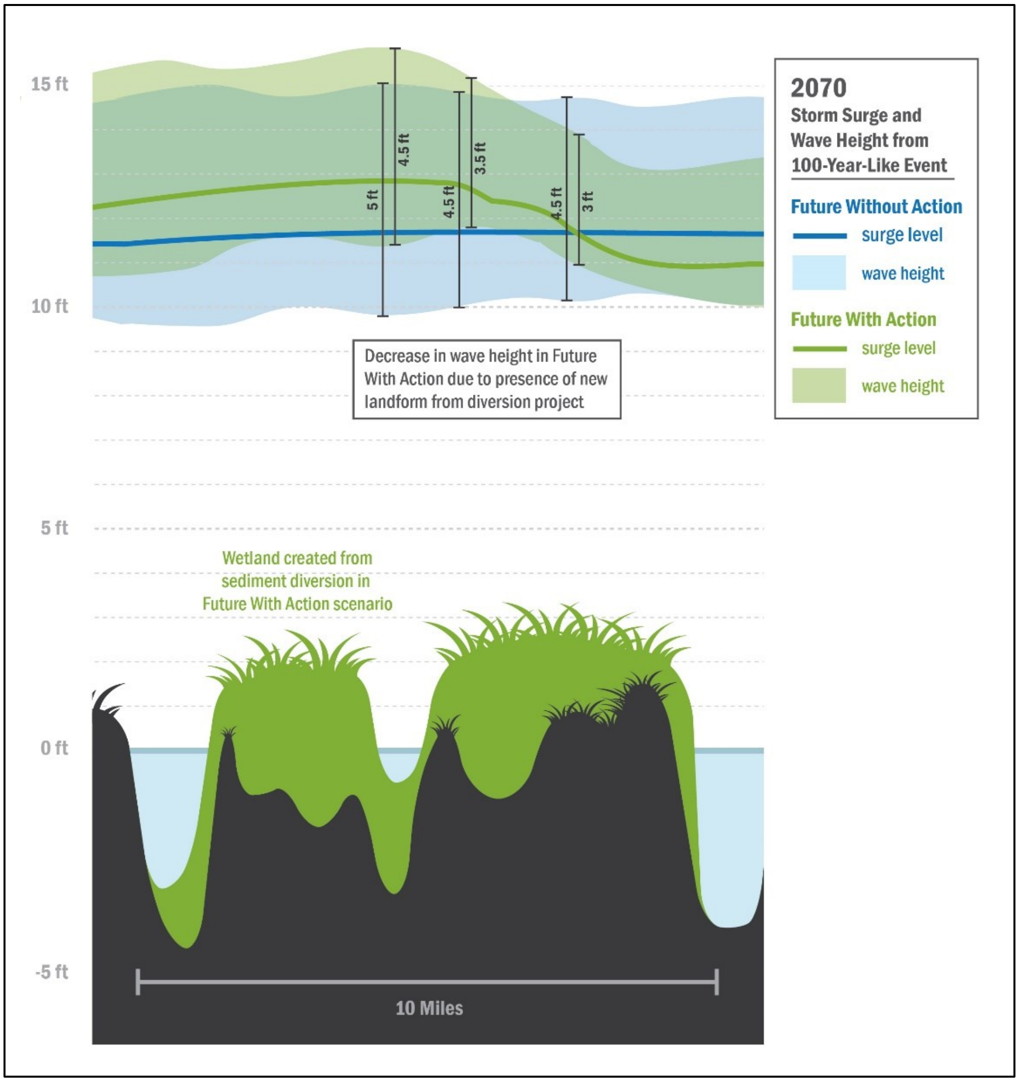


Figure 4.20-15. Simplified illustration of how increases in topography and land acreage in the delta formation area under the Applicant's Preferred Alternative influence storm surge elevation and wave height along a 10-mile cross-section of the delta formation area, as compared to No Action Alternative. Storm surge elevations and wave heights are based on a generalized 1 percent AEP storm.

The reduced inland extent of storm surge and reduction of wave heights would represent permanent, minor to moderate, beneficial impacts on public health and safety associated with storm hazards in communities outside of federal levee systems north of the immediate outfall area (Lafitte and Des Allemands), while the increased storm surge elevation gulfward of the diversion would represent permanent, minor to moderate, adverse impacts on public health and safety risks associated with storm hazards in communities outside of federal levee systems south of the immediate outfall area (see Figures 4.20-16 and 4.20-17).

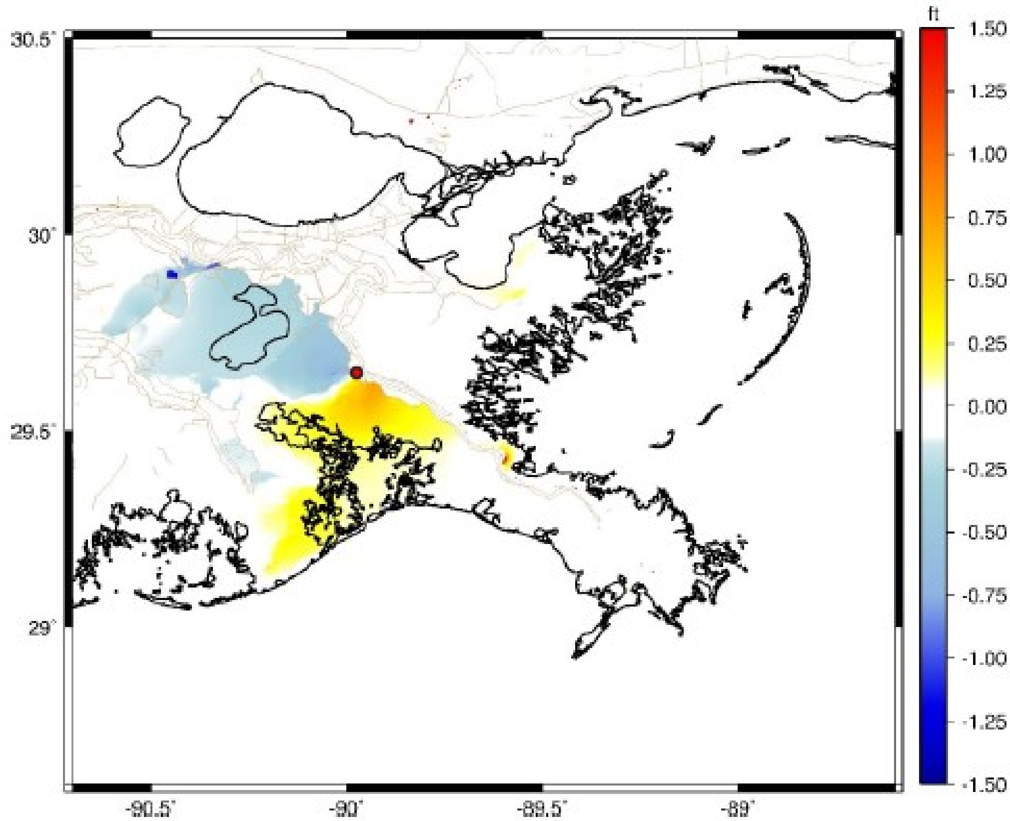


Figure 4.20-16. Change in Maximum Surge Elevations during 1 Percent AEP Storm: Applicant's Preferred Alternative in 2040 less No Action Alternative in 2040. The red dot indicates the proposed location of the diversion.

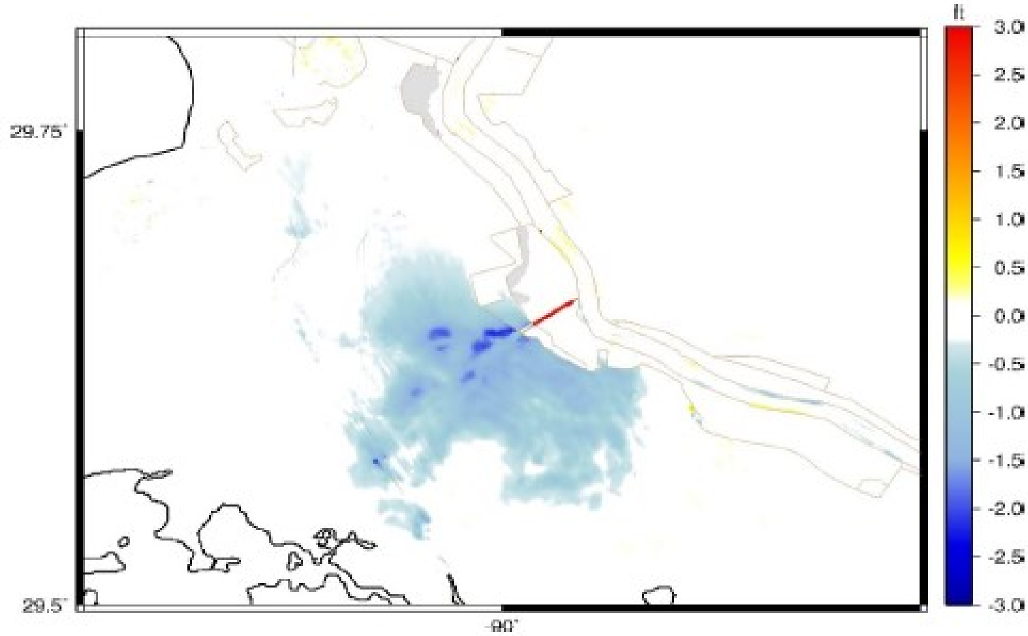


Figure 4.20-17. Change in Maximum Wave Heights during 1 Percent AEP Storm: Applicant's Preferred Alternative in 2040 less No Action Alternative in 2040. The red line indicates the proposed location of the diversion.

Tables 4.20-7 and 4.20-8 provide the range of maximum storm surge elevation and wave height increases under the Applicant's Preferred Alternative compared to the No Action Alternative projected over time adjacent to federal levee systems and in several communities outside these levee systems. The ADCIRC-projected surge and wave elevations are based on the assumption that the diversion would be closed (no flow) prior to the modeled storm event, such that modeled water level increases within the basin would not be caused by diversion flows. The operations plan for the diversion structure would require closure of the diversion gates and cessation of all diversion flows when tropical depressions or named storms are forecasted to impact the Barataria and Mississippi River Basins. The timing of diversion closure would be based in part on modeling analysis which indicates that once the diversion is closed, basin water surface elevations are anticipated to return to ambient water levels in approximately two days in most areas of the basin. Still, depending on the timing of the diversion closure in advance of storm events, if diversion-induced water level increases are not fully dissipated from the Project area in advance of storm impacts, maximum water levels during storm events could be increased over those projected by the ADCIRC model.

Table 4.20-7
Projected Storm Surge Under Applicant's Preferred Alternative Relative to the No Action Alternative for 1 Percent AEP (100-Year) Storms in Years 2040 and 2070[a]

Levee System[b] or Community	2040		2070	
	Minimum Increase (feet)	Maximum Increase (feet)	Minimum Increase (feet)	Maximum Increase (feet)
WBV	-0.3	-0.7	-0.4	-1.0
Des Allemands/ Bayou Gauche	-0.1	-0.2	-0.2	-0.6
Lafitte	-0.4	-0.5	-0.6	-0.8
NOV-NFL	-0.8	0.7	-1.2	1.7
LGM	0	-0.3	0.1	-0.5
Grand Bayou	0.2	0.3	0.3	0.5
NOV	0	0.1	-0.1	0.3
Grand Isle	0	0.2	0	0.1

[a] Negative values indicate a reduction in surge elevations.
[b] WBV: West Bank and Vicinity
NOV-NFL: New Orleans to Venice Non-Federal Levees
LGM: Larose to Golden Meadow
NOV: New Orleans to Venice

Table 4.20-8
Summary of Differences between the Applicant's Preferred Alternative and the No Action Alternative Maximum Wave Height for 1 Percent AEP Storms[a]

Levee System[b] or Community	2040		2070	
	Minimum Increase (feet)	Maximum Increase (feet)	Minimum Increase (feet)	Maximum Increase (feet)
WBV	0	-0.3	0	-0.5
Des Allemands/ Bayou Gauche	0	-0.1	0	-0.1
Lafitte	-0.1	-0.2	-0.2	-0.3
NOV-NFL	-1.4	0.1	-2.1	0.3
LGM	0	0.1	0	-0.1
Grand Bayou	0	0.1	0.1	0.2
NOV	0	0.1	0	0.1
Grand Isle	0	0.1	0	0.2

[a] Negative values indicate a reduction in wave heights.
[b] WBV: West Bank and Vicinity
NOV-NFL: New Orleans to Venice Non-Federal Levees
LGM: Larose to Golden Meadow
NOV: New Orleans to Venice

The differences in maximum surge elevations between the No Action Alternative and the Applicant's Preferred Alternative are generally within +/– 0.5 foot (15.2 centimeters) for simulated 1 percent AEP storms, with a few smaller areas of larger increases and decreases near the NOV-NFL Levee system. Maximum wave heights are projected to have minor decreases within the delta formation area, as compared to the No Action Alternative because bathymetry and topography increases induced by operation of the Applicant’s Preferred Alternative would reduce wave height in the delta formation area (see Tables 4.20-7 and 4.20-8 and Figure 4.20-13). The Applicant’s Preferred Alternative would cause minor increases gulfward of the delta formation area, as compared to the No Action Alternative.

Figures 4.20-16 through 4.20-23 illustrate the differences in projected maximum surge elevations and wave heights between the Applicant’s Preferred Alternative and the No Action Alternative spatially for a single representative 1 percent AEP storm and a single representative 4 percent AEP storm for the Project area in modeled year 2040. As indicated in Figures 4.20-16 and 4.20-18, under the Applicant’s Preferred Alternative, maximum surge elevations in the Barataria Basin are projected to increase gulfward of the immediate outfall area and decrease north of the immediate outfall area. Maximum wave heights are projected to decrease throughout the delta formation area (see Figures 4.20-17 and 4.20-19).

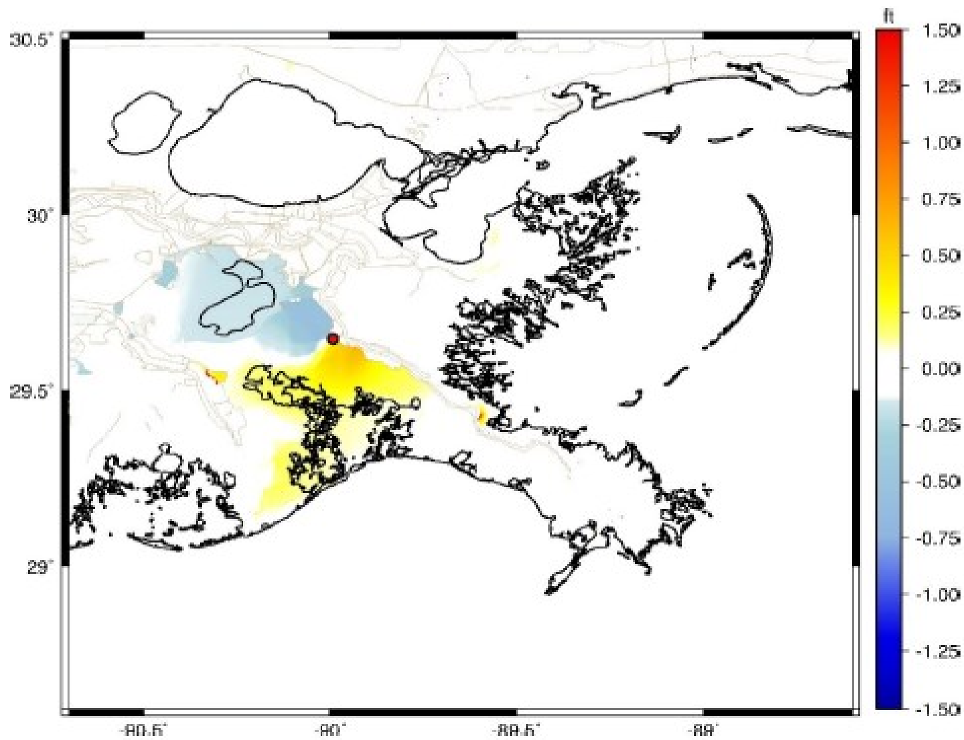


Figure 4.20-18. Change in Maximum Surge Elevations during 4 Percent AEP Storm: Applicant’s Preferred Alternative in 2040 less No Action Alternative in 2040. The red dot indicates the proposed location of the diversion.

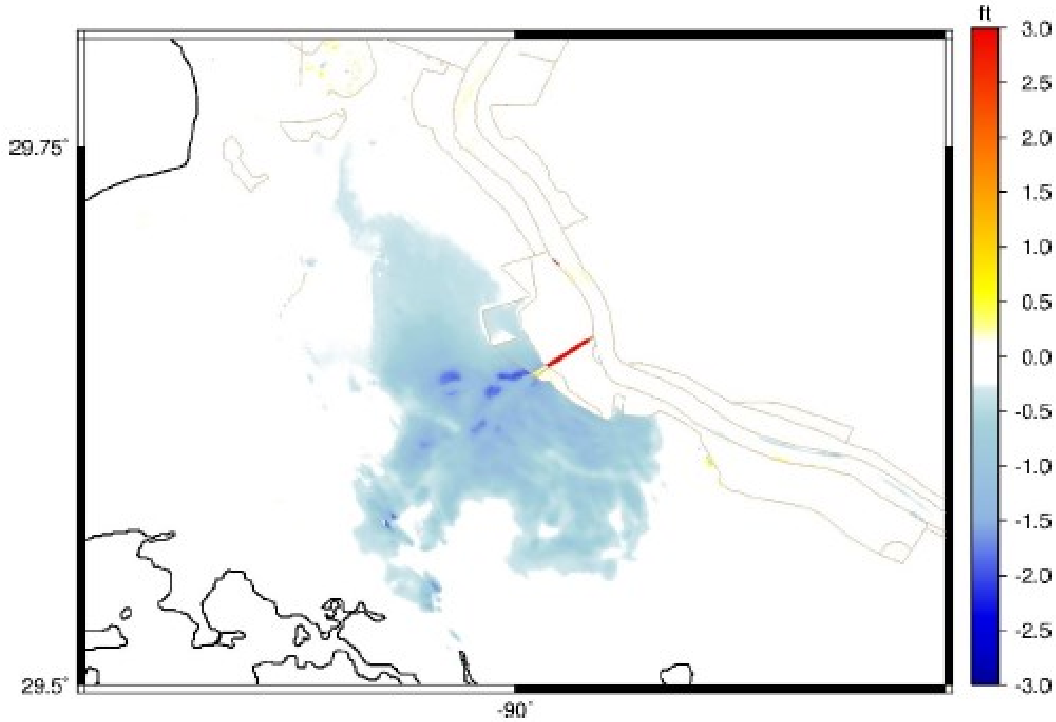


Figure 4.20-19. Change in Maximum Wave Heights during 4 Percent AEP Storm: Applicant's Preferred Alternative in 2040 less No Action Alternative in 2040. The red line indicates the proposed location of the diversion.

As compared with the No Action Alternative, the Applicant's Preferred Alternative is projected to cause maximum increases and decreases in surge elevation and maximum decreases in wave height in the delta formation area where Project-induced land gain and increased bathymetry would occur. Project impacts on surge elevations and wave heights are projected to be less pronounced farther away from the delta formation area. The additional 1 percent AEP and 4 percent AEP storm simulations showed similar differences between the No Action Alternative and Applicant's Preferred Alternative surge and wave elevations (see Appendix P for additional information on ADCIRC storm simulations).

Under the Applicant's Preferred Alternative, the greatest impacts on surge elevation are projected to occur in areas nearest to the immediate outfall area, in the portion of the basin adjacent to the NOV-NFL Levee, as represented by the darkest shades of blue and yellow in Figures 4.20-16 through 4.20-19. Tables 4.20-9 and 4.20-10 provide projected water level impacts adjacent to the NOV-NFL Levee system, and near the communities of Myrtle Grove, Grand Bayou, and Lafitte. Figure 4.20-3 above depicts the location of the stations for which model results are provided. The tables illustrate the projected difference in surge and wave height after 20 and 50 years of operation of the Applicant's Preferred Alternative for both the 1 percent and 4 percent AEP storms.

Table 4.20-9
Projected Maximum Surge Elevation Differences at the NOV-NFL Levee between the No Action Alternative and Applicant's Preferred Alternative for 1 Percent AEP and 4 Percent AEP Storms in 2040 and 2070[a] (feet)

Station Adjacent to NOV-NFL Levee[b]	1 Percent Storms				4 Percent Storms			
	No Action Alternative: Maximum Surge Elevation in 2040	Change in Surge Elevation in 2040: Applicant's Preferred Alternative less No Action Alternative	No Action Alternative: Maximum Surge Elevation in 2070	Change in Surge Elevation in 2070: Applicant's Preferred Alternative less No Action Alternative	No Action Alternative: Maximum Surge Elevation in 2040	Change in Surge Elevation in 2040: Applicant's Preferred Alternative less No Action Alternative	No Action Alternative: Maximum Surge Elevation in 2070	Change in Surge Elevation in 2070: Applicant's Preferred Alternative less No Action Alternative
Arcadis 1	11.0	-0.4	14.4	-0.6	10.3	-0.4	12.5	-0.6
Arcadis 2	11.4	-0.5	14.3	-0.6	10.2	-0.5	11.9	-0.5
Arcadis 8	9.7	-0.4	11.9	-0.6	8.7	-0.2	10.7	-0.5
Arcadis 3	11.1	-0.6	13.7	-0.7	9.8	-0.6	11.4	-0.6
Arcadis 4	11.5	-0.2	14.1	0.0	10.1	0.2	11.6	0.3
Arcadis 5	12.0	0.7	14.5	1.6	10.3	0.7	11.8	1.7
Arcadis 7	12.3	0.7	14.9	1.7	10.5	0.7	12.0	1.7
Arcadis 6	12.3	0.4	14.6	0.9	10.2	0.4	11.7	0.8
Arcadis 10	11.8	0.3	13.7	0.5	9.4	0.2	10.9	0.4
Arcadis 9	11.7	0.2	13.4	0.4	9.5	0.1	10.9	0.3

[a] Negative values indicate a decrease in surge elevations.
[b] See Figure 4.20-13 for locations of these stations.

Table 4.20-10
Projected Maximum Wave Elevation Differences at the NOV-NFL Levee between the No Action Alternative and Applicant's Preferred Alternative for 1 Percent AEP and 4 Percent AEP Storms in 2040 and 2070[a] (feet)

Station Adjacent to NOV-NFL Levee[b]	1 Percent Storms				4 Percent Storms			
	No Action Alternative: Maximum Wave Height in 2040	Change in Wave Height in 2040: Applicant's Preferred Alternative less No Action Alternative	No Action Alternative: Maximum Wave Height in 2070	Change in Wave Height in 2070: Applicant's Preferred Alternative less No Action Alternative	No Action Alternative: Maximum Wave Height in 2040	Change in Wave Height in 2040: Applicant's Preferred Alternative less No Action Alternative	No Action Alternative: Maximum Wave Height in 2070	Change in Wave Height in 2070: Applicant's Preferred Alternative less No Action Alternative
Arcadis 1	2.7	-0.1	4.8	-0.3	2.4	-0.1	4.0	-0.3
Arcadis 2	4.0	-0.1	5.1	-0.4	3.3	-0.2	4.0	-0.2
Arcadis 8	3.6	-0.1	4.7	-0.2	3.3	0.0	4.1	-0.1
Arcadis 3	3.7	-0.4	4.9	-1.2	3.2	-0.4	3.9	-1.2
Arcadis 4	5.0	-1.3	6.1	-1.9	4.4	-1.2	5.1	-1.8
Arcadis 5	4.6	-0.8	5.7	-0.9	3.9	-0.8	4.6	-1.0
Arcadis 7	4.5	-0.8	5.7	-0.6	3.8	-0.8	4.5	-0.7
Arcadis 6	5.3	0.1	6.3	0.3	4.4	0.0	5.0	0.2
Arcadis 10	4.2	0.1	5.2	0.1	3.3	0.0	4.1	0.1
Arcadis 9	3.2	0.0	4.6	0.1	2.6	0.1	3.7	0.0

[a] Negative values indicate a reduction in wave heights.
[b] See Figure 4.20-13 for locations of these stations.

Under the Applicant's Preferred Alternative, storm surge is only projected to increase in 2040 in areas gulfward of the immediate outfall area as compared to the No Action Alternative, with the greatest increases adjacent to the NOV-NFL Levee system, and near the communities of Myrtle Grove and Grand Bayou. Wave heights adjacent to the NOV-NFL Levee system, and near the communities of Myrtle Grove and Lafitte are projected to generally decrease in 2040 under the Applicant's Preferred Alternative, as compared to wave heights in 2020, whereas the wave heights in 2040 under the No Action Alternative are projected to increase as compared to 2020.

For the 2070 conditions, while storm surge and wave elevations are projected to be higher overall than in 2040 largely due to sea-level rise, a similar pattern of increases and decreases in storm surge elevation, and general decreases in wave heights within the delta formation area as compared to the No Action Alternative, are projected to result from operation of the Applicant's Preferred Alternative. Unlike the 2040 projections, wave heights are projected to increase gulfward of the delta formation area in 2070. Accelerated loss of wetlands in the birdfoot delta under the Applicant's Preferred Alternative (as described in Section 4.6.5.1.2.4 Wetland Resources and Waters of the U.S., Land Accretion) could also contribute to this storm hazard vulnerability south of the delta formation area, depending on the storm path and intensity; however, the relative contribution of this accelerated land loss in the birdfoot delta under to the Applicant's Preferred Alternative is likely negligible compared to the relative impact of sea-level rise. Surge impacts in 2070 for the 1 percent AEP and 4 percent AEP storm conditions are shown on Figures 4.20-20 through 4.20-23.

While the patterns of impacts are similar to those projected for 2040, the magnitude and spatial extent of the impacts are projected to be greater in 2070. The greatest increases and decreases in surge and decreases in wave elevations, respectively, are projected to occur within the vicinity of the delta formation area in 2070 conditions, in areas adjacent to the NOV-NFL Levee system, and in Lafitte, as is the case for 2040 conditions. Figures 4.20-21 and 4.20-23 show that wave heights are projected to decrease within the delta formation area, with minor increases in areas more gulfward, as shown in yellow in Figures 4.20-21 and 4.20-23. This minor increase in wave height gulfward is due to increasing water depths in this area outside of the delta formation area.

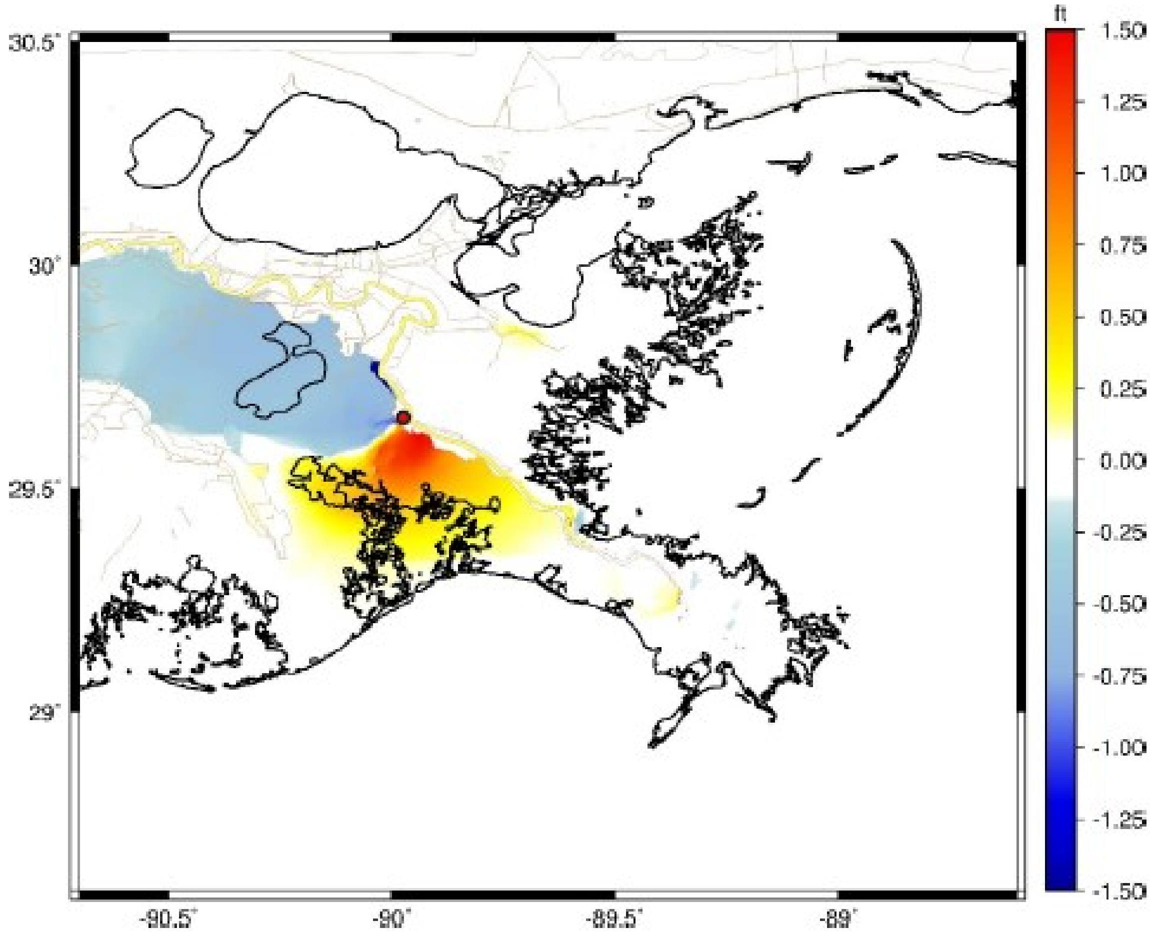


Figure 4.20-20. Change in Maximum Surge Elevations during 1 Percent AEP Storm: Applicant's Preferred Alternative 2070 less No Action Alternative 2070. The red dot indicates the proposed location of the diversion.

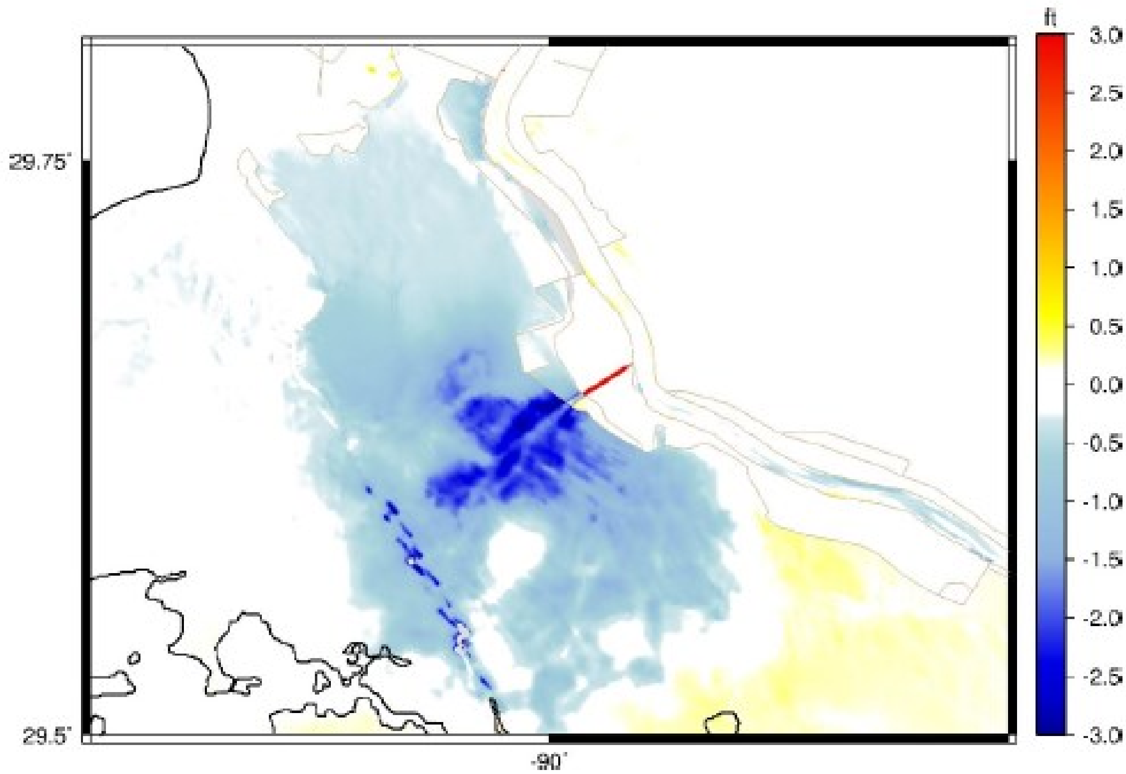


Figure 4.20-21. Change in Maximum Wave Heights during 1 Percent AEP Storm: Applicant's Preferred Alternative 2070 less No Action Alternative 2070. The red dot indicates the proposed location of the diversion.

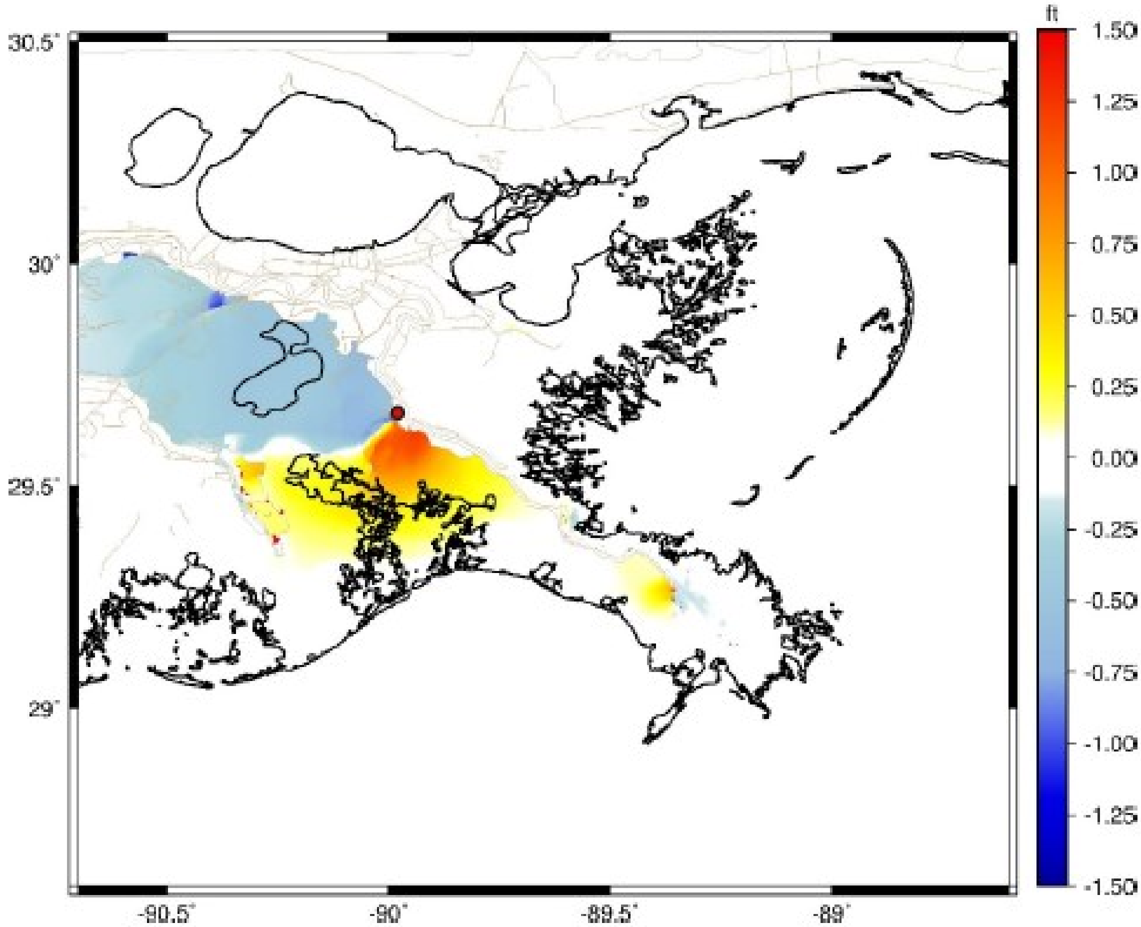


Figure 4.20-22. **Change in Maximum Surge Elevations during 4 Percent AEP Storm: Applicant's Preferred Alternative 2070 less No Action Alternative 2070.** The red dot indicates the proposed location of the diversion.

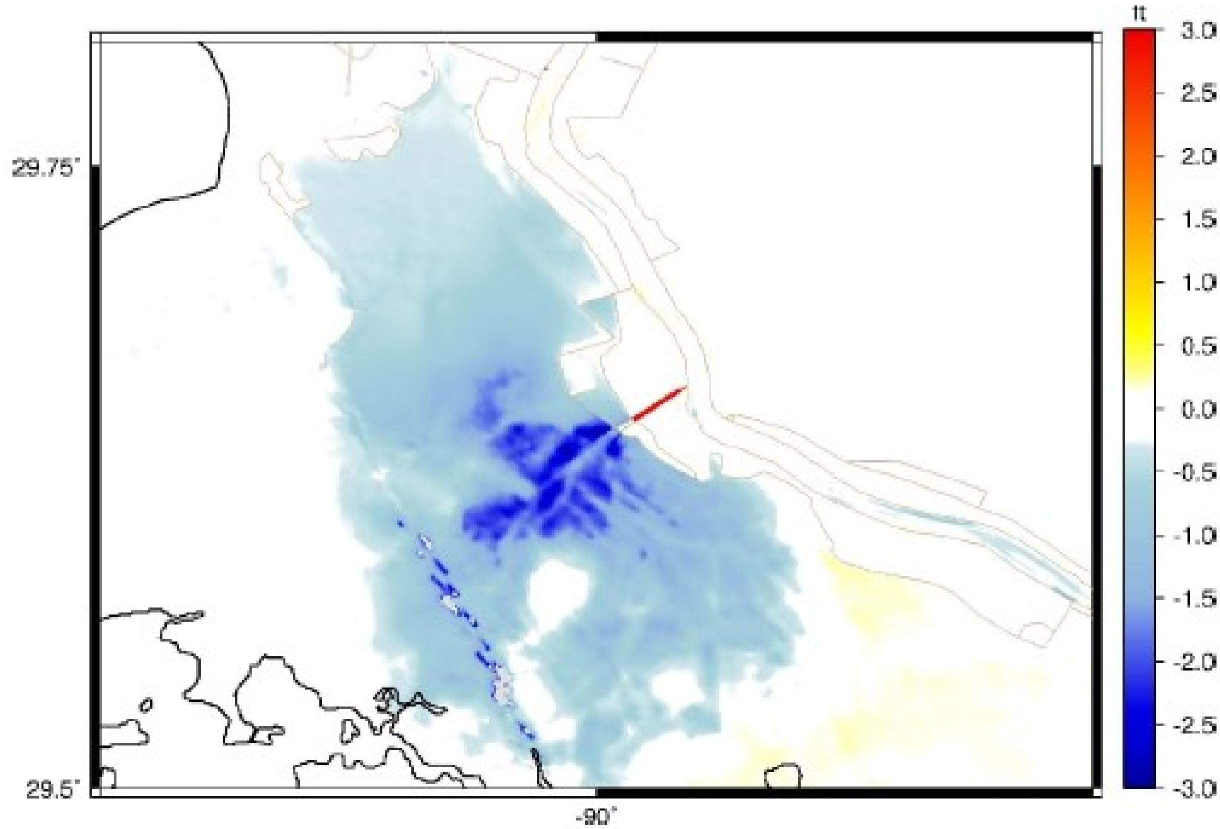


Figure 4.20-23. Change in Maximum Wave Heights during 4 Percent AEP Storm: Applicant's Preferred Alternative 2070 less No Action Alternative 2070. The red line indicates the proposed location of the diversion.

These model results are consistent with prior research suggesting that topography, landscape features, and vegetation have the potential to reduce storm surge elevations and alter storm wave characteristics. Wetlands contain a variety of vegetation type, height, and density that have the potential to create friction and slow the forward speed of storm surge. Waves become depth limited and the wave height and direction can be modified depending on the geotechnical properties and morphology of the wetland.

Relationships documenting the reduction in storm surge elevation due to landscape features and vegetation have been determined based on field studies. The USACE examined high water marks in Louisiana for seven storms prior to 1958 and observed a trend for the decrease in storm surge as a function of inland distance (USACE 1963). Quantifying the degree to which wetlands decrease storm surge with a simple rule of thumb is debatable. The inland penetration of the storm surge is an extremely complex function of storm characteristics (track, speed, duration, pressure index, and size), coastal geology (the regional topography, geometry of the shore, presence of barrier islands, and slope of the ocean bottom) along with wetland biological characteristics (vegetation type, density). While wetlands can effectively slow down storm surge for weak/faster storms, this benefit is not seen in all storm scenarios. Stronger and slower moving storms have the potential to alter landscape during their passage by stripping vegetation away and eroding land masses. Moreover, wetlands subject to strong winds for extended time would completely flood and thus have no dampening effect on storm surge elevation or inland travel. For example, during Hurricane Rita 2005, surge heights increased across nearly 25 miles (40 kilometers) of salt marsh in Louisiana, as steady winds overwhelmed the potentially beneficial friction and drag usually provided by wetland vegetation (Resio and Westerink 2008).

Despite these complexities, there are several lines of evidence that suggest that coastal wetlands do reduce inundation from storms in many instances. Hydrodynamic models of storm surges traversing landscapes suggest that vegetation roughness slows and reduces surge. Wamsley et al. (2010) modeled several storms approaching the Louisiana coast across present wetland cover and a predicted future coast with reduced wetland cover and found that wetlands can play a large role in attenuating storm surge (up to 0.54 foot [16.6 centimeters] attenuation per 0.6 mile [1 kilometer]) of wetland. This effect is dependent upon the characteristics of the wetland and the storm. Field based observations of storm surges traversing wetlands also indicate a dampening effect (Lovelace 1994, Day et al. 2007, Krauss et al. 2009, Wamsley et al. 2010). These impacts range from a dampening of 0.15 foot (4.6 centimeters) (Hurricane Andrew; Lovelace 1994) to 0.52 foot/mile (9.8 centimeters/kilometer) of coastal wetland traversed (Hurricane Charley; Krauss et al. 2009).

To summarize the modeling results described in this section, which are supported by similar findings in published studies, the Applicant's Preferred Alternative would be expected, in general, to cause a decrease in surge elevation north of the immediate outfall area and an increase in surge elevation gulfward of the immediate outfall area. The Applicant's Preferred Alternative would also decrease wave heights within the delta formation area, and slightly increase wave height gulfward of the delta formation area, with the changes increasing in magnitude and spatial extent over time as the size of the delta increases. Decreases in surge and wave height would be expected to lower the risk of inundation in populated areas adjacent to these decreases. Similarly, the increases in surge elevation would be expected to increase the risk of storm surge and wave-induced inundation in populated areas adjacent to these increases. Areas adjacent to the delta formation area south of the immediate outfall area would also be at an increased risk of inundation, as the reduction in wave height within the delta formation area is generally not projected to eliminate the increased risk associated with increased storm surge elevation.

For 1 percent AEP storms (100-year), model results show a consistent pattern of surge elevation increases seaward and decreases inland of the immediate outfall area. The magnitude of these increases and decreases are in the range of 0 to 0.8 foot (0 to 24.4 centimeters) for 2040 conditions and 0 to 1.7 feet (0 to 51.8 centimeters) for 2070 conditions as compared to the No Action Alternative. Wave heights are consistently reduced within the delta formation area, with some slight increases in wave heights seaward of the delta formation area for 2070 conditions. The magnitudes of these wave height reductions are in the range of 0 to 1.4 feet (0 to 42.7 centimeters) for 2040 conditions and 0 to 2.1 feet (0 to 64.0 centimeters) for 2070 conditions as compared to the No Action Alternative. This reduction and increase would have permanent, minor, beneficial impacts and minor adverse impacts on the public health and safety risks associated with storm hazards, respectively. The intensity of these impacts would decrease with distance from the immediate outfall area; minor impacts would occur near the immediate outfall area, and would be reduced to negligible in areas farther from the immediate outfall area.

The impact on the public health and safety risks associated with storm hazards of the proposed Project when considering increases and decreases of wave height would be permanent (over the 50-year analysis period), negligible to moderate, and beneficial. In 2040, wave heights are projected to be reduced by up to 25 percent north of the immediate outfall area; in 2070, wave heights are projected to be reduced up to 30 percent north of the immediate outfall area. This reduction would represent a negligible to moderate beneficial impact on the public health and safety risks associated with storm hazards. As with storm surge, the intensity of these impacts would decrease with distance from the immediate outfall area; the moderate impacts would occur near the immediate outfall area, and would be reduced to negligible in areas farther from the immediate outfall area.

4.20.4.2.2.3 Other Alternatives

Similar to the Applicant's Preferred Alternative, maximum surge elevations would increase gulfward of the immediate outfall area and decrease north of the immediate outfall area for all other action alternatives. Also similar to the Applicant's Preferred Alterative, wave heights within the delta formation area decrease both north and south of the immediate outfall area within the delta formation area. Both surge elevation and wave height differences between all action alternatives and the No Action Alternative are greatest in the vicinity of the immediate outfall area and lessen with distance from the immediate outfall area. As with the Applicant's Preferred Alternative, for all other action alternatives, these projected water elevations assume that the diversion is closed prior to the modeled storm event, such that water levels within the basin are not elevated from diversion flows during the period that the modeled storm impacts water levels within the basin. If the diversion were not closed in enough time prior to a storm event to allow for diversion-introduced water to dissipate throughout the Project area, maximum water levels during storm events could be increased. The timing of diversion closure would be based in part on modeling analysis which indicates that once the diversion is closed (no flow), basin water surface elevations are anticipated to return to ambient water levels in approximately two days in most areas of the basin. Minor differences between the alternatives are discussed below, including the projected differences between maximum surge elevations and wave heights between the alternatives.

4.20.4.2.2.3.1 50,000 cfs Alternative

The 50,000 cfs Alternative is projected to result in a lower spatial extent and magnitude of bathymetry change and less acreage of created and maintained wetlands than the Applicant's Preferred Alternative. The resulting difference in projected surge and wave elevation between the 50,000 cfs Alternative and Applicant's Preferred

Alternative is minimal. Tables 4.20-11 and 4.20-12 provide details on the areas adjacent to the NOV-NFL Levee system as the greatest impacts on surge and waves from the diversion are projected there.

After 20 years of diversion operation, there is no projected difference in maximum surge elevation between the 50,000 cfs Alternative and Applicant's Preferred Alternative near the immediate outfall area; at the end of the 50-year analysis period, the projected difference in maximum surge elevation is less than +/– 0.5 foot (15.2 centimeters). This difference results in a slightly lower surge elevation reduction projected north of the immediate outfall area, and a slightly lower surge elevation increase projected gulfward of the immediate outfall area under the 50,000 cfs Alternative as compared to the Applicant's Preferred Alternative.

A similarly slight and localized difference in maximum wave height is projected between the 50,000 cfs Alternative and the Applicant's Preferred Alternative, with the difference in maximum wave elevation reduction at the end of the 50-year analysis period projected to be less than 0.5 foot (15.2 centimeters) between the two alternatives. The spatial extent of wave height reductions under the 50,000 cfs Alternative is also projected to be slightly smaller than the Applicant's Preferred Alternative. Despite these differences between the Applicant's Preferred Alternative and the 50,000 cfs Alternative, the two alternatives show very minor differences when compared to the No Action Alternative surge and wave elevation predictions. Thus, this alternative is expected to similarly have permanent, minor to moderate, beneficial and adverse impacts on public health and safety as in the Applicant's Preferred Alternative.

Table 4.20-11
Projected Maximum Surge Elevation Differences at the NOV-NFL Levee between the No Action Alternative and 50,000 cfs for 1 Percent AEP and 4 Percent AEP Storms in 2040 and 2070[a] (feet)

Station Adjacent to NOV-NFL Levee[b]	1 Percent Storms				4 Percent Storms			
	No Action Alternative: Maximum Surge Elevation in 2040	Change in Surge Elevation in 2040: 50,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Surge Elevation in 2070	Change in Surge Elevation in 2070: 50,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Surge Elevation in 2040	Change in Surge Elevation in 2040: 50,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Surge Elevation in 2070	Change in Surge Elevation in 2070: 50,000 cfs Alt. less No Action Alt.
Arcadis 1	11.0	-0.3	14.4	-0.4	10.3	-0.4	12.5	-0.5
Arcadis 2	11.4	-0.4	14.3	-0.5	10.2	-0.5	11.9	-0.4
Arcadis 8	9.7	-0.3	11.9	-0.4	8.7	-0.2	10.7	-0.4
Arcadis 3	11.1	-0.5	13.7	-0.5	9.8	v0.5	11.4	-0.5
Arcadis 4	11.5	-0.2	14.1	0.0	10.1	0.1	11.6	0.1
Arcadis 5	12.0	0.7	14.5	1.4	10.3	0.7	11.8	1.5
Arcadis 7	12.3	0.7	14.9	1.5	10.5	0.7	12.0	1.5
Arcadis 6	12.3	0.3	14.6	0.7	10.2	0.3	11.7	0.6
Arcadis 10	11.8	0.2	13.7	0.4	9.4	0.1	10.9	0.3
Arcadis 9	11.7	0.2	13.4	0.4	9.5	0.1	10.9	0.3

[a] Negative values indicate a reduction in surge elevation.
[b] See Figure 4.20-13 for locations of these stations.

Table 4.20-12
Projected Maximum Wave Elevation Differences at the NOV-NFL Levee between the No Action Alternative and 50,000 cfs Alternatives for 1 Percent AEP and 4 Percent AEP Storms in 2040 and 2070[a] (feet)

Station Adjacent to NOV-NFL Levee[b]	1 Percent Storms				4 Percent Storms			
	No Action Alternative: Maximum Wave Height in 2040	Change in Wave Height in 2040: 50,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Wave Height in 2070	Change in Wave Height in 2070: 50,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Wave Height in 2040	Change in Wave Height in 2040: 50,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Wave Height in 2070	Change in Wave Height in 2070: 50,000 cfs Alt. less No Action Alt.
Arcadis 1	2.7	-0.1	4.8	-0.2	2.4	-0.1	4.0	-0.2
Arcadis 2	4.0	-0.1	5.1	-0.3	3.3	-0.1	4.0	-0.1
Arcadis 8	3.6	0.0	4.7	-0.1	3.3	0.0	4.1	-0.1
Arcadis 3	3.7	-0.3	4.9	-0.9	3.2	-0.3	3.9	-0.9
Arcadis 4	5.0	-1.3	6.1	-1.9	4.4	-1.1	5.1	-1.7
Arcadis 5	4.6	-0.6	5.7	-0.8	3.9	-0.6	4.6	-0.8
Arcadis 7	4.5	-0.6	5.7	-0.3	3.8	-0.6	4.5	-0.4
Arcadis 6	5.3	0.1	6.3	0.2	4.4	0.0	5.0	0.1
Arcadis 10	4.2	0.1	5.2	0.1	3.3	0.0	4.1	0.1
Arcadis 9	3.2	-0.1	4.6	0.0	2.6	0.1	3.7	0.0

[a] Negative values indicate a reduction in surge elevation.
[b] See Figure 4.20-13 for locations of these stations.

4.20.4.2.2.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative is projected to result in a greater magnitude and spatial extent of bathymetry change and a greater acreage of created and maintained wetlands than the Applicant's Preferred Alternative. However, the resulting projected surge and wave elevation is only slightly different than the Applicant's Preferred Alternative (see Tables 4.20-13 and 4.20-14). After 20 years of diversion operation, the projected difference in maximum surge elevation between the 150,000 cfs Alternative and Applicant's Preferred Alternative in the delta formation area, is less than 0.5 foot (15.2 centimeters); at the end of the 50-year analysis period, the projected difference in maximum surge elevation is also less than 0.5 foot (15.2 centimeters). This difference results in a slightly greater surge elevation reduction inland of the immediate outfall area, and a slightly greater surge elevation increase projected gulfward of the immediate outfall area under the 150,000 cfs Alternative as compared to the Applicant's Preferred Alternative. A similarly slight and localized difference in maximum wave height is projected between the 150,000 cfs Alternative and the Applicant's Preferred Alternative, with the difference in maximum wave elevation at the end of the 50-year analysis period also generally less than 0.5 foot (15.2 centimeters) lower than under the Applicant's Preferred Alternative. The spatial extent of wave height reductions under the 150,000 cfs Alternative is also projected to be slightly larger than the Applicant's Preferred Alternative. Despite these differences between the Applicant's Preferred Alternative and the 150,000 cfs Alternative, the two alternatives show very minor differences when compared to the No Action Alternative surge and wave elevation predictions. Thus, this alternative is expected to similarly have permanent, minor to moderate, beneficial and adverse impacts on public health and safety as in the Applicant's Preferred Alternative.

4.20.4.2.2.3.3 Terraces Alternatives

The addition of terrace features to the 50,000 cfs, 75,000 cfs, and 150,000 cfs Alternatives is expected to have a negligible impact on storm surge and wave-induced flooding because the terraces are not projected to increase wetland acreage to a degree that would noticeably decrease the risk of wave or surge flooding (see Section 4.6 Wetland Resources and Waters of the U.S., Tables 4.6-3 and 4.6-4 for details regarding wetland acreage under all alternatives). Thus, each terrace alternative would be expected to have the same intensity and duration of impact on public health and safety from storm surge as the corresponding flow capacity alternatives without terraces.

Table 4.20-13
Projected Maximum Surge Elevation Differences at the NOV-NFL Levee between the No Action Alternative and 150,000 cfs for 1 Percent AEP and 4 Percent AEP Storms in 2040 and 2070[a] (feet)

Station Adjacent to NOV-NFL Levee[b]	1 Percent Storms				4 Percent Storms			
	No Action Alternative: Maximum Surge Elevation in 2040	Change in Surge Elevation in 2040: 150,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Surge Elevation in 2070	Change in Surge Elevation in 2070: 150,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Surge Elevation in 2040	Change in Surge Elevation in 2040: 150,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Surge Elevation in 2070	Change in Surge Elevation in 2070: 150,000 cfs Alt. less No Action Alt.
Arcadis 1	11.0	-0.7	14.4	-0.9	10.3	-0.6	12.5	-0.9
Arcadis 2	11.4	-0.7	14.3	-0.9	10.2	-0.8	11.9	-0.8
Arcadis 8	9.7	-0.5	11.9	-0.9	8.7	-0.3	10.7	-0.7
Arcadis 3	11.1	-0.7	13.7	-0.9	9.8	-0.8	11.4	-0.8
Arcadis 4	11.5	0.0	14.1	0.4	10.1	0.3	11.6	0.6
Arcadis 5	12.0	0.7	14.5	1.7	10.3	0.7	11.8	1.4
Arcadis 7	12.3	0.7	14.9	1.6	10.5	0.7	12.0	1.4
Arcadis 6	12.3	0.6	14.6	1.3	10.2	0.7	11.7	1.0
Arcadis 10	11.8	0.4	13.7	0.8	9.4	0.3	10.9	0.6
Arcadis 9	11.7	0.3	13.4	0.6	9.5	0.3	10.9	0.5

[a] Negative values indicate a reduction in surge elevation.
[b] See Figure 4.20-13 for locations of these stations.

Table 4.20-14
Projected Maximum Wave Elevation Differences at the NOV-NFL Levee between the No Action Alternative and 150,000 cfs Alternatives for 1 Percent AEP and 4 Percent AEP Storms in 2040 and 2070[a] (feet)

Station Adjacent to NOV-NFL Levee[b]	1 Percent Storms				4 Percent Storms			
	No Action Alternative: Maximum Wave Height in 2040	Change in Wave Height in 2040: 150,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Wave Height in 2070	Change in Wave Height in 2070: 150,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Wave Height in 2040	Change in Wave Height in 2040: 150,000 cfs Alt. less No Action Alt.	No Action Alternative: Maximum Wave Height in 2070	Change in Wave Height in 2070: 150,000 cfs Alt. less No Action Alt.
Arcadis 1	2.7	-0.2	4.8	-0.5	2.4	-0.2	4.0	-0.5
Arcadis 2	4.0	-0.3	5.1	-0.8	3.3	-0.2	4.0	-0.6
Arcadis 8	3.6	-0.1	4.7	-0.3	3.3	-0.1	4.1	-0.2
Arcadis 3	3.7	-1.1	4.9	-2.1	3.2	-0.8	3.9	-1.8
Arcadis 4	5.0	-1.4	6.1	-2.2	4.4	-1.2	5.1	-1.9
Arcadis 5	4.6	-0.9	5.7	-1.3	3.9	-0.9	4.6	-1.4
Arcadis 7	4.5	-0.7	5.7	-1.2	3.8	-0.9	4.5	-1.3
Arcadis 6	5.3	0.1	6.3	0.3	4.4	0.1	5.0	0.2
Arcadis 10	4.2	0.1	5.2	0.2	3.3	0.0	4.1	0.2
Arcadis 9	3.2	0.0	4.6	0.2	2.6	0.1	3.7	0.1

[a] Negative values indicate a reduction in surge elevation.
[b] See Figure 4.20-13 for locations of these stations.

4.20.4.2.3 Risk Reduction Levees

4.20.4.2.3.1 No Action Alternative

Communities located within levee systems are inherently less susceptible to tidal flooding than communities located outside of levee systems. A review of Delft3D Basinwide Model-projected water levels between 2020 and 2070 at stations in the vicinity of levee systems in the Project area indicate that still water levels occurring during non-storm event conditions are not expected to exceed levee design heights for federal levee systems within the Project area. Note that this comparison of water surface and levee elevations assumes that these federal levees would be maintained over time at elevations that continue to provide their authorized or design level of hurricane and storm damage risk reduction.

Under the No Action Alternative, storm surge elevations and waves could overtop any of the levee systems within the Project area if the storm intensity exceeds the level of hurricane and storm damage risk reduction of a given levee reach. For example, if a 1 percent AEP (100-year) storm were to produce storm surge or waves that overtop a portion of the NOV-NFL Levee system in Plaquemines Parish, which is designed to the 2 percent AEP (50-year) level of risk reduction with some portions designed to the 4 percent AEP (25-year) level of risk reduction, the populated area inside the levee would be subject to inundation and the associated public health and safety risks discussed in Section 4.20.3. Details on the levels of risk reduction for the levee systems within the Project area are provided in Chapter 3, Section 3.20.3.1 in Public Health and Safety, Including Flood and Storm Hazard Risk Reduction.

To understand how model-projected storm surge and wave elevations associated with the Project alternatives, including the No Action Alternative, would potentially impact public health and safety in populated areas inside the levee systems during storm events, a transect analysis was conducted along the NOV-NFL Levee to compare the combined projected storm surge and wave elevations to levee heights. In the levee transect figures below (see Figures 4.20-24 through 4.20-29), the solid black line represents the levee elevations, yellow lines represent the peak wave heights, blue lines represent peak water level elevations, and green lines represent the combined surge and wave elevations. Solid colored lines represent current conditions, dotted lines represent the 2040 No Action Alternative conditions, and dashed lines represent the 2040 and 2070 conditions under the Applicant’s Preferred Alternative. The location map on each figure indicates which portion of the NOV-NFL Levee is under consideration.

The model projects that under the No Action Alternative, surge elevations would increase in 2040 and 2070 as compared to 2020 conditions due to increased sea-level rise (see Tables 4.20-3 and 4.20-4). This increase is not projected to cause overtopping of the NOV-NFL Levee in the event of a 4 percent AEP (25-year) storm, but it would cause overtopping of the levee in the event of a 1 percent (100-year) storm. The No Action Alternative would cause major overtopping along portions of the LGM and Lafitte Levee systems in both the 4 percent and 1 percent AEP storms in 2070.

Thus, under the No Action Alternative, both the 4 percent and 1 percent AEP storms would cause major, adverse risks of storm hazard-related inundation by 2070, even in locations on the protected side of levee systems. The No Action Alternative would likely have permanent, major, adverse impacts on public health and safety due to the increased risk of storm hazard-related inundation.

4.20.4.2.3.2 Applicant's Preferred Alternative

All permanent Project features that would be subject to storm surge and waves would be designed and built to provide a 2 percent AEP (50-year) level of hurricane and storm damage risk reduction. Similar to the No Action Alternative, still water levels are not expected to exceed levee design heights for federal levee systems within the Project area during periods when the diversion is open (flowing above base flow up to maximum capacity) during non-storm event conditions.

During 1 percent AEP (100-year) storm events, the ADCIRC and SWAN models project that the Applicant's Preferred Alternative would have permanent, minor, beneficial impacts on decreasing levee overtopping north of the immediate outfall area and permanent, minor, adverse impacts on increasing levee overtopping south of the immediate outfall area. Figures 4.20-24 through 4.20-29 illustrate these comparisons for a 1 percent AEP storm and a 4 percent AEP storm in 2040 for a portion of the NOV-NFL Levee gulfward of the immediate outfall area, which is projected to experience the greatest increase in storm surge under the Applicant's Preferred Alternative.

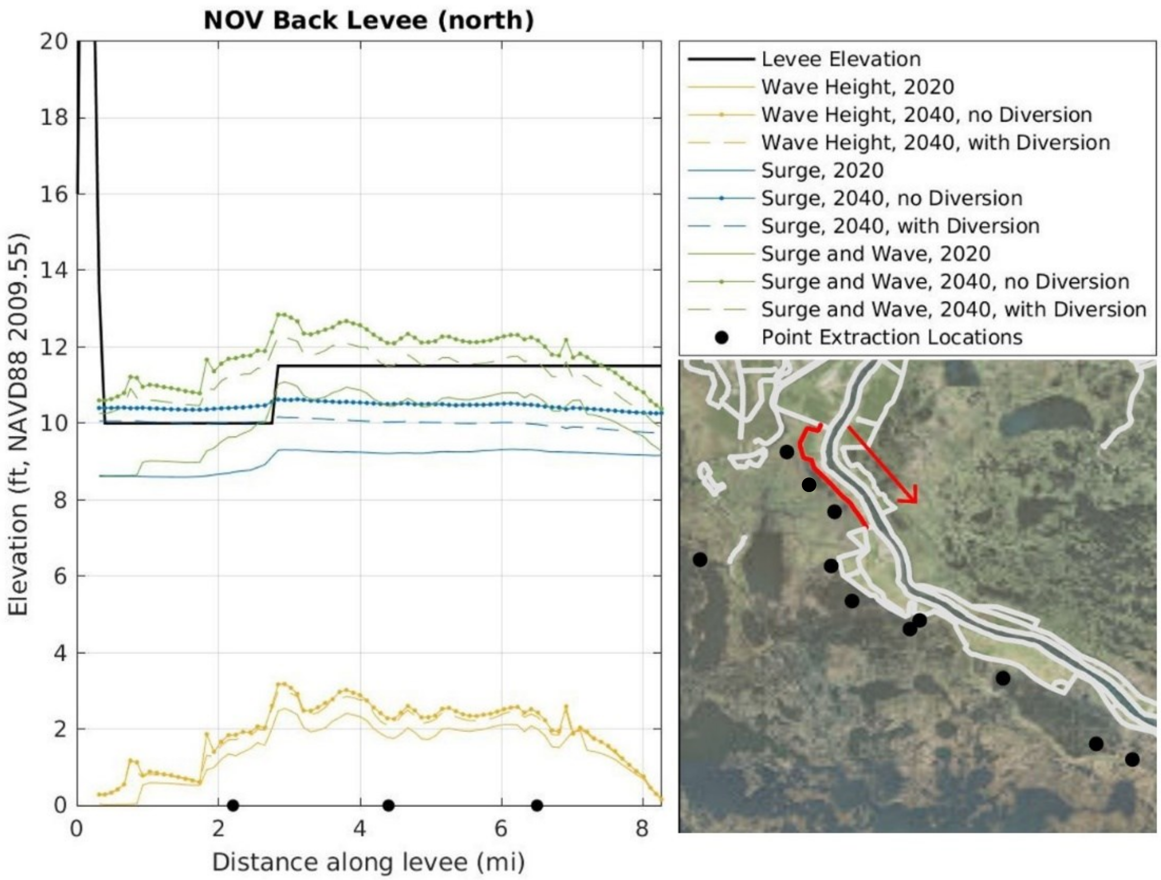


Figure 4.20-24. Comparison of 1 Percent AEP Storm Surge Elevation and Wave Height to Northern NOV-NFL Modeled Levee Height in Years 2020 and 2040 under the No Action Alternative and Applicant's Preferred Alternative.

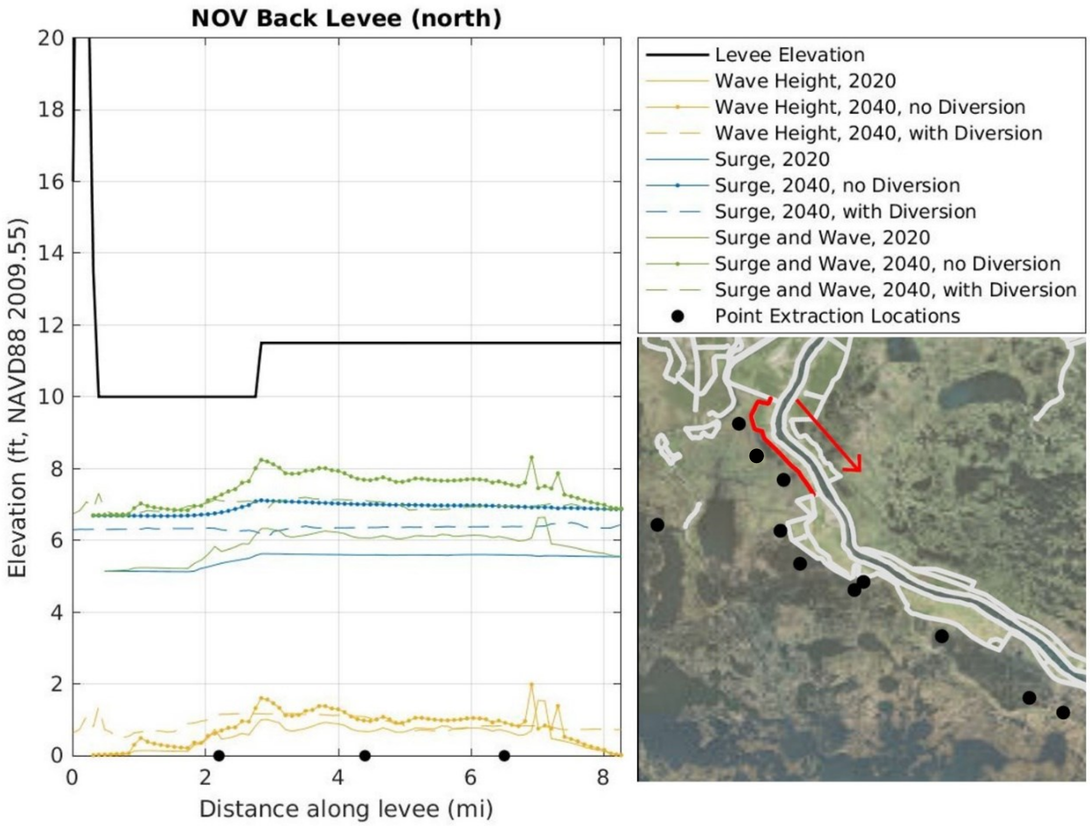


Figure 4.20-25. Comparison of 4 Percent AEP Storm Surge Elevation and Wave Height to Northern NOV-NFL Modeled Levee Height in Years 2020 and 2040 under the No Action Alternative and Applicant's Preferred Alternative.

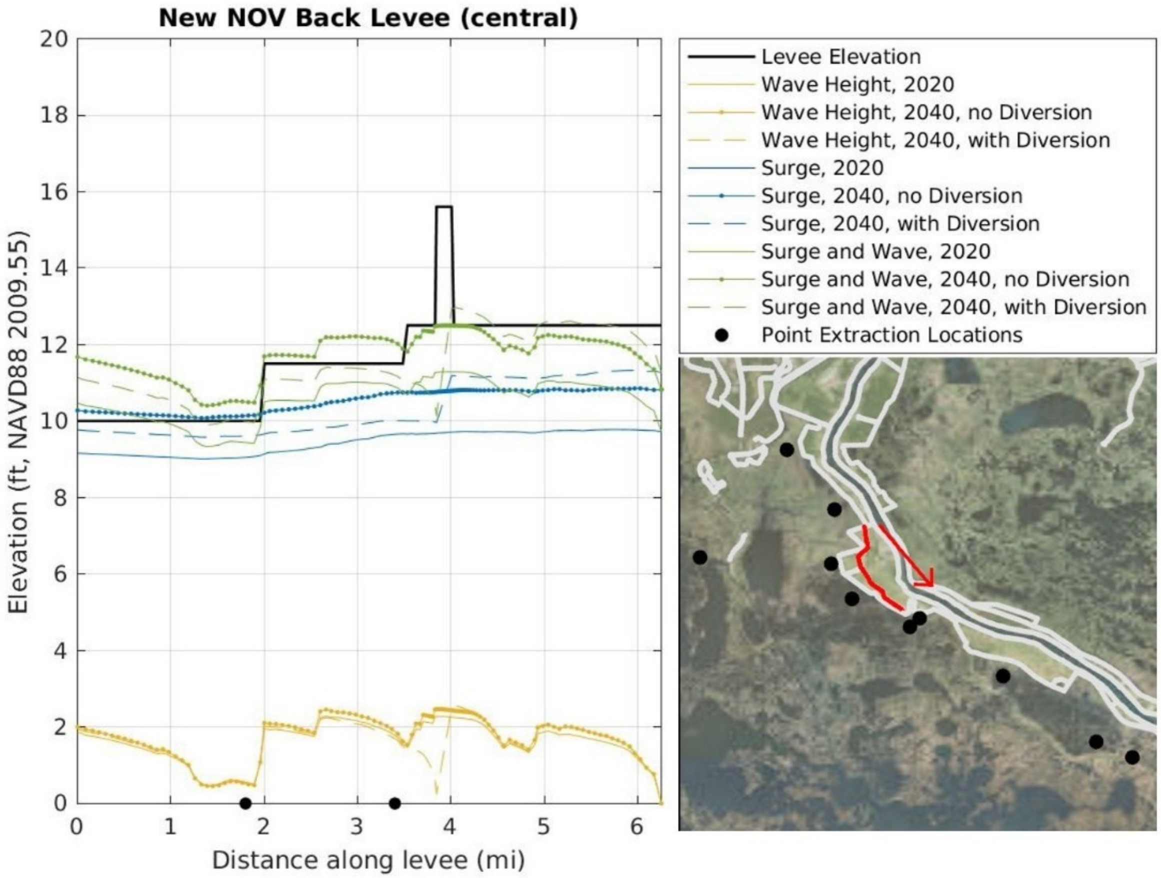


Figure 4.20-26. Comparison of 1 Percent AEP Storm Surge Elevation and Wave Heights to Central NOV-NFL Modeled Levee Height in Years 2020 and 2040 under the No Action Alternative and Applicant's Preferred Alternative.

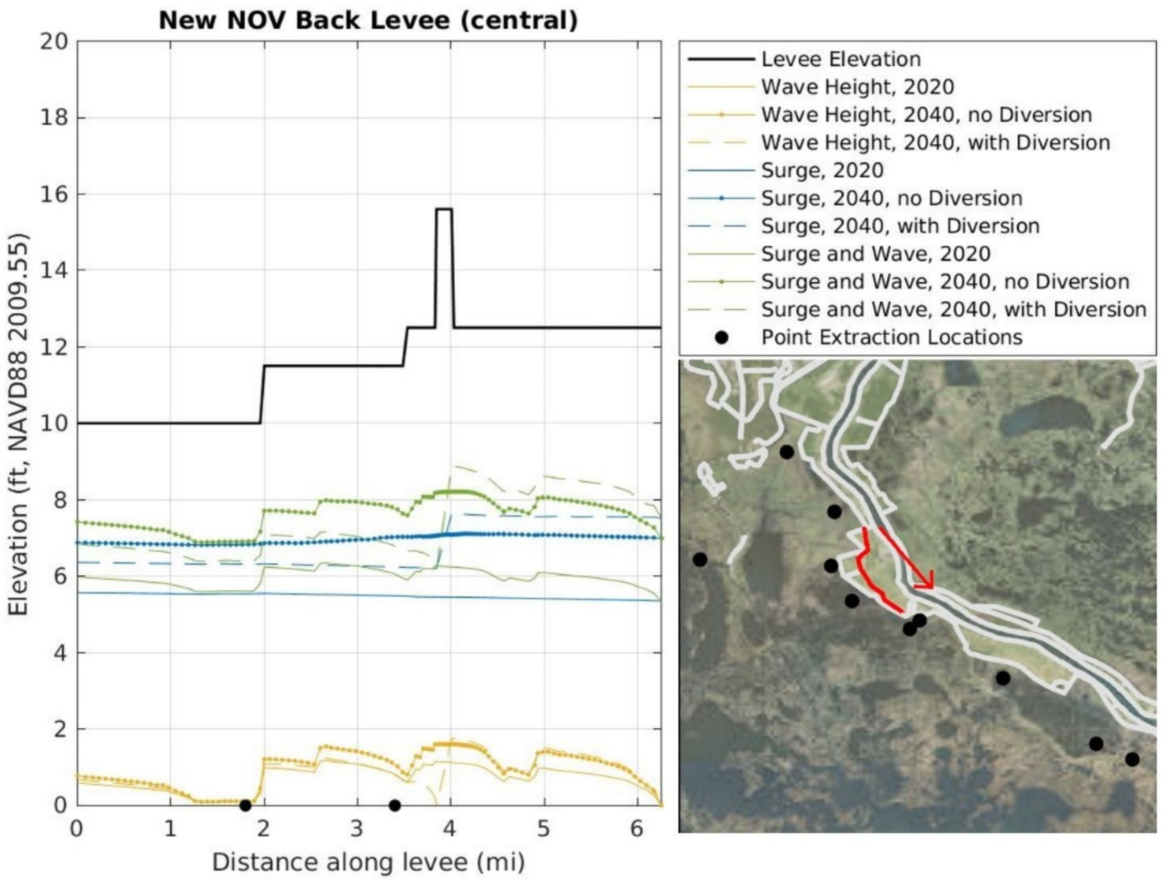


Figure 4.20-27. Comparison of 4 Percent AEP Storm Surge Elevation and Wave Heights to Central NOV-NFL Modeled Levee Height in Years 2020 and 2040 under the No Action Alternative and Applicant's Preferred Alternative.

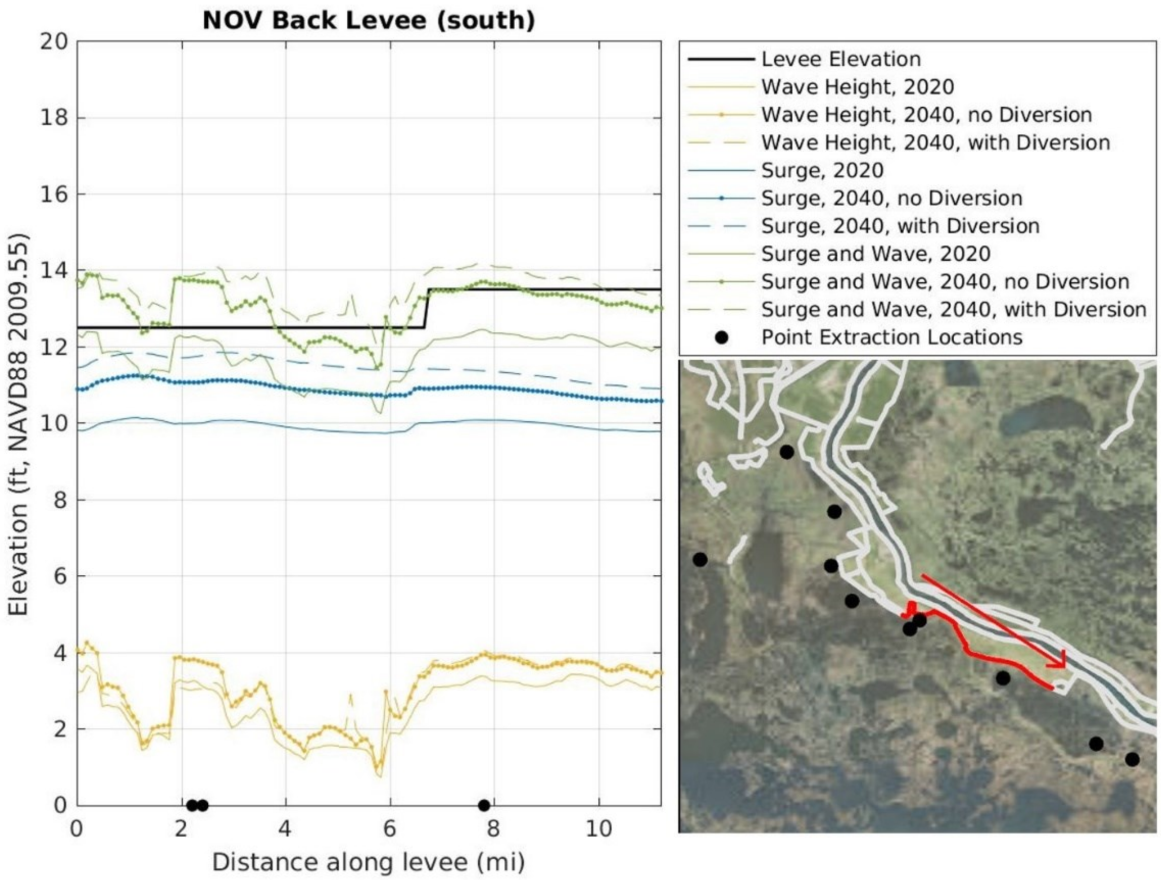


Figure 4.20-28. Comparison of 1 Percent AEP Storm Surge Elevation and Wave Heights to Southern NOV-NFL Modeled Levee Height in Years 2020 and 2040 under the No Action Alternative and Applicant's Preferred Alternative.

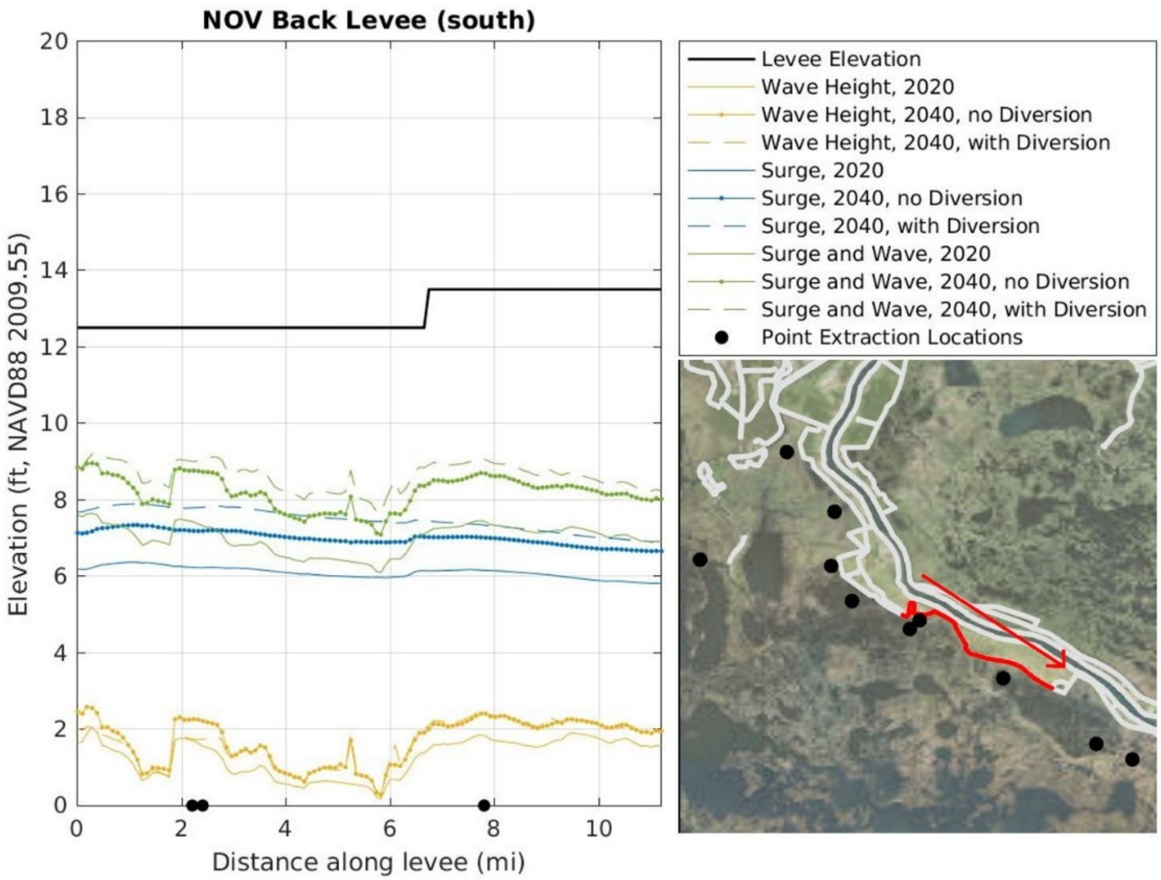


Figure 4.20-29. Comparison of 4 Percent AEP Storm Surge Elevation and Wave Heights to Southern NOV-NFL Modeled Levee Height in Years 2020 and 2040 under the No Action Alternative and Applicant's Preferred Alternative.

For the simulated 4 percent AEP storm, the increased storm surge is not projected to produce a maximum water level (surge plus wave) that exceeds the adjacent NOV-NFL Levee height. However, for the simulated 1 percent AEP storm, maximum water levels are projected to exceed adjacent levee height in some areas with or without the diversion. In other areas along this levee reach, the diversion is projected to cause maximum water levels to exceed levee heights when it would not be exceeded without the diversion. In other words, a 1 percent AEP storm is projected to cause maximum water levels that exceed the height of levees in some areas regardless of the Applicant's Preferred Alternative, whereas some areas of levee would only experience such exceedance under the Applicant's Preferred Alternative. Because this levee reach was designed and built to reduce the risk of hurricane and storm damage from a 4 percent AEP storm, rather than a 1 percent AEP storm, the populated area gulfward of the immediate outfall area is at risk of levee overtopping and inundation from a 1 percent AEP storm regardless of any impact caused by the diversion. This risk would increase over time due to sea-level rise, regardless of the diversion, as seen in the increased storm surge elevations under the No Action Alternative over time. During 1 percent AEP (100-year) storms in 2040 and 2070, the Applicant's Preferred Alternative is projected to cause increased levee overtopping of the NOV-NFL Levee south of the immediate outfall area, by as much as 1.5 feet (45.7 centimeters) as compared to the No Action Alternative.

Because increases in storm surge gulfward of the immediate outfall area and wave decreases within the delta formation area are projected to dissipate with distance from the diversion, the impact of the Applicant's Preferred Alternative on storm surge is not anticipated to have more than a negligible to minor impact on public health and safety within federal levee systems within the basin shown in Figure 4.20-13 other than the NOV-NFL system. For example, for simulated 1 percent AEP storm in 2040, the combined surge and wave height is projected to be reduced (as compared to the No Action Alternative) on the order of 0.2 to 0.5 foot (6 centimeters to 15.2 centimeters), or approximately 3.5 percent on average, along the small portion of the WBV Levee system within Plaquemines Parish (the eastern end of the system). For a simulated 1 percent AEP storm in 2070, the combined surge and wave height is projected to be reduced (as compared to the No Action Alternative) on the order of 0.5 to 0.8 foot (15.2 centimeters to 24.4 centimeters), or approximately 4.3 percent on average along the entire WBV Levee system. Along the eastern and western reaches of the LGM system, combined surge and wave heights are projected to be reduced less than 0.1 foot (3.1 centimeters) for a simulated 1 percent AEP storm in 2040 and 2070, and both the No Action Alternative and Applicant's Preferred Alternative combined surge and wave height are projected to exceed levee heights along most of the LGM system south of Cutoff.

In summary, the Applicant's Preferred Alternative would create bed elevation and topography changes that would reduce storm surge and wave elevations within the northeastern portion of the Project area inland of the immediate outfall area, which could reduce the risk of storm surge and wave-induced inundation in areas within the WBV system and northern reaches within the NOV-NFL Levee system and produce a permanent, negligible to minor, beneficial impact on public health and safety. Conversely, the Applicant's Preferred Alternative would create bathymetry and topography changes that would increase storm surge within the Project area gulfward of the immediate outfall area, which could increase the risk of storm surge and wave-induced inundation for southern reaches of the NOV-NFL and NOV Levee systems. The populated areas located behind the NOV-NFL and NOV systems are currently at a higher risk of storm surge and wave-induced inundation than the WBV system due to the lower risk reduction levels of their respective levee systems, and their closer proximity to the Gulf of Mexico. Therefore, the permanent, adverse impacts on public health and safety in these areas would be minor, as the increase in storm related water levels as compared to the No Action Alternative are negligible to minor. The intensity of this beneficial or adverse impact would range from negligible to minor depending on a given storm's characteristics and the level of risk reduction provided by infrastructure such as levees and floodwalls for a given populated area.

4.20.4.2.3.3 Other Alternatives

Because the projected surge and wave elevations for all other action alternatives, including those with terraces, is only slightly different (less than 0.5 foot [15.2 centimeters]) than the Applicant's Preferred Alternative, they would be expected to have similar impacts on public health and safety in communities within the federal levee systems as the Applicant's Preferred Alternative.

4.20.5 Summary of Potential Impacts

Table 4.20-15 summarizes the potential impacts on public health and safety for each alternative. Details are provided in Sections 4.20.2 through 4.20.4 above.

Table 4.20-15
Summary of Potential Impacts on Public Health and Safety, Including Flood and Storm Hazard Risk Reduction from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts from construction of the proposed Project would occur. • It is reasonable to anticipate that any future development impacting floodplains would be required to comply with all applicable local, state, and federal regulations.
Operational Impacts	• Minor to major, permanent, adverse impacts from increase in frequency and severity of non-storm and storm related flooding inside and outside federal levee systems.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Floodplain alteration would have no impact on public health and safety as existing level of flood risk reduction would be provided. • Stormwater management and drainage alterations would have no impact to risk of flood loss or current floodplain function as drainage would be maintained throughout construction. • Minimized risk of inadvertent releases of contaminants which could cause temporary, adverse impacts that range from no impact to moderate, depending on nature of release. • Minimized risk of storm events which could cause construction equipment and material related impacts which could have short-term, adverse impacts that range from minor to moderate impact. • Alteration of MR&T and NOV-NFL Levee systems would have no impact on public safety as interim risk reduction would be provided.
Operational Impacts	• Minor to major, adverse, long-term impacts on public health and safety due to increased tidal flooding in the Barataria Basin communities not protected by federal levees. • Minor to moderate, beneficial, permanent impacts on public health and safety associated with storm hazards in communities outside of federal levee systems north of the immediate outfall area. • Minor to moderate, adverse, permanent impacts on public health and safety risks associated with storm hazards in communities outside of federal levee systems south of the immediate outfall area. • Negligible to minor, beneficial, permanent impacts on decreasing levee overtopping north of the proposed immediate outfall area structure and permanent, negligible to minor, adverse impacts on increasing levee overtopping south of the immediate outfall area structure.

Table 4.20-15
Summary of Potential Impacts on Public Health and Safety, Including Flood and Storm Hazard Risk Reduction from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
50,000 cfs Alternative	
Construction Impacts	• Similar impacts as Applicant's Preferred Alternative (listed in following bullets), with shorter time period of risk exposure associated with construction-related contamination. • Floodplain alteration would have no impact on public health and safety as existing level of flood risk reduction would be provided. • Stormwater management and drainage alterations would have no impact to risk of flood loss or current floodplain function as drainage would be maintained throughout construction. • Minimized risk of inadvertent releases of contaminants which could cause temporary, adverse impacts that range from no impact to moderate, depending on nature of release. • Minimized risk of storm events which could cause construction equipment and material related impacts which could have short-term, adverse impacts that range from minor to moderate impact. • Alteration of MR&T and NOV-NFL Levee systems would have no impact on public safety as interim risk reduction would be provided.
Operational Impacts	• Similar impacts as Applicant's Preferred Alternative (listed in following bullets). • Minor to major, adverse, long-term impacts on public health and safety due to increased tidal flooding in the Barataria Basin communities not protected by federal levees. • Minor to moderate, beneficial, permanent impacts on public health and safety associated with storm hazards in communities outside of federal levee systems north of the immediate outfall area. • Minor to moderate, adverse, permanent impacts on public health and safety risks associated with storm hazards in communities outside of federal levee systems south of the immediate outfall area. • Negligible to minor, beneficial, permanent impacts on decreasing levee overtopping north of the proposed immediate outfall area structure and permanent, negligible to minor, adverse impacts on increasing levee overtopping south of the immediate outfall area structure.
150,000 cfs Alternative	
Construction Impacts	• Similar impacts as Applicant's Preferred Alternative (listed in following bullets), with longer time period of risk exposure associated with construction-related contamination. • Floodplain alteration would have no impact on public health and safety as existing level of flood risk reduction would be provided. • Stormwater management and drainage alterations would have no impact to risk of flood loss or current floodplain function as drainage would be maintained throughout construction. • Minimized risk of inadvertent releases of contaminants which could cause temporary, adverse impacts that range from no impact to moderate, depending on nature of release. • Minimized risk of storm events which could cause construction equipment and material related impacts which could have short-term, adverse impacts that range from minor to moderate impact. • Alteration of MR&T and NOV-NFL Levee systems would have no impact on public safety as interim risk reduction would be provided.
Operational Impacts	• Similar impacts as Applicant's Preferred Alternative (listed in following bullets)., with greater major intensity of impact on public health and safety than the Applicant's Preferred Alternative during the first 20 years of the analysis period,

Table 4.20-15
Summary of Potential Impacts on Public Health and Safety, Including Flood and Storm Hazard Risk Reduction from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	particularly in communities outside the federal levee system closer to the immediate outfall area. • Minor to major, adverse, long-term impacts on public health and safety due to increased tidal flooding in the Barataria Basin communities not protected by federal levees. • Minor to moderate, beneficial, permanent impacts on public health and safety associated with storm hazards in communities outside of federal levee systems north of the immediate outfall area. • Minor to moderate, adverse, permanent impacts on public health and safety risks associated with storm hazards in communities outside of federal levee systems south of the immediate outfall area. • Negligible to minor, beneficial, permanent impacts on decreasing levee overtopping north of the proposed immediate outfall area structure and permanent, negligible to minor, adverse impacts on increasing levee overtopping south of the immediate outfall area structure.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the substantially similar construction impacts as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs alternatives listed above. • Construction of terraces would alter approximately 88 additional acres of 100-year floodplain than the 75,000 cfs, 50,000 cfs , and 150,000 cfs Alternative, but no impact to public health and safety.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the substantially similar operational impacts on public health and safety as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on public health and safety due to the presence of terraces during Project operations would be negligible.

4.21 NAVIGATION

4.21.1 Area of Potential Impacts

In the Mississippi River, direct impacts on marine traffic operations associated with construction of the proposed training walls and cofferdam would occur within about 1 mile upstream and downstream of Project construction. Direct impacts on marine traffic volumes in the Mississippi River from barge deliveries of construction materials would occur in the river from New Orleans to the Gulf. Indirect impacts on marine traffic could affect additional segments of the Mississippi River upstream of New Orleans and in the Gulf depending upon the origin of construction materials. The area of potential traffic and dredging impacts from sedimentation during proposed Project operations include the Mississippi River from New Orleans to the Gulf.

In the Barataria Basin, the area of potential direct impacts on navigation volumes (number of vessel transits) due to barge deliveries of construction materials include the Harvey Canal/GIWW from New Orleans to Bayou Lafourche, and the Barataria Bay Waterway (see Chapter 3, Section 3.1, Figure 3.1-2 for a map of waterbodies in the

Project area). Indirect impacts on marine traffic could affect traffic volumes in the Mississippi River and the Gulf depending upon the origin of construction materials. During proposed Project operations, the area of potential impacts on navigation from sedimentation includes the Barataria Bay Waterway, the GIWW, and Bayou Lafourche, as well as non-federal channels and waterways affected by sedimentation during proposed Project operations (see Section 4.4.4.2 Hydrology and Hydrodynamics, Operational Impacts for more details about navigation channels and sedimentation impacts during proposed Project operations).

4.21.2 Overview of Modeling Impact Analysis

The Delft3D Basinwide, AdH, and HEC-6T model studies were examined to qualitatively estimate Project impacts on maintenance dredging operations in the Mississippi River and Barataria Basin (Brown et al. 2019, Thomas et al. 2018; see Appendix Q for further information about these models). The models have limitations that allow for a primarily qualitative interpretation of their results. Limitations include, for example:

- none of the three models reproduced the well-known saline wedge in Southwest Pass; therefore, none of their predictions of navigation channel sedimentation are considered reliable in that channel segment. Their results in Southwest Pass are considered only as part of the overall result and may underestimate actual deposition;

- the Delft3D Basinwide and AdH models were not validated by comparison to observed sediment deposition rates in navigation channels; therefore, their predictions of navigation channel sedimentation are considered primarily qualitative. Further, the Delft3D Basinwide and AdH model applications did not compute dredging events during the model simulations; thus, model channels continued to accumulate sediment as if dredging were not performed. Those dredging predictions may be somewhat low as a result;

- in the Barataria Basin, Delft3D Basinwide Model data for Bayou Lafourche were too close to the grid boundary to be used;

- the HEC-6T model was validated by comparison with observed dredging volumes in the Mississippi River AHP; therefore, its predictions of navigation channel sedimentation are considered quantitative in that region but not in Southwest Pass; and

- the AdH model included a 35,000 cfs diversion into Breton Sound, so its results in the main stem Mississippi River were substantially different than a scenario with the Mid-Barataria Sediment Diversion only. Only the Barataria Basin results from AdH were used here.

Sections 4.21.4.2 and 4.21.5.2 below provide these model results in numeric values that can be used for general projections of impacts. See Appendix Q for more information about model limitations and results.

4.21.3 Guidelines for Navigation Impact Determinations

Impact intensities for navigation traffic and federal maintenance dredging are based on the definitions provided in Section 4.1 and the following navigation-specific indicators:

- no impact: no discernible or measurable impact;
- negligible: the impact on navigation would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: there could be detectable but slight increases in local daily marine traffic volumes, resulting in perceived inconvenience to operators but no actual disruptions to transportation. The action could affect maintenance dredging operations, but the impact could be localized and within operational capacities;
- moderate: detectable increases in daily marine traffic volumes and decreases in safety could occur, resulting in slowed traffic and delays. Short service interruptions (temporary delays for a few hours) could occur. The action could affect maintenance dredging operations in local and adjacent areas, and the impact could require the acquisition of additional dredging services; and
- major: extensive increases in daily marine traffic volumes could occur (with reduced speed of travel), resulting in extensive service disruptions (temporary closure of one day or more). Accident risk becomes substantially higher. The action could affect maintenance dredging operations over a widespread area, and the impact could result in a failure to maintain authorized channel depths.

4.21.4 Mississippi River

4.21.4.1 Construction Impacts

4.21.4.1.1 No Action Alternative

4.21.4.1.1.1 Maintenance Dredging

Under the No Action Alternative, construction of the proposed Project would not occur, and there would be no impacts on maintenance dredging in the Mississippi River. Maintenance dredging to remove sediment deposits is required in portions of the Mississippi River navigation channel to provide sufficient depths for the safe transit of watercraft. Maintenance dredging is required to maintain authorized depths for navigation in the New Orleans Harbor (RM 114.9 AHP to RM 82.2 AHP) and from

Venice to the Gulf (RM 13.0 AHP to RM 22.0 BHP), including Southwest Pass. Mississippi River depths between New Orleans Harbor and Venice historically exceed 55 feet and do not require maintenance dredging. In the New Orleans Harbor, the amount dredged annually from 1996 through 2019 ranged from 0.4 mcy to 1.8 mcy with an annual average of 1.0 mcy (USACE 2019a). From Venice to the Gulf, the amount dredged annually from 1996 through 2019 ranged from 3.8 mcy to 48.8 mcy, with an annual average of approximately 17.4 mcy for maintenance of the channels (USACE 2019a). See Chapter 3, Section 3.21 Navigation for more details about maintenance dredging in the Lower Mississippi River south of Baton Rouge. Under the No Action Alternative, existing dredging trends are expected to continue into the future. Ongoing trends of sea-level rise and subsidence would continue, but only limited changes to Mississippi River maintenance dredging are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project).

4.21.4.1.1.2 Traffic

Under the No Action Alternative, construction of the proposed Project would not occur, and there would be no impacts on navigation-related traffic in the Mississippi River due to the proposed Project. Historical cargo data from the USACE Waterborne Commerce Statistics were reviewed to estimate future traffic trends in the Lower Mississippi River, specifically in the Mississippi River Passes segment, which captures all cargo traffic for the import and export of foreign trade (USACE 2018o). Cargo tonnage forecasts for a 20-year period (2017 through 2036)[126] were developed based on an average annual compound growth rate (AACGR) for the major commodity groups that transited the channel from 2000 to 2016.

As explained in Chapter 3, Section 3.21, Navigation because of its slow speed and relatively low cost, waterborne transportation tends to attract heavy bulk cargo. As measured by total annual cargo tons, the most prevalent commodity groups that transited the Mississippi River Passes from 2000 through 2016 were petroleum and petroleum products, followed by food and farm products (primarily consisting of grain exports) (see Table 4.21-1). Traffic on this lower segment of the Mississippi River showed very little growth from 2000 through 2016, with an overall AACGR of 0.8 percent for all commodities, and an AACGR of 1.1 percent for the five major commodity groups. The total tonnage of the five major commodity groups was 204.2 million tons in 2000 and 243.5 million tons in 2016. The AACGR for each major commodity group for the period 2000 through 2016 was 1.8 percent for petroleum, 0.5 percent for food and farm products, 3.1 percent for chemicals, 0.2 percent for crude materials, and -1.9 percent for coal (see Table 4.21-1).

The AACGR for years 2000 through 2016 reflect a period when energy prices were relatively high, particularly oil and natural gas, and the United States was the

[126] Forecasts exceeding 20 years would largely represent a continued extrapolation of recent historical trends that may not be applicable over a long-range period such as more than 20 years due to technological changes.

major world supplier of grains. These trends have recently changed; the United States has become a major world oil producer and exporter rather than a major importer of crude oil, and U.S. exports of grain have lost world market shares to other regions, most notably South America (Brazil and Argentina), such that food and farm exports on the Mississippi River are expected to decline. Declines in crude oil cargo tonnage entering the Mississippi River from foreign sources are not expected to be offset by increasing U.S. crude oil exports because U.S. crude oil is expected to be exported on very large tankers via navigation channels deeper than the Mississippi River or from offshore terminals, such as the Louisiana Offshore Oil Port. These changes to the two largest commodity groups transiting the Mississippi River Passes (petroleum and food and farm products) are expected to cause declines in cargo tonnages transiting the Lower Mississippi River.

Table 4.21-1
Mississippi River Passes[a] Total Cargo Tons (000) by Major Commodity Group by Foreign and Domestic Sources, 2000 – 2016

Year	Petroleum and Petroleum Products[b]	Food and Farm[c]	Chemicals[d]	Crude Materials[e]	Coal[f]	Subtotal	Total ALL Commodities
2000	76,561	85,984	14,815	15,625	11,199	204,184	222,727
2001	74,925	87,525	15,432	16,741	11,295	205,918	218,009
2002	73,596	88,169	14,858	17,044	10,284	203,951	217,898
2003	65,451	78,662	16,794	18,751	10,977	190,635	201,074
2004	70,131	77,149	17,013	20,278	12,374	196,945	213,895
2005	68,323	62,511	16,110	20,209	10,023	177,176	194,331
2006	69,599	76,142	16,662	16,832	12,612	191,847	211,467
2007	84,030	75,046	17,336	17,307	13,535	207,254	219,686
2008	82,845	72,982	18,152	17,758	18,393	210,130	220,442
2009	72,106	74,627	14,353	16,021	11,743	188,850	195,874
2010	77,470	78,480	18,591	17,157	15,187	206,885	214,891
2011	82,897	71,371	19,003	18,369	27,276	218,916	227,981
2012	82,199	69,706	18,654	17,191	32,332	220,082	230,048
2013	88,420	65,770	18,621	18,247	23,216	214,274	224,122
2014	90,657	85,723	19,977	20,744	14,077	231,178	244,928
2015	92,998	86,240	22,505	18,056	11,512	231,311	242,778
2016	101,810	93,032	24,279	16,181	8,182	243,484	254,042
AACGR[g] 2000-2016	**1.8%**	**0.5%**	**3.1%**	**0.2%**	**-1.9%**	**1.1%**	**0.8%**

a Includes South Pass and Southwest Pass.
b Includes crude oil and petroleum products such as gasoline, kerosene, and others.
c Includes grains, vegetables, fish, meat, and other agricultural products.
d Includes fertilizers and other chemicals.
e Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
f Includes coal, lignite, and coal coke.
g AACGR 2000-2016 is the average annual compound growth rate between year 2000 cargo tons and year 2016 cargo tons.
Source: Waterborne Commerce Statistics 2018 (USACE 2018o).

These trends were factored into forecasts of Mississippi River cargo growth rates for a 20-year forecast (2017 through 2036), which project an AACGR of 0.5 percent for petroleum tonnages and 0.3 percent for food and farm tonnages for the period (see Table 4.21-2). The reduced growth rates for the tonnages of the two largest commodity groups on the Lower Mississippi River are projected to reduce the combined AACGR for the five major commodities to 0.6 percent, with a baseline of 243.4 million cargo tons in 2016 and 276.5 million cargo tons in 2036 (see Table 4.21-2).

Future trends in the number of vessels transiting the Lower Mississippi River are expected to follow cargo trends, with little growth under the No Action Alternative. The largest vessels (greater than 39-foot draft) transiting the Mississippi River Passes are attributed to the imports of crude oil and the exports of agriculture (primarily grain). As explained above, crude oil imports are expected to stagnate and decline and grain exports are expected to display little real growth other than for possible aberrations in world supply and demand. Consequently, unless there are major new cargoes or markets, Lower Mississippi River deepest draft vessel calls are expected to grow very slowly and perhaps even decline due to a reduction in crude oil imports.

4.21.4.1.2 Applicant's Preferred Alternative

4.21.4.1.2.1 Maintenance Dredging

Construction of the proposed Project would have negligible impacts on navigation-related maintenance dredging frequencies or volumes in the Mississippi River, including at the Port of New Orleans. Sedimentation results from modeling (see Appendix Q) indicate that construction of the proposed Project would cause localized erosion in the Mississippi River near the proposed intake structure due to cofferdam-induced water flow restrictions and associated increased water flow velocity (see Section 4.4.4 Hydrology and Hydrodynamics for details about proposed Project impacts on Mississippi River hydrology). Erosion and deposition would increase during major flood events when river flow velocities are highest. Although the eroded sediment is expected to be deposited downstream, dredging frequency and volumes are not expected to be impacted in the river because this river segment is naturally deeper than the maintained channel depth.

Table 4.21-2
Mississippi River Passes[a] Total Cargo Tons (000) Forecasted Using Adjusted AACGR 2000-2016 for Petroleum (0.5) and Food and Farm (0.3) Groups, 2017 – 2036

Year	Petroleum and Petroleum Products[b]	Food and Farm[c]	Chemicals[d]	Crude Materials[e]	Coal[f]	Total	Total ALL Commodities
2016 (baseline)	101,810	93,032	24,279	16,181	8,182	243,484	254,042
2017	102,267	93,262	25,040	16,216	8,023	244,809	255,664
2018	102,727	93,492	25,825	16,252	7,867	246,163	257,297

Table 4.21-2
Mississippi River Passes[a] Total Cargo Tons (000) Forecasted Using Adjusted AACGR 2000-2016 for Petroleum (0.5) and Food and Farm (0.3) Groups, 2017 – 2036

Year	Petroleum and Petroleum Products[b]	Food and Farm[c]	Chemicals[d]	Crude Materials[e]	Coal[f]	Total	Total ALL Commodities
2019	103,189	93,723	26,635	16,287	7,714	247,548	258,940
2020	103,652	93,954	27,470	16,323	7,564	248,964	260,594
2021	104,118	94,186	28,332	16,359	7,418	250,412	262,258
2022	104,586	94,418	29,220	16,395	7,273	251,892	263,933
2023	105,056	94,651	30,136	16,430	7,132	253,406	265,618
2024	105,528	94,885	31,081	16,466	6,994	254,954	267,315
2025	106,002	95,119	32,056	16,502	6,858	256,537	269,022
2026	106,478	95,354	33,061	16,539	6,724	258,156	270,740
2027	106,957	95,589	34,097	16,575	6,594	259,812	272,469
2028	107,437	95,825	35,166	16,611	6,466	261,505	274,209
2029	107,920	96,061	36,269	16,647	6,340	263,238	275,960
2030	108,405	96,299	37,406	16,684	6,217	265,010	277,722
2031	108,892	96,536	38,579	16,720	6,096	266,824	279,496
2032	109,381	96,774	39,789	16,757	5,978	268,679	281,280
2033	109,873	97,013	41,036	16,793	5,862	270,578	283,077
2034	110,367	97,253	42,323	16,830	5,748	272,520	284,884
2035	110,863	97,493	43,650	16,867	5,636	274,508	286,704
2036	111,361	97,733	45,019	16,904	5,527	276,543	288,535
AACGR[g] 2017-2036	**0.5%**	**0.3%**	**3.1%**	**0.2%**	**-1.9%**	**0.6%**	**0.6%**

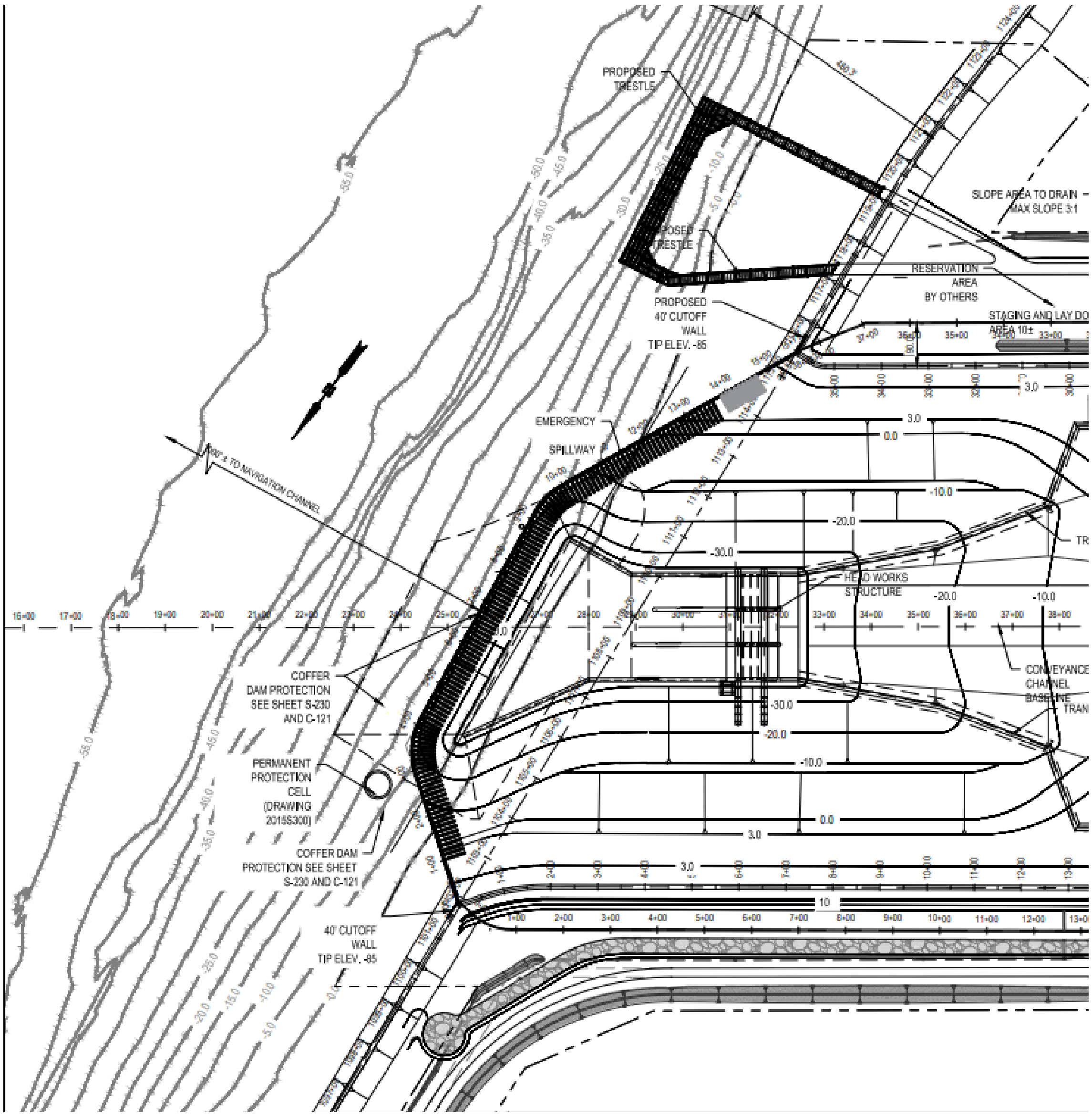
[a] Includes South Pass and Southwest Pass.
[b] Includes crude oil and petroleum products such as gasoline, kerosene, and others.
[c] Includes grains, vegetables, fish, meat, and other agricultural products.
[d] Includes fertilizers and other chemicals.
[e] Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
[f] Includes coal, lignite, and coal coke.
[g] AACGR 2017-2036 is the average annual compound growth rate between year 2000 cargo tons and year 2016 cargo tons adjusted for petroleum and food and farm categories.

Source: Waterborne Commerce Statistics 2018.

4.21.4.1.2.2 Traffic

Construction of the proposed Project would cause temporary, minor, adverse direct impacts on traffic capacity in the Lower Mississippi River. As described in Chapter 3, Section 3.21.1.1 in Navigation, deep-draft vessels transiting the Lower Mississippi River are restricted within the limits of the marked navigation channel (see Figure 4.21-1) where depths are sufficient, while shallow-draft vessels use any part of the river cross-section. The proposed Project would include construction of an intake structure on the Mississippi River bed slope at RM 60.7 AHP consisting of two flared training walls and an intake channel. The navigation channel would be approximately 1,200 feet from the nearest diversion structure (see Figure 4.21-1). A temporary dewatering cofferdam would be installed in the Mississippi River and would tie into an interim levee during construction of the intake system to allow for construction in-the-dry for at least 3 years. The navigation channel would be approximately 1,000 feet from the temporary cofferdam. After construction, the cofferdam and temporary protection cells would be removed to allow the gated control structure to connect to the river, with the exception of two permanent protection cells near the proposed training walls. The temporary cofferdam would be removed after construction is complete to allow the intake structure to connect to the river.

Truck transport would be the primary method of delivering construction materials to the proposed Project construction site, with marine barge transportation serving a supplementary role. Equipment and materials would be barged from vendors north and south of the proposed Project site via the Mississippi River. Annual vessel traffic on the New Orleans to Passes segment of the Lower Mississippi River was about 134,571 vessels in 2016, most of which (121,021 vessels) were shallow-draft. This would equate to an average of about 10,085 shallow-draft vessels transiting past the proposed Project location per month (USACE 2018n) (see Chapter 3, Section 3.21.1.2 in Navigation). The remaining deep-draft vessels are restricted to the limits of the designated navigation channel on the eastern side of the river. As explained under the No Action Alternative above, the number of vessels on the Lower Mississippi River is expected to show little growth throughout the proposed construction period and beyond. CPRA estimates that barge deliveries of construction materials would generate approximately 420 roundtrips to the proposed Project site via the Mississippi River over a period of 42 months (3.5 years) for construction of the cofferdam and intake system, averaging about 10 barge deliveries per month. This would represent a minor increase in existing shallow-draft traffic transiting this segment of the river. Because shallow-draft vessels, including barges, are subject to fewer restrictions than deep-draft vessels and can be maneuvered between other vessels using the channel, this increase in barge traffic would have minor impacts on traffic operations in the channel. Negligible impacts on marine traffic volumes could occur in the Mississippi River upstream of New Orleans and in the Gulf depending upon the origin of construction materials.



Source: CPRA 2022, 60% Designs

Figure 4.21-1. Mississippi River 60 Percent Conceptual Layout of Proposed Intake Structure with Temporary Cofferdam.

Due to potential safety issues, proposed Project construction would cause temporary, minor, adverse impacts on the safety and transit time (referred to as “efficiency” in this section) of shallow-draft vessels transiting past the proposed Project site during the 3.5-year construction period for the MBSD intake system. Navigation accidents, which occur at a rate of about 0.4 accidents per year, per mile on the Lower Mississippi River (Le Blanc and Rucks 1996) can cause injury, loss of life, environmental pollution, and economic damages. To assess potential impacts on the safe and efficient maneuvering of vessels transiting the Mississippi River during construction and operation of the proposed Project, CPRA commissioned Waterway Simulation Technology, Inc. (WST), to prepare a navigation simulation study consisting of real-time, piloted passage of the river by deep-draft and shallow-draft vessels in various river flow, diversion discharge rates, traffic directions, and traffic volume scenarios (see Appendix Q for the full navigation simulation study). Stakeholder concerns identified in the study included potential adverse safety impacts on existing shallow-draft vessels working between the nearby CHS terminal and fleeting areas near the proposed Project site due to traffic constrictions caused by the proposed training walls and cofferdam structures (see Figure 4.21-1). Results of the study indicate that the presence of the proposed cofferdam and protection cells, would require deep and shallow-draft vessels to coordinate meeting and overtaking events in advance of transiting past the proposed Project site to avoid congestion and collisions. The WST study projected that the cofferdam and protection cells could result in delays on the order of 5 minutes based on the simulations conducted for that analysis. It is possible, however, that such delays could extend up to an hour, particularly during the construction period when traffic volumes would increase.

Deep-draft vessels transiting past RM 60.7 are restricted to the designated navigation channel. Proposed Project construction would have negligible impacts on deep-draft vessels because of their distance from construction activities (approximately 1,000 feet away from proposed cofferdam and protection cells). To ensure safety, deep-draft vessels would need to coordinate transits past the Project construction area. See Appendix Q for more details about the navigation simulation study.

4.21.4.1.3 Other Alternatives

4.21.4.1.3.1 Maintenance Dredging

Like the Applicant's Preferred Alternative, the five other action alternatives would have negligible impacts on maintenance dredging frequencies and volumes in the Mississippi River during construction. Construction of the alternatives would cause localized erosion in the Mississippi River near the proposed intake structure due to cofferdam-induced cross-section restrictions and associated increased water flow velocity. Erosion would increase during major flood events when river flow velocities are highest. Although the eroded sediment is expected to be deposited downstream, dredging frequency and volumes are not expected to be impacted in the river because the reach is naturally deeper than the maintained channel depth. See Section 4.4.4 Hydrology and Hydrodynamics for details about proposed Project impacts on hydrology in the river.

4.21.4.1.3.2 Traffic

Impacts from construction of the five other action alternatives on marine traffic and dredging in the Mississippi River would be similar to those caused by the Applicant's Preferred Alternative, with temporary, minor, adverse impacts on traffic capacity in the Lower Mississippi River during construction due to increased shallow-draft vessel traffic associated with material and equipment deliveries via the Mississippi River, and temporary, moderate, adverse impacts on the safety and transit time of shallow-draft vessels transiting past the proposed Project site during the 3.5-year construction period for the MBSD intake system. Variations in the width of the proposed intake channel for the 50,000 cfs and 150,000 cfs Alternatives would cause minor differences in the intensity of impacts on traffic in the river as compared to the Applicant's Preferred Alternative. Under the 50,000 cfs Alternative with and without terraces, CPRA estimates that the width of the proposed Project intake and conveyance channels would be narrower and construction timeframes shorter by several months as compared to the Applicant's Preferred Alternative. As such, the number of shallow-draft vessels delivering construction materials would be about 20 percent less as compared to the Applicant's Preferred Alternative, equating to about eight roundtrips each month during the first 3.5 years of proposed Project construction. This would represent a temporary, minor, adverse increase in monthly marine traffic volumes in this segment of the river. Negligible impacts on marine traffic volumes could occur in the Mississippi River upstream of New Orleans and in the Gulf depending upon the origin of construction materials.

Under the 150,000 cfs Alternative with and without terraces, CPRA estimates that the width of both the proposed intake and conveyance channels would be wider and construction timeframes longer by several months as compared to the Applicant's Preferred Alternative. As such, marine traffic for construction deliveries would be about 50 percent more as compared to the Applicant's Preferred Alternative, equating to about 15 roundtrips each month during the first 3.5 years of proposed Project construction. This would represent temporary, minor, adverse impacts on vessel pilots navigating past the site during construction.

The addition of terrace construction in the immediate outfall area under the 50,000 cfs + Terraces, 75,000 cfs + Terraces, and 150,000 cfs + Terraces Alternatives would not impact marine transportation in the Mississippi River. Terraces would be constructed in the proposed Project outfall area using sediments from adjacent water bottoms; marine deliveries of material via the Mississippi River would not be required.

Also consistent with the Applicant's Preferred Alternative, construction of the other five alternatives would have temporary, minor, adverse impacts on the efficiency of shallow-draft vessels transiting past the construction site at RM 60.7 during the construction period due to safety issues related to waterway obstructions associated with the proposed cofferdam. The presence of the proposed cofferdam and protection cells would require shallow and deep-draft vessels to coordinate meeting and overtaking events in advance of transiting past the proposed Project site to avoid congestion and collisions. The WST study projected that the cofferdam and protection cells could result in delays on the order of 5 minutes based on the simulations conducted for that analysis. It is possible, however, that such delays could extend up to an hour, particularly during the construction period when traffic volumes would increase.

4.21.4.2 Operational Impacts

4.21.4.2.1 No Action Alternative

4.21.4.2.1.1 Maintenance Dredging

Under the No Action Alternative, no impacts on maintenance dredging would occur, and existing dredging trends are expected to continue into the future. Over the long-term, dredging decreases may occur due to ongoing relative subsidence, or dredging increases may occur due to sea-level rise and related increases in sediment supply from flooding, overwash, and bankline erosion. Maintenance dredging volumes in the Mississippi River between Venice and the Gulf are the result of two physical processes. First, reduced river flow resulting from multiple river outlets diminishes the sediment transport capacity of the river, causing sediment to drop to the bottom of the channel. Second, salinity intrusion from the Gulf in the form of a saline wedge within which upstream flow occurs traps fine and coarse sediment within the channel. In the absence of remedial actions or increased river flow, both of these processes are expected to cause ongoing channel sedimentation and result in the continued necessity of maintenance dredging as sea level rises. See Chapter 3, Section 3.21 Navigation for more details about maintenance dredging in the Lower Mississippi River south of Baton Rouge.

4.21.4.2.1.2 Traffic

Under the No Action Alternative, Mississippi River navigation traffic would not be impacted by operation of the Applicant's Preferred Alternative or any of the action alternatives. Under the No Action Alternative, minor increases in commercial navigation traffic for five major commodities (petroleum, food and farm products, chemicals, crude materials, and coal) are anticipated in the Lower Mississippi River during a 20-year planning horizon, with a combined AACGR of 0.6 percent over current levels. In consideration of current, ongoing, and planned developments in the proposed Project area, it is predictable that the proposed Project construction footprint and vicinity may be developed for industrial or commercial purposes. Future development along this section of the Mississippi River could induce increases in marine traffic, but details regarding the scope of such increases are not predictable at this time.

4.21.4.2.2 Applicant's Preferred Alternative

4.21.4.2.2.1 Maintenance Dredging

Modeling results from the Delft3D Basinwide, AdH, and HEC-6T models (Brown et al. 2019, Thomas et al. 2018) were used to forecast dredging impacts from operation of the proposed Project. The models have limitations that allow for a primarily qualitative interpretation of their results. See Section 4.21.2 and Appendix Q for more details about modeled impacts on dredging. Below is a summary of impacts for each section of the Mississippi River in the Project area.

Upriver of Proposed Project Site: Operation of the Applicant's Preferred Alternative is projected to cause negligible impacts on dredging in the Mississippi River upriver of the proposed Project site (RM 60.7 AHP). The Port of New Orleans is located upriver of the proposed Project site and would experience negligible impacts on dredging due to MBSD Project operations.

Project Site and Vicinity: Model results project that although Project operations would cause negligible to minor increases in sedimentation from 1 mile upstream to 1 mile downstream of the proposed MBSD structure, dredging frequency and volumes are not expected to be impacted because this segment of the river is naturally deeper than the maintained channel depth and does not require maintenance dredging.

Project Site to Venice: Operation of the Applicant's Preferred Alternative is projected to cause permanent, minor, potentially adverse impacts on maintenance dredging operations in the Lower Mississippi River between the proposed intake structure location (RM 60.7 AHP) and Venice (RM 13 AHP) by inducing changes to typical shoaling patterns and locations, which may in turn change where maintenance dredging is typically required in the navigation channel such as if new point bar growth intrudes into the navigation channel. Such changes could arise as part of the river's long-term geomorphic response to the diversion.

Venice to the Gulf: Model results project that operation of the Applicant's Preferred Alternative could cause permanent, moderate, potentially adverse impacts on maintenance dredging operations from Venice to the Gulf of Mexico, including Southwest Pass (see Chapter 3, Figure 3.21-1). Modeling results suggest, but do not prove, that the proposed Project operations may increase sedimentation in these areas, either immediately or in the future, which could require increased dredging (see Appendix Q for the dredging impact analysis). The reason for this is that even though the diversion would reduce the total amount of sand in the river downstream, the flow transport capacity of the river would be reduced because of the diversion of river water through the MBSD diversion structure, causing the deposition of sand in the river to be deposited farther upstream than under No Action Alternative conditions. This upstream migration of deposition could have a dynamic influence on dredging, because the specific location of deposition in a given year would change with conditions. Similar increases in sedimentation rates could potentially occur in South Pass, Tiger Pass, Baptiste Collette, and other passes carrying flow to the Gulf, and may cause permanent, moderate, adverse impacts on maintenance dredging operations in these areas.

4.21.4.2.2.2 Traffic

Due to safety issues, proposed Project operations would have intermittent but permanent, moderate, adverse, direct impacts on marine traffic efficiency (transit time) for shallow-draft vessels transiting the Mississippi River near RM 60.7 AHP during the 50-year analysis period. Ship and tow simulations to evaluate traffic safety during construction and operation of the diversion are described in Appendix Q. The simulations were based on anticipated river and traffic conditions in the Project area, from RM 58.5 to RM 62.5, during construction and operation of the proposed Project and especially focused on impacts on tow traffic. Deep-draft ships used in the simulations included Suezmax and Panamax vessels, which are about 900 to 1,000 feet long and up to 157 feet wide. The simulated shallow-draft tows consisted of a push boat and 2 to 30 barges configured to operate as a single unit ranging in a combined size of 108 feet to 270 feet wide and about 200 feet to 1,800 feet long. Experienced marine vessel pilots operated the simulators to evaluate vessel handling and safety under realistic river flows and channel configuration.

Results of WST's navigation simulation study (see Appendix Q) project that the rerouting of river water from the Mississippi River into the diversion intake channel may induce cross-currents extending about 200 feet into the river from the proposed intake structure. With the projected cross-currents, shallow-draft vessel traffic would have an area of about 849 feet between the cross-currents and the navigation channel to use for transit (compared to a current area of about 1,300 feet), requiring marine vessel pilots to coordinate transit times in advance to avoid congestion and accidents during proposed Project operations. Some congestion may be unavoidable and could cause transit delays. After the WST study was conducted, further design work reduced the protrusion distance of the intake walls by 400 feet into the channel as compared to what was assessed in the WST study. Deep-draft vessels transiting within the limits of the Mississippi River navigation channel (see Figure 4.21-1) would be only negligibly affected by proposed Project operations because the navigation channel is outside the area of influence of induced cross-currents (see the navigation traffic study in Appendix Q). Operation of the proposed Project would also induce negligible direct and indirect impacts on waterborne traffic in the Mississippi River from occasional maintenance-related, shallow-draft vessel calls to the diversion structure.

As described above, the proposed Project would have direct impacts on maintenance dredging requirements in the Mississippi River navigation channel below Venice. Increased maintenance dredging operations could restrict access to parts of the channel and result in minor, permanent, indirect impacts on marine traffic due to delays because when dredging equipment is working in the channel, large vessels are often limited to one-way passage or are required to wait for dredging equipment to re-position.

4.21.4.2.3 Other Alternatives

4.21.4.2.3.1 Maintenance Dredging

Impacts from operation of the five other action alternatives on dredging operations in the Mississippi River would be similar to those caused by the Applicant's Preferred Alternative, as described below. As aforementioned, the impacts on dredging summarized here are qualitative projections. See Appendix Q for more details about modeled impacts on dredging.

4.21.4.2.3.1.1 50,000 cfs Alternative

Consistent with the Applicant's Preferred Alternative, operation of the 50,000 cfs Alternative is projected to cause permanent, minor, adverse impacts on dredging operations in the Lower Mississippi River upstream of Venice by inducing changes to typical shoaling patterns and locations, which may in turn change where maintenance dredging is typically required in the navigation channel.

Also consistent with the Applicant's Preferred Alternative, model results project that operation of the 50,000 cfs Alternative would cause permanent, moderate, adverse impacts on dredging operations from Venice to the Gulf of Mexico (see Chapter 3, Section 3.21 Navigation, Figure 3.21-1). Operation of this alternative is projected to increase sedimentation in these areas, which could consequently require increased dredging frequencies and volumes. Similarly, increased sedimentation rates can also be expected in South Pass, Tiger Pass, Baptiste Collette, and other passes and breaches carrying flow to the Gulf and may cause permanent, moderate impacts on maintenance dredging operations in these areas.

4.21.4.2.3.1.2 150,000 cfs Alternative

Consistent with the Applicant's Preferred Alternative, operation of the 150,000 cfs Alternative is projected to cause permanent, minor, adverse impacts on dredging operations in the Lower Mississippi River upstream of Venice by inducing changes to typical shoaling patterns and locations, which may in turn change where maintenance dredging is typically required in the navigation channel.

Also consistent with the Applicant's Preferred Alternative, model results project that operation of the 150,000 cfs Alternative would cause permanent, moderate, adverse impacts on dredging operations from Venice to the Gulf of Mexico (see Chapter 3, Section 3.21 Navigation, Figure 3.21-1). Operation of this alternative is projected to increase sedimentation in these areas, which could consequently require increased dredging frequencies and volumes. Similarly, increased sedimentation rates can also be expected in South Pass, Tiger Pass, Baptiste Collette, and other passes and breaches carrying flow to the Gulf and may cause permanent, moderate impacts on maintenance dredging operations in these areas.

4.21.4.2.3.1.3 Terraces Alternatives

The three terrace alternatives would have the same overall impacts on maintenance dredging in the Mississippi River as those described above for the corresponding capacity alternatives without terraces, with permanent, minor, adverse impacts on dredging operations upstream of Venice and permanent, moderate, adverse impacts on dredging operations from Venice to the Gulf for the reasons described above. The presence of terraces in the immediate outfall area for the three terrace alternatives would not impact dredging operations in the Mississippi River.

4.21.4.2.3.2 Traffic

4.21.4.2.3.2.1 50,000 cfs Alternative

The direct and indirect impacts from operation of the 50,000 cfs Alternative would be similar to those caused by the Applicant's Preferred Alternative. Diversion flow rates up to 75,000 cfs were simulated in CPRA's navigation simulation study (see Appendix Q). Based on study results, operation of the 50,000 cfs Alternative would have intermittent but permanent, moderate, adverse impacts on marine traffic efficiency and safety for shallow-draft vessels transiting the Mississippi River near RM 60.7 AHP during the 50-year analysis period. The rerouting of river water from the Mississippi River into the diversion intake channel during operations may induce cross-currents extending about 200 feet into the river, requiring pilots to coordinate transit times in advance to avoid congestion and accidents during proposed Project operations. Some congestion may be unavoidable and could cause transit delays. The safety and efficiency of deep-draft vessels transiting the area within the designated navigation channel would be negligibly affected by proposed Project operations because the navigational channel is outside the area of influence of cross-currents that would occur during proposed Project operations. Operation of the 50,000 cfs Alternative would induce negligible direct and indirect impacts on waterborne traffic in the Mississippi River from occasional maintenance-related, shallow-draft vessel calls to the diversion structure.

The direct and indirect impacts from operation of the 50,000 cfs Alternative would be similar to those caused by the Applicant's Preferred Alternative with direct impacts on maintenance dredging requirements in the Mississippi River channel below Venice because the diversion would cause a decrease in the flow capacity of the river downstream, causing sand to deposit farther upstream compared to the No Action Alternative. Increased dredging operations could result in indirect, minor, permanent, adverse impacts on marine traffic because when dredging equipment is working in the channel, large vessels are often limited to one-way passage or are required to wait for dredging equipment to re-position.

4.21.4.2.3.2.2 150,000 cfs Alternative

Although navigation simulations were not performed for the 150,000 cfs Alternative, substantially higher diversion flows would create substantially greater cross-currents and further restrict the available river width available for traffic. Restricting the channel width would increase the potential for travel delays; therefore, it is logical to predict that the 150,000 cfs Alternative would cause longer delays than those associated with the Applicant's Preferred Alternative representing similar permanent, moderate, adverse impacts on marine traffic efficiency and safety as compared to the Applicant's Preferred Alternative. Operation of the 150,000 cfs Alternatives would induce negligible direct and indirect impacts on waterborne traffic in the Mississippi River from occasional maintenance-related, shallow-draft vessel calls to the diversion structure.

As described above for the Applicant's Preferred Alternative, the 150,000 cfs Alternative would have direct impacts on maintenance dredging requirements in the Mississippi River channel below Venice. Increased dredging operations could restrict parts of the channel and result in indirect, minor, permanent, adverse impacts on marine traffic due to delays because when dredging equipment is working in the channel, large vessels are often limited to one-way passage or are required to wait for dredging equipment to re-position.

4.21.4.2.3.2.3 Terraces Alternatives

The three terrace alternatives would have the same overall impacts on marine traffic in the Mississippi River as those described above for the corresponding capacity alternatives without terraces, with moderate, intermittent but permanent, adverse impacts on marine traffic efficiency and safety for shallow-draft vessels in the Mississippi River during operations due to cross-currents extending into the channel from the proposed intake structure. Also consistent with the corresponding capacity alternatives without terraces, the three terrace alternatives would have minor, permanent, adverse indirect impacts on marine traffic in the Lower Mississippi River due to increased dredging frequencies (dredging activities may cause delays for marine traffic). The presence of terraces in the immediate outfall area for the three terrace alternatives would not impact traffic in the river.

4.21.5 Barataria Basin

4.21.5.1 Construction Impacts

4.21.5.1.1 No Action Alternative

4.21.5.1.1.1 <u>Maintenance Dredging</u>

Historical trends in maintenance dredging in the three federal Barataria Basin navigation channels are expected to continue under the No Action Alternative, and no impacts from the proposed Project would occur. From 1996 through 2018, 10 maintenance dredging events in the Barataria Bay Waterway averaged 255,000 cy per year accumulation (USACE 2018l). In the Barataria Basin segments of the GIWW, maintenance dredging averaged 96,000 cy annually over the same time period. Maintenance dredging was conducted in Bayou Lafourche 10 times during the 1996 through 2018 time period, mainly in the area of Port Fourchon, with an annual average of 423,000 cy over the 23-year timeframe. See Chapter 3, Section 3.21 Navigation for more details about maintenance dredging in the three federally maintained channels in the Barataria Basin. See Chapter 3, Figure 3.1-2 for locations of the federal navigation channels and major waterbodies in the Barataria Basin. Ongoing trends of sea-level rise and subsidence would continue, but only limited changes to maintenance dredging in the federal navigation channels in the basin are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project). In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that would likely have some effect on maintenance dredging in basin navigation channels. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.21.5.1.1.2 Traffic

Under the No Action Alternative, construction of the proposed Project would not occur and no impacts on navigation-related traffic in the Barataria Basin would occur. Historical data from the USACE Waterborne Commerce Statistics were reviewed to estimate future traffic trends in the three federal navigation channels in the Barataria Basin, including the GIWW, Bayou Lafourche, and the Barataria Bay Waterway. The GIWW is a multiple purpose waterway for a variety of users and cargo types, whereas the Barataria Bay Waterway and Bayou Lafourche are specialized waterways used for transporting a specific subset of cargo types. These characteristics influence expected cargo trends on these waterways, as described below.

4.21.5.1.1.2.1 GIWW

The GIWW (Mississippi River to Sabine River segment) is primarily a petrochemical corridor. The most prevalent commodity groups that transited the GIWW from 2000 through 2016 as measured by total annual cargo tons were petroleum and petroleum products (596.7 million tons, 53.3 percent of total tonnage), followed by crude materials (230.3 million tons, 20.6 percent of total tonnage), and chemicals/chemical-related products (189.5 million tons,16.9 percent of total tonnage) (see Table 4.21-3). Together, these top three commodity groups made up 90.8 percent of all cargo tonnage transiting the GIWW during this timeframe. Primary manufactured goods, food and farm products, manufactured equipment, waste material, and coal/lignite together comprised an additional 9.2 percent of the total cargo tonnage.

Growth in the AACGR for all cargo tonnage on the GIWW during the 2000 through 2016 time period was low (0.4 percent, see Table 4.21-3). Cargo tonnage for the three major commodity groups on the GIWW declined, with the exception of a recent increase in petroleum annual tonnages from 2014 through 2016 (see Table 4.21-3). The AACGR for the period was 2.2 percent for petroleum and petroleum products, -1.4 percent for crude materials, and -1.5 percent for chemicals/chemical-related products, with a combined AACGR of 0.7 percent for the time series. The observed recent growth in petroleum tonnage is expected to continue into the future due to expected increases in U.S. domestic, onshore oil production. This contrasts with expected declines in petroleum cargo tonnage forecasted for the Lower Mississippi River due to declines in foreign imports of crude oil (see Section 4.21.4.1).

Table 4.21-3
GIWW[a] Total Cargo Tons by Major Commodity Group by Foreign and Domestic Sources, 2000 – 2016

Year	Petroleum and Petroleum Products[b]	Crude Materials[c]	Chemicals and Related Products[d]	Subtotal of 3 Major Commodities	Total All Commodities
2000	29,056,693	13,499,800	13,101,357	55,657,850	62,855,461
2001	30,254,727	13,821,174	11,557,719	55,633,620	61,689,462
2002	30,085,726	11,667,824	11,618,764	53,372,314	58,946,416
2003	31,268,871	14,409,795	12,493,429	58,172,095	64,878,888
2004	33,710,641	16,175,644	12,916,338	62,802,623	69,488,543
2005	32,468,025	14,963,971	12,152,511	59,584,507	66,004,653
2006	35,980,783	14,830,251	12,272,321	63,083,355	70,138,307
2007	36,494,849	14,334,510	12,041,707	62,871,066	69,722,996
2008	33,542,469	15,579,121	10,450,498	59,572,088	66,776,850
2009	35,344,520	12,030,792	9,515,415	56,890,727	62,600,509
2010	35,652,936	12,535,641	10,256,086	58,444,663	64,555,637
2011	34,140,038	13,452,433	10,340,408	57,932,879	63,383,833
2012	35,549,244	12,579,734	10,335,623	58,464,601	64,156,513
2013	36,420,920	11,561,162	9,787,777	57,769,859	63,338,728
2014	42,087,311	14,756,163	10,437,115	67,280,589	73,083,342
2015	43,531,142	13,287,783	9,994,704	66,813,629	71,662,895
2016	41,149,856	10,835,353	10,272,005	62,257,214	66,675,836
AACGR[e] 2000-2016	**2.2%**	**-1.4%**	**-1.5%**	**0.7%**	**0.4%**

[a] Mississippi River to Sabine River segment of the GIWW.
[b] Includes crude oil and petroleum products such as gasoline, kerosene, and others.
[c] Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
[d] Includes fertilizers and other chemicals.
[e] AACGR 2000-2016 is the average annual compound growth rate between year 2000 cargo tons and year 2016 cargo tons.
Source: Waterborne Commerce Statistics 2018.

Cargo tons for baseline year 2016 were forecasted for 20 years, 2017 through 2036, for the GIWW by applying the AACGR for the three major commodity groups (see Table 4.21-4). Cargoes of petroleum, crude materials, and chemicals are projected to increase from a baseline of 62.3 million tons in 2016 to 79.4 million tons in 2036 (see Table 4.21-4).

Table 4.21-4
GIWW[a] Cargo Tons Forecasted Using AACGR 2000-2016 by Major Commodity Group, 2017 – 2036

Year	Petroleum and Petroleum Products[b]	Crude Materials[c]	Chemicals and Related Products[d]	Subtotal	Total ALL Commodities
2016 (baseline)	41,149,856	10,835,353	10,272,005	62,257,214	66,675,836
2017	42,054,595	10,687,480	10,116,992	62,859,066	67,490,915
2018	42,979,226	10,541,624	9,964,318	63,485,168	68,315,958
2019	43,924,186	10,397,759	9,813,948	64,135,894	69,151,087
2020	44,889,922	10,255,858	9,665,848	64,811,628	69,996,425
2021	45,876,892	10,115,893	9,519,982	65,512,767	70,852,096
2022	46,885,561	9,977,838	9,376,318	66,239,718	71,718,228
2023	47,916,408	9,841,668	9,234,822	66,992,897	72,594,948
2024	48,969,919	9,707,355	9,095,461	67,772,735	73,482,385
2025	50,046,593	9,574,876	8,958,203	68,579,672	74,380,671
2026	51,146,940	9,444,205	8,823,016	69,414,160	75,289,938
2027	52,271,479	9,315,317	8,689,869	70,276,665	76,210,320
2028	53,420,743	9,188,188	8,558,732	71,167,662	77,141,954
2029	54,595,275	9,062,794	8,429,574	72,087,642	78,084,976
2030	55,795,630	8,939,111	8,302,364	73,037,106	79,039,526
2031	57,022,378	8,817,116	8,177,075	74,016,569	80,005,745
2032	58,276,097	8,696,786	8,053,676	75,026,559	80,983,776
2033	59,557,381	8,578,098	7,932,140	76,067,619	81,973,763
2034	60,866,835	8,461,031	7,812,437	77,140,303	82,975,851
2035	62,205,080	8,345,560	7,694,541	78,245,181	83,990,190
2036	63,572,749	8,231,666	7,578,424	79,382,838	85,016,928
AACGR[e] 2017-2036	**2.2%**	**-1.4%**	**-1.5%**	**1.2%**	**1.1%**

[a] Mississippi River to Sabine River segment of the GIWW.
[b] Includes crude oil and petroleum products such as gasoline, kerosene, and others.
[c] Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
[d] Includes fertilizers and other chemicals.
[e] AACGR 2017-2036 is the average annual compound growth rate between year 2000 cargo tons and year 2016 cargo tons.
Source: Waterborne Commerce Statistics 2018.

Future trends in the number of vessels transiting the GIWW are expected to follow cargo trends. Consistent with cargo forecasts, the number of vessels transiting the GIWW from 2017 to 2036 is expected to modestly increase due to projected increases in petroleum cargo during the same period.

4.21.5.1.1.2.2 Barataria Bay Waterway

As compared to cargo trends on the GIWW, the Barataria Bay Waterway and Bayou Lafourche are more sensitive to short-term trends affecting specific markets and cargo types. Commercial navigation on the Barataria Bay Waterway primarily serves offshore domestic oil and gas production facilities (shallow and deepwater segments). The most prevalent commodity groups that transited the Barataria Bay Waterway from 2000 to 2016 were manufactured equipment and machinery (1.8 million tons, 46.3 percent of total tonnage), crude materials (1.2 million tons, 29.9 percent of total tonnage), and petroleum and petroleum products (783,275 tons, 19.1 percent of total tonnage) (see Table 4.21-5). Together, these top three commodity groups made up 95.4 percent of all cargo tonnage transiting the Barataria Bay Waterway over the 2000 to 2016 timeframe. Food and farm products, primary manufactured goods, and chemicals together comprised an additional 4.6 percent of the total cargo tonnage.

Table 4.21-5
Barataria Bay Waterway Total Cargo Tons by Major Commodity Group, 2000 – 2016

Year	All Manufactured Equipment, Machinery and Products[a]	Crude Materials[b]	Petroleum and Petroleum Products[c]	Subtotal of 3 Major Commodities	Total All Commodities
2000	184,635	168,413	66,097	419,145	445,183
2001	187,781	93,782	90,633	372,196	407,021
2002	134,785	55,317	70,743	260,845	270,425
2003	140,964	86,824	159,384	387,172	392,075
2004	93,819	86,466	31,571	211,856	218,956
2005	95,159	44,323	18,799	158,281	161,229
2006	31,733	30,902	26,977	89,612	91,896
2007	18,144	52,248	31,923	102,315	150,765
2008	47,423	126,206	28,660	202,289	205,513
2009	38,174	56,800	46,655	141,629	142,506
2010	54,938	61,810	19,454	136,202	137,772
2011	113,089	20,710	19,625	153,424	156,314
2012	177,209	51,662	43,291	272,162	288,431
2013	153,726	33,068	15,775	202,569	205,232
2014	186,959	48,479	58,721	294,159	329,264
2015	79,867	111,530	30,957	222,354	224,175
2016	159,221	97,591	24,010	280,822	281,972
AACGR[d] 2000-2016	**-0.9%**	**-3.4%**	**-6.1%**	**-2.5%**	**-2.8%**

[a] Includes machinery and parts, ships, boats, and other equipment.
[b] Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
[c] Includes crude oil and petroleum products such as gasoline, kerosene, and others.
[d] AACGR 2000-2016 is the average annual compound growth rate between year 2000 cargo tons and year 2016 cargo tons.
Source: Waterborne Commerce Statistics 2018.

In recent years, the U.S./deepwater offshore oil and gas sector in the Gulf of Mexico has stagnated relative to a boom in the domestic onshore oil and gas sector from advances in drilling and extraction technologies. These trends have recently influenced cargo movements on these waterways and are expected to continue to do so into the future. The historical commodity tonnages that have typically transited the Barataria Bay Waterway en route to Gulf oil and gas platforms (petroleum, crude materials, and manufactured equipment) have declined consistent with the declining trends of Gulf deepwater oil and gas sector platforms. The AACGR for each of the three major commodity groups for the period was -0.9 percent for manufactured equipment and machinery, -3.4 percent for crude materials, and -6.1 percent for petroleum and petroleum products. These three major commodity groups had a combined AACGR of -2.5 percent for the time series 2000 through 2016.

The AACGR for the major commodity groups was applied to cargo tons in the base line year 2016 to generate cargo forecasts for 20 years, 2017 through 2036, for the Barataria Bay Waterway (see Table 4.21-6). Cargo tons of the three major commodities (manufactured equipment, crude materials, and petroleum) are projected to decrease from a baseline of 280,822 tons in 2016 to 188,426 tons in 2036. In general, this is consistent with the development of new production techniques that have substantially lowered production costs for domestic onshore oil and gas—a trend that has diminished the importance of offshore production.

Future trends in the number of vessels transiting the Barataria Bay Waterway are expected to follow cargo trends. Consistent with cargo forecasts, the number of vessels transiting the Barataria Bay Waterway is expected to decline.

Table 4.21-6
Barataria Bay Waterway Cargo Tons Forecasted Using AACGR 2000-2016 by Major Commodity Group, 2017 – 2036

Year	All Manufactured Equipment, Machinery and Products[a]	Crude Materials[b]	Petroleum and Petroleum Products[c]	Subtotal of 3 Major Commodities	Total ALL Commodities
2016 (baseline)	159,221	97,591	24,010	280,822	281,972
2017	157,754	94,319	22,537	274,611	276,402
2018	156,301	91,157	21,155	268,613	270,942
2019	154,861	88,101	19,858	262,819	265,590
2020	153,434	85,147	18,640	257,221	260,344
2021	152,021	82,292	17,497	251,809	255,202
2022	150,620	79,533	16,424	246,577	250,161
2023	149,232	76,867	15,416	241,515	245,219
2024	147,858	74,289	14,471	236,618	240,375
2025	146,495	71,799	13,583	231,878	235,627
2026	145,146	69,391	12,750	227,288	230,973
2027	143,809	67,065	11,968	222,842	226,410
2028	142,484	64,816	11,234	218,535	221,938
2029	141,171	62,643	10,545	214,360	217,554
2030	139,870	60,543	9,899	210,312	213,257
2031	138,582	58,513	9,292	206,387	209,044
2032	137,305	56,551	8,722	202,578	204,915
2033	136,040	54,655	8,187	198,882	200,867
2034	134,787	52,823	7,685	195,295	196,900
2035	133,545	51,052	7,213	191,811	193,010
2036	132,315	49,340	6,771	188,426	189,198
AACGR[d] 2017-2036	**-0.9%**	**-3.4%**	**-6.1%**	**-2.0%**	**-2.0%**

[a] Includes machinery and parts, ships, boats, and other equipment.
[b] Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
[c] Includes crude oil and petroleum products such as gasoline, kerosene, and others.
[d] AACGR 2017-2036 is the average annual compound growth rate between year 2000 cargo tons and year 2016.
Source: Waterborne Commerce Statistics 2018.

4.21.5.1.1.2.3 Bayou Lafourche

The most prevalent commodity groups that transited Bayou Lafourche from 2000 to 2016 as measured by total annual cargo tons were manufactured equipment and machinery (54.1 million tons, 51.3 percent of total tonnage), followed by petroleum and petroleum products (22.6 million tons, 21.5 percent of total tonnage) and crude materials (14.9 million tons, 14.1 percent of total tonnage) (see Table 4.21-7). Together, these top three commodity groups made up 86.9 percent of all cargo tonnage transiting the bayou over the 2000 through 2016 timeframe. Food and farm products, waste material, chemicals, and primary manufactured goods comprised an additional 13.1 percent of the total cargo tonnage.

Table 4.21-7
Bayou Lafourche Total Cargo Tons by Major Commodity Group, 2000 – 2016

Year	Manufactured Equipment and Machinery[a]	Petroleum and Petroleum Products[b]	Crude Materials[c]	Subtotal	Total ALL Commodities
2000	2,303,847	1,136,178	986,024	4,426,049	5,424,217
2001	2,258,630	1,237,483	1,139,844	4,635,957	5,599,277
2002	1,234,538	1,147,763	1,057,469	3,439,770	4,220,028
2003	1,906,066	1,136,923	856,485	3,899,474	4,483,963
2004	3,694,138	1,440,372	1,001,434	6,135,944	6,975,086
2005	4,255,038	1,285,349	841,167	6,381,554	7,204,057
2006	3,998,842	1,300,889	949,618	6,249,349	7,451,412
2007	3,469,036	1,196,337	654,615	5,319,988	6,129,037
2008	3,562,320	1,032,901	598,414	5,193,635	5,998,282
2009	3,044,690	946,284	538,056	4,529,030	5,110,400
2010	2,317,558	922,641	332,458	3,572,657	4,356,321
2011	2,533,782	1,028,839	508,235	4,070,856	4,753,562
2012	3,038,055	1,408,699	900,870	5,347,624	6,091,866
2013	2,831,588	1,746,933	1,173,942	5,752,463	6,506,221
2014	3,682,753	2,000,041	1,274,799	6,957,593	7,799,611
2015	4,965,255	2,079,020	1,029,391	8,073,666	8,945,397
2016	5,051,417	1,591,315	1,049,855	7,692,587	8,435,991
AACGR[d] 2000-2016	**5.0%**	**2.1%**	**0.4%**	**3.5%**	**2.8%**

[a] Includes machinery and parts, ships, boats, and other equipment.
[b] Includes crude oil and petroleum products such as gasoline, kerosene, and others.
[c] Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
[d] AACGR 2000-2016 is the average annual compound growth rate between year 2000 cargo tons and year 2016 cargo tons.
Source: Waterborne Commerce Statistics 2018.

Bayou Lafourche is another niche sector waterway that primarily serves the domestic offshore oil and gas industry. However, unlike declining cargo volumes displayed for the Barataria Bay Waterway (see Table 4.21-5), cargo traffic on Bayou Lafourche has been growing, particularly for manufactured equipment machinery, which is typically bound for the domestic offshore oil and gas exploration and production sectors. Although the offshore oil and gas sector as noted above has been eclipsed by a boom in onshore domestic oil and gas production, the offshore sector in proximity to Bayou Lafourche has displayed growth, a trend evidenced by the 5.0 percent growth in cargo tonnage for manufactured equipment and machinery over the 2000 through 2016 timeframe (see Table 4.21-7). However, Bayou Lafourche cargo serving the offshore oil and gas sector will not likely have sustained, steady growth but is expected to have fluctuating cargo volumes, consistent with trends shown during the 2000 through 2016 period (see Table 4.21-7). The AACGR for the manufactured equipment category is likely a maximized rate of growth that will fluctuate to the same extent or more over the next 20-year time period.

Cargo forecasts for 20 years (2017 through 2036) for Bayou Lafourche were developed by applying the AACGR of the three major cargo groups to cargo tons in the base line year 2016 (see Table 4.21-8). Using the AACGR for these three groups results in manufactured equipment, petroleum, and crude materials increasing from 7.7 million tons in 2016 to an estimated 17.0 million tons by year 2036. Future trends in the number of vessels transiting Bayou Lafourche are expected to follow forecasted cargo trends. Consistent with cargo forecasts, the number of vessels transiting Bayou Lafourche from 2017 through 2036 is expected to increase as well.

Table 4.21-8
Bayou Lafourche Cargo Tons Forecasted Using AACGR 2000-2016 by Major Commodity Group, 2016 – 2036

Year	Manufactured Equipment and Machinery[a]	Petroleum and Petroleum Products[b]	Crude Materials[c]	Subtotal	Total ALL Commodities
2016 (baseline)	5,051,417	1,591,315	1,049,855	7,692,587	8,435,991
2017	5,305,462	1,625,176	1,053,979	7,984,617	8,778,151
2018	5,572,283	1,659,758	1,058,119	8,290,161	9,134,189
2019	5,852,523	1,695,076	1,062,275	8,609,875	9,504,667
2020	6,146,857	1,731,146	1,066,448	8,944,451	9,890,172
2021	6,455,994	1,767,983	1,070,637	9,294,613	10,291,313
2022	6,780,677	1,805,603	1,074,843	9,661,123	10,708,724
2023	7,121,690	1,844,024	1,079,065	10,044,779	11,143,065
2024	7,479,852	1,883,263	1,083,304	10,446,419	11,595,023
2025	7,856,027	1,923,337	1,087,559	10,866,924	12,065,312
2026	8,251,121	1,964,264	1,091,831	11,307,216	12,554,675
2027	8,666,085	2,006,061	1,096,120	11,768,266	13,063,887
2028	9,101,918	2,048,748	1,100,426	12,251,091	13,593,753
2029	9,559,670	2,092,343	1,104,748	12,756,761	14,145,109
2030	10,040,443	2,136,866	1,109,088	13,286,396	14,718,828
2031	10,545,395	2,182,336	1,113,444	13,841,175	15,315,817
2032	11,075,741	2,228,774	1,117,818	14,422,333	15,937,020
2033	11,632,760	2,276,199	1,122,209	15,031,169	16,583,418
2034	12,217,793	2,324,634	1,126,617	15,669,044	17,256,034
2035	12,832,248	2,374,100	1,131,043	16,337,390	17,955,931
2036	13,477,604	2,424,618	1,135,486	17,037,708	18,684,216
AACGR[d] 2017-2036	**5.0%**	**2.1%**	**0.4%**	**4.1%**	**4.2%**

a Includes machinery and parts, ships, boats, and other equipment.
b Includes crude oil and petroleum products such as gasoline, kerosene, and others.
c Includes forest products, pulp, sand, gravel, stone, iron ore, marine shells, non-ferrous metallic ores, and sulfur.
d AACGR 2017-2036 is the average annual compound growth rate between year 2000 cargo tons and year 2016 cargo tons.
Source: Waterborne Commerce Statistics 2018.

4.21.5.1.2 Applicant's Preferred Alternative

4.21.5.1.2.1 Maintenance Dredging

Construction of the proposed Project would cause negligible impacts on maintenance dredging in the Barataria Basin federal navigation channels. During construction, minor increases in vessel traffic for the delivery of construction materials may exacerbate bankline erosion of the navigation channels, which may cause a negligible increase in sedimentation. This may require negligible increases in maintenance dredging volumes in the basin navigation channels during construction of the proposed Project.

4.21.5.1.2.2 Traffic

Construction of the proposed Project would cause temporary, minor, adverse impacts on safety and traffic capacity in the Barataria Basin federal navigation channels. Truck transport would be the primary method of delivering construction materials to the proposed Project construction site, with marine barge transportation serving a supplementary role. Equipment and materials would be barged from vendors north and south of the Barataria Basin from the Mississippi River and the Gulf of Mexico via the Harvey Canal, the GIWW, the Barataria Bay Waterway, and Bayou Dupont. Construction materials and equipment would be delivered at a boat ramp that CPRA would construct along the shoreline of the proposed conveyance channel construction footprint. CPRA would dredge access channels as needed from Bayou Dupont to the proposed boat ramp to accommodate vessels carrying equipment and materials to and from the construction site (see Figure 4.2-1).

According to 2016 Waterborne Commerce Statistics data, annual vessel traffic on the GIWW and Barataria Bay Waterway in 2016 was about 76,413 vessels and 3,885 vessels, respectively (see Chapter 3, Section 3.21.1.2 in Navigation). CPRA estimates that barge deliveries of construction materials would generate approximately 400 roundtrips to the proposed Project site via the basin channels over a period of 42 months (3.5 years) to deliver materials such as riprap, stone, and sand for construction of the conveyance channel, averaging about 10 barge deliveries per month. This would represent a temporary, minor, adverse impact on existing traffic capacity in the basin navigation channels. Indirect, negligible impacts on marine traffic volumes could occur in the Mississippi River and in the Gulf depending upon the origin of construction materials.

4.21.5.1.3 Other Alternatives

4.21.5.1.3.1 Maintenance Dredging

Like the Applicant's Preferred Alternative, construction of the five other action alternatives would have negligible impacts on maintenance dredging of the Barataria Basin navigation channels.

4.21.5.1.3.2 Traffic

The five other action alternatives would result in construction impacts similar to the Applicant's Preferred Alternative; however, CPRA estimates that the width of the proposed Project conveyance channel under the 50,000 cfs Alternatives would be narrower and construction timeframes shorter by several months as compared to the Applicant's Preferred Alternative. As such, marine traffic for construction deliveries to the construction footprint in the Barataria Basin would be about 20 percent less as compared to the Applicant's Preferred Alternative, equating to about eight roundtrips each month during the first 3.5 years of proposed Project construction. This would represent a temporary, minor, adverse impact on marine traffic capacity in the basin navigation channels. Indirect, negligible impacts on marine traffic volumes could occur in the Mississippi River and in the Gulf depending upon the origin of construction materials.

CPRA estimates that the width of the proposed conveyance channel would be wider and construction timeframes longer by several months for the 150,000 cfs Alternatives as compared to the Applicant's Preferred Alternative. As such, marine traffic for construction deliveries would be about 50 percent more as compared to the Applicant's Preferred Alternative, equating to about 15 roundtrips each month during the first 3.5 years of proposed Project construction. This would represent a temporary, minor, adverse impact on navigation traffic capacity.

4.21.5.2 Operational Impacts

4.21.5.2.1 No Action Alternative

4.21.5.2.1.1 Maintenance Dredging

Under the No Action Alternative, there would be no impacts on maintenance dredging from the Project in the Barataria Basin because construction of the proposed Project would not occur. Under the No Action Alternative, historical dredging trends are expected to continue into the future. Over the long-term, possible dredging decreases may occur due to ongoing relative subsidence, or possible dredging increases may occur due to sea-level rise and related increases in sediment supply from flooding, overwash, and bankline erosion. See Chapter 3, Section 3.21 Navigation for more details about historical maintenance dredging in the GIWW, Barataria Bay Waterway, and Bayou Lafourche.

4.21.5.2.1.2 Traffic

Under the No Action Alternative, commercial navigation traffic and maintenance dredging in the Barataria Basin navigation channels would not be impacted by operation of the Applicant's Preferred Alternative or any of the action alternatives. Under the No Action Alternative, minor increases in commercial navigation traffic are anticipated for the GIWW during a 20-year planning horizon, with a combined AACGR of 1.1 percent of annual cargo tonnages over current levels. The observed recent growth in petroleum tonnage on the GIWW is expected to continue throughout the 20-year planning horizon due to expected increases in domestic, onshore oil production, while the domestic offshore oil and gas sector in the Gulf of Mexico is expected to decline. This development is also expected to influence cargo movements on the Barataria Bay Waterway and Bayou Lafourche over the 20-year planning horizon. Overall decreases in commercial navigation traffic are anticipated for the Barataria Bay Waterway, with a projected AACGR of -2.0 percent for all commodities. Cargo tonnages for Bayou Lafourche are expected to have minor increases (4.2 percent) over current levels because offshore platforms in proximity to Bayou Lafourche have displayed growth; however, Bayou Lafourche cargo serving the offshore oil and gas sector will not likely have sustained, steady growth but is expected to have fluctuating cargo volumes. See Section 4.21.4.1 for further details about expected commercial traffic trends in the Barataria Basin federal navigation channels under the No Action Alternative.

In consideration of current, ongoing, and planned developments in the Project area, it is predictable that the proposed Project construction footprint and vicinity may be developed for industrial or commercial purposes. Future development along this section of the Mississippi River could induce increases in marine traffic, but details regarding the scope of such increases are not predictable at this time.

4.21.5.2.2 Applicant's Preferred Alternative

4.21.5.2.2.1 Maintenance Dredging

Operation of the proposed Project could cause permanent, moderate, adverse impacts on maintenance dredging in the Barataria Bay Waterway; permanent, minor, adverse impacts on maintenance dredging in Bayou Lafourche; and negligible impacts on dredging in the GIWW due to sedimentation caused by the proposed Project.

Based on a semi-quantitative (in other words, qualitative with some indication of relative magnitude) impact assessment using modeling results, dredging volumes in the Barataria Bay Waterway are projected to increase substantially as a result of sediment load delivered by the diversion. Such increases would require CEMVN to investigate available dredged material placement areas to accommodate the additional material generated by the Project. The additional material could provide more sediment for beneficial uses in the basin but at an increased cost for dredging and placement. See Appendix Q for discussion of the models, their limitations, and how these results were obtained.

Modeling of Bayou Lafourche was too close to one modeled boundary to be used and outside of another model's boundary (see Appendix Q). It can be reasonably assumed that Bayou Lafourche would experience less sedimentation than the Barataria Bay Waterway under the Applicant's Preferred Alternative because it is west of the main area of sedimentation impacts projected from proposed Project operations, and those impacts have been projected based on physical processes-based extrapolation of model results (see Figure 4.21-2).

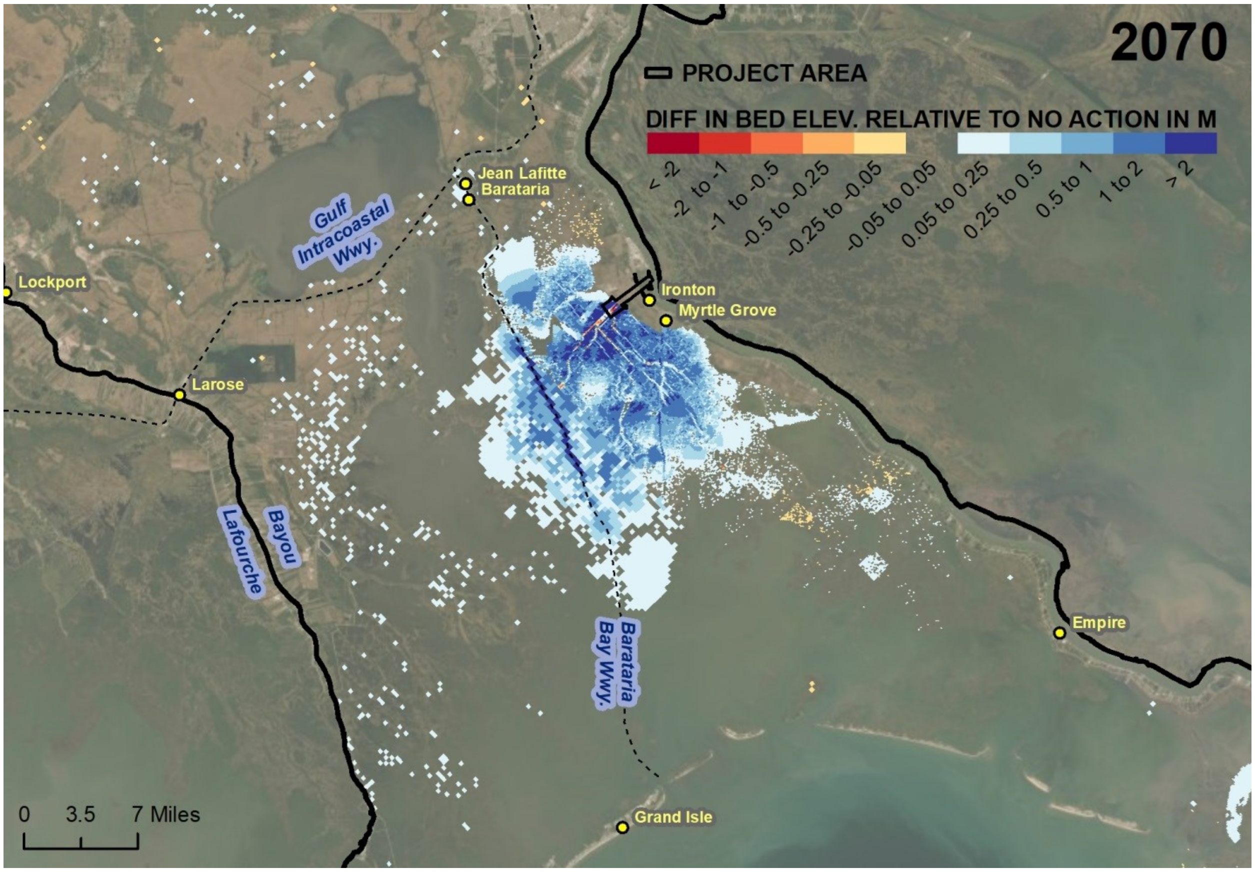


Figure 4.21-2. Location of Federal Navigation Channels in Relation to Projected Sedimentation Impacts in Year 2070 of Project Operations. "Bed elevation increases" shown in the map are synonymous with the term "sedimentation increases" discussed in this section.

Sedimentation results were not sufficiently resolved by the models to enable evaluation of sedimentation volumes for non-federal channels and facilities (ports, marinas, anchorages). However, non-federal facilities near the federal channels can be assumed to experience about the same relative sedimentation changes as the corresponding nearby federal channel. See Section 4.13 Socioeconomics for information about the economic impacts of increased sedimentation and dredging in Barataria Basin non-federal channels.

4.21.5.2.2.2 Traffic

Operation of the proposed Project would induce a negligible increase in waterborne traffic in the Barataria Basin federal navigation channels, including occasional maintenance-related, shallow-draft vessel calls for the delivery of materials or dredging equipment to and from the immediate outfall area. This would represent negligible impacts on Barataria Basin vessel traffic.

As described above, the Project would have direct impacts on maintenance dredging requirements in the Barataria Basin federal navigation channels. Increased dredging operations could result in minor, permanent, indirect, adverse impacts on marine traffic in the basin due to dredging activities restricting or blocking parts of the channel and delaying traffic.

4.21.5.2.3 Other Alternatives

4.21.5.2.3.1 Maintenance Dredging

The five other action alternatives would have dredging impacts similar to those of the Applicant's Preferred Alternative, with permanent, moderate, adverse impacts on maintenance dredging in the Barataria Bay Waterway; permanent, minor, adverse impacts on maintenance dredging in Bayou Lafourche; and negligible impacts on dredging in the GIWW. Sedimentation results were not sufficiently resolved by the models to justify conclusions for non-federal channels and facilities (ports, marinas, anchorages); however, as a first estimate, the above qualitative predictions for federal navigation channels can be assumed to be applicable to adjacent non-federal channels and facilities. See Appendix Q for more details about the qualitative dredging analysis.

4.21.5.2.3.1.1 50,000 cfs Alternative

Barataria Bay Waterway: Qualitative projections from Delft3D Basinwide Modeling indicate increased dredging would be required in the Barataria Bay Waterway due to substantial increases in deposition rates. Under the 50,000 cfs Alternative, dredging volumes would probably be increased by operations as compared to the No Action Alternative but by less than the Applicant's Preferred Alternative.

Bayou Lafourche: Modeling data for Bayou Lafourche were too close to the modeled boundary to be used. It can be reasonably assumed that Bayou Lafourche would experience less sedimentation increases than the Barataria Bay Waterway and more than the GIWW under the 50,000 cfs Alternative, similar to the Applicant's Preferred Alternative. The Barataria Bay Waterway lies between the diversion and Bayou Lafourche, so it would intercept more of the diversion flow and experience the bulk of the increased channel deposition.

GIWW: Qualitative projections from modeling indicate that operation of the 50,000 cfs Alternative would have negligible impacts on dredging quantities in the GIWW in the Barataria Basin. It can be expected that only the most fine-grained, slowest-settling sediment would move to the far sides and bottom of the basin until the basin fills with sediment and flow is well channelized.

4.21.5.2.3.1.2 150,000 cfs Alternative

Barataria Bay Waterway: Qualitative projections from Delft3D Basinwide Modeling indicate increased dredging would be required in the Barataria Bay Waterway due to substantial increases in deposition rates. Under the 150,000 cfs Alternative, dredging volumes would probably be substantially increased by operations as compared to the No Action Alternative or the Applicant's Preferred Alternative.

Bayou Lafourche: Modeling data for Bayou Lafourche were too close to the modeled boundary to be used. It can be reasonably assumed that Bayou Lafourche would experience less sedimentation increases than the Barataria Bay Waterway and more than the GIWW under the 150,000 cfs Alternative, similar to the Applicant's Preferred Alternative. The Barataria Bay Waterway lies between the diversion and Bayou Lafourche, so it would intercept more of the diversion flow and experience the bulk of the increased channel deposition.

GIWW: Qualitative projections from modeling indicate that operation of the 150,000 cfs Alternative would have negligible impacts on dredging quantities in the GIWW in the Barataria Basin. It can be expected that only the most fine-grained, slowest-settling sediment would move to the far sides and bottom of the basin until the basin fills with sediment and flow is well channelized.

4.21.5.2.3.1.3 Terrace Alternatives

The three terrace alternatives would have the same overall impacts on dredging in the basin as the corresponding capacity alternatives without terraces, with permanent, moderate, adverse impacts on maintenance dredging in the Barataria Bay Waterway; permanent, minor, adverse impacts on maintenance dredging in Bayou Lafourche; and negligible impacts on dredging in the GIWW. Sedimentation results were not sufficiently resolved by the models to justify conclusions for non-federal channels and facilities (ports, marinas, anchorages); however, as a first estimate, the above qualitative predictions for federal navigation channels can be assumed to be applicable to adjacent non-federal channels and facilities.

4.21.5.2.3.2 Traffic

4.21.5.2.3.2.1 50,000 cfs Alternative

The direct impacts from operation of the 50,000 cfs Alternative on marine traffic in the Barataria Basin would be similar to those caused by the Applicant's Preferred Alternative with negligible impacts on traffic safety and traffic volumes in the Barataria Basin federal navigation channels for the reasons described above. Also consistent with the Applicant's Preferred Alternative, the 50,000 cfs Alternative would cause indirect increases in Barataria Basin marine traffic due to increased dredging activities restricting or blocking parts of the channel and delaying traffic. The duration of the delays would depend upon the extent of increased dredging.

4.21.5.2.3.2.2 150,000 cfs Alternative

The direct impacts from operation of the 150,000 cfs Alternative on marine traffic in the Barataria Basin would be similar to those caused by the Applicant's Preferred Alternative with negligible impacts on traffic safety and traffic volumes in the Barataria Basin federal navigation channels for the reasons described above. Also consistent with the Applicant's Preferred Alternative, the 150,000 cfs Alternative would cause indirect increases in Barataria Basin marine traffic due to increased dredging activities restricting or blocking parts of the channel and delaying traffic. The duration of the delays would depend upon the extent of increased dredging.

4.21.5.2.3.2.3 Terrace Alternatives

The three terrace alternatives would have the same overall impacts on navigation traffic in the Barataria Basin as the corresponding capacity alternatives without terraces, with negligible direct impacts and adverse indirect impacts for the reasons described above. The presence of terraces in the immediate outfall area for the three terrace alternatives would not impact marine traffic in the basin during operations.

4.21.6 Summary of Potential Impacts

Table 4.21-9 summarizes the potential impacts on navigation for each alternative. Details are provided in Sections 4.21.4 through 4.21.5 above.

Table 4.21-9
Summary of Potential Impacts on Commercial Navigation (including Maintenance Dredging) from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on navigation traffic or maintenance dredging in the Mississippi River or Barataria Basin because construction and operation of the proposed Project would not occur. • Existing dredging trends are expected to continue.
Operational Impacts	• No impacts on navigation traffic or maintenance dredging in the Mississippi River or Barataria Basin because construction and operation of the proposed Project would not occur. • Cargo tonnages and marine vessels transiting the Lower Mississippi River are expected to show very little growth (0.6 percent). • Cargo tonnages and marine vessels transiting the GIWW, Barataria Bay Waterway, and Bayou Lafourche are expected to show little or no growth (1.1 percent, -2.0 percent, and 4.2 percent, respectively). • Existing dredging trends are expected to continue. • Future development in the proposed Project vicinity could result in increases in marine traffic.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Minor, temporary, adverse impacts on traffic capacity in the Lower Mississippi River and the Barataria Basin federal navigation channels due to 10 monthly barge deliveries of construction materials via both the Mississippi River and Barataria Basin channels during the construction period. • Minor, temporary, adverse impacts on safety and efficiency of shallow-draft vessels transiting past the proposed Project site in the Mississippi River during construction due to waterway obstructions associated with the proposed cofferdam for the 3.5-year construction timeframe of the river intake system. • Negligible impacts on deep-draft vessels transiting past the proposed Project site on the other side of the Mississippi River in the navigation channel boundaries. • Negligible impacts on maintenance dredging in the Mississippi River and the Barataria Basin navigation channels.
Operational Impacts	• Moderate, intermittent but permanent, adverse impacts on marine traffic efficiency and safety for shallow-draft vessels in the Mississippi River during

Table 4.21-9
Summary of Potential Impacts on Commercial Navigation (including Maintenance Dredging) from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	operations due to cross-currents extending into the channel from the proposed intake structure. • Minor, permanent, indirect impacts on marine traffic in the Lower Mississippi River due to increased dredging frequencies (dredging activities may cause delays for marine traffic). • Negligible impacts on dredging in the Mississippi River upriver of the proposed Project site. • Minor, permanent, adverse impacts on maintenance dredging between the proposed intake structure (RM 60.7 AHP) and Venice (RM 13 AHP) in the Mississippi River due to changes in typical shoaling patterns and locations and minor increases in dredging quantities if new point bar growth intrudes into the navigation channel. • Moderate, permanent, adverse impacts on maintenance dredging in the Mississippi River from Venice to the Gulf, including Southwest Pass and other passes carrying flow to the Gulf (for example, South Pass, Tiger Pass). • Negligible impacts on marine traffic in the Barataria Basin navigation channels due to a negligible increase in waterborne traffic. • Minor, permanent, indirect, adverse impacts on marine traffic in the Barataria Basin navigation channels due to increased dredging frequencies (dredging activities may cause delays for marine traffic). • Moderate, permanent, adverse impacts on maintenance dredging in the Barataria Bay Waterway due to increased sedimentation. • Minor, permanent, adverse impacts on maintenance dredging in Bayou Lafourche due to increased sedimentation. • Negligible impacts on dredging in the GIWW.
50,000 cfs Alternative	
Construction Impacts	• Minor, temporary, adverse impacts on traffic capacity in the Lower Mississippi River and the Barataria Basin federal navigation channels due to 10 monthly barge deliveries of construction materials via both the Mississippi River and Barataria Basin channels during the construction period. • Minor, temporary, adverse impacts on safety and efficiency of shallow-draft vessels transiting past the proposed Project site in the Mississippi River during construction due to waterway obstructions associated with the proposed cofferdam for the 3.5-year construction timeframe of the river intake system. • Negligible impacts on deep-draft vessels transiting past the proposed Project site on the other side of the Mississippi River in the navigation channel boundaries. • Negligible impacts on maintenance dredging in the Mississippi River and the Barataria Basin navigation channels.
Operational Impacts	• Moderate, intermittent but permanent, adverse impacts on marine traffic efficiency and safety for shallow-draft vessels in the Mississippi River during operations due to cross-currents extending into the channel from the proposed intake structure. • Minor, permanent, indirect impacts on marine traffic in the Lower Mississippi River due to increased dredging frequencies (dredging activities may cause delays for marine traffic). • Negligible impacts on dredging in the Mississippi River upriver of the proposed Project site. • Minor, permanent, adverse impacts on maintenance dredging between the proposed intake structure (RM 60.7 AHP) and Venice (RM 13 AHP) in the Mississippi River due to changes in typical shoaling patterns and locations and

Table 4.21-9
Summary of Potential Impacts on Commercial Navigation (including Maintenance Dredging) from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	minor increases in dredging quantities if new point bar growth intrudes into the navigation channel. • Moderate, permanent, adverse impacts on maintenance dredging in the Mississippi River from Venice to the Gulf, including Southwest Pass and other passes carrying flow to the Gulf (for example, South Pass, Tiger Pass). • Negligible impacts on marine traffic in the Barataria Basin navigation channels due to a negligible increase in waterborne traffic. • Minor, permanent, indirect, adverse impacts on marine traffic in the Barataria Basin navigation channels due to increased dredging frequencies (dredging activities may cause delays for marine traffic). • Moderate, permanent, adverse impacts on maintenance dredging in the Barataria Bay Waterway due to increased sedimentation. • Minor, permanent, adverse impacts on maintenance dredging in Bayou Lafourche due to increased sedimentation. • Negligible impacts on dredging in the GIWW.
150,000 cfs Alternative	
Construction Impacts	• Minor, temporary, adverse impacts on traffic capacity in the Lower Mississippi River and the Barataria Basin federal navigation channels due to 10 monthly barge deliveries of construction materials via both the Mississippi River and Barataria Basin channels during the construction period. • Minor, temporary, adverse impacts on safety and efficiency of shallow-draft vessels transiting past the proposed Project site in the Mississippi River during construction due to waterway obstructions associated with the proposed cofferdam for the 3.5-year construction timeframe of the river intake system. • Negligible impacts on deep-draft vessels transiting past the proposed Project site on the other side of the Mississippi River in the navigation channel boundaries. • Negligible impacts on maintenance dredging in the Mississippi River and the Barataria Basin navigation channels.
Operational Impacts	• Moderate, intermittent but permanent, adverse impacts on marine traffic efficiency and safety for shallow-draft vessels in the Mississippi River during operations due to cross-currents extending into the channel from the proposed intake structure. • Minor, permanent, indirect impacts on marine traffic in the Lower Mississippi River due to increased dredging frequencies (dredging activities may cause delays for marine traffic). • Negligible impacts on dredging in the Mississippi River upriver of the proposed Project site. • Minor, permanent, adverse impacts on maintenance dredging between the proposed intake structure (RM 60.7 AHP) and Venice (RM 13 AHP) in the Mississippi River due to changes in typical shoaling patterns and locations and minor increases in dredging quantities if new point bar growth intrudes into the navigation channel. • Moderate, permanent, adverse impacts on maintenance dredging in the Mississippi River from Venice to the Gulf, including Southwest Pass and other passes carrying flow to the Gulf (for example, South Pass, Tiger Pass). • Negligible impacts on marine traffic in the Barataria Basin navigation channels due to a negligible increase in waterborne traffic. • Minor, permanent, indirect, adverse impacts on marine traffic in the Barataria Basin navigation channels due to increased dredging frequencies (dredging activities may cause delays for marine traffic).

Table 4.21-9
Summary of Potential Impacts on Commercial Navigation (including Maintenance Dredging) from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
	• Moderate, permanent, adverse impacts on maintenance dredging in the Barataria Bay Waterway due to increased sedimentation. • Minor, permanent, adverse impacts on maintenance dredging in Bayou Lafourche due to increased sedimentation. • Negligible impacts on dredging in the GIWW.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar construction impacts on navigation as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on maintenance dredging or marine traffic in the Mississippi River or the Barataria Basin federal navigation channels due to the construction of terraces would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar operational impacts on navigation as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional impacts on maintenance dredging or marine traffic in the Mississippi River or the Barataria Basin federal navigation channels due to the presence of terraces would be negligible.

4.22 LAND-BASED TRANSPORTATION

4.22.1 Area of Potential Impacts

The area of potential impacts during construction includes the construction footprint of the proposed Project, which includes a 1.5-mile section of LA 23 and an approximately 0.7-mile section of the NOGC Railway between W. Ravenna Road and E. Ravenna Road and the town of Ironton (see Chapter 2, Figure 2.8-1 Construction Footprint). Impacts may also occur on LA 23 and local roads south of New Orleans outside of the defined Project construction footprint due to increases in roadway and railroad traffic for construction deliveries and worker commutes. Indirect impacts related to increased air or noise emissions would also occur due to increased construction traffic. These impacts would be highly localized and are assessed in the air and noise sections (see Section 4.7 Air Quality and Section 4.8 Noise). The area of potential impacts during operations includes the portions of LA 23 and the NOGC Railway that would cross the proposed Project diversion complex.

4.22.2 Guidelines for Land-Based Transportation Impact Determinations

Impact intensities for land-based transportation are based on the definitions provided in Section 4.1 and the following transportation-specific indicators for negligible, minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;

- negligible: the impact on land-based transportation would be at the lowest levels of detection, barely measurable, with no perceptible consequences;
- minor: increases in local daily traffic volumes resulting in perceived inconvenience to drivers but no actual disruptions to traffic;
- moderate: detectable increases in daily traffic volumes (with slightly reduced speed of travel), resulting in slowed traffic and delays, but no change in LOS. Short service interruptions (temporary closure for a few hours) to roadway and railroad traffic would occur; and
- major: extensive increases in daily traffic volumes (with reduced speed of travel) resulting in an adverse impact in LOS due to worsened conditions. Extensive service disruptions (temporary closure of one day or more) to roadways or railroad traffic would occur.

4.22.3 Roads

4.22.3.1 Construction Impacts

4.22.3.1.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. As described in Chapter 3, Section 3.22.1 in Land-Based Transportation, CPRA's traffic study found that during peak traffic times, the existing roadway intersections operate at a LOS of A or B, indicating that the current roadway has sufficient capacity with no major queuing or delays. The traffic study predicted that this trend would continue into the future, with minor annual growth rates in traffic of about 2.2 percent annually[127] over current levels.

As part of the traffic study, crash data were reviewed along the roadway from 2012 to 2016, during which time 19 crashes occurred. Ten of the 19 crashes consisted of single-vehicle collisions with objects other than another vehicle or person, including road-departure collisions due to wildlife crossings, vehicle-wildlife collisions, and collisions with construction-related obstructions during construction activities that were completed in 2015. See Chapter 3, Section 3.22.1 in Land-Based Transportation and Appendix I for more details about the LA 23 traffic study. Crash occurrences such as these are expected to continue in the future under the No Action Alternative. Only limited changes to roadway transportation are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project); therefore, there would likely be only negligible impacts on land-based transportation during that timeframe.

[127] Annual growth rates were estimated based on historical AADT counts collected at five DOTD station counters along the Project corridor (see Appendix I).

In consideration of current, ongoing, and planned developments in the Project area, it is predictable that the proposed Project construction footprint and vicinity may be developed for industrial or commercial purposes that could induce increases in traffic, which may result in greater traffic congestion and higher numbers of crashes. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25 Cumulative Impacts for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.22.3.1.2 Applicant's Preferred Alternative

Construction of the proposed Project, which is expected to occur over a 5-year period, would cause temporary, moderate, adverse impacts on roadway traffic including delays and congestion in the Project area as compared to the No Action Alternative. Roadway routes for trucks delivering construction materials to the proposed Project construction footprint are anticipated to include I-10, US 90, and LA 23 from the north and south. Between Belle Chasse and Venice, LA 23 is the main thoroughfare along the west bank of the Mississippi River. This route provides the only access in and out of Plaquemines Parish and is a State of Louisiana evacuation route during hurricane season. During construction of the proposed LA 23 modifications, two-way traffic would be maintained. Northbound traffic would utilize the two existing southbound lanes, maintaining the existing two-lane capacity. Southbound traffic would utilize the shoulder, reducing southbound roadway capacity from two lanes to one. This reduction in capacity may cause delays for southbound traffic over a 1.5-year period during the duration of construction.

LA 23 currently crosses the proposed Project workspace at ground-surface level; therefore, the Project would require that a portion of LA 23 between W. Ravenna Rd. and Ironton Rd. be raised and relocated over the proposed conveyance channel (see Figure 4.22-1). The proposed bridge structure would have a length of approximately 0.4 mile (2,200 feet) with at least 5.0 feet of clearance over the top of the conveyance channel floodwalls, which would be constructed to an elevation of 15.6 feet. There would be 25 feet of vertical clearance between the conveyance channel's maximum water surface elevation and the low chord of the bridge. The affected portion of the existing roadway is a paved four-lane, rural minor arterial roadway with 4-foot wide inside shoulders, 10-foot-wide outside shoulders, and a 36-foot wide depressed grass median. Under the Applicant's Preferred Alternative, the existing rural minor arterial roadway classification and shoulder widths would be maintained, but a 2-foot-wide, 3-foot-tall concrete median barrier would be constructed for safety that would require closing two existing median cross-over locations. The roadway would generally maintain its current alignment, although additional DOTD right-of-way acquisition would be required along the east side of the existing LA 23 right-of-way. Ramps would be constructed on the north side of the diversion channel to maintain access to properties on both sides of the road during construction. Construction would include pile driving for the proposed LA 23 bridge and T-walls for 8 to 12 hours a day for up to 9 months.

Noise impacts associated with pile driving are discussed in Section 4.8 Noise. All roadway and bridge designs would comply with DOTD standards and specifications.

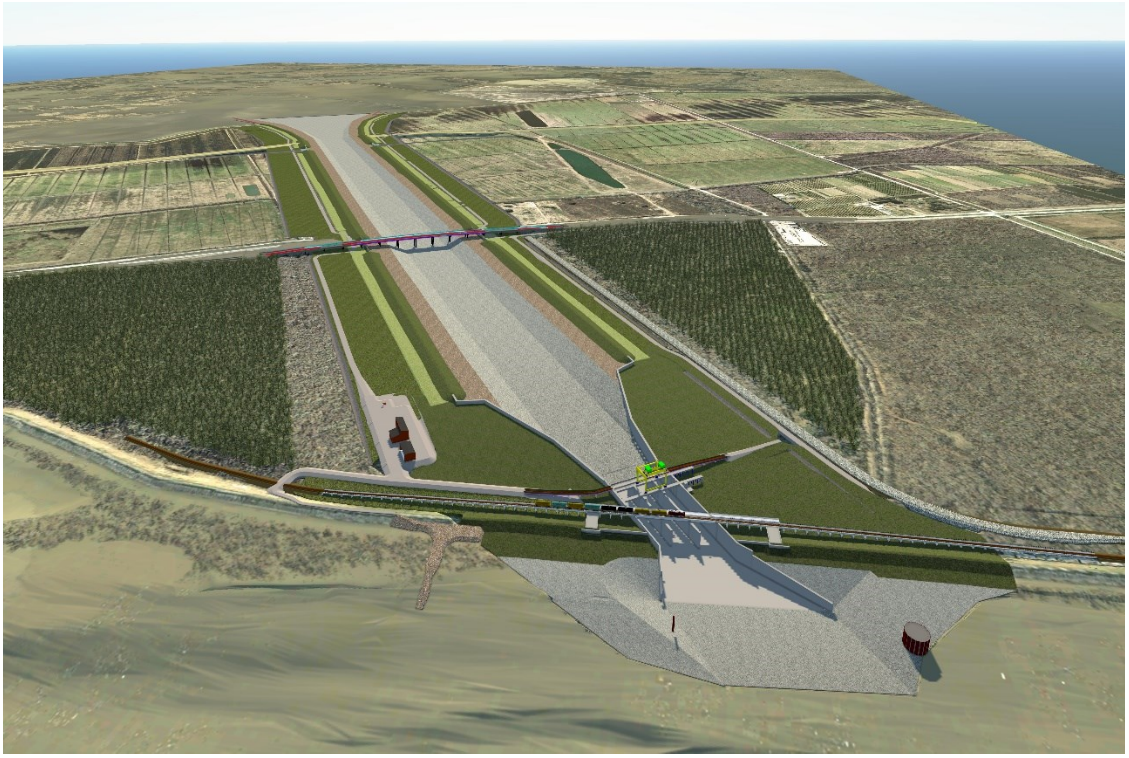


Figure 4.22-1. Schematic Rendering of the Proposed LA 23 Bridge over the Proposed Diversion Channel.

Temporary, moderate, adverse impacts on users of the roadway due to construction of the proposed Project include potential delays from increased traffic levels and reduced roadway capacity. LA 23 would provide the primary vehicular access for transporting equipment, materials, and personnel to and from the construction site during the 5-year construction period. CPRA estimates that construction truck deliveries would generate up to 100,100 roundtrips to the diversion complex via LA 23 during the construction period, with the majority of truck deliveries (approximately 94,000) occurring during the first 42 months (3.5 years) of Project construction. This equates to an estimated 515 truck deliveries per week over this duration, or about 103 roundtrips each day based on a 5-day workweek. This would represent less than a 2 percent increase in the existing daily traffic of 9,300 vehicles. In addition, approximately 500 to 700 construction workers could be present at the construction site over the duration of the construction period; therefore, additional traffic would likely result from construction workers traveling to and from the site, with peak delays expected to occur during daily construction starting and ending times when workers arrive and depart the site. The reduction in roadway capacity for southbound traffic from two lanes to one during construction may cause additional traffic delays over a 1.5-year period during the duration of construction. Impacted users of the roadway would include residents of the nearby town of Ironton, which has been identified as an environmental justice community. See Section 4.15 Environmental Justice for further details about potential Project impacts on environmental justice communities.

Construction traffic would cause temporary, minor, adverse air quality impacts due to criteria pollutant emissions generated by combustion-powered engines and fugitive dust emissions generated by the truck transport of materials. Additionally, combustion engines associated with construction traffic would have temporary, minor, adverse airborne noise impacts. These impacts would be highly localized and are assessed in the air and noise sections (see Section 4.7 Air Quality and Section 4.8 Noise).

4.22.3.1.3 Other Alternatives

4.22.3.1.3.1 50,000 cfs Alternative

This alternative would result in construction impacts similar to the Applicant's Preferred Alternative; however, CPRA estimates that the width of the proposed Project intake channel would be narrower and construction timeframes shorter by several months as compared to the Applicant's Preferred Alternative. As such, truck traffic for construction deliveries would be about 25 percent less as compared to the Applicant's Preferred Alternative, equating to about 77 roundtrips each day based on a 5-day workweek during the first 3.5 years of Project construction. This would represent less than a 1 percent increase in existing daily traffic of 9,300 vehicles. The resulting potential delays for users of the roadway combined with additional traffic generated by construction worker commutes and reduced roadway capacity for southbound traffic from two lanes to one would have temporary, moderate, adverse impacts on users of the roadway during construction.

4.22.3.1.3.2 150,000 cfs Alternative

This alternative would result in construction impacts similar to the Applicant's Preferred Alternative; however, CPRA estimates that the width of both the proposed intake channel and the conveyance channel would be wider and construction timeframes longer by several months as compared to the Applicant's Preferred Alternative. As such, truck traffic for construction deliveries would be about 50 percent more as compared to the Applicant's Preferred Alternative, equating to about 155 roundtrips each day based on a 5-day workweek during the first 3.5 years of Project construction. This would represent less than a 2 percent increase in existing daily traffic of 9,300 vehicles. The resulting potential delays for users of the roadway combined with additional traffic generated by construction worker commutes and reduced roadway capacity for southbound traffic from two lanes to one would have temporary, moderate, adverse impacts on users of the roadway during construction.

4.22.3.1.3.3 Terraces Alternatives

Impacts on roadway transportation due to construction of the three terrace alternatives would be the same as those described above for the corresponding capacity alternatives without terraces, with temporary, moderate, adverse impacts on roadway traffic due to increased traffic volumes associated with construction truck deliveries and construction worker commutes, as well as a reduction in roadway capacity for southbound traffic.

Terraces would be constructed in the Project immediate outfall area using sediments from adjacent water bottoms; truck deliveries would not be required. The addition of terrace construction in the immediate outfall area under the flow capacity alternatives would not impact roadway transportation; therefore, the incremental impacts due to the construction of terraces would be negligible.

4.22.3.2 Operational Impacts

4.22.3.2.1 No Action Alternative

Under the No Action Alternative, roadways and road-based traffic in the Project area would not be impacted by operation of the Applicant's Preferred Alternative or any of the action alternatives. According to CPRA's LA 23 traffic study, under the No Action Alternative, minor increases in average annual daily traffic are anticipated during the 50-year analysis period, with annual growth rates of about 2.2 percent over current levels.[128] See Chapter 3, Section 3.22.1 in Land-Based Transportation and Appendix I for additional information about CPRA's LA 23 traffic study. In consideration of current, ongoing, and planned developments in the Project area, it is predictable that the proposed Project construction footprint and vicinity may be developed for industrial or commercial purposes. Future development along LA 23 could induce increases in traffic, which may result in greater traffic congestion and higher numbers of crashes, which could result in minor, permanent, adverse impacts over time.

4.22.3.2.2 Applicant's Preferred Alternative

Operation of the proposed Project would have both permanent, minor, adverse impacts and permanent, minor, beneficial impacts on roadway transportation. The addition of the roadway bridge would permanently close two median cross-over locations on LA 23, leaving only one median cross-over between Ravenna Rd. and Ironton Rd., a distance of 1.3 miles. This would cause permanent, minor, adverse impacts on roadway users, who would be required to travel farther to reach areas previously accessible via median cross-overs. The proposed addition of the bridge would limit wildlife access on the roadway at this location, which could have beneficial impacts on traffic safety by reducing the potential for wildlife-related crashes. Other impacts on terrestrial wildlife are discussed in Section 4.9 Terrestrial Wildlife and Habitat. During Project operations, Project-generated truck traffic associated with routine maintenance would be limited, and the number of permanent employees at the

[128] Annual growth rates were estimated based on historical AADT counts collected at five DOTD station counters along the Project corridor (see Appendix I).

diversion complex is expected to be less than five, causing negligible impacts on roadway traffic volumes.

4.22.3.2.3 Other Alternatives

4.22.3.2.3.1 50,000 cfs Alternative

The direct and indirect impacts from operation and maintenance of the 50,000 cfs Alternative on roadway transportation would be similar to those caused by the Applicant's Preferred Alternative and would have both permanent, minor, adverse impacts and permanent, minor, beneficial impacts on roadway transportation. There would be negligible differences in impacts on roadway transportation associated with the variations in the width of the intake channel, conveyance channel, and LA 23 bridge lengths for the 50,000 cfs and 75,000 cfs (Applicant's Preferred) Alternatives. Consistent with the Applicant's Preferred Alternative, the addition of the roadway bridge, which would permanently close two median cross-over locations, would represent permanent, minor, adverse impacts on roadway users. The proposed addition of the bridge would limit wildlife access on the roadway at this location, which could improve traffic safety by reducing the potential for wildlife-related crashes. This would represent a permanent, minor, beneficial impact on traffic safety. Because less than five employees are expected to be employed at the facility during operations, additional traffic generated by the proposed Project during operations would be negligible.

4.22.3.2.3.2 150,000 cfs Alternative

The direct and indirect impacts from operation and maintenance of the 150,000 cfs Alternative on roadway transportation would be similar to those caused by the Applicant's Preferred Alternative and would have both permanent, minor, adverse impacts and permanent, minor, beneficial impacts on roadway transportation. There would be negligible differences in impacts on roadway transportation associated with the variations in the width of the intake channel, conveyance channel, and LA 23 bridge lengths for the 150,000 cfs and 75,000 cfs (Applicant's Preferred) Alternatives. Consistent with the Applicant's Preferred Alternative, the addition of the roadway bridge, which would permanently close two median cross-over locations, would represent permanent, minor, adverse impacts on roadway users. The proposed addition of the bridge would limit wildlife access on the roadway at this location, which could improve traffic safety by reducing the potential for wildlife-related crashes. This would represent a permanent, minor, beneficial impact on traffic safety. Because less than five employees are expected to be employed at the facility during operations, additional traffic generated by the proposed Project during operations would be negligible.

4.22.3.2.3.3 Terrace Alternatives

The three terrace alternatives would have the same overall impacts on roadway transportation as the other action alternatives, with both permanent, minor, adverse impacts and permanent, minor, beneficial impacts on roadway transportation for the reasons described above. The presence of terraces in the immediate outfall area for the three terrace alternatives would not impact roadway transportation; therefore, the incremental impacts due to the presence of terraces would be negligible.

4.22.4 Rail

4.22.4.1 Construction Impacts

4.22.4.1.1 No Action Alternative

Under the No Action Alternative, Project-area railroad infrastructure and traffic would not be impacted by construction of the Applicant's Preferred Alternative or any of the action alternatives. The Belle Chasse segment of the NOGC Railway runs from Algiers and terminates in Myrtle Grove, approximately 0.3-mile (1,500 feet) south of the centerline of the proposed MBSD conveyance channel. This NOGC Railway segment operates three trains per day on average, Monday through Friday, with an average train length of 100 cars (1,500 cars weekly) (Federal Railroad Administration and RPC 2018). According to forecasts through 2040, train traffic is expected to remain at current levels along the Belle Chasse segment (Federal Railroad Administration and RPC 2018). NOGC Railway customers in the immediate vicinity (within 0.5-mile) of the construction footprint include the Alliance Refinery and CHS, located adjacent to each other on the Mississippi River within 1.0-mile north of the proposed conveyance channel at E. Ravenna Rd. The 1.0-mile length of track that extends from CHS to the south of the proposed conveyance channel is used for switching operations and the temporary staging of rail cars. Only limited impacts on railroad transportation are expected to occur during the 5-year construction period; therefore, there would likely be only negligible impacts expected during that timeframe.

In consideration of current, ongoing, and planned developments in the vicinity of the area of potential impacts, it is predictable that at some future point, the proposed construction footprint and vicinity may be developed for industrial or commercial purposes that may impact railroad infrastructure and transportation patterns in the Project area. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25 Cumulative Impacts for more details about reasonably foreseeable future projects in the Project area). It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal regulations.

4.22.4.1.2 Applicant's Preferred Alternative

Construction of the proposed railroad modifications would cause temporary, minor, adverse impacts on railroad traffic in the Project area as compared to the No Action Alternative. There would be rail deliveries of construction materials anticipated to originate north of the proposed Project via the Union Pacific Railroad, the New Orleans Public Belt Railroad, and the NOGC Railway. CPRA estimates that approximately 3,000 railcars would be used to transport construction materials and equipment to the construction site during the first 3.5 years (42 months) of construction, which would amount to about 16 train cars weekly throughout this duration. This increase over the

NOGC Belle Chasse segment existing average of 1,500 weekly train cars would represent a minor increase in railroad traffic during construction. Potential indirect, adverse impacts associated with increased NOGC Railway traffic include minor traffic delays at public road crossings in the broader Project area.

Construction of the proposed Project intake system would require that a portion of the NOGC Railway be permanently raised and relocated over the intake channel with a maximum grade of 1.5 percent. The railroad bridge would generally follow the current railroad alignment. The proposed railroad bridge would be supported by the intake structure piers. The low chord of the railroad bridge would clear the top of the intake structure wall and equal or exceed the federally authorized Mississippi River Design Grade, therefore, additional flood proofing of the bridge would not be required. The railroad bridge would be designed in accordance with Union Pacific Railroad and American Railway Engineering and Maintenance-of-Way Association design standards.

Proposed railroad modifications would not impact Alliance Refinery switching operations during construction. To avoid disruptions to railroad operations and maintain rail service during the construction period, CPRA would construct a temporary 2,200-foot-long railroad spur extending from the existing railroad along the north side of the proposed conveyance channel prior to excavation of the intake system and construction of the proposed railroad bridge.

An additional 600 track feet of rail would be constructed at the end of the existing NOGC Railway track termination point, which is located about 0.5-mile north of the town of Ironton. This extension would not change the facilities accessible by rail in the Project area, and is not expected to impact rail traffic volumes.

4.22.4.1.3 Other Alternatives

4.22.4.1.3.1 <u>50,000 cfs Alternative</u>

The 50,000 cfs Alternative would result in construction impacts similar to the Applicant's Preferred Alternative; however, CPRA estimates that the length of the raised track would be shorter and construction timeframes shorter by several months due to a narrower proposed intake channel as compared to the Applicant's Preferred Alternative. As such, train traffic for construction deliveries would be about 25 percent less than those of the Applicant's Preferred Alternative, equating to about 12 additional train cars each week during the first 3.5 years of Project construction. This increase over the No Action Alternative average of 1,500 weekly train cars would represent a minor increase in railroad traffic during construction. An increase in the number of train cars could cause temporary, minor, adverse impacts on railroad traffic in the Project area associated with minor traffic delays at public road crossings in the broader Project area. Proposed railroad modifications would not impact NOGC train operations or Alliance Refinery switching operations during construction.

4.22.4.1.3.2 150,000 cfs Alternative

The 150,000 cfs Alternative would result in construction impacts similar to the Applicant's Preferred Alternative; however, CPRA estimates that the length of the raised track would be longer and construction timeframes longer by several months due to a wider proposed intake channel as compared to the Applicant's Preferred Alternative. As such, train traffic for construction deliveries would be about 50 percent more as compared to the Applicant's Preferred Alternative, equating to about 24 additional train cars each week during the first 3.5 years of Project construction. This increase over the No Action Alternative average of 1,500 weekly train cars would represent a minor increase in railroad traffic during construction. An increase in the number of train cars could cause temporary, minor, adverse impacts on railroad traffic in the Project area associated with minor traffic delays at public road crossings in the broader Project area. Proposed railroad modifications would not impact NOGC train operations or Alliance Refinery switching operations during construction.

4.22.4.1.3.3 Terrace Alternatives

Impacts on railroad transportation due to construction of the three terrace alternatives would be the same as those described above for the corresponding capacity alternatives without terraces, with temporary, minor, adverse impacts on railroad traffic in the Project area from rail deliveries of construction materials and associated minor traffic delays at public road crossings in the broader Project area.

Terraces would be constructed in the immediate outfall area using sediments from adjacent water bottoms; train deliveries of equipment or material would not be required. The addition of terrace construction in the immediate outfall area under this alternative would not impact railroad transportation.

4.22.4.2 Operational Impacts

4.22.4.2.1 No Action Alternative

Under the No Action Alternative, the NOGC Railway and Project-area railroad traffic would not be impacted by operation of the Applicant's Preferred Alternative or any of the action alternatives. According to forecasts through 2040, train traffic is expected to remain at current levels through the Belle Chasse segment (Federal Railroad Administration and RPC 2018). It is predictable to expect that during the 50-year analysis period (2020 to 2070), Project-area railroads may be modified through other projects, and future trends may alter railroad traffic volumes and patterns, which could result in negligible to minor, permanent, adverse impacts over time, depending on the type of development. It is reasonable to anticipate that any future man-made development would be required to comply with applicable local, state, and federal environmental regulations.

4.22.4.2.2 Applicant's Preferred Alternative

Diversion operations would not impact Project-area railroad traffic volumes so there would be only negligible impacts on railroad transportation as compared to the No Action Alternative. Once constructed, the relocation of the railroad would have negligible impacts on railroad fuel consumption and associated negligible air and noise emissions due to the additional 600 track feet of rail and trains having to traverse the proposed 1.3-percent-grade railroad bridge over the conveyance channel. These negligible impacts on air quality and noise would be highly localized and are assessed in the air and noise sections (see Section 4.7 Air Quality and Section 4.8 Noise). Negligible increases in air and noise emissions may have negligible impacts on the nearby community of Ironton due to the track termination point being 600 feet closer to Ironton. The 1.0-mile portion of the track that runs from CHS to the railway termination point would continue to be used for switching operations and temporary staging of rail cars.

4.22.4.2.3 Other Alternatives

4.22.4.2.3.1 50,000 cfs Alternative

Once constructed, the modifications to the NOGC Railway, including raising and relocating a portion of the railroad over the proposed Project intake channel and extending the track by about 600 feet, would become permanent features of all action alternatives during the 50-year analysis period. The direct and indirect impacts associated with these impacts on Project-area rail transportation would be similar to those described under the Applicant's Preferred Alternative with negligible impacts on railroad fuel consumption and associated negligible impacts on air and noise emissions. There would be negligible operational impact differences associated with the shorter length of bridged track for the 50,000 cfs Alternative and the Applicant's Preferred Alternative. Consistent with the Applicant's Preferred Alternative, operation of the 50,000 cfs Alternative would not impact Project-area railroad traffic volumes. Negligible impacts on train-induced air and noise emissions on the nearby community of Ironton are expected during operation of the 50,000 cfs Alternative due to trains traversing the proposed railroad bridge and the extension of the track termination point to be 600 feet closer to Ironton.

4.22.4.2.3.2 150,000 cfs Alternative

The direct and indirect impacts associated with operation of the 150,000 cfs Alternative on Project-area rail transportation would be similar to those described under the Applicant's Preferred Alternative with negligible impacts on railroad fuel consumption and associated negligible increases in air and noise emissions. There would be negligible operational impact differences associated with the longer length of bridged track for the 150,000 cfs Alternative as compared to the Applicant's Preferred Alternative. Consistent with the Applicant's Preferred Alternative, operation of the 150,000 cfs Alternative would not impact Project-area railroad traffic volumes. Negligible impacts on train-induced air and noise emissions on the nearby community of

Ironton are expected during operation of the 150,000 cfs Alternative due to trains traversing the proposed railroad bridge and the extension of the track termination point to be 600 feet closer to Ironton.

4.22.4.2.3.3 Terrace Alternatives

The presence of terraces in the basin near the proposed diversion structure associated with the three terrace alternatives would have the same overall negligible impacts on rail transportation as the corresponding flow capacity alternatives without terraces.

4.22.5 Summary of Potential Impacts

Table 4.22-1 summarizes the potential impacts on land-based transportation for each alternative. Details are provided in Sections 4.22.2 through 4.22.4 above.

Table 4.22-1
Summary of Potential Impacts on Land-Based Transportation from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• Future increases in LA 23 traffic volumes of 2.2 percent annually. • NOGC train traffic expected to remain at current levels. • Future industrial and commercial development in vicinity of the proposed Project site may induce increases in roadway and railroad traffic volumes, which may result in congestion and delays for motorists, but only limited impacts are expected to occur during the 5-year construction period and there would likely be only negligible impacts on land-based transportation during that timeframe.
Operational Impacts	• Future increases in LA 23 traffic volumes of 2.2 percent annually. • NOGC train traffic expected to remain at current levels. • Future industrial and commercial development in vicinity of the proposed Project site may induce increases in roadway and railroad traffic volumes, which may result in congestion and delays for motorists and minor, permanent, adverse impacts over time.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Temporary, moderate, adverse impacts on roadway traffic delays and congestion from construction-generated traffic and reduced roadway capacity for southbound traffic on LA 23. • Temporary, minor, adverse impacts on increased NOGC train traffic from rail deliveries of construction materials. • No impacts on Alliance Refinery rail switching operations during construction.
Operational Impacts	• Permanent, minor, adverse impacts on LA 23 traffic access due to closure of two median cross-over locations. • Permanent, minor, beneficial impacts on LA 23 traffic safety due to limited wildlife access on proposed LA 23 bridge. • Negligible impacts on NOGC train fuel consumption due to proposed 1.3-percent-grade railroad bridge; indirect impacts on air and noise would be negligible.

Table 4.22-1
Summary of Potential Impacts on Land-Based Transportation from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
50,000 cfs Alternative	
Construction Impacts	• Temporary, moderate, adverse impacts on roadway traffic delays and congestion from construction-generated traffic and reduced roadway capacity for southbound traffic on LA 23. • Temporary, minor, adverse impacts on increased NOGC train traffic from rail deliveries of construction materials. • No impacts on Alliance Refinery rail switching operations during construction.
Operational Impacts	• Permanent, minor, adverse impacts on LA 23 traffic access due to closure of two median cross-over locations. • Permanent, minor, beneficial impacts on LA 23 traffic safety due to limited wildlife access on proposed LA 23 bridge. • Negligible impacts on NOGC train fuel consumption due to proposed 1.3-percent-grade railroad bridge; indirect impacts on air and noise would be negligible.
150,000 cfs Alternative	
Construction Impacts	• Temporary, moderate, adverse impacts on roadway traffic delays and congestion from construction-generated traffic and reduced roadway capacity for southbound traffic on LA 23. • Temporary, minor, adverse impacts on increased NOGC train traffic from rail deliveries of construction materials. • No impacts on Alliance Refinery rail switching operations during construction.
Operational Impacts	• Permanent, minor, adverse impacts on LA 23 traffic access due to closure of two median cross-over locations. • Permanent, minor, beneficial impacts on LA 23 traffic safety due to limited wildlife access on proposed LA 23 bridge. • Negligible impacts on NOGC train fuel consumption due to proposed 1.3-percent-grade railroad bridge; indirect impacts on air and noise would be negligible.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar construction impacts on land-based transportation as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • The addition of terrace construction in the immediate outfall area would not impact land-based transportation; therefore, the incremental impacts due to the construction of terraces would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar operational impacts on land-based transportation as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • The presence of terraces would not impact land-based transportation; therefore, the incremental impacts due to the presence of terraces would be negligible.

4.23 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE ASSESSMENT

4.23.1 Area of Potential Impacts

During construction of the Project, impacts would be localized to areas where earthmoving activities and inadvertent spills could occur. Therefore, the area of potential construction impacts associated with HTRW is within the immediate vicinity (within approximately 0.5-mile) of the construction footprint. During operation of the

Project, potential contaminants would be limited to those areas where operational spills could impact soils, surface water, and groundwater. Impacts associated with airborne contaminants during construction and operation are discussed in Section 4.7 Air Quality.

4.23.2 Guidelines for HTRW Impact Determinations

Impact intensities for HTRW are based on the definitions provided in Section 4.1 and the following HTRW-specific indicators for negligible, minor, moderate, and major impacts:

- no impact: no discernible or measurable impact;
- negligible: impacts from HTRW would be at the lowest levels of detection, barely measurable, with no perceptible consequences;[129]
- minor: actions would not result in (1) soil, groundwater, and/or surface water contamination; (2) exposure of contaminated media to construction workers or transmission line operations personnel; and/or (3) mobilization and migration of contaminants currently in the soil, groundwater, or surface water at levels that would harm the workers or general public;
- moderate: Project construction and operation would result in (1) exposure, mobilization, and/or migration of existing contaminated soil, groundwater, or surface water to an extent that requires mitigation; and/or (2) would introduce detectable levels of contaminants to soil, groundwater, and/or surface water in localized areas within the Project boundaries such that mitigation/remediation is required to restore the affected area to the preconstruction conditions; and
- major: actions would result in (1) soil, groundwater, and/or surface water contamination at levels exceeding federal, state, or local hazardous waste criteria, including those established by 40 CFR 261; (2) mobilization of contaminants currently in the soil, groundwater, or surface water, resulting in exposure of humans or other sensitive receptors such as plants and wildlife to contaminant levels that would result in health effects; and (3) the presence of contaminated soil, groundwater, or surface water within the Project area, exposing workers and/or the public to contaminated or hazardous materials at levels exceeding those permitted by the federal OSHA in 29 CFR 1910.

[129] The term "negligible" will be used as defined here and is not intended to indicate a negligible impact or effect under other applicable statutory or regulatory review.

4.23.3 Construction Impacts

4.23.3.1 No Action Alternative

Under the No Action Alternative, the temporary impacts associated with HTRW resulting from construction of the proposed Project would not occur; potentially contaminated soils would not be disturbed; surface and groundwater would not be impacted by earth moving activities; and spills of contaminants with the potential to impact soils, surface water, and groundwater would not occur. The soil, groundwater, surface water, and air quality would not be modified from existing conditions described in Chapter 3, Section 3.23 Hazardous, Toxic, and Radioactive Waste, unless by other future activities and projects. Only limited impacts on HTRW are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project); therefore, there would likely be only negligible HTRW impacts during that timeframe.

In consideration of current and planned developments in the area, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes. However, it would be speculative to guess what exactly those future developments might be (but see Section 4.25, Cumulative Impacts, for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws.

4.23.3.2 Applicant’s Preferred Alternative

Construction of the proposed Project could result in temporary, minor to moderate, adverse impacts due to potential unexpected discovery of and exposure to existing contaminated sites and inadvertent releases of contaminants from construction activities and equipment, as compared to the No Action Alternative. As discussed in Chapter 3, Section 3.23 Hazardous, Toxic, and Radioactive Waste, through the review of federal, state, and local environmental databases, historical research, interviews, and site investigations, no REC sites were noted within the construction footprint. Debris was observed but none appeared to have spilled or caused contamination on the property and are considered to be de minimis conditions and not an indication of an adverse environmental condition at the site.

There are two unregistered free flowing water wells that were discovered within the pasture land of the construction footprint during the site investigation. There is also a corroded steel oil well pipe that was observed protruding from the water near the center of the West Access Canal which would not be visible under normal water level conditions. These are areas of concern to note during construction but would not be considered a REC; however, these would likely need to be capped or plugged and abandoned prior to construction. There are known abandoned oil and/or gas waste pits in the outfall area. Disturbance of potentially contaminated sediments associated with construction in the outfall area could result in the release of contaminants from these pits into water media in the vicinity of the Project area. Also, multiple underwater obstructions were encountered during the field survey that may be encountered during construction.

In addition, excavation, grading, and leveling activities could generate temporary, minor, adverse impacts resulting from the discovery of unregistered, historic USTs or exposed contaminants associated with previous spills in the vicinity of the proposed construction areas. Discovery of USTs or potential contaminants could indicate impacts on soil, groundwater, and surface water within the proposed construction area. Excavation or earth moving activities at these locations could result in the migration of contaminated soil, surface water, and groundwater media offsite if not properly remediated or disposed. If contaminated media with concentrations exceeding regulatory limits is unearthed or discovered during construction, CPRA would be required to notify the LDEQ in accordance with 33 LAC and ensure the appropriate disposal of contaminants offsite.

Maintenance, refueling, and the use of heavy equipment, machinery, and vehicles during construction would create the potential for inadvertent releases of contaminants. Liquid materials required for construction include, but are not limited to, fuels, oil, lubricants, and coolants. These materials would be transported and stored on-site. During refueling and maintenance activities, these chemicals could reach the ground surface and impact localized soil, shallow groundwater, and surface water. Additionally, spills could occur during transport to the proposed active construction areas as well as during loading and unloading. To minimize impacts associated with construction, CPRA would implement its SPCC Plan, Waste Management Plan, Contaminant Prevention Plan, and Environmental Monitoring Plan which are included in an overall environmental protection plan (EPP) and would report any large-quantity spills to the appropriate regulatory agency in accordance with 49 CFR 161.15, 40 CFR 112, and 33 LAC, Part IX, Chapter 9. Further, transporters of these materials would develop and implement a spill contingency plan in accordance with LAC 33, Section 1315.

An updated ASTM Standard E1527-13 Phase I Environmental Site Assessment would be conducted within 6 months before construction begins to identify any additional potential RECs or historic RECs (HRECs) that could be encountered during construction and operation of the proposed Project.

4.23.3.3 Other Alternatives

The potential impacts from construction of the five other action alternatives associated with HTRW would be similar to those described above for the Applicant's Preferred Alternative. There would be negligible differences in the duration and intensity of impacts related to HTRW associated with the variations in the width of the intake and conveyance channels for the 50,000 cfs and 150,000 cfs Alternatives. Consistent with the Applicant's Preferred Alternative, construction of the five other alternatives could result in temporary, minor, adverse impacts due to potential unexpected discovery and exposure to existing contaminated sites and inadvertent releases of contaminants from construction activities and equipment. CPRA would implement its SPCC Plan and other best management practices described in Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan to minimize impacts on the human and natural environment during construction.

The construction of terraces in the immediate outfall area under three of the flow capacity alternatives may increase the potential for inadvertent releases of contaminants due to additional heavy equipment required to construct the terraces in the immediate outfall area as compared to the three corresponding flow capacity alternatives without terraces, but incremental differences would be negligible.

4.23.4 Operational Impacts

4.23.4.1 No Action Alternative

Under the No Action Alternative, the short- to long-term impacts associated with HTRW resulting from operation of the proposed Project would not occur, and operational spills with the potential to impact soils, surface water, and groundwater would not occur. Existing HTRW within the basin and the birdfoot delta could be impacted as a result of future development or ongoing processes, including sea-level rise, erosion, subsidence, flooding, wave activity, saltwater intrusion, and damaging wind during storm events. This could create conditions for exposure, mobilization, and/or migration of existing contaminated soil, groundwater, or surface water or introduce detectable levels of contaminants to soil, groundwater, and/or surface water in localized areas within the Project boundaries such that mitigation/remediation is required within the Project area. All of these factors could potentially result in minor to major, permanent adverse impacts over time, depending on the type of future developments or events.

4.23.4.2 Applicant's Preferred Alternative

Operation of the proposed Project could result in short- to long-term minor to major, adverse HTRW impacts. Similar to impacts during construction, operation of the proposed Project could result in short- to long-term, minor, adverse impacts resulting from the transport and use of potentially harmful chemicals and fuels needed for general equipment maintenance and operation as compared to the No Action Alternative. During operation, liquid materials and chemicals may be stored or transported on-site for the operation and maintenance of combustion engines used for backup storm generators. To minimize impacts associated with operation and maintenance of the proposed Project, CPRA would be required to report any large-quantity spills to the appropriate regulatory agency in accordance with 49 CFR 161.15, 40 CFR 112, and 33 LAC, Part IX, Chapter 9. Further, transporters of these materials would be required to develop and implement a spill contingency plan in accordance with 33 LAC, Section 1315 (see Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan for minimization measures).

As indicated in the Applicant's Operations Plan, in the event of a spill or other hazardous discharge requiring notification or other reportable release of hazardous materials in the Mississippi River upstream of the diversion intake with high likelihood to be imminently entrained, CPRA would cease diversion operations immediately. For spills or other hazardous discharges in the Mississippi River downstream of the diversion, a decision would be made regarding any changes in standard operations by the operator in consultation with relevant agencies. Additionally, CPRA would cease operations upon learning that an imminent threat of a spill exists (such as vessel groundings, collisions, loss of steerage). For spills occurring in the Barataria Basin, CPRA will assess the event and potential impacts in consultation with LOSCO or LDEQ and other relevant response agencies to determine what, if any, changes in diversion operations are warranted. See Appendix F2 for details regarding CPRA's Operations Plan.

As discussed in Chapter 3, Section 3.23 Hazardous, Toxic, and Radioactive Waste, multiple camp structures, submerged oil well pipes; capsized boats; oil field facilities; well platforms; pipelines and associated debris were observed in the outfall area. Some of these facilities were observed to be abandoned (see Appendix J). Although no evidence of leaks, spills, stains, stressed vegetation, hydrocarbon sheen, or odors were observed at these sites, increased water flow and sedimentation due to operation of the proposed Project could potentially create exposure to existing contaminated sites and inadvertent releases of contaminants resulting in minor to major, short to long-term, adverse impacts over time.

4.23.4.3 Other Alternatives

4.23.4.3.1 50,000 cfs Alternative

The direct HTRW impacts from operation and maintenance of the 50,000 cfs Alternative would be similar to those described above for the Applicant's Preferred Alternative. There would be negligible differences in the duration and intensity of impacts related to HTRW associated with the variations in the width of the intake and conveyance channels for the 50,000 cfs Alternative. Consistent with the Applicant's Preferred Alternative, operation of the 50,000 cfs Alternative could result in short- to long-term, minor to major adverse impacts resulting from the transport and use of potentially harmful chemicals and fuels for equipment maintenance, as well as from exposure to existing contaminated sites due to water flow and sedimentation. CPRA would implement the actions described in Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan to minimize potential impacts related to HTRW during operations.

4.23.4.3.2 150,000 cfs Alternative

The direct HTRW impacts from operation and maintenance of the 150,000 cfs Alternative would be similar to those described above for the Applicant's Preferred Alternative. There would be negligible differences in the duration and intensity of impacts related to HTRW associated with the variations in the width of the intake and conveyance channels for the 150,000 cfs Alternative. Consistent with the Applicant's Preferred Alternative, operation of the 150,000 cfs Alternative could result in short- to long-term, minor to major adverse impacts resulting from the transport and use of potentially harmful chemicals and fuels for equipment maintenance, as well as from exposure to existing contaminated sites due to water flow and sedimentation. CPRA would implement the actions described in Section 4.27 Mitigation Summary and Appendix R1 Mitigation and Stewardship Plan to minimize potential impacts related to HTRW during operations.

4.23.4.3.3 Terrace Alternatives

As compared to the No Action Alternative, all three terrace alternatives would have minor to major, adverse, short- to long-term HTRW impacts similar to those described above for the Applicant's Preferred Alternative. The presence of terraces in the basin near the proposed diversion structure associated with the three terrace alternatives would cause negligible impacts as compared to the corresponding flow capacity alternatives without terraces.

4.23.5 Summary of Potential Impacts

Table 4.23-1 summarizes the potential impacts associated with HTRW for each alternative. Details are provided in Sections 4.21.2 through 4.21.4 above.

Table 4.23-1
Summary of Potential Impacts Associated with HTRW from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• Future industrial and commercial development in vicinity of the Project site may pose HTRW risks, such as unexpected discoveries of and exposure to existing contaminated sites and inadvertent releases of contaminants from construction activities and equipment; however only limited changes to HTRW are expected to occur during the 5-year analysis period (the period that would otherwise be required for construction of the proposed Project) and there would likely only negligible HTRW impacts during that timeframe. • Any future man-made development would be required to comply with applicable local, state, and federal laws.
Operational Impacts	• Existing HTRW within the basin and the birdfoot delta could be impacted as a result of future development or ongoing processes, potentially resulting in minor to major, permanent adverse impacts over time, depending on the type of future developments or events.
75,000 cfs Alternative (Applicant's Preferred)	
Construction Impacts	• Temporary, minor to moderate, adverse impacts due to potential unexpected discovery of and exposure to existing contaminated sites and inadvertent releases of contaminants from construction activities and equipment.
Operational Impacts	• Short- to long-term, minor to major adverse impacts resulting from the transport and use of potentially harmful chemicals and fuels needed for general equipment maintenance and operation and increased water flow and sedimentation due to operation.
50,000 cfs Alternative	
Construction Impacts	• Temporary, minor to moderate, adverse impacts due to potential unexpected discovery of and exposure to existing contaminated sites and inadvertent releases of contaminants from construction activities and equipment.

Table 4.23-1
Summary of Potential Impacts Associated with HTRW from Each Alternative

Impact Type	Impact Description (as Compared to the No Action Alternative unless Otherwise Stated)
Operational Impacts	• Short- to long-term, minor to major adverse impacts resulting from the transport and use of potentially harmful chemicals and fuels needed for general equipment maintenance and operation and increased water flow and sedimentation due to operation.
150,000 cfs Alternative	
Construction Impacts	• Temporary, minor to moderate, adverse impacts due to potential unexpected discovery of and exposure to existing contaminated sites and inadvertent releases of contaminants from construction activities and equipment.
Operational Impacts	• Short- to long-term, minor to major adverse impacts resulting from the transport and use of potentially harmful chemicals and fuels needed for general equipment maintenance and operation and increased water flow and sedimentation due to operation.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar construction HTRW impacts as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • The construction of terraces in the immediate outfall area may increase the potential for inadvertent releases of contaminants due to additional heavy equipment required to construct the terraces in the immediate outfall area but incremental differences would be negligible.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have substantially similar operational HTRW impacts as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs Alternatives listed above. • Any additional HTRW impacts due to the presence of terraces during Project operations would be negligible.

4.24 CULTURAL RESOURCES

4.24.1 Area of Potential Impacts

The Construction Impacts APE for cultural resources, which may also be referred to as the area of potential impacts for construction, is comprised of approximately 3,095 acres and encompasses the footprint of the diversion complex, a buffer outside the east and west conveyance channel guide levees, locations of the LA 23 and New Orleans Gulf Coast Rail Way realignments, and the area in the immediate basin outfall that would be dredged to enhance water conveyance and sediment deposition during operation.

The Operational Impacts APE for cultural resources, which may also be referred to as the area of potential impacts during Project operations, is comprised of approximately 70,630-acres within the Barataria Basin in which cultural resources may be affected during the 50-year analysis period (see Chapter 3, Section 3.24 Cultural Resources for further description of the Construction and Operational Impacts APEs).

4.24.2 Construction Impacts

4.24.2.1 No Action Alternative

Under the No Action Alternative, construction of the proposed Project would not occur. Under the No Action Alternative, it is assumed that a continuation of existing trends in the Construction Impacts APE would continue. Over the long-term, commercial and industrial development of the Mississippi River floodplain would continue.

In consideration of current and planned developments in the vicinity of the proposed Project's construction footprint, it is predictable that at some future point the area of the proposed Project may be developed for industrial or commercial purposes that may have some impact on cultural resources. However, it would be speculative to project what exactly those future developments might be (but see Section 4.25 Cumulative Impacts for more details about reasonably foreseeable future projects in the Project area). It is reasonable to assume that any future man-made development would be required to comply with applicable local, state, and federal laws and regulations.

4.24.2.2 Applicant's Preferred Alternative

Known cultural resources are present within the Construction Impacts APE (Cropley et al. 2020). Based on a review of the proposed construction footprint, the Applicant's Preferred Alternative would not impact the recently identified St. Rosalie Plantation Cemetery (16PL280) or the nearby Ironton Cemetery. Visitation access to both locations would not be impacted by construction or operation of the proposed MBSD Project.

Two cultural resources located in the Construction Impacts APE were not previously evaluated for NRHP eligibility. As part of the NHPA Section 106 consultation process, CEMVN determined that archaeological site 16PL296, within the proposed Project construction footprint in the Construction Impacts APE, is not eligible for the NRHP; SHPO concurred with this determination. Consultation for Phase II NRHP-eligibility testing at 16PL107 (St. Rosalie Plantation) within the Construction Impacts APE was ongoing by others at the time the Draft EIS was released for public review; that consultation was terminated in 2021 without an eligibility determination for 16PL107. As a result, CPRA undertook Phase II NRHP-eligibility testing at the portion of 16PL107 within the construction footprint of the proposed Project within the Construction Impacts APE. RCG&A found 26 brickwork architectural features, three refuse pits, two prepared pavements, and eight rubble features of indeterminate origin/function. The brickwork architectural features outline buildings that may have been residences for the St. Rosalie Sugar Plantation labor force after the Civil War. Thousands of historic artifacts dating from the late 19th to early 20th century were recovered and analyzed. The analysis of all data suggests that the residents of the post-Civil War St. Rosalie community were African-Americans living in tenant housing. Based on the review of the results of this investigation, CEMVN determined, and SHPO concurred, that the portion of 16PL107 within the proposed Project's construction footprint is eligible for the NRHP under Criteria A and D.

The PA prepared by CEMVN, states a treatment plan will be developed by the Applicant, signatories to the PA, and consulting parties in order to mitigate impacts to the portion of 16PL107 within the construction footprint of the proposed Project. The PA also includes an unanticipated discovery plan that outlines a process for the Applicant to follow if additional cultural resources or historic properties are discovered during construction activities. See Appendix K Draft Programmatic Agreement.

4.24.2.3 Other Alternatives

Construction of the other alternatives would be similar to the Applicant's Preferred Alternative. Each of the other alternatives would have similar impacts on the portion of 16PL107 within the construction footprint of that alternative.

4.24.3 Operations Impacts

4.24.3.1 No Action Alternative

Under the No Action Alternative, ongoing wetland loss would adversely impact cultural resources over time. As projected by the Delft3D Basinwide Model, approximately 298,235 acres total (80.4 percent) and 52,525 acres (89.1 percent) of wetlands would be lost over a 50-year period (2020 to 2070) in the Barataria Basin and birdfoot delta, respectively (see Section 4.6 Wetland Resources and Waters of the U.S. for additional information about wetland loss in the Project area under the No Action Alternative). Over the long-term, cultural resources located within wetlands in the basin and the birdfoot delta would be impacted as a result of ongoing processes including sea-level rise, erosion, subsidence, flooding, wave activity, saltwater intrusion, and damaging wind and storm surge during tropical storms (see Chapter 3, Section 3.1.3 Climate).

4.24.3.2 Applicant's Preferred Alternative

Multiple previously recorded prehistoric shell midden sites were confirmed present within the Operational Impacts APE (see Chapter 3, Section 3.24 Cultural Resources). In addition, RCG&A identified two new archaeological sites within the Operational Impacts APE (see Chapter 3, Section 3.24 for details about these sites). CEMVN determined four previously recorded archaeological sites retain integrity and are eligible for listing in the NRHP. In addition, CEMVN considered one previously-identified site to have undetermined NRHP eligibility, and therefore, treated it as NRHP eligible (see Table 4.24-1). In a letter dated June 30, 2020, CEMVN concluded that the proposed Project would have adverse effects on these five historic properties in the Operational Impacts APE. The SHPO concurred and federally-recognized Tribal Nations agreed with CEMVN's determinations.

In addition, two cemeteries may also be directly impacted during operation. According to the Louisiana SHPO database, the Lake Hermitage Cemetery (also identified as the Bieber Cemetery) and the Deer Range Cemetery in Suzie Bayou are located along the eastern boundary of the Operational Impacts APE that may be subject to direct impacts during operation of the proposed Project, such as increased tidal flooding or sediment deposition (burial) (see Figure 4.24-1).

Table 4.24-1
CEMVN NRHP-Eligibility Determinations

Designation	Site Description	CEMVN NRHP-Eligibility Determination
16PL107	Historic plantation site; Construction Impacts APE Intact architectural foundations and archaeological features still remain	Eligible
16PL175	Historic structure, historic deposit; Construction Impacts APE	Ineligible
16PL280	Historic cemetery site; Construction Impacts APE;	Undetermined
16PL296	Historic surface and subsurface concentration of historic artifacts; Construction Impacts APE	Ineligible
16JE2	Prehistoric deposit, shell middens, historic deposit; Previously recorded eligible and intact portions still remain	Eligible
16JE3	Prehistoric deposit, shell midden; Previously recorded eligible and intact portions still remain	Eligible
16JE11	Prehistoric deposit, shell midden, historic deposit; Previously recorded eligible and intact portions still remain	Eligible
16JE147	Prehistoric deposit, shell midden, historic deposit; Previously recorded eligible and intact portions still remain	Eligible
16JE236	Prehistoric deposit, shell midden; Newly discovered but does not possess qualities of significance and integrity	Ineligible
16JE237	Prehistoric shell midden; Newly discovered and intact strata have been identified	Undetermined
16JE1	Prehistoric scatter, shell midden, historic scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE9	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE12	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible

Table 4.24-1 CEMVN NRHP-Eligibility Determinations		
Designation	**Site Description**	**CEMVN NRHP-Eligibility Determination**
16JE13	Prehistoric scatter, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE14	Prehistoric scatter, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE15	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE16	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE48	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE59	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE92	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE94	Historic scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE95	Historic scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE96	Historic scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE97	Prehistoric scatter, shell midden, historic scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE98	Prehistoric deposit, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE100	Prehistoric scatter, shell midden, historic scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE101	Prehistoric scatter, shell midden, historic scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE102	Prehistoric scatter, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE103	Prehistoric scatter, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE131	Prehistoric scatter, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE146	Prehistoric scatter; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16PL17	Prehistoric scatter, shell midden; Previously recorded portion could not be relocated; does not possess qualities of significance and integrity	Ineligible
16JE8	Prehistoric deposit, shell midden; Previously recorded as ineligible; does not possess qualities of significance and integrity	Ineligible
16JE10	Prehistoric scatter; Previously unassessed; does not possess qualities of significance and integrity	Ineligible
16JE38	Prehistoric deposit, shell midden; Previously recorded as eligible but no remaining intact strata were located; does not possess qualities of significance and integrity	Ineligible
16JE99	Prehistoric scatter, shell midden, historic scatter; Previously unassessed; does not possess qualities of significance and integrity	Ineligible

Table 4.24-1 CEMVN NRHP-Eligibility Determinations		
Designation	Site Description	CEMVN NRHP-Eligibility Determination
16PL190	Historic water control structure; Previously recorded as ineligible; does not possess qualities of significance and integrity	Ineligible

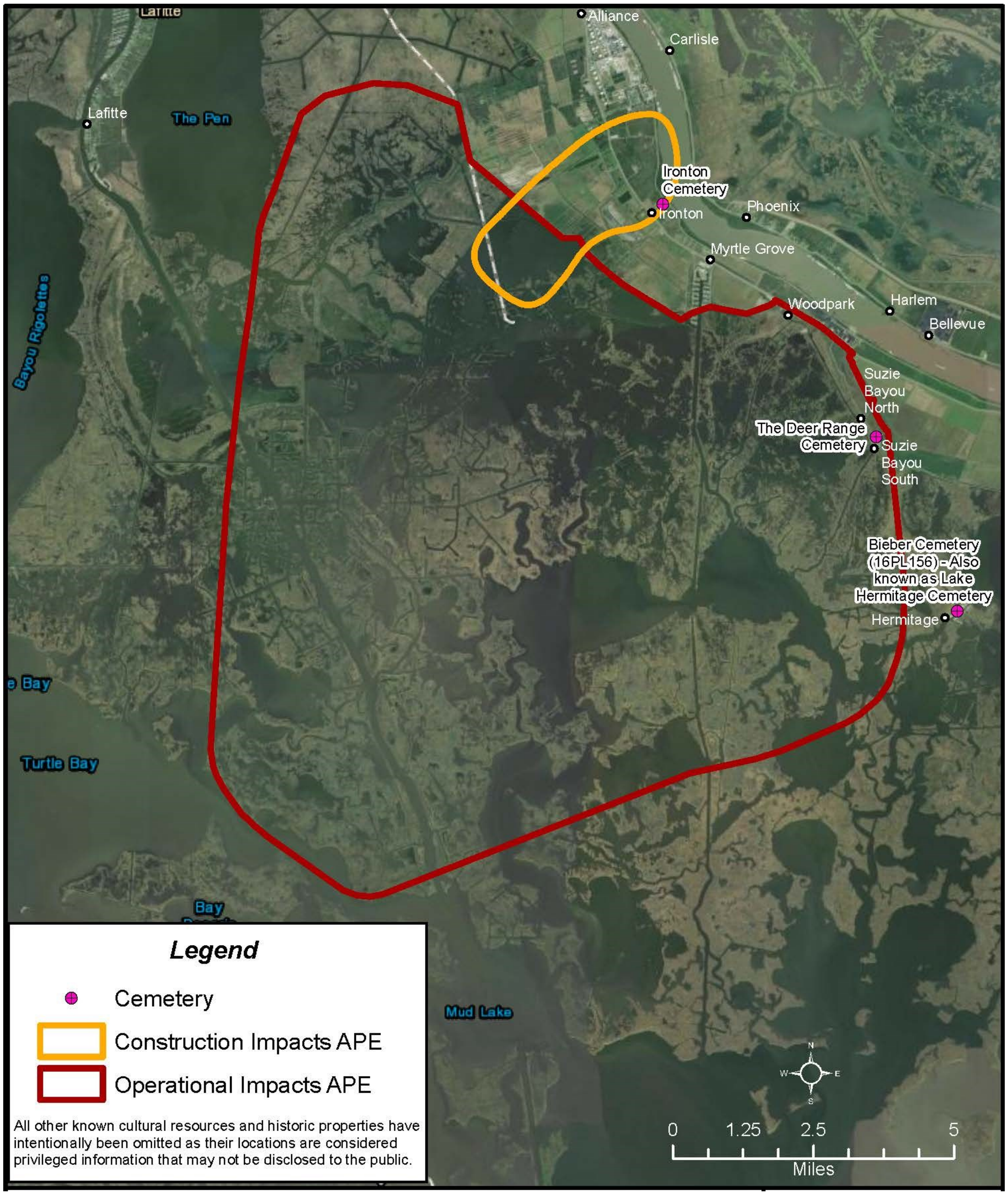


Figure 4.24-1. Deer Range, Bieber, and Ironton Cemeteries

Examples of potential direct impacts on cultural resources during operation would include sediment deposition (burial) and erosion resulting from changes in flow velocity, increased tidal flooding, and storm surge (see Chapter 4, Section 4.4.4 in Surface Water and Coastal Processes and Section 4.13.3.1 in Socioeconomics for more detail). Given the large size and submerged nature of much of the Operational Impacts APE, as well as the multiple other processes affecting these submerged areas (for example, subsidence, erosion, and channel dredging), CEMVN determined that it is currently not possible to fully separate the impacts on cultural resources caused by subsidence, erosion, and other processes unrelated to the Project from those that could be caused by the Project, particularly over the 50-year analysis period of the MBSD Project. Therefore, the intensity and duration of potential Project-induced impacts on sites identified in the basin are uncertain.

CEMVN and the consulting parties have developed a draft PA for the MBSD Project. As proposed, the PA includes an alternative mitigation plan, agreed to by the Applicant, to resolve adverse effects within the Operational Impacts APE. It also includes the agreed upon plan for monitoring Project impacts on cultural resources within the Operational Impacts APE as well as an unanticipated discoveries plan. See Appendix K, Draft Programmatic Agreement.

4.24.3.3 Other Alternatives

4.24.3.3.1 50,000 cfs Alternative

Operational impacts of the 50,000 cfs Alternative would be similar to the Applicant's Preferred Alternative. Examples of potential direct impacts on cultural resources during operation would include sediment deposition (burial) and erosion resulting from changes in flow velocity. As with the Applicant's Preferred Alternative, the intensity and duration of potential Project-induced impacts are uncertain.

4.24.3.3.2 150,000 cfs Alternative

Operational impacts of the 150,000 cfs Alternative would be similar to the Applicant's Preferred Alternative. Examples of potential direct impacts on cultural resources during operation would include sediment deposition (burial) and erosion resulting from changes in flow velocity. As with the Applicant's Preferred Alternative, the intensity and duration of potential Project-induced impacts are uncertain.

4.24.3.3.3 Terrace Alternatives

The three terrace alternatives would have operational impacts similar to those anticipated under the corresponding flow capacity alternatives without terraces. The presence of terraces in the immediate outfall area in the basin associated with the three terrace alternatives would cause negligible additional impacts on cultural resources.

4.24.4 Summary of Potential Impacts

Table 4.24-2 summarizes the potential impacts on wetlands for each alternative. Details are provided in Sections 4.24.1 through 4.24.3 above.

Table 4.24-2
Summary of Potential Impacts on Cultural Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
No Action Alternative	
Construction Impacts	• No impacts on cultural resources from construction of the proposed Project would occur. • Any future projects would be required to comply with applicable permitting and laws.
Operational Impacts	• Existing trends, including subsidence and erosion, in the Operational Impacts APE would continue.
75,000 cfs Alternative (Applicant's Preferred Alternative)	
Construction Impacts	• CEMVN determined, and SHPO agreed, that the portion of 16PL107 in the construction footprint within the Construction Impacts APE is eligible for the NRHP under Criteria A and D. CEMVN developed a PA in consultation with SHPO, ACHP, federally-recognized Tribal Nations, and the Applicant to address adverse effects. • The Applicant, in consultation with CEMVN, SHPO, and consulting parties, will develop a treatment plan to mitigate adverse effects to the portion of 16PL107 in the construction footprint of the proposed Project. • The PA includes an unanticipated discoveries plan for cultural resources or historic properties encountered during construction activities.
Operational Impacts	• CEMVN determined there will be an adverse effect to five archaeological sites eligible for the NRHP as a result of the undertaking. The Applicant agreed to an Alternative Mitigation Plan to resolve adverse effects. • It is not possible to separate the impacts on cultural resources caused by subsidence, erosion and other processes unrelated to the Project from those caused by the Project, particularly over the 50-year analysis period. • The PA includes monitoring to address future unanticipated effects and discoveries as a result of the Project.
50,000 cfs Alternative	
Construction Impacts	• CEMVN determined, and SHPO agreed, that the portion of 16PL107 in the construction footprint within the Construction Impacts APE is eligible for the NRHP under Criteria A and D. CEMVN developed a PA in consultation with SHPO, ACHP, federally-recognized Tribal Nations, and the Applicant to address adverse effects. • The Applicant, in consultation with CEMVN, SHPO, and consulting parties, will develop a treatment plan to mitigate adverse effects to the portion of 16PL107 in the construction footprint of the proposed Project. • The PA includes an unanticipated discoveries plan for cultural resources or historic properties encountered during construction activities.
Operational Impacts	• CEMVN determined there will be an adverse effect to five archaeological sites eligible for the NRHP as a result of the undertaking. The Applicant agreed to an Alternative Mitigation Plan to resolve adverse effects. • It is not possible to separate the impacts on cultural resources caused by subsidence, erosion and other processes unrelated to the Project from those caused by the Project, particularly over the 50-year analysis period. • The PA includes monitoring to address future unanticipated effects and discoveries as a result of the Project.

Table 4.24-2
Summary of Potential Impacts on Cultural Resources from Each Alternative

Impact Type	Impact Description (as Compared to No Action Alternative unless Otherwise Stated)
150,000 cfs Alternative	
Construction Impacts	• CEMVN determined, and SHPO agreed, that the portion of 16PL107 in the construction footprint within the Construction Impacts APE is eligible for the NRHP under Criteria A and D. CEMVN developed a PA in consultation with SHPO, ACHP, federally-recognized Tribal Nations, and the Applicant to address adverse effects. • The Applicant, in consultation with CEMVN, SHPO, and consulting parties, will develop a treatment plan to mitigate adverse effects to the portion of 16PL107 in the construction footprint of the proposed Project. • The PA includes an unanticipated discoveries plan for cultural resources or historic properties encountered during construction activities.
Operational Impacts	• CEMVN determined there will be an adverse effect to five archaeological sites eligible for the NRHP as a result of the undertaking. The Applicant agreed to an Alternative Mitigation Plan to resolve adverse effects. • It is not possible to separate the impacts on cultural resources caused by subsidence, erosion and other processes unrelated to the Project from those caused by the Project, particularly over the 50-year analysis period. • The PA includes monitoring to address future unanticipated effects and discoveries as a result of the Project.
Terrace Alternatives	
Construction Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same construction impacts on cultural resources as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs alternatives listed above. • No additional incremental impacts on cultural resources from the construction of terraces are expected.
Operational Impacts	• As compared to the No Action Alternative, all three terrace alternatives would have the same operational impacts on cultural resources as those of the 75,000 cfs, 50,000 cfs, and 150,000 cfs alternatives listed above. • CEMVN determined there will be an adverse effect to five archaeological sites eligible for the NRHP as a result of the undertaking. The Applicant agreed to an Alternative Mitigation Plan to resolve adverse effects. • It is not possible to separate the impacts on cultural resources caused by subsidence, erosion, and other processes unrelated to the Project from those caused by the Project, particularly over the 50-year analysis period. • The PA includes monitoring to address future unanticipated effects and discoveries as a result of the Project.

4.25 CUMULATIVE IMPACTS

NEPA requires the lead federal agency to consider the potential cumulative impacts of proposals under its review. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

With respect to past actions, CEQ guidance (2005) allows agencies to adopt a broad, aggregated approach without "delving into the historical details of individual past actions," an approach we have taken here. Chapter 3 Affected Environment characterizes the natural and human environment of the Project area and the past and present actions and trends (for example, the channelization of the Mississippi River and the impacts of the DWH oil spill) that shaped it. Chapter 4, Sections 4.2 through 4.24 project how past, present, and future actions and trends would continue to impact each resource 50 years into the future (2020 through 2070). In those sections, past, present, and ongoing actions and trends are factored into the No Action Alternative, which served as the baseline conditions against which the impacts of the MBSD Project action alternatives were assessed. For example, the Delft3D Basinwide Model discussed throughout Sections 4.2 through 4.24 includes freshwater input from the Davis Pond Freshwater Diversion and the effects of ongoing sea-level rise.

The cumulative impacts analysis provided below builds upon the discussions in Chapters 3 and 4 by assessing potential impacts of additional projects that may contribute to impacts on Project area resources. The analysis focuses on the overall cumulative impacts of the MBSD Project action alternatives when added to the impacts of relevant past, present, and reasonably foreseeable future projects that could continue to impact the same resources in the same approximate spatial extent and timeframe.

4.25.1 Methodology for Assessing Cumulative Impacts

The four-step methodology for conducting this analysis is described below.

4.25.1.1 Step 1: Identify Resources Affected

Only those resources expected to be directly or indirectly impacted by the MBSD Project action alternatives based on evaluations in Sections 4.2 through 4.24 were analyzed for cumulative impacts. The following resources were only negligibly impacted by construction and/or operation of the MBSD Project action alternatives and therefore were not further analyzed in the cumulative impacts analysis for either construction or operational impacts, or both.

- groundwater resources (negligibly impacted by both construction and operation of the MBSD Project action alternatives; see Section 4.3 Groundwater Resources);
- air quality (negligibly impacted by operation of the MBSD Project action alternatives; see Section 4.7 Air Quality);
- sediment quality and atrazine (negligibly impacted by both construction and operation of the MBSD Project action alternatives; see Section 4.5 Surface Water and Sediment Quality);
- stormwater management (negligibly impacted by construction of the MBSD Project action alternatives; see Section 4.4.5 in Surface Water and Coastal Processes);

- risk reduction levees (negligibly impacted by construction of the MBSD Project action alternatives; see Section 4.20.4.1 in Public Health and Safety, Including Flood and Storm Hazard Risk Reduction);

- maintenance dredging (negligibly impacted by construction of the MBSD Project action alternatives; see Section 4.21 Navigation);

- commercial navigation traffic in the Barataria Basin (negligibly impacted by construction and operation of the MBSD Project action alternatives; see Section 4.21 Navigation);

- rail transportation (negligibly impacted by both construction and operation of the MBSD Project action alternatives; see Section 4.22 Land-Based Transportation);

- road-based traffic during operations (negligibly impacted by operation of the MBSD Project action alternatives; see Section 4.22.2 in Land-Based Transportation); and

- HTRW (negligibly impacted by both construction and operation of the MBSD Project action alternatives; see Section 4.23 Hazardous, Toxic, and Radioactive Waste).

4.25.1.2 Step 2: Establish Spatial and Temporal Boundaries

Only projects or actions that contribute impacts on a resource within the same geographic area and timeframe as the MBSD Project action alternatives (overlapping in space and time) were included in the analysis. The spatial and temporal boundaries are described below.

4.25.1.2.1 Spatial Boundaries

A geographic area of impact (AOI) was defined and assessed for each resource in Sections 4.2 through 4.24. These AOIs were applied to the cumulative impacts analysis for each resource analyzed to identify which other projects within the same AOI as the MBSD Project action alternatives would potentially contribute to cumulative impacts. These other projects that would have direct or indirect impacts on a resource within the established AOI for that resource were included in the cumulative impacts analysis. In accordance with USACE NEPA regulations, the scope of the analysis was expanded beyond the limits of the USACE's regulatory jurisdiction (waters of the U.S.) to address upland portions of the larger Project area (33 CFR Part 325, Appendix B, paragraph 7b).

4.25.1.2.2 Temporal Boundaries

The next step involved determining whether each of the other past, present, and reasonably foreseeable projects within the same AOI as the MBSD Project action alternatives would also have impacts during the same construction and operations timeframes as the MBSD Project action alternatives. The assessment determined what past actions to analyze as part of the environmental baseline. CEQ (2005) issued a memorandum entitled "Guidance on Consideration of Past Actions in Cumulative Effects Analysis" that states, "Agencies are not required to list or analyze effects of individual past actions—unless such information is necessary to describe cumulative effects of all past actions combined. Generally, agencies can conduct adequate effects analysis by focusing on current aggregate effects of past actions without delving into the historical details of individual past actions." The temporal boundaries established for the assessment of cumulative impacts of the MBSD Project action alternatives were years 2022 through 2026 for construction with an operational start time in year 2027.

4.25.1.3 Step 3: Identify the Projects and Actions to be Considered

In this step, the past, present, and reasonably foreseeable future actions to be included in the cumulative impacts analysis were determined. These projects and actions are detailed below.

4.25.1.3.1 Past, Present, and Ongoing Actions and Trends

In Sections 4.2 through 4.24, key past, present, and future ongoing actions and trends were quantitatively or qualitatively factored into the projections for each Project area resource under each alternative, including the No Action Alternative, and their contribution to Project area resources is reflected in the data presented therein. Actions and trends that continue to impact the Project area resources include, but are not limited to, the following (see the No Action Alternative discussion in Sections 4.2 through 4.24 for further details):

- Levees and channelization of the Mississippi River: these actions have caused major, adverse, permanent impacts on the Barataria Basin by altering natural sediment transport from the river into the basin, removing the source of sediment and fresh water that built and maintained wetlands and marshes. As a result, the basin is suffering from significant coastal habitat loss (USGS 2015; CPRA 2012). Under the No Action Alternative, this reduced input of sediment due to Mississippi River Levees would continue to cause major wetland loss in the Barataria Basin (see Section 4.6 Wetland Resources and Waters of the U.S.);

- Subsidence and sea-level rise: these ongoing trends continue to be a primary cause of major, adverse, permanent impacts on Barataria Basin wetland and land loss by increasing flooding frequency and duration, marsh vegetation break-up, and erosion (BTNEP 2010; USGS 2016). Subsidence and sea-level rise were factored into the baseline conditions and Project alternatives over the 50-year period of analysis for all resources in Sections 4.2 through 4.24. Further details about sea-level rise scenarios and specific subsidence and sea-level rates are provided in Section 4.1.3.2 Sea-Level Rise;

- Storm and hurricane events: these ongoing major, adverse events will continue to cause loss of life, major economic damages, and outmigration of residents and businesses. They also convert wetlands to open water from erosion when large storm surges bring salt water inland (Day et al. 2007). Results of ADCIRC/SWAN modeling of storm surge and wave height elevation simulations over the 50-year analysis period, which included past and present projects in the Delft3D Basinwide Model (see Appendix E), are provided in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction;

- Canals dredged in the Barataria Basin for navigation and oil and gas development: canals and channels in the basin provide a conduit for saltwater intrusion and obstruct the natural hydrology and sheet flow of water across and through marsh, causing marsh loss and impoundment (Boesch et al. 1994 from Turner and Cahoon 1989, Swenson and Turner 1987). Canals and channels in the basin were factored into the baseline conditions and Project alternatives for 50-year hydrologic, vegetation, and water quality projections in Sections 4.2 Geology and Soils, 4.4 Surface Water and Coastal Processes, 4.5 Surface Water and Sediment Quality, 4.6 Wetland Resources and Waters of the U.S., and other resource sections through the Delft3D Basinwide Model;

- 2010 DWH oil spill: this major disaster was the direct cause of a minimum of 850 miles of shoreline oiling in coastal Louisiana, with the most widespread oiling occurring in Barataria Bay salt marshes (see Table 4.6-2 in DWH NRDA Trustees 2016a). The consequences of the spill included major adverse impacts on aquatic resources, including marsh vegetation, intertidal biota (for example, fiddler crabs), and shoreline erosion (Zengel et al. 2015). This catastrophic event is the basis of the purpose and need of the proposed MBSD Project which is to help restore habitat and ecosystem services injured by the DWH oil spill. The impacts of the DWH oil spill are captured in the baseline conditions of the Project area presented in Chapter 3 and factored into the MBSD No Action and action alternatives in Sections 4.2 through 4.24;

- Shoreline and marsh restoration projects: the Delft3D Basinwide Model incorporates past or recently completed restoration projects into the baseline conditions of Project area topography, bed elevations, hydrology, water quality, and wetland conditions in Chapter 4. See Appendix E for a list of all restoration projects included in the baseline conditions of the Delft3D Basinwide Model;

- Rivers and diversions: within the Delft3D Basinwide Model, numerous rivers are applied at the model boundary. The rivers carry fresh water, sediments, and nutrients into the model domain. Additionally, the model incorporates the impacts of the following natural and man-made diversions that allow Mississippi River water to leave: the Davis Pond Freshwater Diversion (see more information about this diversion below), the Bonnet Carré Spillway, the

Caernarvon Freshwater Diversion, Mardi Gras Pass, the West Pointe A La Hache Siphon, and various passes in the birdfoot delta (see Appendix E for more details). Ongoing operations and influences of rivers and diversions were incorporated into the Delft3D Basinwide Model baseline conditions and 50-year projections for the MBSD No Action and action alternatives for hydrology, hydrodynamics, water quality, vegetation/wetlands, and other resources in the Project area. The additive impacts of the MBSD Project action alternatives in combination with these existing freshwater influences are discussed as appropriate in Sections 4.2 through 4.24; and

- Davis Pond Freshwater Diversion: as described above, ongoing operations and influences of this diversion were incorporated into the Delft3D Basinwide Model baseline conditions and 50-year projections for the MBSD No Action and action alternatives This diversion operates at a minimum of 1,000 cfs flow with the capacity to divert up to 10,650 cfs of water from the Mississippi River at RM 118 AHP (approximately 15 miles upriver from New Orleans). The diversion introduces fresh water, sediments, and nutrients into the marshes of the northern Barataria Basin (see Figure 4.25.1-1) (USACE 2018h, CPRA 2016a).

4.25.1.3.2 Reasonably Foreseeable Future Projects

The determination of whether a potential future action is reasonably foreseeable was based on the stage of development that a potential action had reached at the time the Draft EIS was being prepared. Courts have generally accepted the idea that "reasonably foreseeable" projects include those that are proposed rather than contemplated, and that reasonably foreseeable projects should not be speculative or remote (Weinberger v. Catholic Action of Hawaii, 454 US 139, 70 E.Ed.2d 298, 1981; Kleppe v. Sierra Club, 427 US 390, 1976). Projects that would require a Department of the Army permit application, including but not limited to projects proposed for the Project area in CPRA's 2017 Coastal Master Plan, were considered reasonably foreseeable if a permit application had been submitted to the USACE by May 2020. A USACE project was considered reasonably foreseeable if it was funded for engineering and design prior to issuance of the Draft EIS.

Reasonably foreseeable projects not under the USACE's jurisdiction were identified through publicly available information such as CPRA's Annual Plan 3-year expenditure projections (CPRA 2020c), press releases, parish websites, the Louisiana Economic Development website, scoping, and through CEMVN, Federal Coordination Team (FCT), LA TIG, and CPRA communications with local, state, and federal agencies. The LDEQ Electronic Document Management System and the LDNR SONRIS database were searched for active and pending permits to help identify planned projects in the Project area. In searching parish websites, a comprehensive search of press releases was conducted, as well as an expedited review of archived news releases focused on identifying completed projects or actions that have continuing or additive impacts in the Project area. The Federal Energy Regulatory Commission website includes information on approved and pending gas pipeline and storage projects under its regulatory review. This information was used to identify planned energy projects in the Project area.

Such projects were deemed reasonably foreseeable if the action required federal and/or state approval and such agencies had approved the action (permit issuance); if the project sponsors provided assurance that the action will proceed; if contracting had been initiated for construction; if state or local planning agencies indicated that grant of authority for the action was imminent; or where historic data demonstrated an established trend that may be forecast into the future as reasonably certain to occur. These indicators demonstrated that the included projects were more than speculation or a mere possibility.

Based on this screening, 50 reasonably foreseeable projects were identified for the cumulative impacts assessment. They include the following types of projects:

- restoration;
- hurricane and flood risk reduction;
- major industrial developments;
- recreation;
- navigation; and
- municipal.

Table 4.25.1-1 lists each project considered in the cumulative impacts analysis, its distance from the MBSD Project action alternatives, and the resources that each would potentially impact. Each project listed includes a mapped number that corresponds to Figures 4.25.1-1 and 4.25.1-2 showing the geographic location of the project in relation to the MBSD Project action alternatives. Some of the reasonably foreseeable projects assessed were incorporated into the Delft3D Basinwide Model to simulate cumulative impacts on wetlands, land accretion, water quality, and hydrologic resources, as indicated in the table. Only those projects that would impact areas large enough to be captured in the Delft3D Basinwide Model resolution were simulated in the model.

One of the reasonably foreseeable projects included in the analysis is the Tallgrass Energy Plaquemines Liquid Terminal[130] (Tallgrass PLT), which may be built along the Mississippi River adjacent to and upstream of the MBSD Project action

[130] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR Coastal Use Permit [CUP] number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the Memorandum of Understanding (MOU) (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

alternatives. CPRA and the facility's sponsors—the Plaquemines Port and Harbor Terminal District and Tallgrass Energy, LP Plaquemines Liquid Terminal (PPHTD/PLT) —signed a Memorandum of Understanding (MOU) dated April 24, 2019 pertaining to the facility's application for a CUP (number P20180379). According to the MOU, as part of CPRA's consistency determination process for the CUP application, the sponsors have agreed to conduct sediment transport modeling to determine the potential impacts, if any, the construction and operation of the facility may have on the construction and operation of the MBSD Project action alternatives. The results of the study were not available prior to issuance of the Draft EIS. However, according to the MOU, the results of the sediment transport modeling study may result in PPHTD/PLT and CPRA mutually agreeing to certain terms and conditions, such as operational restrictions or other mitigation measures, for the construction, operation, and administration of the Tallgrass PLT to ensure that the project does not have adverse impacts on the design, construction, and operation of the MBSD Project action alternatives. Measures may include mitigation of sediment loss due to the physical presence of the proposed Tallgrass PLT docking facilities and operational activities. Tallgrass PLT activities for which mitigation measures may be devised may include, but not be limited to, marine activities, docking and fleeting, loading and unloading vessels, and, if necessary, design and construction. See Section 4.25.4.4.4 Sediment Transport for the cumulative impact assessment of this facility on hydrology and hydrodynamics in the Mississippi River.

4.25.1.4 Step 4: Assess Potential Cumulative Impacts on Each Resource

Sections 4.25.2 through 4.25.24 include an assessment of cumulative impacts for each resource affected by the MBSD Project action alternatives. Depending on the resource or project, the analysis was quantitative, qualitative, or both using the best available data at the time of analysis. The Delft3D Basinwide Model was the primary quantitative tool but limited to certain impacted resources, including Geology and Soils (Section 4.25.2), Surface Water and Coastal Processes (Section 4.25.4), Surface Water and Sediment Quality (Section 4.25.5), and Wetland Resources and Waters of the U.S. (Section 4.25.6). Other resource sections drew from the quantitative data reported in these sections to aid in determining cumulative impacts. For example, the Aquatic Resources section drew on quantitative data from the Surface Water and Sediment Quality section to assess cumulative impacts on aquatic resources related to salinity tolerance. Quantitative assessments of reasonably foreseeable projects using the Delft3D Basinwide Model were also limited to certain projects depending on the project scale or the availability of detailed geographic project information. Table 4.25.1-1 lists each project in order from closest to farthest from the proposed MBSD diversion structure, and also notes whether each project was included in the Delft3D Basinwide Model simulation for cumulative impacts.

In the following sections, each resource section begins with a description of the AOI assessed for construction and operation, followed by a listing or description of the projects that would contribute to cumulative impacts within the identified AOI. The analysis is organized following the pattern below for each resource:

- Past, Present, and Reasonably Foreseeable Future Projects and Trends (X): This section assesses the No Action Alternative described in Sections 4.2 through 4.24 combined with all applicable reasonably foreseeable projects (excluding the MBSD Project action alternatives).
- Incremental Impacts of MBSD Project Action Alternatives (Y): This discussion summarizes the impacts on the resource from the MBSD Project action alternatives, as described in Sections 4.2 through 4.24.
- Cumulative Impacts of Past, Present, and Reasonably Foreseeable Future Projects and Trends combined with MBSD Project Action Alternatives: The remainder of each section combines the potential cumulative impacts of the past, present, and reasonably foreseeable projects (X) and the MBSD Project action alternatives (Y) on an affected resource (Z), where the effects may interact and be additive; more simply, X + Y = Z. The cumulative impacts determinations apply to all MBSD Project action alternatives unless otherwise stated.

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
1	NOV-NF-W-05a.1 – La Reussite to Myrtle Grove Project/USACE	Hurricane and Flood Risk Reduction	0.0 miles/ crosses MBSD diversion channel	Levee modifications that include the realignment of the existing drainage canal and construction of three new floodwalls, a drainage structure, and a 6.3-mile long levee spanning from La Reussite to Myrtle Grove in Plaquemines Parish. The project would redirect water flow to a nearby canal to accommodate additional water flow from expansion of the levee base.	Yes	2021 – 2026	Geology/Soils, Hydrology, Surface Water Quality, Air Quality, Noise (airborne), Terrestrial Wildlife and Vegetation, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Land Use, Aesthetics and Visual, Aquatic Resources, Marine Mammals, Land-based Transportation, Public Health and Safety

Table 4.25.1-1 Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis							
Map #[a]	**Project Name/ Proponent**	**Project Type**	**Closest Distance to Project Location**	**Description and Status**	**In Delft3D Basinwide Model Reasonably Foreseeable Simulation?**	**Estimated Timeframe of Construction**	**Resources Cumulatively Impacted**
2	Tallgrass Energy Plaquemines Liquid Terminal (PLT)/Plaquemines Port and Harbor Terminal District & Tallgrass Energy, LP[131]	Major Industrial	0.0 miles/ Adjacent to northern boundary	A 200-acre oil export terminal facility on the Mississippi River within Plaquemines Parish. Oil storage tanks, a dock, and rail offloading facility would be constructed. No dredging is required. A construction servitude easement would be established.	No	Unavailable	Geology/Soils, Hydrology, Surface Water Quality, Air Quality, Noise, Terrestrial Wildlife and Vegetation, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Land Use, Aesthetics and Visual, Land-based Transportation, Public Health and Safety

[131] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
3	Loading Dock on Mississippi River/Plaquemines Holdings, LLC	Major Industrial	0.3 mile north	A 22-foot x 70-foot loading dock, four barge dolphins, a raised road, and pipe rack with 12-inch pipeline that will serve an existing motor oil refining plant being placed back into service. A barge mounted crane will be used for all work beyond the low water reference plane, and a land-based crane will be utilized for all other work. Project implementation will require fill of 0.01 acre of non-vegetated water bottom for riprap around pilings which penetrate the revetment, temporary impacts on 0.39 acre of wetlands for work areas, and permanent impacts on 0.21 acre of wetlands for road and pipeline rights-of-way. The permit was issued on June 20, 2016.	No	Unavailable	Geology/Soils, Hydrology, Surface Water Quality, Air Quality, Noise, Terrestrial Wildlife and Vegetation, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Land Use, Aesthetics and Visual, Land-based Transportation, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

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4	Mid-Breton Sediment Diversion/CPRA	Restoration	0.4 mile east	Placement of a sediment diversion at Mississippi RM 68 AHP that will convey fresh water and sediment from the Mississippi River into marshes in Mid-Breton Sound Basin in the vicinity of White Ditch to build and maintain land.	Yes	2024 – 2026	Geology/Soils, Hydrology, Surface Water Quality, Noise, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Lands, Wetlands, Public Health and Safety, Navigation/Dredging
5	NOLA Oil Terminal/NOLA Oil Terminal, LLC	Major Industrial	1.5 mile south	A 5-million-barrel crude, heavy, and finished oil blending and storage facility located at mile marker 59 on the Mississippi River. Work would occur in the Mississippi River, batture, and levee.	No	2020 – 2025	Surface Water Quality, Noise (underwater), Terrestrial Wildlife and Vegetation, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Land-based Transportation, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
6	Gulf Coast Methanol Complex/IGP Methanol LLC	Major Industrial	2.4 miles south	Methanol manufacturing facility with 200,000-metric ton daily production capacity of feedstock natural gas to be supplied via ~13-mile-long lateral to Tennessee gas pipeline near Happy Jack, Louisiana. The multiphase project is expected to take 5–7 years to construct, with each phase staggered 12 months apart. Air permit received from LDEQ in 2018.	No	Unavailable	Surface Water Quality, Air Quality, Noise (underwater), Terrestrial Wildlife and Vegetation, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Health and Safety
7	NOV-NF-W-05a.2, 06a.1, 06a.2 Projects/USACE	Hurricane and Flood Risk Reduction	3.4 miles south	Levee modifications that include the incorporation of segments NFL Levees into the NOV system.	No	2020 – 2025	Terrestrial Wildlife and Vegetation, Aquatic Resources, Marine Mammals, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Land-based Transportation, Public Health and Safety

Table 4.25.1-1 Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis							
Map #[a]	**Project Name/ Proponent**	**Project Type**	**Closest Distance to Project Location**	**Description and Status**	**In Delft3D Basinwide Model Reasonably Foreseeable Simulation?**	**Estimated Timeframe of Construction**	**Resources Cumulatively Impacted**
8	Large-Scale Marsh Creation and Component E-Planning/CPRA	Restoration	4.1 miles south	Creation of approximately 8,070 acres of marsh in the Barataria Basin including placement at an elevation of 2.5 feet NAVD88 to create new wetland habitat, restore degraded marsh, and reduce wave erosion.	Yes	2021 – 2028	Geology/Soils, Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety
9	Delta LNG/Delta Express Pipeline/Venture Global	Major Industrial	4.2 miles south	Liquid Natural Gas (LNG) export terminal near Mississippi River mile 54. The terminal will include liquefaction trains, four 200,000-cubic meter LNG storage tanks, and approximately 3,100 feet of river frontage to accommodate three marine berths. Domestic natural gas will be delivered to the terminal via the 287-mile Delta Express Pipeline originating in Perryville, Louisiana.	No	2021 – 2024	Terrestrial Wildlife and Vegetation, Air Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Land-based Transportation

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
10	Plaquemines LNG/Gator Express Pipeline/Venture Global	Major Industrial	5.0 miles south	LNG export terminal and a pipeline system in Plaquemines Parish to supply domestic natural gas. The LNG terminal is being constructed on a 632-acre parcel and would have a production capacity of 20.0 million tons per annum. The pipeline system includes two new 42-inch-diameter pipeline laterals (totaling about 26.8 miles), two metering and regulation stations, six mainline valves, and appurtenant facilities.	No	2019 – 2023	Surface Water Quality, Terrestrial Wildlife and Vegetation, Air Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Land-based Transportation
11	Long-Distance Sediment Pipeline, Phase 2/Jefferson Parish	Restoration	5.2 miles	Create a pipeline access corridor and emergent marsh on the Barataria Landbridge using sediment dredged from the Mississippi River. Phase 2 will extend the existing Phase 1 corridor an additional 12.6 miles, stretching from the Barataria Waterway, west into Lafourche Parish, and commencing in the area of Clovelly Canal.	No	Unavailable	Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

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12	Lafitte Area Levee Repair/CPRA & Lafitte Area Independent Levee District	Hurricane and Flood Risk Reduction	6.6 miles	Repair damages to the existing levees in the Fisher Basin Area which was caused by heavy equipment and vehicles used on the levee for flood fighting activities during Hurricanes Ike and Gustav. This project will provide for a 4-inch lift on an approximately 5-mile stretch of levee.	No	Unavailable	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Health and Safety
13	Northeast Turtle Bay Marsh Creation and Critical Area Shoreline Protection/CPRA & NRCS	Restoration	9.1 miles	Create approximately 377 acres and nourish approximately 300 acres of marsh in Northeast Turtle Bay in Jefferson Parish using sediment dredged from Turtle Bay. Semi-contained and fully contained containment will be utilized. Approximately 2,870 feet of critical shoreline would be protected and two channel liners would be installed to prevent further enlargement of two primary water exchange points.	No	Unavailable	Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety

Table 4.25.1-1 Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis							
Map #[a]	**Project Name/ Proponent**	**Project Type**	**Closest Distance to Project Location**	**Description and Status**	**In Delft3D Basinwide Model Reasonably Foreseeable Simulation?**	**Estimated Timeframe of Construction**	**Resources Cumulatively Impacted**
14	Jean Lafitte Tidal Protection/CPRA/ Lafitte Area Independent Levee District	Hurricane and Flood Risk Reduction	9.3 miles	Flood protection improvements for the town of Jean Lafitte in Jefferson Parish including raising 15,840 linear feet of existing earthen levee and constructing approximately 7,600 linear feet of concrete, capped steel sheet pile floodwall, and flood gates.	No	2020 – 2021	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety
15	Rosethorne Tidal Protection/CPRA	Hurricane and Flood Risk Reduction	9.6 miles	Provide flood protection improvements for the community of Rosethorne in Jefferson Parish by constructing new earthen levees, approximately 8,010 linear feet of reinforced concrete floodwall, and flood gates.	No	2020 – 2021	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety
15	Rosethorne Wetland Assimilation Project/CPRA	Hydrologic Restoration	9.6 miles	Utilize secondary treated municipal effluent diverted from the Rosethorne treatment facility to restore and sustain coastal wetland habitats.	No	Unavailable	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety

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16	HSDRRS Mitigation - WBV/USACE	Restoration	9.9 miles	Suite of projects to provide mitigation for USACE impacts during construction of the WBV HSDRRS. Involves the restoration of approximately 1,540 acres of bottomland hardwood, marsh, and swamp in the Barataria Basin.	No	2020 – 2021	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Lands, Marine Mammals, Public Health and Safety
17	Grand Cheniere Ridge and Marsh Creation/CPRA/US FWS (CWPPRA)	Restoration	9.9 miles	Create approximately 500 acres of marsh in the open-water areas and nourish marsh along the eastern side of Bayou Grande Cheniere ridge in Plaquemines Parish using sediment from the Mississippi River, as well as create 12 acres of forested coastal ridge habitat.	No	Unavailable	Hydrology, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety
18	Northwest Turtle Bay Marsh Creation/CPRA & USFWS	Restoration	10.5 miles	Create approximately 423 acres and nourish approximately 337 acres of marsh using sediment dredged from Turtle Bay or Little Lake. Existing canal spoil banks, emergent marsh, and limited segments of containment dikes will be used to guide the distribution of the dredged material.	Yes	2018 – 2020	Geology/Soils, Hydrology, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety

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Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
19	Bayou Grande Cheniere Marsh & Ridge Restoration/CPRA & USFWS	Restoration	10.7 miles	Hydraulically dredge the Mississippi River and pipe the material for use in creating approximately 342 acres of marsh habitat in the open-water areas and nourish marsh along the eastern side of the Bayou Grande Cheniere ridge, as well as create 12 acres of forested coastal ridge habitat.	Yes	Unavailable	Geology/Soils, Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety
20	Grand Bayou Ridge and Marsh Restoration/CPRA & NOAA (CWPPRA)	Restoration	11.2 miles	Creation or nourishment of approximately 356 acres of marsh along Grand Bayou in Plaquemines Parish using sediment from the Mississippi River, and the construction of 25,000 linear feet of terraces (19 acres) in open-water areas west of Grand Bayou using in situ material. The construction of approximately 10,657 linear feet (13 acres) of forested ridges along the western bank of Grand Bayou using material from the bayou.	No	Unavailable	Hydrology, Wetlands, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
21	Barataria Bay Rim Marsh Creation and Stabilization/CPRA & NRCS	Restoration	11.8 miles	Create approximately 251 acres of marsh and nourish approximately 266 acres of marsh (517 acres total) with dredged material from Barataria Bay.	Yes	Unavailable	Geology/Soils, Hydrology, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety
22	Braithwaite Methanol Plant/CCI Port Nickel LLC	Major Industrial	13.0 miles	Methanol manufacturing facility with 5,000-metric ton daily production capacity (1.8 million tons per annum) of feedstock natural gas from an unspecified connection. The schedule for the construction is unknown. Air permit received from LDEQ in December 2019.	No	2020 – 2023	Air Quality, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism
23	Shoreline Protection at Jean Lafitte National Historical Park and Preserve/USFWS	Restoration	14.1 miles	Restoration and re-establishment of approximately 50 acres of SAV including a rock breakwater structure along the shorelines of Lake Cataouatche, Lake Salvador, and Bayou Bardeaux.	No	Unavailable	Hydrology, Surface Water Quality, Wetlands, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Lands, Marine Mammals, Public Health and Safety

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24	Pointe LNG/Pointe LNG[132]	Major Industrial	14.7 miles	LNG export facility on the east bank of the Mississippi River near mile marker 46 in Plaquemines Parish to supply domestic natural gas to foreign markets. The LNG terminal site covers an area of about 600 acres, with about 6,500 feet of river frontage. The terminal would occupy 195 acres of the site and upon completion would have a production capacity of 6.0 million tons per annum. Two pipeline laterals are to connect the terminal to gas supplies about 3.2 miles northwest and 3.4 miles southeast of the terminal site.	No	2022 – 2025	Air Quality, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism

[132] Since publication of the Draft EIS, FERC has removed the planned Pointe LNG project from the pre-filing process. This project is no longer moving forward.

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Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
25	Previously Authorized Mitigation-WBV/USACE	Restoration	18.3 miles	Mitigation for impacts during construction of the WBV Pre-Katrina (2005) Hurricane protection projects and involves the restoration of approximately 1,217 acres of swamp and bottomland hardwood habitats in the Barataria Basin.	No	2020	Hydrology, Surface Water Quality, Wetlands, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety
26	Bayou Segnette State Park Improvements/ CPRA	Recreational Use	19.1 miles	Infrastructure improvements in Bayou Segnette State Park in Jefferson Parish, including upgrades to an existing boating area to improve access, upgrades to a playground to comply with ADA requirements, and repairs to road and parking areas damaged by repeated flooding.	No	2020	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism
27	Bayou L'Ours Marsh Terracing/USFWS & Ducks Unlimited	Restoration	19.4 miles	Restore 1,254 acres of coastal marsh and 130 acres of sand dunes in southeast Louisiana through the construction of terraces. Using existing soil to create long, linear segments configured to reduce the effect of erosion and calm the waters to promote growth of aquatic vegetation.	Yes	Unavailable	Geology/Soils, Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety

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Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

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28	Queen Bess Island Restoration/CPRA	Restoration	22.8 miles	Restore colonial waterbird nesting habitat on Queen Bess Island in Jefferson Parish from its pre-project size of less than 5 acres of nesting habitat to approximately 36 acres using sediment from the Mississippi River.	No	2020	Hydrology, Surface Water Quality, Wetlands, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety
29	West Grand Terre Beach Nourishment and Stabilization/CPRA	Restoration	24.9 miles	Restore approximately 235 acres along 12,700 feet of beach and dune and up to 66 acres of back barrier marsh on West Grand Terre Island in Jefferson Parish including the construction of a rock revetment to protect the restored marsh.	Yes	Unavailable	Geology/Soils, Wetlands, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety

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30	Grand Isle State Park Improvements/ CPRA	Recreational Use	25.7 miles	Provide improved fishing and recreational use for Grand Isle State Park in Jefferson Parish and provide protection of coastal, nearshore marine habitats, and inland infrastructure. Project features include upgrading the existing fishing pier and extension of the rock jetties on the east shore and extend the north end of the park.	No	2020	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals
31	Expansion of Luling Plant/Bayer	Major Industrial	28.5 miles	Construction and expansion of existing Luling plant site by Bayer who acquired the project in April of 2019.	No	2020 – 2021	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism,

Table 4.25.1-1
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Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
32	Magnolia Ridge Levee Lift and Road/BOEM	Hurricane and Flood Risk Reduction	29.0 miles	Elevating approximately 11,800 linear feet of the Magnolia Ridge Levee in St. Charles Parish to 7.5 feet NAVD88 at all locations except existing pipeline crossings; installing a 12-foot wide parallel access road with 20-foot wide vehicle turnarounds at various intervals; canal shaping as required; and seeding, fertilizing and mulching. The project is a component of Upper Barataria Risk Reduction System.	No	2020	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Health and Safety
33	East Leeville Marsh Creation and Nourishment/ NOAA	Restoration	29.1 miles	Create approximately 358 acres and nourish 124 acres of saline marsh east of Leeville in Lafourche Parish using sediment dredged from Caminada Bay.	Yes	Unavailable	Geology/Soils, Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

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34	Grand Isle and Vicinity Breakwater/CPRA & USACE	Restoration	29.9 miles	Stabilize the western portion of beach and dune in Grand Isle in Jefferson Parish. The stabilization will consist of the construction of beach, dune, and segmented rock breakwaters.	No	2020	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety
35	Levee Improvements for Gheens Community/BOEM	Hurricane and Flood Risk Reduction	30.1 miles	Improve approximately 21,000 linear feet of existing levee along the north side of LA 654 in Gheens in Lafourche Parish to an elevation of 7.0 feet NAVD88. Modification of the levee footprint to provide greater stability.	No	2020	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Health and Safety
36	St. Charles West Bank Hurricane Protection Levee Initiative/ St. Charles Parish/ Lafourche Basin Levee District	Hurricane and Flood Risk Reduction	30.6 miles	A system of levees, drainage structures, and pump stations being constructed to provide flood protection to the communities of St. Charles Parish on the West Bank of the Mississippi River.	No	2019	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

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37	Caminada Headlands Back Barrier Marsh Creation Increment 2/CPRA & USEPA	Restoration	31.7 miles	Create and/or nourish 444 acres of back barrier intertidal marsh and create a platform upon which the beach and dune can migrate. This project will work synergistically with existing Caminada dune and back barrier marsh projects.	Yes	2020	Geology/Soils, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety
38	Caminada Headlands Back Barrier Marsh Creation/CPRA & USEPA	Restoration	35.9 miles	Create and nourish 385 acres of back barrier intertidal marsh behind 3.5 miles of Caminada Headland in Lafourche Parish using material dredged from the Gulf of Mexico. This project will work synergistically with existing Caminada Headland dune and back barrier marsh projects.	Yes	2020 – 2021	Geology/Soils, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety
39	Barataria Basin Ridge and Marsh Creation-Spanish Pass Increment/CPRA	Restoration	38.2 miles	Restore 120 acres of earthen ridge and approximately 1,134 acres of marsh along Spanish Pass in Plaquemines Parish by dredging sediment from the Mississippi River.	Yes	2020 – 2022	Geology/Soils, Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

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40	Kraemer Bayou Boeuf Levee Lift/CPRA	Hurricane and Flood Risk Reduction	38.9 miles	Elevate 33,000-foot ring levee surrounding community of Lac Des Allemands in Lafourche Parish by providing a levee lift.	No	2018	Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Health and Safety
41	Baton Rouge to Gulf Channel Deepening/USACE	Navigation	42.4 miles	Deepen the Mississippi River Ship Channel from RM 13.4 AHP to RM 22 BHP and the 12 regularly maintained crossings located within the Port of South Louisiana and the Port of Baton Rouge (these 12 crossings are located at bends in the river upriver from New Orleans Harbor) from 45 to 50 feet for deep-draft navigation. It is currently authorized to 55 feet.	No	2020 – 2021	Hydrology, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Navigation/Dredging
42	Spanish Pass Ridge and Marsh Restoration/CPRA	Restoration	44.0 miles	Restore a historic ridge backed by a 500-foot-wide marsh platform using dredged material removed through the routine operation and maintenance dredging of the USACE Authorized Navigation Project.	Yes	2020 – 2022	Geology/Soils, Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Marine Mammals, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
43	Pass A Loutre Crevasses NRDA/CPRA	Recreational Use and Restoration	59.0 miles	Construction of five crevasses in natural spoil banks along passes within the Pass A Loutre WMA to provide recreational hunters, fishermen, and non-consumptive users access to wetlands that are currently inaccessible by boat. The crevasses would also divert sediment-laden river water into shallow open ponds, enhancing habitat for wildlife and fisheries.	No	2020 – 2021	Hydrology, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Lands, Wetlands
44	Pass A Loutre Campground NRDA/CPRA	Recreational Use	59.3 miles	Improvements at five existing campgrounds in the Pass A Loutre WMA to enhance the experience of campground users and reduce ongoing erosion. Project features include new picnic tables, fire pit/barbeque areas, and docks at all campgrounds; bulkhead installation at two campgrounds; and dredged material placement at three other campgrounds to elevate the facilities above expected storm surge inundation elevations.	No	2020 – 2021	Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Lands

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
45	South Pass Bird Island Enhancement/ CPRA	Restoration	61.2 miles	Restoration of South Pass Bird Island in Plaquemines Parish.	No	Unavailable	Hydrology, Surface Water Quality, Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Wetlands, Public Health and Safety
46	Pumping Capacity Improvements Phase I/ LDEQ/CPRA & Fresh Water District	Municipal	67.5 miles	Construction of a pump station on the Mississippi River at Donaldsonville in Ascension Parish with a minimum pumping capacity of 1,000 cfs alongside the existing 500-cfs pump station, thereby tripling the capacity for fresh water entering Bayou Lafourche to combat saltwater intrusion and provide fresh drinking water to over 300,000 residents in Assumption, Ascension, Lafourche, and Terrebonne Parishes.	No	Unavailable	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
N/A	New Orleans to Venice Mitigation – Plaquemines Non-Federal/USACE	Restoration	Not determined	This suite of projects provides mitigation for USACE impacts incurred during construction of the NOV Plaquemines Non-Federal Levee protection projects, and involves the restoration of approximately 230 acres of bottomland hardwood, marsh, and swamp in the Barataria Basin.	No	2021 – unavailable	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety
N/A	New Orleans to Venice Mitigation- Federal/USACE	Restoration	Not determined	This suite of projects provides mitigation for USACE impacts incurred during construction of the NOV Plaquemines Federal Levee protection projects, and involves the restoration of approximately 303 acres of bottomland hardwood, marsh, and swamp in the Barataria Basin.	No	2021 – unavailable	Aquatic Resources, Threatened and Endangered Species, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Marine Mammals, Public Health and Safety

Table 4.25.1-1
Reasonably Foreseeable Future Projects Considered in the Cumulative Impacts Analysis

Map #[a]	Project Name/ Proponent	Project Type	Closest Distance to Project Location	Description and Status	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?	Estimated Timeframe of Construction	Resources Cumulatively Impacted
N/A	Mississippi River Beneficial Use of Dredged Material Program/CEMVN	Navigation/ Restoration	varies	Since 1976, CEMVN has used dredged material from the maintenance of federal navigation channels to create or restore coastal habitat in Louisiana. Any beneficial use of dredged material beyond the Federal Standard limitations requires statutory authority and funding from other programs. From 1996-2018, 9,656 acres of material dredged to maintain Southwest Pass in the birdfoot delta created 9,656 acres of wetlands and other restoration projects.	No	Varies	Hydrology, Socioeconomics, Commercial Fisheries, Environmental Justice, Recreation and Tourism, Public Lands, Wetlands, Public Health and Safety

[a] Projects ordered by distance from the MBSD diversion structure.

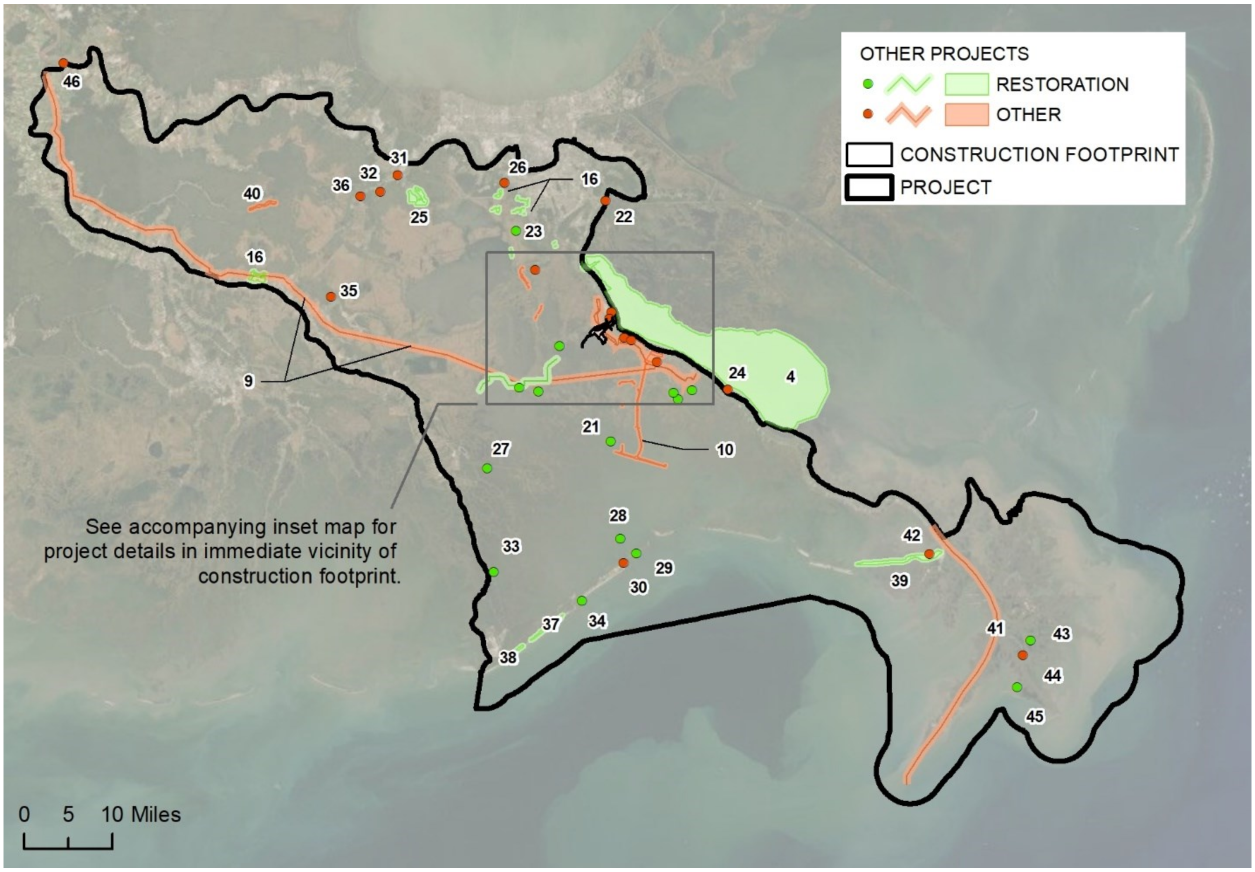


Figure 4.25.1-1. Map of Projects with Potential Cumulative Impacts.

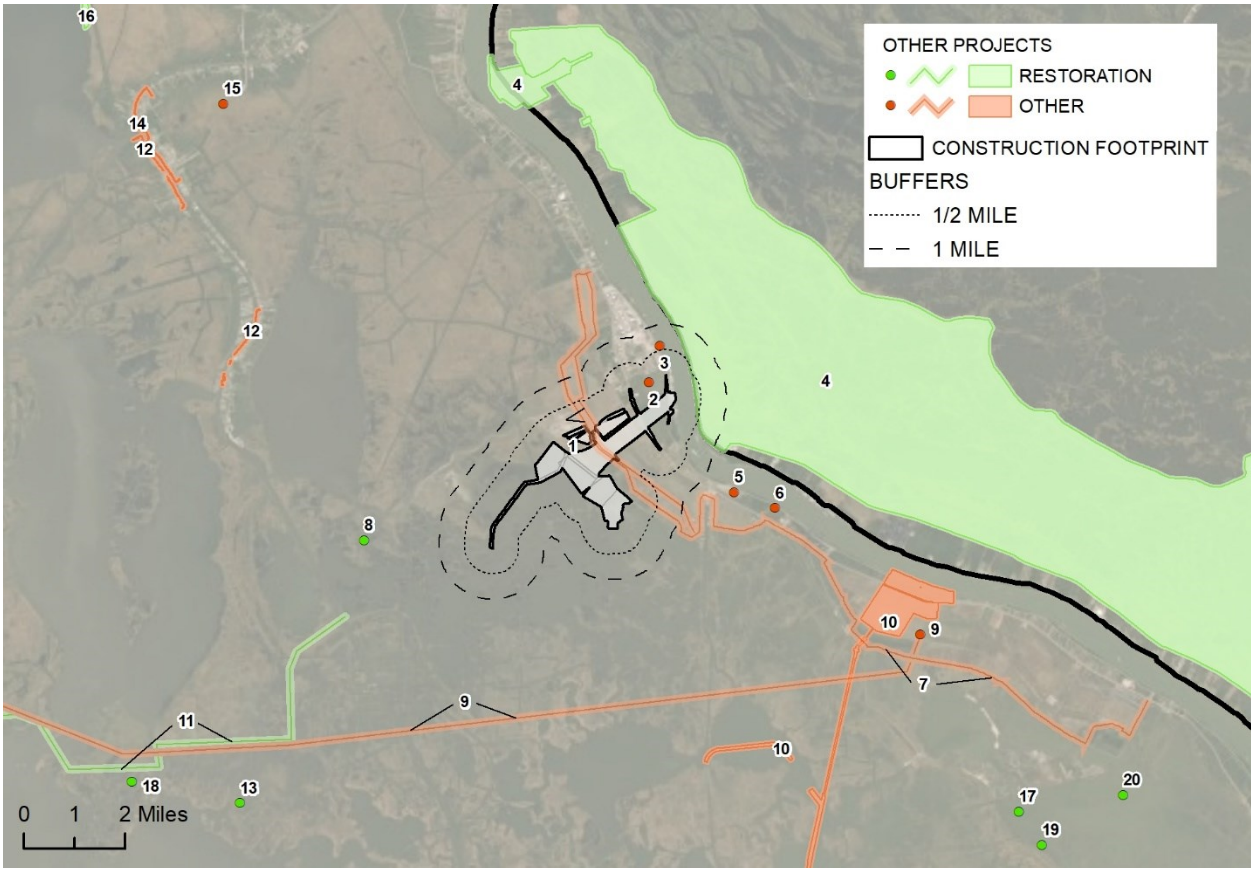


Figure 4.25.1-2. Inset Map of Projects with Potential Cumulative Impacts.

4.25.2 Geology and Soils

4.25.2.1 Geographic and Temporal Extent of Analysis

The AOI associated with geology and soils impacted by construction of the MBSD Project action alternatives during the 5-year construction period is limited to the areas within the Project construction footprint, as well as adjacent areas that may also be affected during construction within a one-mile buffer of the construction footprint.

The AOI associated with geology and soils impacted by operation of the MBSD Project action alternatives during the 50-year analysis period includes the majority of the Barataria Basin and the Mississippi River birdfoot delta, where the extent of geology and soils would be impacted by the diversion of sediment and water from the Mississippi River to the basin (see Section 4.2 Geology and Soils).

4.25.2.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Key past or present projects and trends with ongoing potential to impact geology and soils in the Barataria Basin and the birdfoot delta include substantial development by the oil and gas industry as well as other anthropogenic modifications to the geology of the area for navigation and flood protection. These activities have occurred against a backdrop of wide-scale, multi-decadal land and wetland loss due to subsidence, sea-level rise, saltwater intrusions, and storm events. Multiple wetland and barrier island restoration projects located within the Project area have been implemented in past decades to combat these losses (see Section 4.25.1). These trends and projects collectively contribute to the characterization of the Project area as described in Chapter 3, Section 3.2 Geology and Soils; their contribution to geology and soils in the Project area is reflected in the data presented therein. As such, the impact on geology and soils from past or recently completed projects is captured in the No Action Alternative analysis in Section 4.2 Geology and Soils.

The reasonably foreseeable projects with the potential to contribute to cumulative impacts on geology and soils are shown in Table 4.25.2-1.

Table 4.25.2-1
Reasonably Foreseeable Projects with Cumulative Impacts on Geology and Soils concurrent with MBSD Project Construction and Operations

Project Name (Mapped # in Figure 4.25.1-1)	Construction Overlap	Operations Overlap	Cumulatively Impacted Area	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?
Tallgrass PLT (2)[133]	X		Forced Drainage Area between Levees near Construction Footprint	No
Loading Dock on Mississippi River (3)	X		Forced Drainage Area between Levees near Construction Footprint	No
NOV-NF-W-05a.1 Project (1)	X		Forced Drainage Area between Levees near Construction Footprint	Yes
Large-Scale Marsh Creation and Component E- Planning (8)		X	Barataria Basin	Yes
Plaquemines LNG/Gator Express Pipeline (10)		X	Barataria Basin	No
Mid-Breton Sediment Diversion (4)		X	Birdfoot delta	Yes
Barataria Basin Ridge and Marsh Creation- Spanish Pass Increment (39)		X	Barataria Basin and Birdfoot delta	Yes
Spanish Pass Ridge and Marsh Restoration (42)		X	Birdfoot delta	Yes
South Pass Bird Island Enhancement (45)		X	Birdfoot delta	No

[133] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

Table 4.25.2-1
Reasonably Foreseeable Projects with Cumulative Impacts on Geology and Soils concurrent with MBSD Project Construction and Operations

Project Name (Mapped # in Figure 4.25.1-1)	Construction Overlap	Operations Overlap	Cumulatively Impacted Area	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?
Pass A Loutre Crevasses (43)		X	Birdfoot delta	No
Mississippi River Beneficial Use of Dredged Material Program (not mapped)		X	Birdfoot delta	No
Long-Distance Sediment Pipeline, Phase 2 (11)		X	Barataria Basin	No
Northeast Turtle Bay Marsh Creation and Critical Area Shoreline Protection (13)		X	Barataria Basin	No
Grand Cheniere Ridge and Marsh Creation (17)		X	Barataria Basin	No
Northwest Turtle Bay Marsh Creation (18)		X	Barataria Basin	Yes
Bayou Grande Cheniere Marsh & Ridge Restoration (19)		X	Barataria Basin	Yes
Grand Bayou Ridge and Marsh Restoration (20)		X	Barataria Basin	No
Barataria Bay Rim Marsh Creation and Stabilization (21)		X	Barataria Basin	Yes
Shoreline Protection at Jean Lafitte National Historical Park and Preserve (23)		X	Barataria Basin	No
Previously Authorized Mitigation-WBV (25)		X	Barataria Basin	No
Bayou L'Ours Marsh Terracing (27)		X	Barataria Basin	Yes
Queen Bess Island Restoration (28)		X	Barataria Basin	No
East Leeville Marsh Creation and Nourishment (33)		X	Barataria Basin	Yes

4.25.2.3 Cumulative Impacts during Construction

4.25.2.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The past and present projects and trends that would continue to impact geology and soils in the AOI are described briefly in Section 4.25.2.2 above and captured in the analysis in Section 4.2 Geology and Soils. The additional impacts of the reasonably foreseeable projects are described here. The NOV-NF-W-05a.1 Project would involve constructing three new floodwalls and a 6.3-mile-long levee predominately on agricultural and open lands. The Tallgrass PLT project would involve the excavation of primarily agricultural and developed land to accommodate the terminal facility. The Loading Dock on the Mississippi River would involve the construction of a 70-foot loading dock and associated infrastructure along the waterfront of an existing industrial facility. Based on project permit application files available on LDNR's SONRIS database, construction activities for these projects would result in the conversion of an estimated 1,700 acres of prime farmland to other uses. Therefore, construction impacts on geology and soils from reasonably foreseeable projects are expected to be minor to moderate, adverse, short-term and permanent.

4.25.2.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on geology and soils from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.2 Geology and Soils.

4.25.2.3.3 Overall Cumulative Impacts

Cumulative impacts from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would be short-term and permanent, minor to moderate and adverse in the AOI. Clearing would remove protective vegetation cover and expose the soil to the impacts of wind and rain, which would increase the potential for soil erosion. Grading, spoil storage, and equipment traffic could compact soil, reducing porosity and increasing runoff potential. Soil impacts would be minimized by the implementation of best management practices documented in SWPPPs and SPCC Plans in accordance with Louisiana Title 33, Part IX 901 and 2707, and 40 CFR 112.

4.25.2.4 Cumulative Impacts during Operations

4.25.2.4.1 Geology, Topography, and Geomorphology

4.25.2.4.1.1 <u>Past, Present, and Reasonably Foreseeable Future Projects</u>

The past and present projects and trends that would continue to impact geology, topography, and geomorphology in the AOI over the 50-year analysis period are described briefly in Section 4.25.2.2 above and captured in the analysis in Section 4.2 Geology and Soils. The additional impacts of the reasonably foreseeable projects during operations are described here.

Most of the reasonably foreseeable projects included in the Delft3D Basinwide Model are restoration projects and are anticipated to contribute minor to major, permanent beneficial cumulative impacts on the geology, geomorphology and topography in the areas of newly created land, marsh protection, or stabilization resulting from each project. While marsh creation, land building, and sediment input associated with the Mid-Breton Sediment Diversion would occur outside of the MBSD AOI, the diversion of sediment resulting from this project could result in additional land loss in the birdfoot delta due to reduced riverine sediment inputs, which could contribute minor to moderate, permanent, adverse cumulative impacts on geology, geomorphology, and topography in that area.

The Delft3D Basinwide Modeling results presented in Table 4.25.2-2 quantify changes in retained sediment volume and land area that are expected due to implementation of the reasonably foreseeable projects. If the other reasonably foreseeable projects are completed without the MBSD Project action alternatives, the Delft3D Basinwide Model projects a peak net creation of 4,800 acres (7.5 square miles) of land in 2040 in the Project area as compared with the No Action Alternative, and declining thereafter as sea-level rise and subsidence increasingly counter the land-building impacts in the Barataria Basin and birdfoot delta (see Table 4.25.2-2). By 2070, the Delft3D Basinwide Model projects a net loss of 2,200 acres of land compared to the No Action Alternative in spite of these restoration projects. This loss would take place nearly entirely in the birdfoot delta and is projected because of the operation of the Mid-Breton Sediment Diversion, which would reduce the sediment input to the delta. The Mid-Breton Sediment Diversion is projected to result in substantial land building in Breton Sound (13,900 acres, peaking in 2060) but would have little impact in the Barataria Basin. The Delft3D Basinwide Model similarly projects an initial net gain that transitions into a net loss in the volume of sediment retained in the Project area due to foreseeable projects alone. This is generally attributable to the effect of the Mid-Breton Sediment Diversion in the birdfoot delta counterbalancing the beneficial impacts of other projects.

Table 4.25.2-2
Cumulative Net Changes in Retained Sediment Volume and Land Area[a]: Foreseeable Projects with and without MBSD Project (150K+ Terraces Alternative)

Year	Project Area Change in Sediment Volume (million cy) Relative to NAA	Project Area Total Land Area (ac) under NAA	Project Area Total Land Area (ac) under Alternative	Project Area Change in Land Area (ac) Relative to NAA	Difference in Land Area (ac and % Change Relative to NAA) – Barataria Basin Only		Difference in Land Area (ac and % Change Relative to NAA) – Birdfoot Delta Only	
Foreseeable Projects without MBSD Project Alternatives Alternative								
2030	40	342,000	344,000	2,600	3,000	1%	–100	0%
2040	17	276,000	280,000	4,400	4,000	2%	800	3%
2050	2	204,000	207,000	3,100	2,000	1%	800	4%
2060	–16	127,000	129,000	2,200	2,000	2%	200	2%
2070	–51	58,700	56,500	-2,240	0	0%	–2,200	–33%
Foreseeable Projects with MBSD 150,000 cfs + Terraces Alternative								
2030	107	342,000	353,000	11,600	14,000	5%	–2,500	–6%
2040	184	276,000	298,000	22,400	25,000	10%	–2,300	–9%
2050	293	204,000	236,000	32,100	33,000	18%	–1,200	–7%
2060	411	127,000	159,000	32,200	34,000	29%	–1,900	–18%
2070	520	58,700	86,100	27,400	29,400	56%	–2,000	–31%

[a] Modeled land areas and changes have been rounded to three significant digits. Land areas are considered accurate to within ±200 acres. That produces an estimated error of ±300 acres in the land change difference values and an average ±3 percent in percent land change values.
NAA is No Action Alternative

4.25.2.4.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on geology, topography, and geomorphology from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.2 Geology and Soils.

4.25.2.4.1.3 Overall Cumulative Impacts

Cumulative impacts from operation of the reasonably foreseeable future actions combined with operation of the MBSD Project action alternatives would likely be permanent, major, and beneficial on land building in the Barataria Basin and permanent, minor, and adverse for the first four decades of operation rising to permanent, moderate, and adverse by 2070 in the birdfoot delta. By 2070, the impacts of the Applicant's Preferred Alternative in the birdfoot delta appear relatively large because the impacts of sea-level rise and subsidence become predominant and even small changes in wetland acreage represent a large portion of what remains.

The Delft3D Basinwide Modeling results presented in Table 4.25.2-2 above compare model-projected changes in retained sediment volume and land area that are expected due to implementation of the reasonably foreseeable projects by themselves, and together with the MBSD Project 150,000 cfs + Terraces Alternative (this is the MBSD Project alternative with the maximum land-building benefits). Cumulative impacts from reasonably foreseeable projects combined with the 150,000 cfs + Terraces Alternative would result in increases in land building and sediment input with a total peak net increase of 32,100 acres in land by 2060 as compared to the No Action Alternative. Most of this increase would occur in the Barataria Basin, where implementation of the 150,000 cfs + Terraces Alternative combined with other reasonably foreseeable projects would result in a peak increase of 34,000 acres (see Table 4.25.2-2). This alternative would result in a larger magnitude of change as compared to the other five MBSD action alternatives; however, the Applicant's Preferred Alternative and other MBSD Project action alternatives would have the same overall impact determination as that of the 150,000 cfs + Terraces Alternative, which is permanent, major, and beneficial. The addition of the 150,000 cfs + Terraces Alternative to the other restoration projects would contribute substantial benefits in land gains in decades 2060 and 2070, indicating the major beneficial role that any of the MBSD Project action alternatives would have in creating and retaining land in spite of the increasing adverse influences of sea-level rise and subsidence in these latter decades.

Additional land building in the birdfoot delta may be expected to occur in the future from reasonably foreseeable projects not included in the Delft3D Basinwide Model simulation including marsh and ridge restoration projects and the beneficial use of dredged material occurring as part of CEMVN's maintenance dredging in the Mississippi River Passes. These projects were not included in the Delft3D Basinwide Model simulation due to unavailable data at the time of the model simulations. Additional benefits expected to result from implementation of these projects may counterbalance some of the land loss in the birdfoot delta projected to occur by 2070.

The cumulative impacts from reasonably foreseeable projects combined with the MBSD Project action alternatives on sediment volume retained in the Project area would mirror the projected trends in land loss and gain. The reasonably foreseeable projects combined with the MBSD Project action alternatives would contribute additional major, beneficial impacts on the volume of sediment retained in the basin as compared with reasonably foreseeable projects on their own.

4.25.2.4.2 Mineral Resources

4.25.2.4.2.1 Past, Present, and Reasonably Foreseeable Future Projects

The past and present projects and trends that would continue to impact mineral resources in the AOI over the 50-year analysis period are described briefly in Section 4.25.2.2 above and captured in the analysis in Section 4.2 Geology and Soils. The additional impacts of the reasonably foreseeable projects during operations are described here.

Reasonably foreseeable restoration projects that pump or place sediment from the Mississippi River or other nearby waterbodies for the creation of wetlands may have long-term to permanent, minor, adverse and beneficial impacts on mineral resources in the AOI due to potential burial and access limitations. For oil and gas infrastructure, burial may be adverse in that it would impede access to the infrastructure for maintenance activities. Conversely, burial may be considered beneficial in that it would reduce the exposure to wave energy or collision damage, thereby decreasing the risk of petroleum spills. Foreseeable projects in the outfall area also include the construction of new natural gas infrastructure: specifically, the Delta LNG/Delta Express Pipeline, and the Plaquemines LNG/Gator Express pipeline projects. Both projects may be impacted by deposition of new sediment in a similar manner to existing pipeline infrastructure.

4.25.2.4.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on mineral resources from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.2 Geology and Soils.

4.25.2.4.2.3 Overall Cumulative Impacts

Cumulative impacts on mineral resources from operation of the reasonably foreseeable future actions combined with operation of the MBSD Project action alternatives would likely be long-term to permanent, minor, and both beneficial and adverse. Reasonably foreseeable restoration projects in the AOI may have similar impacts as those of the MBSD Project action alternatives, though likely of a smaller magnitude.

4.25.2.4.3 Soils

4.25.2.4.3.1 Past, Present, and Reasonably Foreseeable Future Projects

The past and present projects and trends that would continue to impact soils in the AOI over the 50-year analysis period are described briefly in Section 4.25.2.2 above and captured in the analysis in Section 4.2 Geology and Soils. The additional impacts of the reasonably foreseeable projects during operations are described here.

The reasonably foreseeable projects without the MBSD Project action alternatives would have short-term to permanent, moderate, adverse and beneficial impacts on the Lafitte-Clovelly association wetland soils due to changes in depth and duration of flooding as a result of the pumping or placement of sediments from the Mississippi River or other nearby waterbodies, particularly the Large-Scale Marsh Creation and Component E- Planning, Grand Cheniere Ridge and Marsh Creation, Bayou Grande Cheniere Marsh & Ridge Restoration, and Grand Bayou Ridge and Marsh Restoration projects. Impacts can be considered both adverse and beneficial, in that existing soils and associated ecological communities would be disrupted, and new soils and ecological communities would be established. No prime farmland would be impacted.

4.25.2.4.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on soils from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.2 Geology and Soils.

4.25.2.4.3.3 Overall Cumulative Impacts

Cumulative impacts from operation of the reasonably foreseeable future actions combined with operation of the MBSD Project action alternatives would likely be minor to moderate, both short-term to permanent and both adverse and beneficial. Soils would be impacted by the reasonably foreseeable projects in the same but more minor way than they would be impacted by the MBSD Project action alternatives.

4.25.2.4.4 Faulting

As described in Section 4.2 Geology and Soils, faulting could affect the MBSD Project action alternatives through episodic movement along a fault that would lower the land surface by inches to feet over the 50-year analysis period, and through fault movement that could be induced by the weight of the diversion structure and the added sediment load diverted into the Barataria Basin during Project operations. If episodic faulting and consequent surface displacement in the Project area occur, these would be considered permanent, major, adverse operational impacts of the MBSD Project action alternatives. However, scientific uncertainty regarding the location of existing faults and the causes of fault movement prevents a conclusive determination of impact of operations. As explained in Section 4.2 Geology and Soils, this uncertainty is due to the following factors: (1) there are no surficial fault lines indicating episodic activity in the Project area; and (2) there is insufficient understanding of the factors that could trigger elevation changes at the surface if a fault were present, with or without the MBSD Project. Furthermore, the potential cumulative impacts of faulting would be similar among all MBSD alternatives; therefore, gathering additional information on these potential impacts is not essential to a reasoned choice among alternatives. For these reasons, the cumulative impacts of the MBSD Project action alternatives on faulting together with other reasonably foreseeable projects are not assessed further.

4.25.3 Groundwater

Direct, indirect, and cumulative impacts from the MBSD Project action alternatives would be negligible. For this reason, the cumulative impacts of the MBSD Project action alternatives on groundwater together with other reasonably foreseeable projects are not assessed further.

4.25.4 Surface Water and Coastal Processes

4.25.4.1 Geographic and Temporal Extent of Analysis

The AOI of potential direct and indirect cumulative construction impacts on hydrology and hydrodynamics in the Mississippi River is within the immediate vicinity (approximately 0.5 mile) of the construction footprint of the intake structure and cofferdam (see Figure 4.25.1-2 above). The MBSD Project action alternatives would have negligible impacts on sediment transport and stormwater drainage during construction. Therefore, the cumulative construction impacts on sediment transport and stormwater drainage are not assessed. The AOI of potential direct and indirect cumulative construction impacts on hydrology and hydrodynamics in the Barataria Basin is within the immediate vicinity (approximately 0.5 mile) of the construction footprint of the outfall transition feature, beneficial use sites, and the barge access channel. The temporal extent of the analysis is the 5-year construction period.

The operational AOI on hydrology and hydrodynamics includes the Lower Mississippi River, the Barataria Basin, and the birdfoot delta, all of which encompass projected impacts on sediment transport, bed elevations, and hydrodynamic impacts from the MBSD Project action alternatives. The AOI on stormwater management and drainage is the forced drainage area between the MR&T and NOV-NFL Levees within approximately 2 miles of the MBSD diversion channel. The temporal extent of the analysis is the 50-year operational analysis period.

4.25.4.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

4.25.4.2.1 Past and Present Projects Considered

The key past and present projects and trends that have impacted hydrology and hydrodynamics in the Project area include the channelization of the Mississippi River, completed and ongoing river diversions, sea-level rise, and subsidence, all of which are described in Section 4.25.1.3. Ongoing operations of the Davis Pond Freshwater

Diversion Project, the Caernarvon Freshwater Diversion Project, and other existing natural and human-made diversions of the river restore fresh water and sediment input into the basin and impact water levels, currents, flows, and bed elevations in the basin, Mississippi River, and birdfoot delta. The ongoing trends of land subsidence and sea-level rise decrease bed elevations and increase water levels throughout the Barataria Basin. These projects and trends collectively contribute to the characterization of the Project area as described in Chapter 3, Section 3.4 Surface Water and Coastal Processes and their contribution to hydrology and hydrodynamics in the Project area is reflected in the data presented therein. As such, the impact on hydrology and hydrodynamics from past or recently completed projects is captured in the analysis in Section 4.4 Surface Water and Coastal Processes.

4.25.4.2.2 Reasonably Foreseeable Future Projects Considered

The reasonably foreseeable projects encompassed by the construction AOI for hydrology and hydrodynamics include:

- Loading Dock on Mississippi River and Tallgrass PLT[134] (Map #2 in Figure 4.25.1-1)
- NOV-NF-W-05a.1 Project (Map #1 n Figure 4.25.1-1)

The names and impacted waterbodies of the reasonably foreseeable projects that would add cumulative impacts on hydrology and hydrodynamics during operations are listed in Table 4.25.4-1 below. Details about these projects are included in Table 4.25.1-1, and their locations are shown in Figures 4.25.1-1 and 4.25.1-2.

[134] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

Table 4.25.4-1 Reasonably Foreseeable Projects with Cumulative Impacts on Hydrology and Hydrodynamics during MBSD Project Operations		
Project Name (Mapped # in Figure 4.25.1-1)	**Potentially Impacted Waterbody**	**In Delft3D Basinwide Model Simulation?**
Tallgrass PLT (2)	Mississippi River and Barataria Basin	No
Loading Dock on Mississippi River (3)	Mississippi River and Barataria Basin	No
Mid-Breton Sediment Diversion (4)	Mississippi River and birdfoot delta	Yes
Baton Rouge to the Gulf Channel Deepening (41)	Mississippi River and birdfoot delta	No
Mississippi River Beneficial Use of Dredged Material Program (not mapped)	Mississippi River and birdfoot delta	No
Barataria Basin Ridge and Marsh Creation – Spanish Pass Increment (39)	Birdfoot delta	Yes
Spanish Pass Ridge and Marsh Restoration (42)	Birdfoot delta	Yes
South Pass Bird Island Enhancement (45)	Birdfoot delta	No
Pass A Loutre Crevasses (43)	Birdfoot delta	No
Large-Scale Marsh Creation and Component E- Planning (8)	Barataria Basin	Yes
Long-Distance Sediment Pipeline, Phase 2 (11)	Barataria Basin	No
Northeast Turtle Bay Marsh Creation and Critical Area Shoreline Protection (13)	Barataria Basin	No
Grand Cheniere Ridge and Marsh Creation (17)	Barataria Basin	No
Northwest Turtle Bay Marsh Creation (18)	Barataria Basin	Yes
Bayou Grande Cheniere Marsh & Ridge Restoration (19)	Barataria Basin	Yes
Grand Bayou Ridge and Marsh Restoration (20)	Barataria Basin	No
Barataria Bay Rim Marsh Creation and Stabilization (21)	Barataria Basin	Yes
Shoreline Protection at Jean Lafitte National Historical Park and Preserve (23)	Barataria Basin	No
Previously Authorized Mitigation-WBV (25)	Barataria Basin	No
Bayou L'Ours Marsh Terracing (27)	Barataria Basin	Yes
Queen Bess Island Restoration (28)	Barataria Basin	No
East Leeville Marsh Creation and Nourishment (33)	Barataria Basin	Yes

4.25.4.3 Cumulative Impacts during Construction

The past and present projects and trends that would continue to impact hydrology and hydrodynamics in the river are described briefly in Section 4.25.4.2 above and captured in the analysis in Section 4.4 Surface Water and Coastal Processes. The additional impacts of the reasonably foreseeable projects are described here. Construction of the new NOV-NF-W-05a.1 Project would be completed before the start of the 5-year construction period of the proposed MBSD Project; therefore, construction impacts of the NOV-NF-W-05a.1 Project would not overlap construction impacts of the MBSD Project and are not assessed further. Cumulative impacts associated with operation of the NOV-NF-W-05a.1 Project are assessed in

Stormwater Management and Drainage in Section 4.25.4.4 Cumulative Impacts during Operations.

4.25.4.3.1 Mississippi River

Impacts of the reasonably foreseeable projects on bed elevations in the construction AOI include disruption of bed features and water bottom substrates for the construction of pilings, piers, and barge docks. According to the Joint Public Notices for the facilities' CWA Section 10/404 permit applications on LDNR's SONRIS database, construction of the Loading Dock on Mississippi River and the Tallgrass PLT would include the installation of dock platforms and barge dolphins, which would require pile driving but not dredging. These actions would have negligible impacts on Mississippi River bed elevations because impacts would be localized and along an area of the river banks where bed elevations have already been modified by revetment and other existing industry modifications. These foreseeable projects would not add cumulative impacts on bed elevations during construction of the MBSD Project action alternatives. Therefore, no additional cumulative impacts are expected.

Given the negligible impacts from construction of the reasonably foreseeable future projects on water levels, tides, currents, flow, and sediment transport in the AOI for the Mississippi River, overall, the cumulative impacts on these processes would be consistent with those impacts for the MBSD Project action alternatives described in Section 4.4.1 Surface Water and Coastal Processes and summarized in Chapter 2, Table 2.9-1.

4.25.4.3.2 Barataria Basin

Because no reasonably foreseeable projects overlap temporally with the portion of the construction footprint in the Barataria Basin, there would be no cumulative impacts on hydrology and hydrodynamics during construction in the AOI for the basin.

4.25.4.4 Cumulative Impacts during Operations

4.25.4.4.1 Bed Elevations

4.25.4.4.1.1 <u>Past, Present, and Reasonably Foreseeable Future Projects and Trends</u>

The impacts on bed elevations from ongoing sea-level rise, subsidence, and restoration projects including the Davis Pond Freshwater Diversion Project and the Caernarvon Freshwater Diversion Project are factored into baseline conditions for the 50-year analysis period as presented in Section 4.4.4 Hydrology and Hydrodynamics in Surface Water and Coastal Processes. The additional impacts of the reasonably foreseeable projects identified in the operational AOI are presented below.

The impacts of reasonably foreseeable projects on bed elevations in the Lower Mississippi River upstream of the birdfoot delta during operations include the following:

- the Mid-Breton Sediment Diversion Project (at RM 68 AHP) would increase erosion upstream of the Mid-Breton diversion and increase deposition downstream. These projections are supported by a study indicating that deposition generally occurs downstream of a diversion (Allison et al. 2013, Meselhe et al. 2016). The driving force for these changes would be the reduced flow in the river and consequently slower water velocity downstream of diversions from the rerouting of the water through the diversion. Upstream of the Mid-Breton diversion, erosion is expected to increase due to the increased water surface slope induced when the diversion is open (flowing greater than the 5,000 cfs base flow).

- the Tallgrass PLT and the Loading Dock on Mississippi River projects would contribute negligible impacts on bed elevations in the river.

The Delft3D Basinwide Model was used to project cumulative impacts of the reasonably foreseeable projects on bed elevations, water levels, and tidal values in the Barataria Basin and birdfoot delta. Output was provided for the seven representative stations in the basin shown in Table 4.4.1-1 (see Section 4.4.1 Hydrology and Hydrodynamics for more information about these station locations). Table 4.25.4.1 above indicates which reasonably foreseeable project was included in the model simulation. Based on that model simulation (and qualitative analyses for those projects not included in the model simulation), the impacts of the reasonably foreseeable projects on bed elevations in the birdfoot delta during operations include the following:

- in the birdfoot delta, the Mid-Breton Sediment Diversion would have permanent, moderate, adverse decreases in bed elevations due to the reduced sediment load reaching the delta during operations. These impacts would represent minor to moderate, permanent impacts on bed elevations in the Lower Mississippi River;

- the Baton Rouge to Gulf Channel Deepening would decrease bed elevations from RM 13.4 AHP to RM 22 BHP (this includes Southwest Pass) from 45 to 50 feet for deep-draft navigation. This deepening would represent major, permanent decreases in bed elevations in the navigation channel boundaries of the river that would benefit deep-draft navigation;

- the Mississippi River Beneficial Use of Dredged Material Program would increase bed elevations to restore eroded wetlands in specific areas of the birdfoot delta. Therefore, this foreseeable project would contribute minor, beneficial increases in bed elevations in the birdfoot delta.

Based on the model simulation, the impacts of the reasonably foreseeable projects on bed elevations in the Barataria Basin would be negligible as compared to the No Action Alternative because they would not offset the stronger influence that subsidence and sea-level rise would exert in decreasing bed elevations across the basin. Therefore, the foreseeable projects would not contribute appreciably to cumulative impacts on bed elevations in the Barataria Basin. However, while the life of the reasonably foreseeable marsh creation projects is limited, they would provide substantial benefits over the course of their life including fisheries production and storm surge risk reduction. Future projects are anticipated to continue those benefits, but those projects were not sufficiently developed to be evaluated in this document. Additional beneficial cumulative impacts on bed elevations may arise by the implementation of reasonably foreseeable restoration projects not factored into the Delft3D Basinwide Model output as well as from the beneficial use of dredged material in the basin occurring as part of CEMVN's maintenance dredging in the Mississippi River (see Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2 for more information about these restoration projects).

4.25.4.4.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on bed elevations from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.4 Surface Water and Coastal Processes.

4.25.4.4.1.3 Overall Cumulative Impacts

When combined, overall cumulative impacts of operations of the MBSD Project action alternatives and the reasonably foreseeable projects would result in minor to moderate, permanent impacts on bed elevations in the Lower Mississippi River during operation of the MBSD Project. As compared to the No Action Alternative, cumulative impacts in the Lower Mississippi River include (moving in a southward direction in the river):

- permanent, moderate decreased and increased bed elevations immediately upstream and downstream, respectively, of the Mid-Breton Sediment Diversion structure (RM 68 AHP) and the MBSD Project diversion structure (RM 60.7 AHP). Although these bed elevation impacts from both projects would occur in the Lower Mississippi River AOI, their respective impacts would be so localized they would not cumulatively overlap geographically;
- permanent, major, decreased bed elevations from RM 13.4 AHP to RM 22 BHP (this includes Southwest Pass) from the Baton Rouge to the Gulf Channel Deepening Project. These impacts would be beneficial for deep-draft navigation in the river;
- permanent, moderate to major, adverse decreased bed elevations in the birdfoot delta due to combined operations of the Mid-Breton Sediment Diversion and the MBSD Project action alternatives due to the reduced sediment load reaching the delta during operations of the diversion projects. Both projects on their own would have moderate, adverse decreases in bed elevations in the birdfoot delta. When operations of the two diversion projects are combined, decreased bed elevations in the delta may be more widespread. Additional analysis of the cumulative impacts of these two

projects will be included in a forthcoming EIS for the Mid-Breton Sediment Diversion Project, currently in development.

In the Barataria Basin, given the negligible impacts from the reasonably foreseeable projects on bed elevations, overall, the cumulative impacts on bed elevations would be consistent with those operational impacts for the MBSD Project action alternatives described in Section 4.4.4 Hydrology and Hydrodynamics and summarized in Chapter 2, Table 2.9-1.

4.25.4.4.2 Water Levels

4.25.4.4.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The impacts on water levels from ongoing sea-level rise, subsidence, and restoration projects including the Davis Pond Freshwater Diversion Project and the Caernarvon Freshwater Diversion Project are factored into baseline conditions for the 50-year analysis period as presented in Section 4.4.4 Hydrology and Hydrodynamics in Surface Water and Coastal Processes. The additional impacts of the reasonably foreseeable projects identified in the operational AOI are presented below.

In the Mississippi River and birdfoot delta, the Mid-Breton Sediment Diversion is expected to have minor, beneficial, permanent impacts on water levels during the 50-year operational analysis period. Water levels are projected to decrease upriver and downriver of the Mid-Breton Sediment Diversion structure compared to the No Action Alternative due to diverting water from the river into the Breton Sound Basin. The Baton Rouge to the Gulf Channel Deepening Project (USACE 2018l), the Mississippi River Beneficial Use of Dredged Material Program, the Tallgrass PLT project, and the Loading Dock on the Mississippi River project are not expected to have more than negligible impacts on water levels in the Mississippi River and, therefore, would not contribute to cumulative impacts on water levels in the river.

The reasonably foreseeable projects in the Barataria Basin mainly involve marsh restoration projects that would place or pump dredged material into open-water areas of the basin (see Table 4.25.4-2). Water level increases related to dredged material placement or pumping would not cause more than negligible impacts on existing water levels and would therefore not contribute appreciably to cumulative impacts on water levels in the basin.

4.25.4.4.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on water levels from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.4 Surface Water and Coastal Processes.

4.25.4.4.2.3 Overall Cumulative Impacts

The combined operations of both the Mid-Barataria and Mid-Breton Sediment Diversion Projects would cause permanent (lasting the 50-year analysis period), moderate impacts on water levels in the Mississippi River. Combined maximum decreases of more than a foot would occur upriver and downriver of the diversion projects during Project operations. In accordance with the surface water and coastal processes impact determination guidelines (see Section 4.4 Surface Water and Coastal Processes), cumulative water level impacts would be moderate because they would be measurable, limited to local areas, and permanent. Decreases in water levels may be beneficial for flood control purposes.

In the Barataria Basin, given the negligible impacts from the reasonably foreseeable projects on water levels, overall, the cumulative impacts on water levels would be consistent with those operational impacts for the MBSD Project action alternatives described in Section 4.4.4 Hydrology and Hydrodynamics and summarized in Chapter 2, Table 2.9-1.

4.25.4.4.3 Tides, Currents, and Flows

4.25.4.4.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The impacts on tides, currents, and flows from ongoing sea-level rise, subsidence, and restoration projects including the Davis Pond Freshwater Diversion Project and the Caernarvon Freshwater Diversion Project are factored into baseline conditions for the 50-year analysis period as presented in Section 4.4.4 Hydrology and Hydrodynamics in Surface Water and Coastal Processes. The additional impacts of the reasonably foreseeable projects identified in the operational AOI are presented below.

In the Mississippi River, the Mid-Breton Sediment Diversion would not contribute to cumulative impacts on tides, currents, and flows because it would be located 7 miles upriver from the MBSD Project intake structure, outside of the AOI of the MBSD Project on cross-stream velocity in the river. The Baton Rouge to Gulf Channel Deepening Project (USACE 2018), Mississippi River Beneficial Use of Dredged Material Program, the Tallgrass PLT project, and the Loading Dock on the Mississippi River project are not expected to have more than negligible impacts on tides, current and flows in the Mississippi River and, therefore, would not contribute to cumulative impacts on tides, currents, and flow in the river.

In the Barataria Basin and birdfoot delta, the minimum, maximum, and range of tidal projections for 2020, 2040, and 2070 for the reasonably foreseeable projects were compared to the No Action Alternative (see Table 4.25.4-2). Tidal projections were based on the 1994 Mississippi River hydrograph representing high, consistent spring flow. This hydrograph would be expected to cause the greatest effect on tides and flows. The comparison indicates negligible to moderate differences in tidal range from the reasonably foreseeable projects. The model projects that the tidal minimums would be lower with respect to the No Action Alternative in the northern basin (northern/mid-basin station [CRMS 3985], station near Lafitte [USACE 82875], and western station [Little L. near Cutoff]) in 2020 and 2040 when cumulative impacts from reasonably foreseeable projects are considered. These differences would become less pronounced by 2070. In 2070, the tidal range at the central station (CRMS 0224) is projected to increase by (0.3 foot [0.1 meter), while the tidal range impacts at the other six stations would be negligible as compared to the No Action Alternative (see Table 4.25.4-2). These differences indicate that reasonably foreseeable projects in the basin are projected to cause minor increases in the extent of tidal influence in the lower basin and minor decreases in tidal influence in the upper basin.

Table 4.25.4-2
Tidal Values for Reasonably Foreseeable Projects Relative to No Action Alternative
2020, 2040, and 2070 Conditions (feet [meters])
May 1994 Hydrograph – High, Consistent Spring Flow

Tidal Value	Northern/ Mid-Basin (CRMS 3985) (ft[m])	Near Lafitte (USACE 82875) (ft[m])	Station Nearest Diversion (CRMS 0276) (ft[m])	Central Station (CRMS 0224) (ft[m])	Western Station (Little L. Cutoff) (ft[m])	Southwestern Station, at Barataria Pass near Grand Isle (B. Pass at GI) (ft[m])	Birdfoot Delta (CRMS 0163) (ft[m])
2020							
Diff. in Max comp. to No Action	0 (0)	0 (0)	0.03 (0.01)	0 (0)	0.06 (0.02)	–0.1 (–0.03)	0.1 (0.03)
Diff. in Min. comp. to No Action	0.16 (0.05)	0.16 (0.05)	0 (0)	0 (0)	0.43 (0.13)	–0.1 (–0.03)	–0.03 (–0.01)
2040							
Diff. in Max comp. to No Action	0.1 (0.03)	0.1 (0.03)	0.03 (0.01)	0.1 (0.03)	0.16 (0.05)	0.03 (0.01)	0.06 (0.02)
Diff. in Min. comp. to No Action	0.1 (0.03)	0.13 (0.04)	0 (0)	–0.03 (–0.01)	0 (0)	0.03 (0.01)	0.03 (0.01)
2070							
Diff. in Max comp. to No Action	–0.03 (–0.01)	0 (0)	0 (0)	0.06 (0.02)	0.03 (0.01)	0.03 (0.01)	0.1 (0.03)
Diff. in Min. comp. to No Action	0 (0)	0 (0)	–0.06 (–0.02)	–0.26 (–0.08)	0 (0)	–0.13 (–0.04)	–0.13 (–0.04)

4.25.4.4.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on tides, currents, and flows from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.4 Surface Water and Coastal Processes.

4.25.4.4.3.3 Overall Cumulative Impacts

Given the negligible impacts from the reasonably foreseeable projects on water levels, overall, cumulative impacts on water levels would be consistent with those operational impacts of the MBSD Project action alternatives as described in Section 4.4.1 and summarized in Chapter 2, Table 4.9-1. Cumulative impacts on tides, currents, and flow in the Barataria Basin from operation of the reasonably foreseeable projects combined with operation of the MBSD Project action alternatives would be negligible to moderate on tidal ranges compared to the No Action Alternative. This would be expected, as reasonably foreseeable marsh creation, levee construction, dredging, and channelization activities throughout the basin, in conjunction with the MBSD Project action alternatives, would impact the existing tidal, current, and flow patterns. The differences in tidal ranges throughout the basin are projected to vary; this may reflect the varying nature of the reasonably foreseeable restoration projects and their proximity to each station, but the general north to south flow projected as a result of the MBSD Project action alternatives would still be dominant. The magnitude of the cumulative impacts on tidal ranges is projected to decrease with distance from the diversion structure; for example, impacts in the southern basin near Grand Isle and in the birdfoot delta would be negligible.

4.25.4.4.4 Sediment Transport

4.25.4.4.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The impacts on sediment transport from ongoing sea-level rise, subsidence, and restoration projects including the Davis Pond Freshwater Diversion Project and the Caernarvon Freshwater Diversion Project are factored into baseline conditions for the 50-year analysis period as presented in Section 4.4.4 Hydrology and Hydrodynamics in Surface Water and Coastal Processes. The additional impacts of the reasonably foreseeable projects identified in the operational AOI are presented below.

The Mid-Breton Sediment Diversion may have moderate, adverse, permanent impacts on sediment transport to the birdfoot delta via the Mississippi River because sediment from the river would be diverted to the Breton Sound. The other reasonably foreseeable projects would have negligible impacts on sediment transport to the birdfoot delta.

In the Barataria Basin, the reasonably foreseeable restoration projects involving pumping or placing dredged material from the river into the basin would have minor, beneficial, permanent impacts on the transport of sediment from the Mississippi River to the Barataria Basin. However, as described above, benefits related to increasing bed elevations in the basin over the long-term would be negligible. While the life of other reasonably foreseeable marsh creation projects is limited, they would provide substantial benefit over the course of their life including fisheries production and storm surge risk reduction. Future projects are anticipated to continue those benefits, but those projects were not sufficiently developed to be evaluated in this document. The reasonably foreseeable Tallgrass PLT facility has the potential to impact sediment transport into the Barataria Basin during operations of the MBSD Project action alternatives, as further described below in “Overall Cumulative Impacts.”

4.25.4.4.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on sediment transport from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.4 Surface Water and Coastal Processes.

4.25.4.4.4.3 Overall Cumulative Impacts

The Tallgrass PLT oil export facility, which would include a docking facility for loading and unloading deep-draft vessels along the Mississippi River adjacent to and upstream of the MBSD Project intake structure, has the potential to have moderate, adverse, permanent impacts on sediment transport. A CWA Section 10/404 permit application was submitted to CEMVN in 2012 to construct a similar oil export docking facility, RAM Terminal, at the same location. A sediment transport study was conducted by the Water Institute (2012) to examine potential impacts of that facility on altering river flow patterns near the proposed MBSD intake structure that could alter the amount of sediment transported to the MBSD diversion intake structure. The results of the 2012 study showed that the presence of the docking facility and the deep-draft vessels calling on it would affect river local water flows to the extent that the SWR transported from the Mississippi River to the Barataria Basin via the MBSD intake structure and diversion channel would be reduced by nearly 17 percent. Although there are a number of differences between the docking facility for the prior RAM Terminal project and the proposed Tallgrass PLT project, the Water Institute (2012) study provides useful data and insight regarding the potential impact the Tallgrass PLT facility could have on sediment transport abilities of the MBSD Project.

CPRA and the Tallgrass PLT facility’s sponsors PPHTD/PLT signed a MOU dated April 24, 2019 pertaining to the facility’s application for a CUP (number P20180379). According to the MOU, as part of CPRA’s Coastal Master Plan consistency determination process for the facility’s permit application, PPHTD/PLT and CPRA would be required to mutually agree on certain terms and conditions, such as operational restrictions or other mitigation measures, for the construction, operation, and administration of the Tallgrass PLT project to ensure that it would not have adverse impacts on the design, construction, and operation of the MBSD Project, including but not limited to sediment loss. According to the MOU, mitigation measures may be required for the physical presence of the docking facility, marine activities, docking fleeting, and the loading and unloading of vessels, and, if necessary, design and construction modifications.

Cumulative impacts on sediment transport from operation of the other reasonably foreseeable projects combined with operation of the MBSD Project action alternative impacts would be major, beneficial, and permanent in the Barataria Basin. The combined impacts of transporting sediment from the Mississippi River to the Barataria

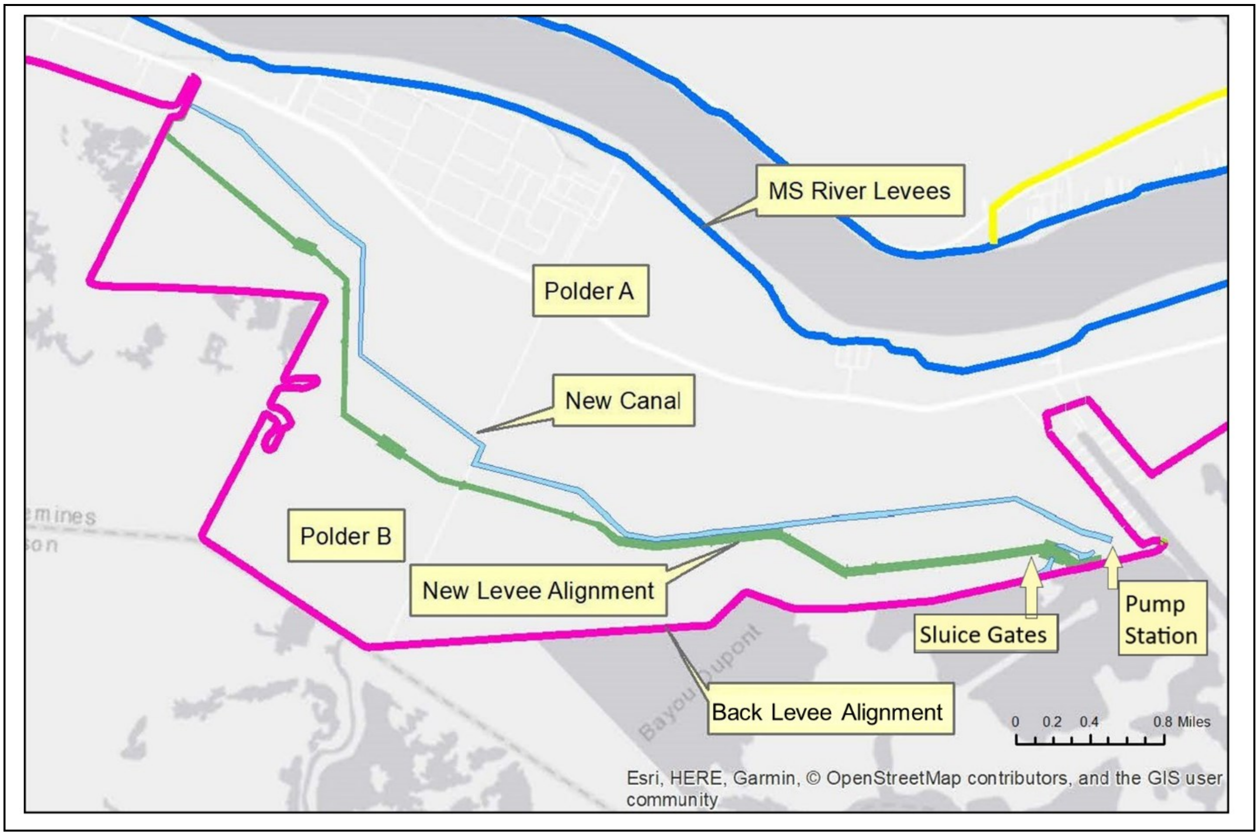
Basin through these projects would play a significant role in creating and sustaining wetlands in the basin, as described further in Section 4.25.6 Wetland Resources and Waters of the U.S.

4.25.4.4.5 Stormwater Management and Drainage

4.25.4.4.5.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The impacts on stormwater management and drainage from past and ongoing projects are factored into baseline conditions for the 50-year analysis period as presented in Section 4.4.4 Hydrology and Hydrodynamics in Surface Water and Coastal Processes. The additional impacts of the reasonably foreseeable projects identified in the operational AOI are presented below.

The authorized NOV-NF-W-05a.1 Project would involve constructing a new levee at approximately 10 feet NAVD88, relocating the existing drainage canal with a new alignment along the toe of the protected side of the NOV-NF-W-05a.1 levee reach, and constructing a sluice gate structure that would convey flows to the Wilkinson Canal Pump Station (see Figure 4.25.4-1 below). The existing non-federal back levee (with elevations of 3 feet to 5 feet NAVD88) would be left in place, creating a new polder between it and the NOV-NF-W-05a.1 levee reach where water would be trapped during storm surge overtopping events (see Polder B in Figure 4.25.4-1). To evaluate the potential for induced flooding related to Polder B, the USACE conducted hydraulic modeling that indicates that during storm surge events in the Barataria Basin that overtop the back levee, a scenario is possible where Polder B would be completely inundated, requiring unwatering (USACE 2019c). The sluice gates would be operated to drain Polder B to Polder A and then drain to the Wilkinson Canal Pump Station, but Polder B would still be subject to higher water levels for approximately 1 to 3 weeks. With a sluice gate opening of 2 feet, Polder B would drain in 11 days without increasing water levels in Polder A. This may represent a beneficial impact on stormwater drainage in Polder A during overtopping events, because with protection of the NOV-NF-W-05a.1 levee reach, Polder B would serve as a storage area for floodwater that would otherwise inundate a larger area in Polder A. Nevertheless, because the NOV-NF-W-05a.1 levee reach is designed to provide storm risk reduction up to the 4 percent AEP (25-year) storm, Polder A could still experience inundation due to overtopping during storms affecting this area that are greater than the 4 percent AEP (25-year) storm.



Source: USACE 2019, modified by GEC

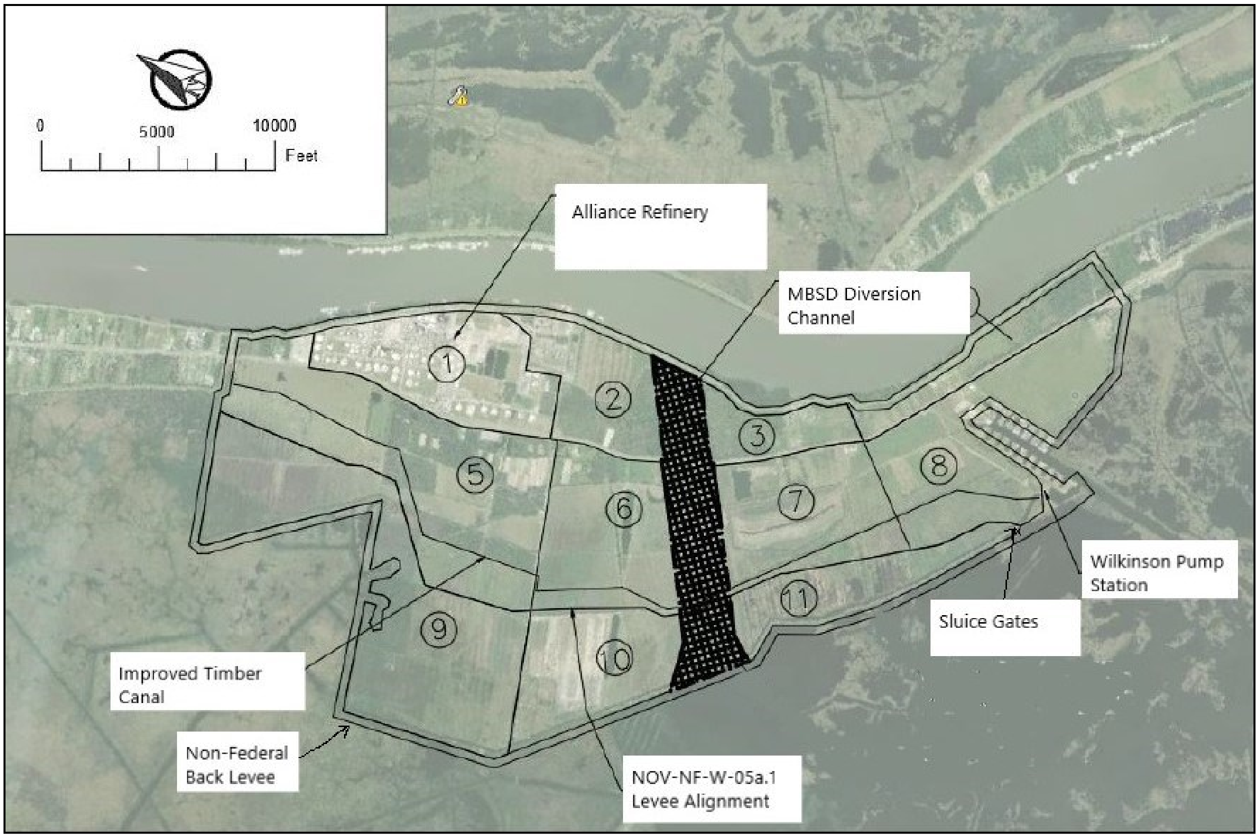
Figure 4.25.4-1. NOV-NF-W-05a.1 Project Map.

4.25.4.4.5.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on stormwater management and drainage from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.4 Surface Water and Coastal Processes.

4.25.4.4.5.3 Overall Cumulative Impacts

The MBSD diversion channel would tie-in to the back levee and the NOV-NF-W-05a.1 levee reach and would cross Polders A and B, thereby hydraulically isolating the upstream portions of the polders (see subbasins 1, 2, 5, 6, 9 and 10 in Figure 4.25.4-2). As described in Section 4.4.4 Hydrology and Hydrodynamics, construction of the MBSD diversion channel would include a siphon that would convey stormwater from the relocated Timber Canal under the diversion channel to the Wilkinson Canal Pump Station. Additionally, a sluice gate structure would be constructed to convey stormwater from subbasins 9 and 10 to Timber Canal, to be routed through the MBSD diversion channel siphon to eventually reach the Wilkinson Canal Pump Station (see Figure 4.25.4-2). Based on hydrologic and hydraulic modeling conducted by CPRA (2018c), as compared to the No Action Alternative, the MBSD diversion channel and siphon would have negligible impacts on stormwater drainage in the new polder areas created by the NOV-NF-W-05a.1 levee reach.



Source: Interior Drainage Report (CPRA 2018b), labels modified by GEC

Figure 4.25.4-2. NOV-NF-W-05a.1 Project Map with Location of Mid-Barataria Sediment Diversion Channel.

4.25.5 Surface Water and Sediment Quality

4.25.5.1 Geographic and Temporal Extent of Analysis

The AOI associated with surface water quality affected by construction of the Project includes the area within approximately 1 mile of the construction footprint. The temporal extent of the analysis is the 5-year construction period.

The AOI associated with surface water quality affected by operation of the MBSD Project action alternatives includes the majority of the Barataria Basin and the Mississippi River birdfoot delta (see Section 4.5 Surface Water and Sediment Quality). The temporal extent of the analysis is the 50-year analysis period.

4.25.5.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to contribute to existing surface water quality include operation of the Davis Pond Freshwater Diversion, which periodically introduces fresh water into the Barataria Basin, the Caernarvon Freshwater Diversion Project, and other existing natural and human-made diversions of the river, as explained in Appendix E. Additionally, sea-level rise, subsidence, and wetland loss contribute to the introduction of salt water from the Gulf into the Project area. These projects and conditions collectively contribute to the existing water quality conditions characterized in Chapter 3, Section 3.5 Surface Water and Sediment Quality. The impacts on water quality from these ongoing projects and conditions are captured in the analysis in Section 4.5 Surface Water and Sediment Quality.

The surface waters that could be affected by construction of the MBSD Project action alternatives include the Mississippi River and the portions of the Barataria Basin within approximately 1 mile of construction areas. The planned projects encompassed by the construction impact area for surface waters include those shown in Table 4.25.5-1 below.

The MBSD Project action alternatives are not expected to impact water quality in the Mississippi River during operations, so the river is not included in the analysis with the exception of the western portion of the birdfoot delta outside of the Southwest Pass navigation channel. However, the combined impact of several Mississippi River diversions operating simultaneously may reduce nutrient flow from the river to the Gulf, having a beneficial impact on the hypoxic zone (LDEQ et al. 2019) outside of the defined AOI.

Table 4.25.5-1
Reasonably Foreseeable Projects with Cumulative Impacts on Water Quality during MBSD Project Construction and Operations

Project Name (Mapped # in Figure 4.25.1-1)	Construction Overlap	Operations Overlap	Cumulatively Impacted Waterbody	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?
Tallgrass PLT[135] (2)	X	Yes, but only related to accidental or emergency spills	Mississippi River and Barataria Basin	No
Loading Dock on Mississippi River (3)	X		Mississippi River	No
Gulf Coast Methanol Complex (6)	X		Mississippi River	No
NOV-NF-W-05a.1 Project (1)	X		Drainage Canals between Levees	Yes
NOLA Oil Terminal (5)	X	Yes, but only related to permitted discharges into the basin	Mississippi River and Barataria Basin	No

[135] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

Table 4.25.5-1
Reasonably Foreseeable Projects with Cumulative Impacts on Water Quality during MBSD Project Construction and Operations

Project Name (Mapped # in Figure 4.25.1-1)	Construction Overlap	Operations Overlap	Cumulatively Impacted Waterbody	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?
Large-Scale Marsh Creation and Component E- Planning (8)	X	X	Barataria Basin	Yes
Plaquemines LNG/Gator Express Pipeline (10)		Yes, but only related to potential permitted discharges in the basin	Mississippi River and Barataria Basin	No
Mid-Breton Sediment Diversion (4)		X	Birdfoot delta	Yes
Barataria Basin Ridge and Marsh Creation- Spanish Pass Increment (39)		X	Birdfoot delta	Yes
Spanish Pass Ridge and Marsh Restoration (42)		X	Birdfoot delta	Yes
South Pass Bird Island Enhancement (45)		X	Birdfoot delta	No
Pass A Loutre Crevasses (43)		X	Birdfoot delta	No
Long-Distance Sediment Pipeline, Phase 2 (11)		X	Barataria Basin	No
Northeast Turtle Bay Marsh Creation and Critical Area Shoreline Protection (13)		X	Barataria Basin	No
Grand Cheniere Ridge and Marsh Creation (17)		X	Barataria Basin	No
Northwest Turtle Bay Marsh Creation (18)		X	Barataria Basin	Yes
Bayou Grande Cheniere Marsh & Ridge Restoration (19)		X	Barataria Basin	Yes
Grand Bayou Ridge and Marsh Restoration (20)		X	Barataria Basin	No
Barataria Bay Rim Marsh Creation and Stabilization (21)		X	Barataria Basin	Yes
Shoreline Protection at Jean Lafitte National Historical Park and Preserve (23)		X	Barataria Basin	No
Previously Authorized Mitigation-WBV (25)		X	Barataria Basin	No
Bayou L'Ours Marsh Terracing (27)		X	Barataria Basin	Yes
Queen Bess Island Restoration (28)		X	Barataria Basin	No
East Leeville Marsh Creation and Nourishment (33)		X	Barataria Basin	Yes

4.25.5.3 Cumulative Impacts during Construction

4.25.5.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on water quality from past and present projects and trends are factored into baseline conditions as presented in Section 4.5 Surface Water and Sediment Quality. The additional impacts of the reasonably foreseeable projects identified in the construction AOI are presented below.

Each of the reasonably foreseeable projects identified in Table 4.25.5-1 require Section 10/404 authorization from the USACE and corresponding Section 401 Water Quality Certification from LDEQ. These authorizations would be contingent on the use of best management practices to minimize impacts on water quality and to ensure that state water quality standards are not violated.

The reasonably foreseeable construction activities that would have the greatest potential impact on surface waters would be excavation, dredging, and fill material placement. These activities could cause temporary increases in suspended solids and turbidity levels resulting from in-water activities or runoff of sediment from adjacent work zones. Construction impacts from reasonably foreseeable projects would be offset or minimized by the implementation of best management practices that would be documented in project SWPPPs and SPCC Plans as required by Louisiana Title 33, Part IX 901 and 2707, and 40 CFR 112. Therefore, construction impacts on water quality from reasonably foreseeable projects without the MBSD Project action alternatives are expected to be minor, adverse, and temporary.

4.25.5.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on surface waters during construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.3.3 Overall Cumulative Impacts

Cumulative impacts on surface water quality from construction of the reasonably foreseeable projects planned along the Mississippi River within 1 mile of the MBSD construction footprint (Gulf Coast Methanol Complex, Loading Dock on Mississippi River, NOLA Oil Terminal, and Tallgrass PLT) and construction of the MBSD Project action alternatives would be temporary, minor, and adverse. The impacts on water quality in the river (for example, increased turbidity and total suspended solids) could be exacerbated in the vicinity of these projects. Each reasonably foreseeable project would require construction activities along approximately 5,000 to 7,000 feet of river frontage, as compared to the Project's construction footprint of approximately 1,500 feet of river frontage. On average, the Mississippi River discharges approximately 53.5 billion cubic feet of water daily. The volume and velocity of water flowing down the Mississippi River would aid in rapid mixing of suspended sediments so that any cumulative impacts would likely be minor and localized to the Project area. Turbidity and suspended sediment loads are normally high in the Mississippi River, even with the high flushing rates, such that turbidity and sediment contributions from the five actions occurring simultaneously, including the MBSD Project, would have a minor, temporary, adverse cumulative effect on water quality.

If construction of the reasonably foreseeable projects planned in the Barataria Basin AOI (see Table 4.25.5-1) were to occur at the same time as construction of the MBSD Project action alternatives, turbidity and total suspended solid impacts on water quality in Barataria Basin could be increased. However, the MBSD Project action alternatives are designed to increase sediment in the Barataria Basin for marsh restoration. Therefore, a cumulative increase in turbidity and total suspended solids in the basin may be considered beneficial.

Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) to surface water in both the Mississippi River and the Barataria Basin. Contaminant loads may ultimately settle in river or basin sediments. The impact intensity of inadvertent releases of contaminants would depend upon the nature of the release. Accidental spills during routine construction activities such as fueling construction vehicles would likely be temporary, minor, and adverse. These types of spills would be controlled and mitigated in accordance with the SPCC Plan for each planned project. A spill or leak from any of the projects could be significant; however, it is unlikely that multiple actions would result in spills or leaks in the same relative timeframe to produce a significant cumulative effect given the regulatory environment regarding spill prevention. Therefore, the cumulative impacts of potential spills resulting from simultaneous construction of the MBSD Project action alternatives and reasonably foreseeable projects are expected to be temporary, adverse, and minor.

4.25.5.4 Cumulative Impacts during Operations

Cumulative impacts on water quality during operations were evaluated both quantitatively and qualitatively. To quantitatively characterize seasonal trends in water quality, the Delft3D Basinwide Model was used to evaluate impacts of the reasonably foreseeable projects shown in Table 4.25.5-1 above on monthly average concentrations of water quality parameters at the six representative water quality stations listed in Table 4.25.5-2 (see Section 4.5 Surface Water and Sediment Quality for more details about the water quality analysis at these stations for the MBSD Project action alternatives). The reasonably foreseeable projects included in the Delft3D Basinwide Model are restoration projects, with the exception of the NOV-NF-W-05a.1 Project, which is a hurricane and flood risk reduction project (see Table 4.25.5-1 and Figures 4.25.1-1 and 4.25.1-2). Three other projects, the Tallgrass PLT project, the NOLA Oil Terminal, and the Plaquemines LNG/Gator Express Pipeline, were not included in the Delft3D Basinwide Modeling analysis; cumulative impacts for those projects were considered qualitatively.

Table 4.25.5-2
Stations for Comparison of Cumulative Impacts

Station ID	Description
CRMS 3985	Northern/Mid-Basin
CRMS 0276[a]	Station Nearest Diversion
CRMS 0224	Central Station
Little L. Cutoff	Western Station
B. Pass at GI	Southwestern Station, at Barataria Pass near Grand Isle
CRMS 0163[b]	Birdfoot Delta

a The Delft3D Basinwide Model cell for the station nearest the diversion (CRMS 0276 station grid cell) is projected to be dry at some points during the analysis period. Model data was extracted from the nearest grid cell that was wet.

b The Delft3D Basinwide Model cell for the birdfoot delta station (CRMS 0163) is projected to be partially dry marsh in modeled year 2020 transitioning to open water in year 2030. For this reason, results before 2030 are not included for the birdfoot delta station (CRMS 0163) in the analysis.

4.25.5.4.1 Permitted Discharges

4.25.5.4.1.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on water quality from past and present projects and trends are factored into baseline conditions as presented in Section 4.5 Surface Water and Sediment Quality. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented below.

The NOLA Oil Terminal plans to discharge treated water into the Barataria Basin once operational (LDEQ Agency Interest # 186945, PER20140001, January 7, 2016). In 2016, the NOLA Oil Terminal was issued an LPDES permit to discharge industrial stormwater, fire test water, hydrostatic test water, and miscellaneous wastewater (from safety shower and eyewash stations) to an unnamed drainage canal that drains to the Wilkinson Canal. The limits and conditions of the permit were designed to avoid any negative impacts on the designated or existing uses of the receiving waterbody, though the permit does allow for changes in water quality as long as the change does not adversely affect designated or existing uses. In the Wilkinson Canal, those uses are primary contact recreation, secondary contact recreation, and propagation of fish and wildlife. The Plaquemines LNG/Gator Express Pipeline may seek a LPDES permit to discharge into the Barataria Basin. Designated uses of the receiving waterbodies in the vicinity of the Plaquemines LNG/Gator Express Pipeline project include primary contact recreation, secondary contact recreation, propagation of fish and wildlife, and oyster propagation. If permitted, restrictions similar to, but likely more stringent than, those described for the NOLA Oil Terminal would apply. The Tallgrass PLT project is an oil terminal that would be constructed immediately adjacent and upriver from the MBSD Project action alternatives intake structure in the Mississippi River. Operational activities associated with the handling and transport of oil and gas could create the potential for inadvertent oil spills to surface water in the Mississippi River, which, if not cleaned up quickly enough, could enter the MBSD Project intake structure and may ultimately settle in Barataria Basin sediments. The impact intensity of inadvertent releases of contaminants would depend upon the nature of the release. This risk would be addressed and mitigated in accordance with the Tallgrass PLT project SPCC Plan, SWPPP, and accident prevention plans.

None of the other reasonably foreseeable projects would be expected to require LPDES permits during operations.

4.25.5.4.1.2 Incremental Impacts of the MBSD Project Action Alternatives

The MBSD Project action alternatives would not have any LDPES permitted discharges during operations.

4.25.5.4.1.3 Overall Cumulative Impacts

Cumulative impacts on water quality from the two reasonably foreseeable projects in the AOI when combined with the MBSD Project action alternatives would likely be negligible. Any accidental spills or inadvertent releases of contaminants from operation of the nearby Tallgrass PLT facility could have adverse impacts on surface water and sediment quality in the Barataria Basin depending on the nature of the release. These impacts would be minimized and mitigated in accordance with the facilities' SPCC, SWPPP, and accident prevention plans. In the event of oil spills and other hazardous discharges into the Mississippi River upstream of the proposed MBSD intake structure, the diversion structure would be closed (see Appendix F MBSD Design and Operations Information).

4.25.5.4.2 Salinity

4.25.5.4.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on salinity from past and present projects and trends are factored into baseline conditions as presented in Section 4.5 Surface Water and Sediment Quality. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented below.

Table 4.25.5-3 below presents the cumulative range of salinities projected by the Delft3D Basinwide Model at each station over the 50-year analysis period. As compared to the No Action Alternative, the reasonably foreseeable projects without the MBSD Project action alternatives would have negligible impacts on monthly average salinities at all representative stations with the exception of the birdfoot delta station (CRMS 0163). A moderate increase in maximum monthly average salinity with respect to the No Action Alternative is projected at this station. The elevated salinity projected at the birdfoot delta station (CRMS 0163) for the reasonably foreseeable projects is likely a result of decreased fresh water from the river and sea-level rise. The negligible differences between the No Action Alternative and the combined impacts from the reasonably foreseeable projects indicate that modeled foreseeable projects, which are primarily restoration projects, would have minimal to no impacts on salinity in the majority of the Barataria Basin. A decadal comparison of modeled average monthly salinity for the reasonably foreseeable projects with and without the MBSD Project action alternatives is included in Appendix L.

4.25.5.4.2.2 Incremental Impacts of the MBSD Project Action Alternatives

The MBSD Project action alternatives would cause permanent impacts on salinity as summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.2.3 Overall Cumulative Impacts

The overall cumulative impacts on salinity from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would be moderate, permanent reductions throughout the basin primarily due to the MBSD Project action alternatives (Table 4.25.5-3). Reasonably foreseeable projects that were not included in the Delft3D Basinwide Model would not be expected to have substantial impacts on salinity because they are primarily restoration projects similar to those included in the model simulation.

Table 4.25.5-3
Cumulative Minimum and Maximum Average Monthly Salinities for the Reasonably Foreseeable Projects compared to MBSD Project Alternatives (2020 to 2070) (ppt)

Station	No Action Alternative	Foreseeable Projects without MBSD Project action alternatives	Applicant's Preferred Alternative	50,000 cfs Alternative	150,000 cfs Alternative
Northern/Mid-Basin (CRMS 3985)	0 – 2	0 – 2	0 – 1	0 – 1	0 – 1
Station Nearest Diversion (CRMS 0276)	1 – 8	1 – 9	0 – 4	0 – 5	0 – 7
Central Station (CRMS 0224)	1 – 17	1 – 17	0 – 12	0 – 13	0 – 11
Western Station (Little Lake near Cutoff)	0 – 10	0 – 10	0 – 5	0 – 6	0 – 3
Southwestern Station, at Barataria Pass near Grand Isle (B. Pass at GI)	6 – 28	6 – 29	2 – 27	3 – 28	1 – 26
Birdfoot Delta (CRMS 0163)	0 – 5	0 – 8	0 – 1	0 – 9	0 – 5

4.25.5.4.3 Temperature

4.25.5.4.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on temperature from past and present projects and trends are factored into baseline conditions as presented in Section 4.25.1.3. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented below.

The Delft3D Basinwide Model projects that impacts from reasonably foreseeable projects without the MBSD Project action alternatives on temperature would be similar to the No Action Alternative, indicating that reasonably foreseeable projects would have negligible to minor impacts on water temperatures. While the range of temperatures would remain consistent throughout the 50-year analysis period, the Delft3D Basinwide Model projects that, in general, the increase in temperatures would become more gradual during the winter to spring months at the six representative stations. A decadal comparison of modeled average monthly temperatures for reasonably foreseeable projects with and without the MBSD Project action alternatives is included in Appendix L. Cumulative impacts resulting from reasonably foreseeable projects without the MBSD Project action alternatives are expected to be negligible to minor and permanent. Reasonably foreseeable projects that were not included in the Delft3D Basinwide Model would not be expected to have substantial impacts on temperature because they are primarily restoration projects similar to those included in the model.

4.25.5.4.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on temperature from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.3.3 Overall Cumulative Impacts

The cumulative impacts on temperature from operation of the reasonably foreseeable projects combined with operation of the MBSD Project action alternatives are projected to be negligible to minor and permanent at all six representative stations. A decadal comparison of modeled average monthly temperature for the reasonably foreseeable projects with and without the MBSD Project action alternatives is included in Appendix L.

4.25.5.4.4 Nitrogen

4.25.5.4.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on nitrogen from past and present projects and trends are factored into baseline conditions as presented in Section 4.25.1.3. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here.

The Delft3D Basinwide Model projects that impacts of the reasonably foreseeable projects without the MBSD Project action alternatives on total nitrogen (TN) concentrations and nitrogen loading would be minor as compared to the No Action Alternative. A decadal comparison of modeled average monthly TN and nitrite (NO_3) fractions of TN for the reasonably foreseeable projects with and without the MBSD Project action alternatives is included in Appendix L. Reasonably foreseeable projects that were not included in the Delft3D Basinwide Model would not be expected to have substantial impacts on nitrogen because they are primarily restoration projects similar to those included in the model.

In addition to the reasonably foreseeable projects tabulated above, the Gulf Hypoxia Action Plan 2008 (and it's 2014 update) for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico and Improving Water Quality in the Mississippi River Basin (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008, 2014) outlines a strategy for reducing the size and impact of the Gulf of Mexico hypoxic zone and improve water quality in the Mississippi River Basin. A goal of the plan is to reduce the hypoxic zone to less than 5,000 square kilometers by 2035 with an interim target to reduce nitrogen and phosphorus loading 20 percent by 2025 (relative to the 1980 to 1996 baseline average loading to the Gulf). If these goals are attained, they would have moderate beneficial impacts on nitrogen concentrations in the river and reduce the likelihood of HAB formation in the Project area.

4.25.5.4.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on nitrogen from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.4.3 Overall Cumulative Impacts

Cumulative impacts on average nitrogen concentrations in the basin from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely be permanent and minor to moderate. Louisiana has narrative nutrient criteria (LAC 33:IX.1113.B.8) that states:

> "The naturally occurring range of nitrogen-phosphorous ratios shall be maintained. This range shall not apply to designated intermittent streams. To establish the appropriate range of ratios and compensate for natural seasonal fluctuations, the administrative authority will use site-specific studies to establish limits for nutrients. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters."

It is unlikely that the cumulative impacts would result in a change in naturally occurring range of nitrogen-phosphorous ratios. The Section 4.10.4.4 evaluation of impacts on aquatic resources is inconclusive as to whether nutrient inputs associated with the Applicant's Preferred Alternative would produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses. Attainment of Gulf Hypoxia Action Plan 2008 goals would likely partially mitigate conditions that would foster HAB formation.

When the MBSD Project action alternatives are combined with reasonably foreseeable projects, Delft3D Basinwide Model output projects that TN would increase at the northern/mid-basin station (CRMS 3985) as compared to the MBSD Project action alternatives alone. Additional cumulative impacts on TN are not projected at the other five representative stations. The elevated TN at the northern/mid-basin station (CRMS 3985) indicates that the combination of reasonably foreseeable projects and the MBSD Project action alternatives would result in elevated TN in the upper basin. Because the TN concentrations projected for the other five representative stations are not elevated as compared to the MBSD Project action alternatives alone, the system appears to return to projected MBSD action alternative levels projected at the northern-most station.

4.25.5.4.5 Phosphorus

4.25.5.4.5.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on phosphorus from past and present projects and trends are factored into baseline conditions as presented in Section 4.25.1.3. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here. There would be negligible to minor impacts on TP from reasonably foreseeable projects without the MBSD Project action alternatives. The model projects a seasonal variability in TP at all six representative stations. The duration of minimum and maximum TP concentrations would vary at each station. In general, maximums would occur in the winter, and minimums would occur in the summer (see Appendix L for detailed data showing these trends). Reasonably foreseeable projects that were not included in the Delft3D Basinwide Model would not be expected to have substantial impacts on phosphorus because they are primarily restoration projects similar to those included in the model.

The PO_4 fractions of TP projected for the reasonably foreseeable projects without the MBSD Project action alternatives would be negligible, except at northern/mid-basin station (CRMS 3985). At this station, the reasonably foreseeable projects would cause the fraction of PO_4 to be higher and to exhibit less seasonality when compared to the No Action Alternative. A similar trend in TP is not apparent, indicating that while the total amount of phosphorus remains similar, the bioavailable fraction is projected to be greater. This could be related to differences in hydraulic mixing or oxygen content associated with inputs from reasonably foreseeable projects. The Delft3D Basinwide Model projects that the system would return to PO_4 fractions consistent with the No Action Alternative fractions at the remaining five representative stations. Overall impacts on phosphorus from reasonably foreseeable projects without the MBSD Project action alternatives are expected to be negligible to minor and permanent as compared to the No Action Alternative.

In addition to the reasonably foreseeable projects tabulated above, the Gulf Hypoxia Action Plan 2008 (and it's 2014 update) for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico and Improving Water Quality in the Mississippi River Basin (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008, 2014) outlines a strategy for reducing the size and impact of the Gulf of Mexico hypoxic zone and improve water quality in the Mississippi River Basin. A goal of the plan is to reduce the hypoxic zone to less than 5,000 square kilometers by 2035 with an interim target to reduce nitrogen and phosphorus loading 20 percent by 2025 (relative to the 1980 to 1996 baseline average loading to the Gulf). If these goals are attained, they would have moderate beneficial impacts on phosphorus concentrations in the river and reduce the likelihood of HAB formation in the Project area.

4.25.5.4.5.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on phosphorus from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.5.3 Overall Cumulative Impacts

In general, the cumulative impacts of the MBSD Project action alternatives plus reasonably foreseeable projects on TP concentrations would be elevated over projected No Action concentrations at stations located closer to the immediate outfall area (station nearest the diversion [CRMS 0276] and the central station [CRMS 0224]). The model projects that cumulative impacts from reasonably foreseeable projects plus the MBSD Project action alternatives on TP would result in moderate increases in overall TP concentrations with respect to the No Action Alternative at all stations except the southwestern station, at Barataria Pass near Grand Isle (B. Pass at GI) and the birdfoot delta station (CRMS 0163), indicating that reasonably foreseeable projects plus the MBSD Project action alternatives in the basin would contribute to phosphorus loading. Negligible impacts on TP concentrations at the southwestern station, at Barataria Pass near Grand Isle (B. Pass at GI) and the birdfoot delta station (CRMS 0163) are projected. Seasonal trends and trend shifts similar to those noted for the MBSD Project action alternatives would remain under the cumulative TP projections. In general, lower-flow Project alternatives (50,000 cfs and 50,000 cfs + Terraces) are projected to result in slightly lower TP concentrations as compared to the Applicant's Preferred Alternative, and higher-flow Project alternatives (150,000 cfs and 150,000 cfs + Terraces) are projected to result in slightly higher TP concentrations.

Louisiana has narrative nutrient criteria (LAC 33:IX.1113.B.8) that states:

> "The naturally occurring range of nitrogen-phosphorous ratios shall be maintained. This range shall not apply to designated intermittent streams. To establish the appropriate range of ratios and compensate for natural seasonal fluctuations, the administrative authority will use site-specific studies to establish limits for nutrients. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters."

It is unlikely that the cumulative impacts would result in a change in naturally occurring range of nitrogen-phosphorous ratios. The Section 4.10.4.4 evaluation of impacts on aquatic resources is inconclusive as to whether nutrient inputs associated with the Applicant's Preferred Alternative would produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses. Attainment of Gulf Hypoxia Action Plan 2008 goals would likely partially mitigate conditions that would foster HAB formation.

4.25.5.4.6 Dissolved Oxygen

4.25.5.4.6.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on DO from past and present projects and trends are factored into baseline conditions as presented in Section 4.25.1.3. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here. Reasonably foreseeable projects without combined operations of the MBSD Project action alternatives would cause negligible impacts on monthly average DO concentrations (see Table 4.25.5-4) at the six representative stations of the basin. A decadal comparison of modeled average monthly DO concentrations for reasonably foreseeable projects with and without the MBSD Project action alternatives is included in Appendix L. Reasonably foreseeable projects that were not included in the Delft3D Basinwide Model that may have an impact on DO include the NOLA Oil Terminal and the Plaquemines LNG/Gator Express Pipeline LDPES discharges. The NOLA Oil Terminal is already permitted to discharge into the basin, and it is not known whether the Plaquemines LNG/Gator Express Pipeline will apply for a permit to discharge into the basin. LDPES permit limits are designed to allow discharges at concentrations that are not expected to cause impairment; therefore, potential impacts on DO from these facilities would be temporary and minor. The impacts could be adverse or beneficial, depending on whether they increase or reduce DO concentrations.

Table 4.25.5-4
Cumulative Minimum and Maximum Average Monthly DO for the Reasonably Foreseeable Projects with and without the Proposed MBSD Project Action Alternatives (2020 to 2070) (mg/L)

Station	No Action Alternative	Foreseeable projects without MBSD Project action alternatives	Foreseeable projects with MBSD Project action alternatives
Northern/Mid-Basin (CRMS 3985)	5.8 – 11.0	5.8 – 11.0	5.7 – 11.2
Station Nearest Diversion (CRMS 0276)	6.5 – 11.4	6.5 – 11.4	6.5 – 11.3
Central Station (CRMS 0224)	5.9 – 10.6	5.9 – 10.6	5.8 – 14.2
Western Station (Little Lake near Cutoff)	6.0 – 10.9	6.0 – 10.9	5.9 – 11.0
Southwestern Station, at Barataria Pass near Grand Isle (B. Pass at GI)	6.0 – 9.0	6.0 – 9.0	5.6 – 10.0
Birdfoot Delta (CRMS 0163)	6.8 – 13.9	6.8 – 13.9	6.9 – 13.9

4.25.5.4.6.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on DO from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.6.3 Overall Cumulative Impacts

Overall cumulative impacts on DO from operation of the MBSD Project action alternatives combined with operation of the reasonably foreseeable projects would be minor to moderate and permanent. Actions that may increase DO concentrations include water column mixing and/or algae blooms. Reasonably foreseeable projects planned in the vicinity of the central station (CRMS 0224) include the Barataria Basin Ridge and Marsh Creation – Spanish Pass Increment. Projects planned in the vicinity of the southwestern station, at Barataria Pass near Grand Isle (B. Pass at GI) include the West Grand Terre Beach Nourishment and Stabilization project. Overall cumulative impacts on DO resulting from the reasonably foreseeable projects combined with the MBSD Project action alternatives are expected to be minor to moderate and permanent. Cumulative impacts on DO from the other action alternatives are expected to be similar to the modeled action alternative.

Average DO concentrations at the six representative stations are not projected to fall below LDEQ's DO criteria, which range from 3.8 to 5.0 mg/L in selected months, during the 50-year analysis period. See Chapter 3, Section 3.5 Surface Water and Sediment Quality for additional information about water quality standards in the Barataria Basin and Mississippi River.

4.25.5.4.7 Total Suspended Solids

4.25.5.4.7.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on water quality from past and present projects and trends are factored into baseline conditions as presented in Section 4.25.1.3. The reasonably foreseeable projects without the MBSD Project action alternatives are projected to have minor impacts on monthly average TSS concentrations at the six representative stations. The minor changes in TSS indicate that reasonably foreseeable projects would contribute to minor fluctuations in TSS concentrations in the basin (see Appendix L for detailed data).

4.25.5.4.7.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on TSS from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.7.3 Overall Cumulative Impacts

Cumulative impacts on TSS from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely be minor to moderate increases at all six representative stations over the 50-year analysis period as compared to the No Action Alternative. The increases are projected to be more pronounced at the stations nearest to the immediate outfall area. In general, lower-flow Project alternatives (50,000 cfs and 50,000 cfs + Terraces) are projected to result in slightly lower TSS concentrations as compared to the Applicant's Preferred Alternative, and higher-flow Project alternatives (150,000 cfs and 150,000 cfs + Terraces) are projected to result in slightly higher TSS concentrations. These cumulative impacts may be considered minor to moderate and permanent. These impacts may be considered beneficial if TSS drops out of the water column, as the MBSD Project action alternatives are designed to increase sediment in the Barataria Basin. However, these impacts may indirectly result in adverse impacts on turbidity in some areas of the basin. Louisiana has not adopted water quality standards for TSS.

4.25.5.4.8 Sulfate

4.25.5.4.8.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on sulfate from past and present projects and trends are factored into baseline conditions as presented in Section 4.25.1.3. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here. The Delft3D Basinwide Model projects that the reasonably foreseeable projects without the MBSD Project action alternatives would have negligible impacts on seasonal variability, but minor to moderate impacts on monthly average sulfate concentrations as compared to the No Action Alternative across the basin. The cumulative Delft3D Basinwide Model output projects that sulfate concentrations would be variable by station (some stations are projected to have higher sulfate concentrations, and some are projected to have lower concentrations) as compared to the No Action Alternative, indicating that reasonably foreseeable projects in the basin are likely to have an impact on sulfate cycling throughout the system. The magnitude of differences between the No Action Alternative and the reasonably foreseeable projects without the MBSD Project action alternatives would decrease slightly with distance from the Project immediate outfall area. A decadal comparison of modeled average monthly sulfate concentrations for the reasonably foreseeable projects with and without the MBSD Project action alternatives is included in Appendix L. The impacts on sulfate from reasonably foreseeable projects without the MBSD Project action alternatives may be considered minor to moderate and permanent.

4.25.5.4.8.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on sulfate from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.8.3 Overall Cumulative Impacts

Cumulative impacts on sulfate concentrations from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely be minor to moderate and permanent, with general decreases in the basin as compared to the No Action Alternative. The range of decreases is projected to be similar to that projected for the MBSD Project action alternatives. The largest consistent decreases (ranging from 0 to 260 mg/L) are projected to occur at the station nearest the diversion (CRMS 0276) and the central station (CRMS 0224). The impact of foreseeable projects plus the MBSD Project action alternatives would be moderate but greater than the Applicant's Preferred Alternative, with decreases of 100 to 200 mg/L projected at the southwestern station, at Barataria Pass near Grand Isle (B. Pass at GI) in the winter months (November through February). In general, lower-flow Project alternatives (50,000 cfs and 50,000 cfs + Terraces) are projected to result in slightly higher sulfate concentrations as compared to the Applicant's Preferred Alternative, and higher-flow Project alternatives (150,000 cfs and 150,000 cfs + Terraces) are projected to result in slightly lower sulfate concentrations. This would be consistent with the varying amount of lower sulfate Mississippi River water impacting the basin.

The combined impacts of the reasonably foreseeable projects including the MBSD Project action alternatives are projected to cause average monthly sulfate concentrations to seasonally exceed the LDEQ water quality criteria of 50 to 150 mg/L that is applicable to portions of the basin. However, the LDEQ water quality criteria are not applicable to the estuarine subsegments where the six representative stations are located. Overall, the cumulative impact of the MBSD Project action alternatives of generally lowering sulfate concentrations would improve water quality conditions with respect to sulfate. This impact may be considered minor to moderate, permanent, and beneficial.

4.25.5.4.9 Fecal Coliform

4.25.5.4.9.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on fecal coliform from past and present projects and trends are factored into baseline conditions as presented in Section 4.5 Surface Water and Sediment Quality. The majority of reasonably foreseeable projects are restoration projects that would have negligible impacts on fecal coliform concentrations. The NOLA Oil Terminal plans to discharge treated water into the Barataria Basin (LDEQ Agency Interest # 186945, PER20140001, January 7, 2016). In 2016, the NOLA Oil Terminal was issued an LPDES permit to discharge industrial stormwater, fire test water, hydrostatic test water, and miscellaneous wastewater (from safety shower and eyewash stations) to an unnamed drainage canal that drains to the Wilkinson Canal. The permit does not include sanitary wastewater or require monitoring for fecal coliforms; therefore, impacts on fecal coliforms from the NOLA Oil Terminal are expected to be negligible.

The Plaquemines LNG/Gator Express Pipeline may seek a LPDES permit to discharge into the Barataria Basin. Designated uses of the receiving waterbodies in the vicinity of the Plaquemines LNG/Gator Express Pipeline project include primary contact recreation, secondary contact recreation, propagation of fish and wildlife, and oyster propagation. If permitted for sanitary discharge, the limits and conditions of the permit would be designed to avoid any negative impacts on the designated or existing uses of the receiving waterbody, though they would allow for changes in water quality as long as the change would not adversely affect designated or existing uses. Therefore, cumulative impacts on water quality from these two reasonably foreseeable projects would likely be negligible to minor and localized.

4.25.5.4.9.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on fecal coliform from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.5 Surface Water and Sediment Quality.

4.25.5.4.9.3 Overall Cumulative Impacts

Cumulative impacts on fecal coliform from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely be permanent, major, and adverse.

4.25.6 Wetland Resources and Waters of the U.S.

4.25.6.1 Geographic and Temporal Extent of Analysis

The AOI associated with wetlands impacted by construction of the MBSD Project action alternatives during the 5-year construction period is limited to the areas where wetlands are within the Project construction footprint, as well as existing and created wetlands that could be affected by sedimentation due to runoff from construction (about 0.25 mile from the Project).

The AOI associated with wetlands impacted by operation of the MBSD Project action alternatives during the 50-year operational analysis period includes the Barataria Basin and the birdfoot delta, where the extent of wetlands would change as a result of the diversion of sediment and water from the Mississippi River to the basin (see Section 4.6 Wetland Resources and Waters of the U.S.).

4.25.6.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

As described in Chapter 3, Section 3.6.2 in Wetland Resources and Waters of the U.S., ongoing environmental trends including coastal erosion, subsidence, sea-level rise, saltwater intrusion, and storms have contributed to wetland loss in coastal Louisiana. Past and present human actions contributing to the loss or conversion of wetlands in the Project area include oil and gas and other development; levee construction; canal dredging; and fluid withdrawal for oil and gas extraction or groundwater wells. Conversely, past and present wetland restoration projects, including Mississippi River diversions and wetland restoration projects in Barataria Basin and the birdfoot delta contribute to wetland gains and help to offset ongoing wetland loss in the Project area (see Section 4.25.1 for more information about past and present projects). These projects and trends collectively contribute to the existing wetland conditions in the Barataria Basin and the birdfoot delta as described in Chapter 3, Section 3.6 Wetland Resources and Waters of the U.S. and as assessed for the No Action

Alternative and the six action alternatives in Section 4.6 Wetland Resources and Waters of the U.S.

Reasonably foreseeable projects that have the potential to contribute cumulative impacts on wetlands are shown in Table 4.25.6-1. These include hurricane and flood risk reduction, major industrial developments, recreation, navigation, and municipal projects.

Table 4.25.6-1
Reasonably Foreseeable Projects with Potential Cumulative Impacts on Wetlands during MBSD Project Construction and Operations

Project Name (Mapped # in Figure 4.25.1-1)	Construction Overlap	Operations Overlap	Cumulatively Impacted Area	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?
Tallgrass PLT[136] (2)	X		Forced Drainage Area Between Levees	No
NOV-NF-W-05a.1 Project (1)	X		Forced Drainage Area Between Levees	Yes
Mid-Breton Sediment Diversion (4)		X	Birdfoot delta	Yes
Barataria Basin Ridge and Marsh Creation-Spanish Pass Increment (39)		X	Birdfoot delta	Yes
Spanish Pass Ridge and Marsh Restoration (42)		X	Birdfoot delta	Yes
Mississippi River Beneficial Use of Dredged Material Program (not mapped)		X	Birdfoot delta	No
Pass A Loutre Crevasses (43)		X	Birdfoot delta	No
South Pass Bird Island Enhancement (45)		X	Birdfoot delta	No
Barataria Bay Rim Marsh Creation and Stabilization (21)		X	Barataria Basin	Yes
Bayou Grande Cheniere Marsh & Ridge Restoration (19)		X	Barataria Basin	Yes
Bayou L'Ours Marsh Terracing (27)		X	Barataria Basin	Yes
Caminada Headlands Back Barrier Marsh Creation (38)		X	Barataria Basin	Yes
Caminada Headlands Back Barrier Marsh Creation Increment 2 (37)		X	Barataria Basin	Yes
East Leeville Marsh Creation and Nourishment (33)		X	Barataria Basin	Yes

[136] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

Table 4.25.6-1
Reasonably Foreseeable Projects with Potential Cumulative Impacts on Wetlands during MBSD Project Construction and Operations

Project Name (Mapped # in Figure 4.25.1-1)	Construction Overlap	Operations Overlap	Cumulatively Impacted Area	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?
Large-Scale Marsh Creation and Component E- Planning (8)		X	Barataria Basin	Yes
Northwest Turtle Bay Marsh Creation (18)		X	Barataria Basin	Yes
Grand Bayou Ridge and Marsh Restoration (20)		X	Barataria Basin	No
Grand Cheniere Ridge and Marsh Creation (17)		X	Barataria Basin	No
Long-Distance Sediment Pipeline, Phase 2 (11)		X	Barataria Basin	No
Northeast Turtle Bay Marsh Creation and Critical Area Shoreline Protection (13)		X	Barataria Basin	No
Previously Authorized Mitigation-WBV (25)		X	Barataria Basin	No
Queen Bess Island Restoration (28)		X	Barataria Basin	No
Shoreline Protection at Jean Lafitte National Historical Park and Preserve (23)		X	Barataria Basin	No
West Grand Terre Beach Nourishment and Stabilization (29)		X	Barataria Basin	Yes

4.25.6.3 Cumulative Impacts during Construction

4.25.6.3.1 Wetland Types and Extent

4.25.6.3.1.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on wetlands from past or present projects and trends are captured in the analysis in Section 4.6 Wetland Resources and Waters of the U.S. Reasonably foreseeable projects identified in the cumulative impacts AOI may result in the permanent, moderate loss or conversion of wetlands where present within their construction boundaries. Additionally, stormwater runoff during construction of these other projects could have a temporary, negligible to minor, adverse impact on water quality in existing and created wetlands. The NOV-NF-W-05a.1 Project would directly impact about 7 acres of wet pasture in the cumulative impact AOI. While issuance of a permit for the Tallgrass PLT project is pending, the project would directly impact 19.6 acres of jurisdictional wetlands. However, both project proponents would be required to comply with USACE mitigation requirements to ensure no net loss of wetland functions through implementation of wetland restoration or compensatory mitigation.

4.25.6.3.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on wetlands during construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.6 Wetland Resources and Waters of the U.S.

4.25.6.3.1.3 Overall Cumulative Impacts

Consequently, cumulative impacts on wetlands from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would be temporary to permanent, negligible to moderate, and adverse. Impacts on wetlands resulting from the MBSD Project action alternatives would be adequately minimized and mitigated by operational benefits and applicable compensatory mitigation. Any wetland mitigation requirements for Tallgrass PLT and NOV-NF-W-05a.1 projects would offset the impacts on wetlands from those projects. These potential cumulative impacts would be consistent across all six MBSD action alternatives.

4.25.6.3.2 Wetland Invasive Plants

4.25.6.3.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on wetlands from the spread and establishment of aquatic invasive species are presented in the analysis in Section 4.6 Wetland Resources and Waters of the U.S. Reasonably foreseeable projects identified in the cumulative impacts AOI may result in the permanent, moderate loss or conversion of wetlands where present within their construction boundaries. Where wetlands are lost or converted, these alternatives would result in minor, direct, permanent, beneficial impacts from the removal of invasive species in wetlands converted to developed land. Alternatively, minor to moderate, indirect, long-term adverse impacts could occur in the event that disturbance from construction of reasonably foreseeable future projects results in the spread of aquatic invasive species.

4.25.6.3.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on wetland invasive plants from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.6 Wetland Resources and Waters of the U.S.

4.25.6.3.2.3 Overall Cumulative Impacts

Consequently, cumulative impacts on wetland invasive species from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would include minor, direct, permanent, beneficial impacts where invasive species are removed from wetlands converted to developed land and open water. Minor to moderate indirect, long-term, adverse impacts would occur in the event that disturbance of the construction footprint of the projects results in the spread of aquatic invasive species.

4.25.6.4 Cumulative Impacts during Operations

4.25.6.4.1 Wetland Types and Extent

4.25.6.4.1.1 Salinity and Nutrients

4.25.6.4.1.1.1 Past, Present, and Reasonably Foreseeable Future Projects without MBSD Project Action Alternatives

The ongoing impacts on wetlands related to salinity and nutrients from past and present projects and trends are factored into baseline conditions as presented in Section 4.6 Wetlands and Waters of the U.S and Section 4.5.4. in Surface Water and Sediment Quality. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here. As described in Section 4.25.5 (Surface Water and Sediment Quality), reasonably foreseeable projects would have negligible impacts on salinity, nitrogen, and phosphorous loading in the Barataria Basin and birdfoot delta. Therefore, other reasonably foreseeable future projects are not expected to contribute to cumulative impacts on marsh types related to salinity impacts and wetland plant productivity related to nitrogen and phosphorus loading.

4.25.6.4.1.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on wetlands related to salinity and nutrients from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.6 Wetland Resources and Waters of the U.S.

4.25.6.4.1.1.3 Overall Cumulative Impacts

Given the negligible impacts of other reasonably foreseeable projects on salinity and nutrient loading, overall, the cumulative impacts on salinity and nutrients are expected to be permanent, and to be consistent with those impacts described above for the MBSD Project action alternatives.

4.25.6.4.1.2 Soil Shear Strength

4.25.6.4.1.2.1 Past, Present, and Reasonably Foreseeable Future Projects without MBSD Project Action Alternatives

The impacts on soil shear strength from recently completed and ongoing projects and trends are factored into baseline conditions as presented in Section 4.6 Wetland Resources and Waters of the U.S. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here.

Reasonably foreseeable restoration projects in the Barataria Basin could also affect soil shear strength within the specific wetland areas subject to wetland creation, restoration, or enhancement by each project. Soil properties in restored wetlands depend on the source of fill material and site-specific restoration methods (Feher et al. 2018). However, generally the deposition of sediments transported by diversions or via placement of dredged material is expected to increase soil elevations. Because the impact on nutrients in Barataria Basin associated with the other reasonably foreseeable projects would be negligible (as described above), adverse impacts on soil shear strength due to associated reduced root-shoot ratios would not be expected. Bulk density, which depends on the inorganic content of soils, may be an indicator of shear strength in wetland soils (Jafari et al. 2019). Therefore, the localized soil shear strength associated with each reasonably foreseeable wetland restoration project will be site-specific, dependent on the soils or sediments used for restoration, and may be both adverse and beneficial.

4.25.6.4.1.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on soil shear strength from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.6 Wetland Resources and Waters of the U.S.

4.25.6.4.1.2.3 Overall Cumulative Impacts

Overall, the cumulative impact on soil shear strength from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely be permanent, and to vary from adverse to beneficial, depending on localized nutrient loading and sediment deposition.

4.25.6.4.1.3 Land Accretion

Cumulative impacts on wetland accretion were evaluated both quantitatively and qualitatively. The results of the Delft3D Basinwide Model numerical, ecosystem, and vegetation models were used to project vegetation cover types and extent over the 50-year analysis period, as further described in Section 4.6.2 in the Wetland and Waters of the U.S. section. The reasonably foreseeable projects included in Delft3D Basinwide Model that would impact wetland accretion during operation are restoration projects (see Table 4.25.6-1 and Figures 4.25.1-1 and 4.25.1-2). In addition to the reasonably foreseeable projects in the Delft3D Basinwide Model, restoration projects not included in the model would restore about 4,500 acres of wetlands (marsh, swamp, and bottomland hardwoods) in the Barataria Basin (see restoration projects listed in Table 4.25.1-1). Cumulative impacts on wetlands from those projects not included in the model were assessed qualitatively.

4.25.6.4.1.3.1 Past, Present, and Reasonably Foreseeable Projects without MBSD Project Action Alternatives

The impacts on land accretion from recently completed and ongoing projects and trends are factored into baseline conditions as presented in Section 4.6 Wetland Resources and Waters of the U.S. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here.

Reasonably foreseeable projects included in the Delft3D Basinwide Model are restoration projects and as such are anticipated to have major, long-term beneficial impacts on wetlands in the areas where wetlands are sustained and created by each respective project. However, these beneficial wetland impacts would not be permanent; by 2070 the benefits of the reasonably foreseeable projects in the Barataria Basin are expected to be negligible to minor as compared with the No Action Alternative, due to projected wetland losses caused by saltwater intrusion and sea-level rise, as assessed in the Delft3D Basinwide Model. If all of the other projects are completed, wetland loss in the Barataria Basin and birdfoot delta would nevertheless total 298,000 and 54,700 acres, respectively, by 2070. While the life of other proposed marsh creation projects is limited, they would provide substantial benefits over the course of their life including fisheries production and storm surge risk reduction. In addition to the reasonably foreseeable projects in the Delft3D Basinwide Model, about 4,500 acres of wetlands are planned to be restored associated with the restoration projects presented in Table 4.25.6-1 not included in the Delft3D Basinwide Model. Additional future projects are anticipated to continue those benefits, but those projects were not sufficiently developed to be evaluated in this document.

Within the operational AOI, reasonably foreseeable restoration projects would involve land building by using dredged materials to create wetland habitat, restore degraded marsh, and nourish existing marsh; however, between 2020 and 2070, these projects would cause only an increase of 42 acres in the basin (see Table 4.25.6-2). Reasonably foreseeable restoration projects not included in the Delft3D Basinwide Model would add additional benefits to wetlands, but some contributions to wetland acreages from these additional projects would likely be offset by sea-level rise. Therefore, the reasonably foreseeable future restoration projects would result in a permanent, negligible to minor, benefit to the extent of wetlands in the Barataria Basin (see Figure 4.25.6-1 below).

Table 4.25.6-2
Results of Vegetation Modeling and Projected Acreage of Wetland Acreage, by Decade and Wetland Type, for the Project Alternatives

Alternative/ Area	Wetland Cover Type	2020	2030	2040	2050	2060	2070	Total Acres of Wetland Loss by 2070[a]
Foreseeable Projects without MBSD Project Action Alternatives								
Barataria Basin	Fresh/ Intermediate Marsh	233,000	228,000	210,000	177,000	122,000	60,600	173,000
	Brackish Marsh	66,500	58,900	44,100	23,900	12,100	5,890	64,700
	Saline Marsh	73,700	56,600	36,400	19,100	8,590	6,300	60,500
	Total	373,000	343,000	290,000	220,000	143,000	72,800	298,000
Birdfoot Delta	Fresh/ Intermediate Marsh	44,400	35,600	21,000	13,100	8,900	2,420	42,000
	Brackish Marsh	10,300	3,510	3,640	4,070	1,570	1,670	8,670
	Saline Marsh	4,220	1,880	1,360	1,030	240	160	3,990
	Total	58,900	41,000	26,000	18,200	10,700	4,260	54,700
Foreseeable Projects with MBSD 150,000 cfs + Terraces Alternative								
Barataria Basin	Fresh/ Intermediate Marsh	275,000	279,000	270,000	227,000	164,000	93,700	140,000
	Brackish Marsh	54,500	51,600	25,600	12,600	3,040	950	69,700
	Saline Marsh	43,700	23,100	13,100	10,100	4,580	4,120	62,700
	Total	373,000	354,000	309,000	250,000	172,000	98,800	272,000
Birdfoot Delta	Fresh/ Intermediate Marsh	43,600	32,800	18,800	11,900	7,360	3,260	41,200
	Brackish Marsh	10,600	3,770	2,990	3,330	922	935	9,410
	Saline Marsh	4,710	2,080	1,420	871	322	158	3,990
	Total	58,900	38,600	23,200	16,100	8,600	4,350	54,600

[a] As compared with the No Action Alternative in 2020.

Table 4.25.6-3
Wetland Gains and Losses when Compared with the No Action Alternative
Acres (Percent)

Alternative	Watershed	2020	2030	2040	2050	2060	2070
Foreseeable Projects without MBSD Project action alternatives	Barataria Basin	2,340	3,010	3,470	2,470	3,560	42
		(0.6)	(0.9)	(1.2)	(1.1)	(2.6)	(0.1)
	Birdfoot Delta	–36	–359	546	747	228	–2,150
		(–0.1)	(–0.9)	(2.1)	(4.3)	(2.2)	(–33.6)
Foreseeable Projects with MBSD 150,000 cfs + terraces action alternative	Barataria Basin	2,294	13,034	22,098	32,013	32,685	26,021
		(0.6)	(3.8)	(7.7)	(14.7)	(23.5)	(35.8)
	Birdfoot Delta	–61	–2,680	–2,340	–1,300	–1,870	–2,060
		(–0.1)	(–6.5)	(–9.2)	(–7.5)	(–17.9)	(–32.1)

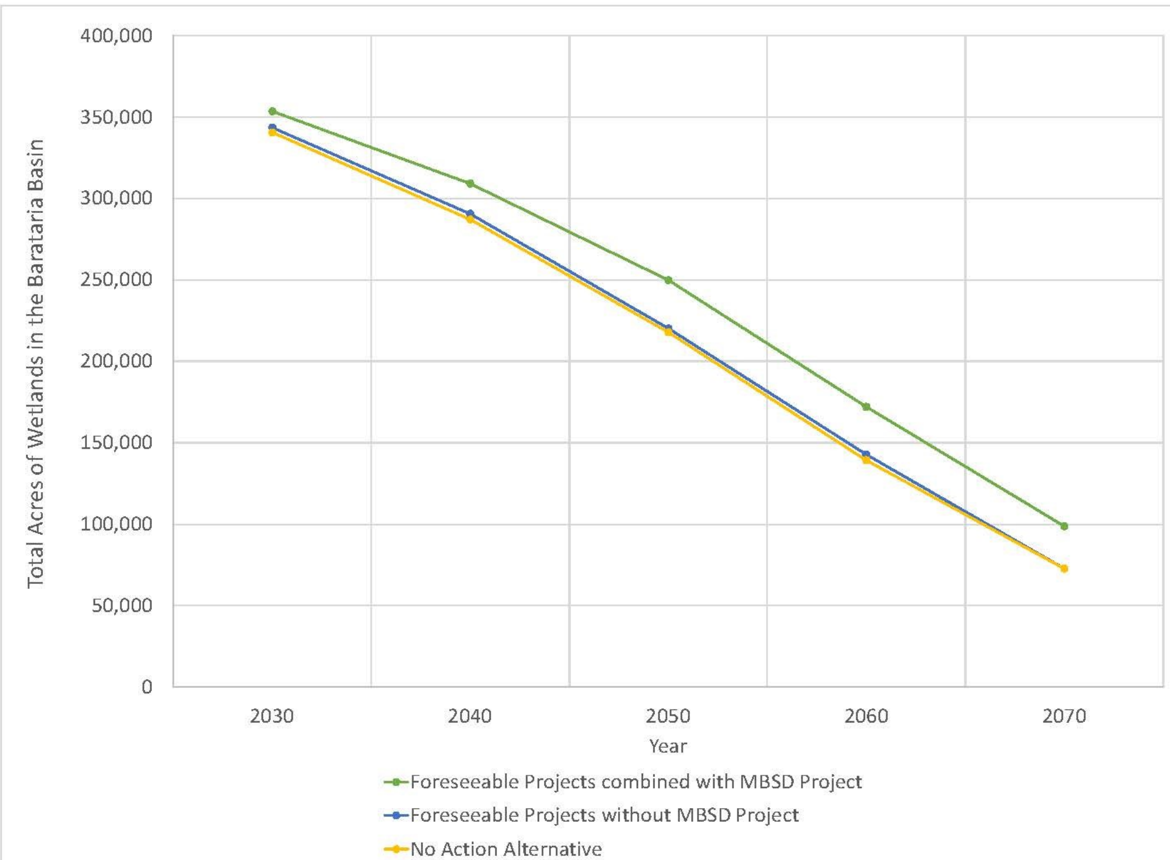


Figure 4.25.6-1. Barataria Basin Wetlands Created and Sustained by Foreseeable Projects with and without the Proposed MBSD Project (based on Delft3D Basinwide Model under then 150,000 cfs + Terraces Alternative).

The diversion of sediment and fresh water associated with the Mid-Breton Sediment Diversion could result in wetland losses in the birdfoot delta where wetlands are lost due to reduced sediment and freshwater inputs, which could contribute minor to moderate, permanent, adverse impacts on wetlands. However, the Barataria Basin Ridge and Marsh Creation – Spanish Ridge Increment and the Spanish Pass Ridge and Marsh Restoration projects would use dredged sediment to restore over 1,600 acres of marsh in the birdfoot delta (see Table 4.25.1-1). Between 2020 and 2050, the reasonably foreseeable projects would reduce wetland losses by a maximum of 747 acres. However, by 2070 wetland losses would be similar to the No Action Alternative. Overall, the birdfoot delta is projected to lose 2,150 acres of wetlands if the reasonably foreseeable projects are built based on the results of the Delft3D Basinwide Model, as compared with the No Action Alternative (see Table 4.25.6-3). Therefore, over the 50-year analysis period, the reasonably foreseeable projects would contribute a minor to moderate, permanent, adverse effect on the wetland area in the birdfoot delta (see Figure 4.25.6-2 below).

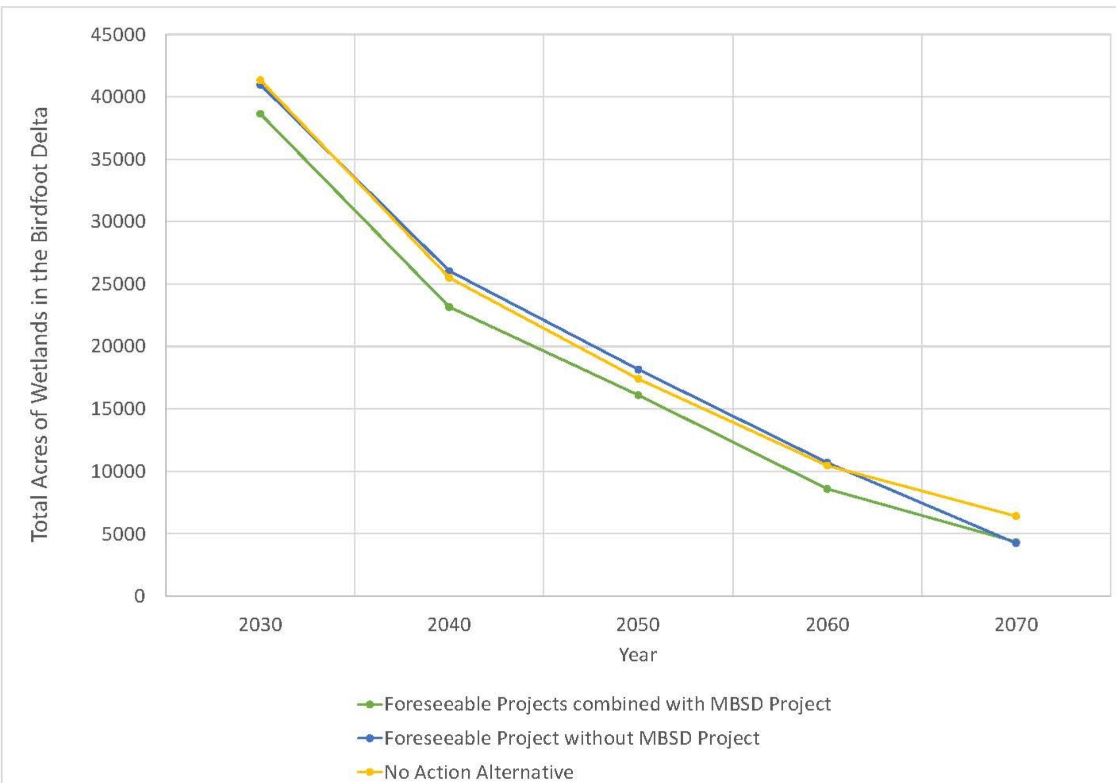


Figure 4.25.6-2. Birdfoot Delta Wetlands Created and Sustained by Foreseeable Projects with and without the Proposed MBSD Project (based on Delft3D Basinwide Model under then 150,000 cfs + Terraces Alternative).

4.25.6.4.1.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on land accretion from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.6 Wetland Resources and Waters of the U.S.

4.25.6.4.1.3.3 Overall Cumulative Impacts

Cumulative impacts on wetland accretion from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely result in fewer losses in wetlands in both the Barataria Basin and birdfoot delta, but most notably in the Barataria Basin where implementation of the MBSD Project action alternatives would prevent the loss of an additional 26,000 acres. The change in wetland gains over each decade of operations is shown in Table 4.25.6-2. If all of the reasonably foreseeable projects plus the MBSD Project action alternatives are built, the results of the Delft3D Basinwide Model project a 35.7 percent increase in total wetland area in the Barataria Basin when compared with the No Action Alternative by 2070. Figures 4.25.6-1 and 4.25.6-2 show these results graphically. As described above, additional wetland benefits would occur through the implementation of the foreseeable future restoration projects not included in the model simulation. Therefore, the MBSD Project action alternatives in combination with other reasonably foreseeable projects would contribute major, direct, permanent, beneficial impacts on wetlands in Barataria Basin.

Both the MBSD Project action alternatives and Mid-Breton Sediment Diversion would reduce sediment transport to the birdfoot delta, thereby reducing the capability of wetlands to build land at a rate sufficient to offset relative sea-level rise. However, other reasonably foreseeable restoration projects in the birdfoot delta are projected to offset some of those losses between 2020 and 2060, resulting in a temporary benefit to wetland area. The change in wetland gains over each decade of operations are shown in Table 4.25.6-2 when compared with the No Action Alternative. Overall, cumulative impacts of the MBSD Project action alternatives and the reasonably foreseeable projects on land accretion in the birdfoot delta would be adverse, moderate, and permanent (a loss of 2,060 acres by 2070 as compared with the No Action Alternative).

While the Delft3D Basinwide Model simulation for cumulative impacts uses the 150,000 cfs + Terraces Alternative to capture the greatest potential cumulative wetland impacts associated with the action alternatives, the impacts of the other action alternatives (including the 50,000 and 75,000 Action Alternatives, and all three terrace alternatives) would be similar, but would scale with the volume of sediment and fresh water diverted. As such, the direct and indirect impacts from operation of all other action alternatives combined with foreseeable projects would be the same as for the MBSD Project action alternatives, with major, permanent, beneficial impacts in the Barataria Basin and moderate, permanent, adverse impacts in the birdfoot delta.

4.25.6.4.2 Wetland Invasive Plants

4.25.6.4.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Invasive plant species are already present in the Barataria Basin under current conditions; because of the rapid growth characteristics of invasive plants (described further in Chapter 3, Section 3.6 Wetland Resources and Waters of the U.S.), they could be established in enhanced, restored, and created wetlands associated with the reasonably foreseeable restoration projects in the cumulative impacts area. Because newly created and/or restored wetlands may be vulnerable to the establishment of invasive plants, the other reasonably foreseeable projects could result in minor to moderate, permanent, adverse impacts from the spread of invasive species in the Barataria Basin. In the birdfoot delta, the relative loss of wetland area associated with the reasonably foreseeable future project could restrict the range of some invasive species, or preclude their establishment. Therefore, the reasonably foreseeable future projects could result in negligible to minor, permanent, beneficial impacts on the spread and introduction of invasive species in the birdfoot delta.

4.25.6.4.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on wetland invasive species from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.6 Wetland Resources and Waters of the U.S.

4.25.6.4.2.3 Overall Cumulative Impacts

Cumulative impacts on the spread and introduction of invasive species in wetlands from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely be minor to moderate, permanent, and adverse in the Barataria Basin and negligible to minor, permanent, and beneficial in the birdfoot delta.

4.25.7 Air Quality

4.25.7.1 Geographic and Temporal Extent of Analysis

The cumulative impact area associated with construction air emissions is the immediate vicinity (within about 1 mile) of the construction footprint because construction emissions are highly localized. This is the area in which potential construction impacts from the Project could result in overlapping impacts on air quality. The temporal extent of the analysis is the 5-year construction period.

During operations, air quality impacts would be negligible and are therefore not assessed further for cumulative impacts.

4.25.7.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to contribute to existing air quality would be construction projects that require the use of heavy equipment, which generate emissions of air pollutants and fugitive dust, as well as facilities that require air permits for operation. These types of projects generally include major industrial projects. These projects collectively contribute to the characterization of the Project area as described in Chapter 3, Section 3.7 Air Quality and their contribution to air quality in the Project area is reflected in the data presented therein. As such, the impact on air quality from past or present projects is captured in the analysis in Section 4.7 Air Quality.

As identified in Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2, the planned projects encompassed by the construction impact area for air quality include the following:

- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[137] (Map #2 in Figure 4.25.1-1)

4.25.7.3 MBSD Cumulative Impacts during Construction

4.25.7.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Construction of each of the reasonably foreseeable projects would likely involve operation of combustion-powered equipment, barges delivering construction materials and equipment, and trucks, equipment, and workers traveling to work areas. The emissions and dust generated from these activities would have temporary, minor to moderate adverse direct and indirect impacts on air quality. These projects would be required to comply with applicable regulations for the control of fugitive dust, and therefore the cumulative impacts from the reasonably foreseeable projects on air quality in the Project area are expected to be temporary, direct and indirect, and minor to moderate.

[137] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

4.25.7.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on air quality from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.7 Air Quality.

4.25.7.3.3 Overall Cumulative Impacts

If construction of the reasonably foreseeable projects planned along the Mississippi River (Loading Dock on Mississippi River, NOV-NF-W-05a.1 Project, and Tallgrass PLT) were to occur at the same time as construction of the MBSD Project action alternatives, concurrent construction would result in cumulative, adverse impacts on air quality (for example, increased emissions of criteria pollutants from operation of combustion-powered equipment or fugitive dust). Construction pollutant emissions associated with the MBSD Project action alternatives would be temporary and spread out over 5 years. Once construction of the MBSD Project action alternatives, and other reasonably foreseeable projects, is completed, the combustion and fugitive emissions described above would no longer occur.

As discussed in Section 4.7 Air Quality, all diversion capacity alternatives (including the 50,000 cfs Alternative and 150,000 cfs Alternative) would have similar construction footprints. However, construction timeframes for the 50,000 cfs and 150,000 cfs alternatives would be slightly shorter or longer than the MBSD Applicant's Preferred Alternative; the difference in which would be negligible. Further, any incremental impacts on air quality from the construction of terraces would be negligible. As such the cumulative impact from any Project action alternative combined with foreseeable projects would be the same as for the MBSD Project action alternatives.

4.25.7.4 Cumulative Impacts during Operations

Direct, indirect, and cumulative impacts from operation of the MBSD Project action alternatives would be negligible. Therefore, the cumulative impacts of the MBSD Project action alternatives on air quality during the 50-year analysis period are not assessed further.

4.25.8 Noise

4.25.8.1 Geographic and Temporal Extent of Analysis

4.25.8.1.1 Airborne Noise

The AOI for the evaluation of cumulative construction impacts on airborne noise is the immediate vicinity (within about 1 mile) of the construction footprint since construction activities would be highly localized and sound attenuates with increasing distance from the source. At this distance, noise from construction of the MBSD Project action alternatives and other reasonably foreseeable projects could result in overlapping impacts on NSAs. Similar to construction, operation of the MBSD Project action alternatives would produce noise in the immediate Project vicinity, and that noise would attenuate over distance. Consistent with the airborne noise AOI during construction, the area of potential cumulative impacts on airborne noise during operations was set at 1 mile.

4.25.8.1.2 Underwater Noise

The construction AOIs for underwater noise are the species-specific ZOIs that were identified for the MBSD Project, as further described in Section 4.10 Aquatic Resources, Section 4.11 Marine Mammals, and Section 4.12 Threatened and Endangered Species. For fish in the Mississippi River, this includes an AOI of 2.9 miles. For aquatic resources in the Barataria Basin, the largest effective ZOI is 2 miles, which is the behavioral ZOI for mid-frequency cetaceans (dolphins). Adverse noise impacts on aquatic resources due to maintenance dredging during operations, if required, would be negligible as these events would be relatively brief and are not anticipated to exceed injury levels.

4.25.8.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with activities contributing to ambient or background noise would be projects that require use of heavy equipment or pile driving during construction, as well as operation of industrial facilities and large project components (such as a diversion complex that involves opening and closing of diversion gates), and water flow through existing diversions. Vessel traffic in the Mississippi River and Barataria Bay also contribute to the airborne and underwater noise environments. These types of projects generally include major industrial projects and some restoration projects. These projects collectively contribute to the ambient or background noise as characterized in Chapter 3, Section 3.8 Noise. As such, the impact on noise from these past or recently completed projects is captured in the analysis in Section 4.8 Noise.

4.25.8.2.1 Airborne Noise

As identified in Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2, the reasonably foreseeable projects encompassed by the construction and operational AOIs for airborne noise include the following:

- Mid-Breton Sediment Diversion (Map #4 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)

- Tallgrass PLT[138] (Map #2 in Figure 4.25.1-1)

4.25.8.2.2 Underwater Noise

As identified in Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2, the reasonably foreseeable projects encompassed by the construction AOI for underwater noise impacts on fish include the following:

- Tallgrass PLT (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- Mid-Breton Sediment Diversion (Map #4 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)

As the MBSD Project would result in negligible impacts (no exceedance of thresholds) during operational maintenance dredging, cumulative impacts from underwater noise during operations are not assessed further.

4.25.8.3 Cumulative Impacts during Construction

4.25.8.3.1 Past, Present, and Reasonably Foreseeable Future Projects Considered

4.25.8.3.1.1 Airborne Noise

Construction of the reasonably foreseeable projects would require use of noise-generating equipment. The most prevalent noise-generating equipment and activity for projects in the AOI is anticipated to be pile driving, although internal combustion engines associated with general construction equipment and dredging would also produce sound that would be perceptible in the vicinity of these activities. Noise from construction activities varies greatly depending on the type and model of construction equipment, the operations being performed, and the overall condition of the equipment. The foreseeable projects are relatively large projects that are anticipated to have similar impacts on airborne noise as those described for the MBSD Project action alternatives in Section 4.8.3.2 in Noise. However, the NOV-NF-W-05a.1 Project would not require pile driving or dredging for construction.

[138] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

The reasonably foreseeable projects would be required to comply with applicable noise ordinances during construction, which include limits on permissible sound levels based on land use categories (Plaquemines Parish Code of Ordinances, Chapter 17, Article IX: Noise; see Chapter 3, Section 3.8 Noise). As discussed in Section 3.8, Jefferson Parish has established a similar ordinance; however, construction activities are generally exempt from the ordinance unless operating within 300 feet of NSAs. Therefore, the airborne noise generated by these projects would have a direct, minor to moderate, temporary adverse impact on receptors in proximity to work areas.

4.25.8.3.1.2 Underwater Noise

Pile driving and dredging during construction are likely to have the greatest potential noise impact on aquatic species. Most, if not all, of the reasonably foreseeable projects would likely include in-water pile driving and/or dredging during construction. If in-water work were to occur at the same time for each of the projects, there would be higher injury potential as fish could be exposed to injurious sound levels throughout the AOI. Although it is not likely that in-water work for all projects would occur at the same time, overlapping in-water noise would result in minor, adverse, temporary, and direct impacts on fish in the Mississippi River.

4.25.8.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on noise from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.8 Noise.

4.25.8.3.3 Overall Cumulative Impacts

4.25.8.3.3.1 Airborne Noise

During construction, sound levels would temporarily increase above the existing ambient sound levels. If construction of the reasonably foreseeable projects planned in the AOI were to occur at the same time as construction of the MBSD Project action alternatives, concurrent construction would result in temporary increases in noise where sound from more than one project overlaps at nearby NSAs. Once construction of the MBSD Project action alternatives and other reasonably foreseeable projects is completed, noise impacts from construction would no longer occur. Therefore, the cumulative impacts from the MBSD Project action alternatives combined with other reasonably foreseeable projects on noise levels in the Project area are expected to be temporary and minor to moderate during construction.

4.25.8.3.3.2 Underwater Noise

If in-water work for the MBSD Project action alternatives and the reasonably foreseeable projects were to occur at the same time, there would be higher injury potential to fish as they could be exposed to injurious sound levels in a larger area. However, only three (Tallgrass PLT, Loading Dock on Mississippi River, and Mid-Breton Sediment Diversion) would be within the conservative injury radius for fish. Although it is not likely that in-water work for all projects would occur at the same time, overlapping in-water noise would result in minor, adverse, temporary, and direct cumulative impacts on fish in the Mississippi River.

4.25.8.4 Cumulative Impacts during Operations

4.25.8.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

4.25.8.4.1.1 <u>Airborne Noise</u>

Impacts from operation of the Mid-Breton Sediment Diversion would be expected to result from activation of the diversion components and ongoing maintenance activities. Operations of the Tallgrass PLT and Loading Dock on Mississippi River projects may emit noise consistent with typical industrial operations. These projects would be required to comply with applicable noise ordinances, which would minimize noise impacts on any nearby residential areas. Noise impacts (other than negligible noise associated with routine vegetation maintenance) are not anticipated from concurrent operation of the NOV-NF-W-05a.1 Project. Therefore, impacts from the reasonably foreseeable projects in the AOI are expected to be permanent, negligible to minor, and adverse.

4.25.8.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on noise from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.8 Noise.

4.25.8.4.3 Overall Cumulative Impacts

4.25.8.4.3.1 <u>Airborne Noise</u>

Concurrent operation of the reasonably foreseeable projects planned in the AOI with the MBSD Project action alternatives would result in permanent increases in noise where sound from more than one project overlaps at nearby NSAs. Therefore, the cumulative impacts from the MBSD Project action alternatives, combined with other reasonably foreseeable projects, on noise in the AOI are expected to be permanent, negligible to minor, and adverse during operations.

4.25.9 Terrestrial Wildlife and Habitat

4.25.9.1 Geographic and Temporal Extent of Analysis

The AOI associated with terrestrial wildlife and vegetation affected by construction of the Project includes the immediate vicinity (within approximately 1 mile) of all active construction areas to account for the construction of in-water structures, dredging, and the placement of dredged material within the beneficial use placement areas, as well as the human disturbance associated with these activities. The temporal extent of the analysis is the 5-year construction period.

During operations, terrestrial vegetation is not projected to be affected outside of the construction footprint of the MBSD Project action alternatives; however, upland wildlife (such as deer and rabbits) habitat loss originally incurred during construction would result in less overall habitat during the operational phases of the proposed and reasonably foreseeable projects in the area. The movements of upland species are likely limited by their presence on the west bank of the Mississippi River, due to the presence of natural and anthropogenic features that may restrict widespread movement; therefore, the operations AOI assessed for upland vegetation and terrestrial wildlife, including upland invasive species, is 5 miles to account for longer-term changes in vegetation coverage.

Because of the increasing availability of wetland habitat over time from the MBSD Project action alternatives, which could alter the populations of wetland-associated terrestrial wildlife at the basin-wide level, the operations AOI assessed for wetland-associated terrestrial wildlife includes the entire Project area inside of the barrier islands, including the Barataria Basin and the birdfoot delta within the boundaries of the Delft3D Basinwide Model domain (see Appendix E). The temporal extent of the analysis is the 50-year operational analysis period.

4.25.9.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to impact terrestrial wildlife and upland vegetation patterns include major industrial projects that require a substantial amount of tree clearing or other landscape alterations for built structures. In addition to meteorological events and anthropogenic effects (for example, conversion of historic land cover types to agriculture), alteration of habitat and changes in vegetation patterns from navigation and flood protection projects have resulted in extensive wetland loss and barrier island erosion in the Barataria Basin and the larger delta. These projects collectively contribute to the characterization of the Project area as described in Chapter 3, Section 3.9 Terrestrial Wildlife and Habitat and their contribution to wildlife habitat and vegetation patterns in the Project area is reflected in the data presented therein. As such, the impact on terrestrial wildlife and vegetation from past or recently completed projects is captured in the analysis in Section 4.9 Terrestrial Wildlife and Habitat.

Reasonably foreseeable projects within 1 mile of the MBSD Project action alternatives include:

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)

- Tallgrass PLT[139] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)

These projects are located in uplands or along the Mississippi River banks and are discussed below. No projects are within the wetland portion of the AOI in the Barataria Basin and therefore no cumulative impacts on terrestrial wildlife in wetlands in the basin (such as alligators or ducks) would occur.

The reasonably foreseeable projects affecting terrestrial wildlife in uplands, within 5 miles of the MBSD Project action alternatives on the west bank of the Mississippi River include the:

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)
- NOV-NF-W-05a.2, 06a.1, 06a.2 Projects (Map #7 in Figure 4.25.1-1)
- Delta LNG/Delta Express Pipeline Terminal (Map #9 in Figure 4.25.1-1)
- Plaquemines LNG/Gator Express Pipeline (Map #10 in Figure 4.25.1-1)

For wetland-associated terrestrial wildlife, reasonably foreseeable projects that have been excluded from the cumulative impacts assessment for wetland-associated terrestrial wildlife that use basin-area wetlands include projects that affect only terrestrial uplands or riverine habitats, are on the Gulf-side of barrier islands, or have negligible impacts on basin waters. Although the Mid-Breton Sediment Diversion is on the east bank of the Mississippi River, it is considered insofar as it would affect land loss in the birdfoot delta. In addition, improvements to existing levee systems are effectively part of the baseline environment. With these considerations, a total of 37 projects (including the MBSD Project action alternatives) have been considered with respect to cumulative impacts on wetland-associated terrestrial wildlife that may be affected by changes in wetland extent in the Project area. These projects include 24 restoration projects, 7 hurricane/ flood risk reduction projects, 2 major industrial projects, 2 recreational use

[139] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

projects, a municipal project, and a navigation project (see Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2).

4.25.9.3 Cumulative Impacts during Construction

4.25.9.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Reasonably foreseeable projects identified in the AOI may result in the loss or conversion of additional forested lands where present within their construction boundaries, as well as additional temporary or short- or long-term impacts, such as stress on wildlife and an increased potential for the spread of invasive species, depending on construction and restoration methods. Based on review of aerial imagery, each of the additional projects appear to be in areas where trees would be cleared, and may result in the clearance of additional trees in the forested patch that is already bisected by the MBSD Project action alternatives, which would cause additional stress on wildlife. However, it is unknown whether trees cleared for these projects would be allowed to regrow (likely taking decades) or if they would be permanently converted to a developed or otherwise non-forested land type. In either case (whether long-term or permanent), the reduction in available habitat would likely reduce the size of some local populations given the limited forest habitat in the immediate vicinity (within 0.5-mile) of the Project footprint, albeit marginally given the range and abundance of many of the affected species within and even beyond the larger Project area. Therefore, the cumulative adverse impact on terrestrial wildlife and vegetation from reasonably foreseeable projects would be minor to moderate, temporary to permanent, and adverse.

4.25.9.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on terrestrial wildlife and vegetation from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.9 Terrestrial Wildlife and Habitat.

4.25.9.3.3 Overall Cumulative Impacts

Although additional habitat would be cleared, likely further reducing the size of some local populations, the cumulative adverse impact on terrestrial wildlife and vegetation from the construction of the MBSD Project action alternatives combined with construction of the reasonably foreseeable future projects would be minor to moderate, temporary to permanent, and adverse.

4.25.9.4 Cumulative Impacts during Operations

4.25.9.4.1 Vegetation and Upland Wildlife

4.25.9.4.1.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The terrestrial parcels for the five LNG and oil terminals that are reasonably foreseeable projects would permanently encumber about 1,696 acres of land on the Mississippi River's west bank; additional lands would be encumbered by the levee projects and loading dock, resulting in a moderate, permanent, adverse impact on upland vegetation and wildlife. The disturbed upland vegetation communities are likely similar to those disturbed by the MBSD Project action alternatives described below for the MBSD Project action alternatives (such as forested blocks, agricultural lands, and developed lands).

Impacts from all past, present, and reasonably foreseeable projects on invasive wildlife and plant species would be minor given that invasive wildlife are likely present in adjacent habitats already and much of the cumulatively disturbed habitat would be permanently converted to non-vegetated land, limiting the spread of invasive species.

4.25.9.4.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on vegetation and upland wildlife from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.9 Terrestrial Wildlife and Habitat.

4.25.9.4.1.3 Overall Cumulative Impacts

With the addition of over 500 acres of forested land and upland agricultural land that would be permanently encumbered by the MBSD Project action alternatives, adverse impacts on upland vegetation would be moderate and permanent, and impacts on upland wildlife would be moderate to potentially major, particularly for wildlife that are present between the MBSD Project alternatives and the Plaquemines LNG/Gator Express Pipeline (see Figure 4.25.1-2). As with the MBSD Project action alternatives, impacts from all reasonably foreseeable projects on invasive wildlife and plant species would be minor given that invasive wildlife are likely present in adjacent habitats already and much of the cumulatively disturbed habitat would be permanently converted to non-vegetated land, limiting the spread of invasive species.

4.25.9.4.2 Terrestrial Wildlife in Wetlands

4.25.9.4.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

As described in Section 4.25.6 (Wetland Resources and Waters of the U.S.), Delft3D Basinwide Modeling for 12 restoration projects (all modeled projects less the MBSD Project action alternatives) indicates that in spite of these restoration projects, wetland loss in the Barataria Basin and birdfoot delta would total 298,000 and 55,000 acres, respectively, by 2070 even if all modeled projects are completed. Comparatively, the No Action Alternative is projected to result in 298,000 and 53,000 acres of wetland loss in the Barataria Basin and birdfoot delta, respectively (see Section 4.6 Wetland Resources and Waters of the U.S.). Therefore, the reasonably foreseeable projects would result in a negligible impact on wetland-associated terrestrial wildlife in the Barataria Basin and a moderate, permanent, adverse impact on wetland-associated terrestrial wildlife in the birdfoot delta.

4.25.9.4.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on terrestrial wildlife in wetlands from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.9 Terrestrial Wildlife and Habitat.

4.25.9.4.2.3 Overall Cumulative Impacts

Because the MBSD Project action alternatives in combination with other reasonably foreseeable projects would retain a higher acreage of wetlands as compared to the No Action Alternative (26,000 acres for the 150,000 cfs + Terraces, and likely similar, but smaller amounts for the other alternatives; see Section 4.25.6, Wetland Resources and Waters of the U.S.), a major gain in wetlands is projected for the Barataria Basin over time as compared to the No Action Alternative, and a cumulatively moderate to major, permanent, beneficial impact on wetland-associated terrestrial species is anticipated. Adverse impacts in the birdfoot delta would be moderate due to the permanent loss of cumulative acreage (about 2,000 acres) by 2070, which would result in minor to moderate, permanent, and adverse impacts on wetland-associated terrestrial species.

4.25.10 Aquatic Resources

4.25.10.1 Geographic and Temporal Extent of Analysis

The AOI associated with aquatic resources affected by construction of the MBSD Project includes the immediate vicinity (within approximately 1 mile) of the Project construction footprint in the Mississippi River and Barataria Basin to account for the construction of in-water structures, dredging, and the placement of dredged material within the beneficial use placement areas, as well as the turbidity and sedimentation associated with these activities.

Because the MBSD Project action alternatives would have negligible impacts on aquatic habitat outside of the barrier islands, the AOI assessed for aquatic resources includes the entire Project area inside of the barrier islands, including the Barataria Basin and the birdfoot delta within the boundaries of the Delft3D Basinwide Model domain (see Appendix E).

4.25.10.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to impact aquatic resources include major industrial, flood and storm hazard risk reduction projects (for example, levees), and restoration projects such as existing freshwater diversions. Climate change events such as sea-level rise continue to increase tidal influence and circulation patterns of coastal waters. Further, anthropogenic causes, most notably the DWH oil spill, have contaminated habitat, impacting sediment, soil, benthic infauna, oysters, shrimps, crabs, and benthic feeding fishes, and have altered habitat during subsequent remediation efforts. These types of projects and activities collectively contribute to the characterization of the aquatic environment in the Project area as described in Chapter 3, Section 3.10 Aquatic Resources, and their ongoing contribution to the environment is reflected in the data presented therein. As such, the impact on aquatic resources from past or recently completed projects is captured in the analysis in Section 4.10 Aquatic Resources.

Reasonably foreseeable projects within 1 mile of the MBSD Project action alternatives and considered in the analysis of cumulative construction impacts include:

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[140] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)

These projects are located in uplands or along the Mississippi River banks. No projects are within the AOI in the Barataria Basin and therefore cumulative impacts on aquatic resources during construction of the MBSD Project would be restricted to the Mississippi River.

To determine cumulative impacts on aquatic resources during operations, reasonably foreseeable projects have been excluded from the assessment if they affect only terrestrial lands or riverine habitats, are on the Gulf-side of barrier islands, or have negligible impacts on basin waters. The Mississippi River projects are not included because the MBSD Project action alternatives are not expected to impact water quality in the river during operations; however, freshwater fishes entrained into the Barataria Basin are considered. Similarly, the MBSD Project action alternatives have negligible impacts on water quality outside of the barrier islands. Although the Mid-Breton Sediment Diversion is considered insofar as it would further minimize freshwater flows into the birdfoot delta, impacts of the diversion in Breton Sound, further into the Gulf of

[140] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

Mexico (such as potential effects on the hypoxic zone), and on the east bank of the Mississippi River are outside of the AOI. In addition, although new levee projects are considered for their potential to preclude freshwater input into the Barataria Basin, improvements to existing levee systems are not because the loss of freshwater input at those locations is effectively part of the baseline environment captured in the No Action Alternative 50-year projections in Section 4.10 Aquatic Resources.

With these considerations, a total of 37 reasonably foreseeable projects (including the MBSD Project action alternatives) have been considered with respect to operational cumulative impacts on aquatic resources. These projects include 24 restoration projects, 7 hurricane/flood risk reduction projects, 2 major industrial projects, 2 recreational use projects, a municipal project, and a navigation project (see Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2). All of these projects would be located in the basin and the birdfoot delta, with the exception of the Mid-Breton Sediment Diversion, as discussed above.

Although cumulative impacts from the Mid-Barataria and Mid-Breton Sediment Diversion Projects only overlap spatially in the MBSD Project area within the Mississippi River and birdfoot delta (construction of infrastructure and the diversion of freshwater and sediments), impacts from each of these projects in their respective Project areas could result in additional cumulative impacts on aquatic fauna life stages occurring outside of either basin. For example, as described in Section 4.10 Aquatic Resources, the brown shrimp population is anticipated to decrease over time in the Barataria Basin, which may result in a smaller number of brown shrimp surviving to migrate out of the estuary to spawn on the Louisiana shelf. If the Mid-Breton Sediment Diversion Project were to result in similar impacts on the brown shrimp population in the Breton Sound Basin and, further, result in a decreased number of spawning adults, the overall spawning population of brown shrimp along the Louisiana shelf may decrease over time (or decrease at a faster rate) if both projects were to operate simultaneously over time. If the Mid-Barataria and Mid-Breton Sediment Diversion Projects were to result in similar basin-wide impacts on other species, similarly, increased adverse or beneficial (depending on the species) cumulative impacts from the diversions would be anticipated for other species which migrate from the respective basins to offshore habitats (see Section 4.10, Table 4.10-7 in Aquatic Resources). The full effect of how individually modified basin-wide populations (of brown shrimp or other species) would affect the viability of the larger migrating populations is unknown. Analysis of the combined effects of the two projects is premature at this time. Additional analysis of the cumulative impacts of these two projects will be included in a forthcoming EIS for the Mid-Breton Diversion Project once the impacts of the Mid-Breton Sediment Diversion are better understood through EIS development.

4.25.10.3 Cumulative Impacts during Construction

4.25.10.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The amount of forested vegetation that would be cleared along the river's edge for the reasonably foreseeable projects is unknown, although review of aerial imagery indicates that riparian vegetation is predominant within the AOI on both the east and west river banks. Therefore, these projects would all result in removal of small amounts of riverine habitat, overhanging vegetation, and downstream turbidity in the river, which have the potential to affect fish by reducing available DO, reducing swimming performance, physical abrasion (including gill trauma), and increasing water temperature (Kjelland et al. 2015). In-water construction and structural placement would also modify limited amounts of aquatic habitat. The impacts on habitat and fauna from these activities would likely be temporary to permanent, minor, and adverse.

4.25.10.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on aquatic resources from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.10 Aquatic Resources.

4.25.10.3.3 Overall Cumulative Impacts

Impacts from the combined MBSD Project alternatives and reasonably foreseeable projects in the Mississippi River would be mitigated through best management practices required through CWA Section 10, 401, and 404 permits, as well as through implementation of each project's SWPPP and SPCC. Further, turbidity and suspended sediment loads are normally high in the Mississippi River, such that turbidity and sediment contributions from construction of the three reasonably foreseeable projects combined with the MBSD Project action alternatives, if occurring simultaneously, would have minor, adverse cumulative impacts on aquatic resources, ranging from temporary turbidity impacts on permanent loss of riparian habitat (shading).

4.25.10.4 Cumulative Impacts during Operations

4.25.10.4.1 Aquatic Habitat

4.25.10.4.1.1 <u>Past, Present, and Reasonably Foreseeable Future Projects and Trends</u>

Salinity in the Barataria Basin from the reasonably foreseeable projects is not projected to change substantially (if at all) with implementation of the restoration projects included in the Delft3D Basinwide Model (see Table 4.25.1-1), while salinity in the birdfoot delta is expected to rise moderately over time. Although the construction of about 36 miles of new levee systems in the basin (Jean Lafitte and Rosethorne Tidal Protection projects and the St. Charles West Bank Hurricane Protection Levee Initiative) were not included in the Delft3D Basinwide Model, this represents a relatively small area of new land where freshwater runoff into the basin may be restricted; therefore, these projects are not anticipated to substantially affect salinity in the basin. Similarly, although the purpose of the Pumping Capacity Improvements Phase I Project is to combat saltwater intrusion in Bayou Lafourche for drinking water purposes, it is not anticipated to substantially affect saltwater intrusion in the wider basin.

As salinity in the basin is not expected to substantially change from the presence and operation of the past, present, and reasonably foreseeable projects as compared to the No Action Alternative (which includes only past and present projects such as the Davis Pond Freshwater Diversion that will continue to contribute to future conditions under the No Action Alternative), similar impacts on SAV would be expected in terms of decreases in overall abundance as saltwater encroachment continues, wetlands are lost, and wave action increases. However, multiple restoration projects are planned in the basin that would result in decreased water depth at discrete locations, as well as decreased wave action adjacent to these locations, both of which may allow for localized increases in SAV abundance. Similarly, infauna and epifauna generally occur in higher densities within and immediately adjacent to marsh habitats, such that the creation or restoration of marsh in the basin would result in benefits to the benthic community.

Delft3D Basinwide Modeling for the 12 other reasonably foreseeable projects indicates that wetland loss in the Barataria Basin and birdfoot delta would total 298,000 and 55,000 acres, respectively, by 2070 if all modeled projects are completed. These projects would result in a negligible impact in the Barataria Basin and a moderate, permanent, adverse impact on the birdfoot delta over the No Action Alternative by 2070, which is projected to result in wetland losses in the Barataria Basin and birdfoot delta of 298,000 and 53,000 acres, respectively. In addition to the reasonably foreseeable projects in the Delft3D Basinwide Model, about 4,500 acres of wetlands (marsh, swamp, and bottomland hardwoods) in the Barataria Basin are planned to be restored, which would allow for minor benefits to SAV abundance and the benthic community, as well as to the basin-wide food web from the increase in these resources. The combination of modeled and non-modeled projects combined are likely to provide a minor to moderate benefit to aquatic species and habitat during portions of the analysis period, but these benefits may be negligible to minor by the end of the analysis period.

Ongoing changes on other habitat characteristics, including water flow and tidal transport (from changes in marsh presence and in-water structure), hard substrate (from project placements); turbidity and sedimentation (from the placement of dredged materials), nutrient loading and dissolved oxygen (from freshwater runoff or inputs), and temperature (from changing water levels), would not be likely to change substantially from the No Action Alternative, although temporary and localized impacts may occur during the various activities related to the reasonably foreseeable projects.

4.25.10.4.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on aquatic habitat from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.10 Aquatic Resources.

4.25.10.4.1.3 Overall Cumulative Impacts

With the addition of the MBSD Project action alternatives to the other reasonably foreseeable projects, the Delft3D Basinwide Model projects that changes in the cumulative average monthly salinity in the AOI would cause moderate decreases in cumulative average monthly salinity in the AOI (see Section 4.25.5 [Surface Water and Sediment Quality], Table 4.25.5-3).

As identified in Table 4.25.6-1 in Section 4.25.6 (Wetland Resources and Waters of the U.S.), the addition of the MBSD Project 150,000 cfs Alternative would result in less wetland loss in the Barataria Basin, where an additional 26,000 acres would be maintained or created (and a likely similar, but smaller, gain associated with the other action alternatives), representing a major, permanent, and beneficial impact on wetland habitat in the Barataria Basin. Cumulatively, the birdfoot delta is projected to lose an additional 2,000 acres of wetlands if the reasonably foreseeable projects are built, as compared with the No Action Alternative, by 2070. Cumulative impacts on wetlands from these projects combined with the MBSD Project action alternatives would result in similar wetland losses; however, the MBSD Project action alternatives would contribute to greater wetland losses in the birdfoot delta between 2020 and 2060. Losses in the birdfoot delta would be substantially less than the wetland gains described above for the Barataria Basin.

This overall gain in wetland habitat, along with the decrease in salinity in the Barataria Basin would result in major, permanent, beneficial impacts on the abundance of SAV over time in the Barataria Basin. Similarly, over time the projects would result in minor to moderate, permanent, and beneficial impacts in the benthic community from the increased availability of wetland habitat in the Barataria Basin. Because of the overall increase in structured habitat (wetlands and SAV), the projects would also have a major, permanent, and beneficial impact on EFH. Conversely, the decrease in wetlands, and the increased water depth in the birdfoot delta would have a permanent, moderate, and adverse impact on EFH (structured habitat) and the benthic community (but negligible impacts on SAV) compared to the No Action Alternative.

4.25.10.4.2 Aquatic Fauna

4.25.10.4.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

As discussed above, over the long-term, the reasonably foreseeable projects do not result in substantial changes to most habitat characteristics such that they would produce measurable impacts on aquatic fauna. Instead, ongoing natural changes in habitat (most notably sea-level rise and wetland loss) would be the drivers of change, resulting in benefits to species and species life stages that prefer more saline and less structured habitats. Conversely, species and species life stages that use brackish/ intermediate salinities and structured habitats would be negatively affected over time. Although multiple wetland restoration projects are planned in the Barataria Basin and birdfoot delta during the analysis period, Delft3D Basinwide Modeling indicates that these projects would have limited benefits to wetland coverage (and therefore to aquatic species) over time, although they would likely provide minor benefits during portions of the analysis period (after establishment but before sea-level rise and saltwater intrusion overtake the benefits). Overall, similar to the No Action Alternative, the ongoing loss of wetland habitat that would occur with the presence of the reasonably foreseeable projects is expected to result in major adverse impacts on aquatic fauna over time, as described for the No Action Alternative, although not all individual species would incur major impacts. For example, brown and white shrimp were determined to have major, adverse, and permanent impacts, predominantly from the loss of marsh habitat in the No Action Alternative; however, adverse impacts on red drum and spotted seatrout are anticipated to be minor due to the decreased reliance of the species on marsh habitat compared to brown and white shrimp. Impacts on key species from the reasonably foreseeable projects are anticipated to be substantially similar to those identified for the No Action Alternative, which are discussed in detail in Section 4.10.4.5 in the Aquatic Resources section.

4.25.10.4.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on aquatic fauna from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.10 Aquatic Resources.

4.25.10.4.2.3 Overall Cumulative Impacts

The MBSD Project action alternatives are anticipated to cause near-term population decreases for various species due to immediate decreases in salinity and related changes in habitat and biota (see Section 4.10 Aquatic Resources). Comparatively, the No Action Alternative is projected to affect the various species later in the analysis period as the habitat changes more gradually over time. Although the reasonably foreseeable marsh restoration projects do not result in substantial differences in marsh habitat over time, it is possible that their presence during earlier portions of the analysis period may provide new or higher quality habitat in areas that would not be as affected by the immediate salinity decreases from the MBSD Project action alternatives. For example, under the MBSD Project action alternatives, the brown shrimp population is expected to decline earlier in the analysis period as compared to the No Action Alternative because of impacts on larval transport (from changes to water flow and tidal transport) as well as decreases in salinity. However, early- or mid-term increases in available larval- and early juvenile-stage marsh habitat in areas that would be less affected by salinity changes from the MBSD Project action alternatives may allow for increased recruitment or survival in those locations. For example, larval and early juvenile brown shrimp recruiting to newly established wetlands in the western basin as part of the Bayou L'Ours Marsh Terracing Project may experience increased survival and growth. However, because Delft3D Basinwide Modeling does not indicate substantial changes in marsh habitat over the entire analysis period from the reasonably foreseeable projects, incremental impacts on aquatic fauna and key species are anticipated to be similar to that discussed for the MBSD Project action alternatives; impacts on key species are stated in Section 4.10 Aquatic Resources, Table 4.10-5.

4.25.11 Marine Mammals

This section addresses the cumulative impacts of the MBSD Project action alternatives on marine mammals (excluding those protected under the Endangered Species Act, which are discussed in Section 4.25.12 Threatened and Endangered Species). As discussed in Section 4.11 Marine Mammals, the BBES stock of bottlenose dolphins is the stock most likely to be affected by the MBSD Project action alternatives, and therefore the BBES stock is the focus of the cumulative impacts analysis. However, there are circumstances in which the MBSD Project action alternatives in combination with reasonably foreseeable projects could result in minimal, if any, cumulative impacts on the TTES, MRD, and/or coastal stocks of bottlenose dolphins, including:

- If the MBSD Project action alternatives drive BBES dolphins out of their stock area and into the TTES, MRD, and/or coastal stock areas, negative impacts from increased competition for prey could be exacerbated by stressors from reasonably foreseeable projects. However, BBES dolphins have strong site-fidelity and are not expected to emigrate out of their stock area.

- If construction and/or operation of the MBSD Project action alternatives and reasonably foreseeable projects individually result in a shift of fishing, recreation, and other eco-tourism activities away from the Barataria Basin (either following shifts in shrimp/fish populations or simply due to inconvenience from additional vessel traffic) and into other dolphin stock areas (see Section 4.18 Land Use and Land Cover), it is feasible that the cumulative impacts could include the potential for increased fishing gear interactions (for example, entanglements with nets or hook-and-line gear) and vessel strikes. However, the projects are predicted to lead to incremental changes in habitat that have a low likelihood of creating shifts in fishing/recreational effort.

- The MBSD Project action alternatives are projected to result in reduced freshwater/sediment discharge and reduced wetland acreage in the birdfoot delta, but the impact to MRD dolphins is expected to be negligible. However, if the MBSD Project action alternatives are operational simultaneously with the proposed Mid-Breton Sediment Diversion Project, the combined effects on reduced sediment reaching the birdfoot delta could result in adverse cumulative impacts on the MRD stock due to the lost wetland acreage. Additional analysis of the cumulative impacts of these two projects will be included in a forthcoming EIS for the Mid-Breton Sediment Diversion Project.

In the worst case scenario, it is feasible, although unlikely, that these situations could occur simultaneously in the same stock area (for example, the MRD stock area near the birdfoot delta) to create even greater cumulative impacts. Thus, based on the best available information, cumulative impacts on the TTES, MRD, and coastal bottlenose dolphin stocks, as well as Atlantic spotted dolphins will be minimal, if any, and the cumulative impacts analysis below focuses on the BBES stock only.

4.25.11.1 Geographic and Temporal Extent of Analysis

To account for the potentially wide-ranging movements of BBES dolphins, the AOI considered in this cumulative impacts analysis for both construction and operation of the MBSD Project action alternatives considers reasonably foreseeable projects in and near the BBES stock area, as depicted in Chapter 3, Section 3.11 Marine Mammals, Figure 3.11-1. This includes the Barataria Basin inside of the barrier islands and coastal waters within 1 mile of the barrier islands, while also accounting for projects in the northern basin that may affect salinity or water quality in the wider basin. The construction AOI also considers the BBES' potential to be affected by construction of the MBSD Project action alternatives within a 2-mile radius around in-water construction in the Barataria Basin, which accounts for the effective 2-mile ZOI for the potential propagation of underwater construction noise (see Section 4.11 Marine Mammals for details), in addition to the potential cumulative effects of noise from other reasonably foreseeable projects throughout the BBES stock area.

4.25.11.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to impact marine mammals would be projects that involve the use of heavy equipment or pile driving during construction that could increase turbidity and underwater noise. Vessel traffic in the Barataria Bay also contributes to the underwater noise environments. Projects generating these types of impacts typically include major industrial projects and some restoration projects. Industrialization and coastal development can also lead to increased nutrient loads resulting in harmful algal blooms, decreases in DO levels, and increased contaminant levels. Further, anthropogenic disasters, most notably the DWH oil spill, can and have resulted in severe adverse health effects, such as compromised reproduction and increased rates of disease (for example, chronic lung, anemia), with long-term consequences on population levels. These types of projects and activities collectively contribute to the marine environment in the Project area as described in Chapter 3, Section 3.11 Marine Mammals and their ongoing contribution is reflected in the data presented therein. Although the DWH oil spill is currently the only anthropogenic activity (or project) explicitly analyzed in the literature for effects on BBES dolphins, our overall understanding of the current state of BBES dolphins (as presented in Section 4.11 Marine Mammals) is influenced by the impacts of past or recently completed projects. Thus, we focus this cumulative impacts analysis on reasonably foreseeable projects in the future.

Within the construction/operational AOI, reasonably foreseeable projects that have been excluded from the cumulative impacts assessment for the BBES stock include projects that affect only terrestrial lands or riverine habitats, or have negligible impacts on basin waters. The Mississippi River projects are not included because the BBES stock’s range does not include the river. Similarly, the Mid-Breton Sediment Diversion is on the east bank of the Mississippi River, and would further minimize freshwater flows into the birdfoot delta; however, the BBES stock’s range does not include the birdfoot delta. In addition, although new levee projects are considered for their potential to preclude freshwater input into the Barataria Basin, improvements to existing levee systems are not, as the loss of freshwater input at those locations is effectively part of the baseline environment.

With these considerations, a total of 35 projects (including the MBSD Project action alternatives) have been considered with respect to cumulative impacts on marine mammals. These projects include 23 restoration projects, 7 hurricane/flood risk reduction projects, 3 major industrial projects, a recreational use project, and a municipal project (see Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2). All of these projects would be located in the basin or on the barrier islands. Although five projects are within 2 miles of the proposed Project, they are not expected to include in-water construction and would therefore not contribute to an additive cumulative noise effect on the BBES stock within the ZOI.

4.25.11.3 Assessment of Cumulative Impacts during Construction

Impacts related to construction of the MBSD Project are discussed in Section 4.11 Marine Mammals and are generally limited to small areas and short durations where suitable dolphin habitat and construction activities (for example, channel marker installation and dredging) overlap. Although it is unlikely that these activities affect BBES dolphins via noise or effects on water quality, if impacts did occur, it is technically feasible that noise (or other stressors) from reasonably foreseeable projects elsewhere in the BBES stock area (for example, the Delta LNG/Delta Express Pipeline/Venture Global project and the Plaquemines LNG/Gator Express Pipeline/Venture Global project, which have known, anticipated construction periods that would overlap that of the MBSD Project) could result in cumulative impacts. This could include disturbance or modifications of available habitat, particularly if these actions were to occur simultaneously. In addition, if in-water construction were to occur at multiple sites simultaneously, individual dolphins might be less able to transit their ranging areas without experiencing increased sound levels (whether they be injurious or behavioral levels). However, due to the low likelihood of overlap (both temporally and spatially) between MBSD Project construction activities and BBES dolphin habitat, the overall cumulative impacts from construction of the reasonably foreseeable future projects combined with the MBSD Project action alternatives would likely be negligible.

4.25.11.4 Cumulative Impacts during Operations

4.25.11.4.1 Past, Present, and Reasonably Foreseeable Future Projects

As discussed in Section 4.25.5 (Surface Water and Sediment Quality), long-term, average salinity in the Barataria Basin from the reasonably foreseeable projects is not projected to change substantially (if at all) with implementation of the projects included in the Delft3D Basinwide Model for the cumulative impacts assessment. Although the construction of about 36 miles of new levee systems in the basin (Jean Lafitte and Rosethorne Tidal Protection projects and the St. Charles West Bank Hurricane Protection Levee Initiative) were not included in the Delft3D Basinwide Model, this represents a relatively small area of new land where freshwater runoff into the basin may be restricted; therefore, these projects are not anticipated to substantially affect salinity in the basin. Similarly, although the purpose of the Pumping Capacity Improvements Phase I Project is to combat saltwater intrusion in Bayou Lafourche for drinking water purposes, it is not anticipated to substantially affect saltwater intrusion in the wider basin. As operation of the reasonably foreseeable projects is not expected to substantially affect salinity in the Barataria Basin, impacts on habitat, the local food web, and available prey would be similar to that described for the No Action Alternative (see Section 4.11.5.1 in Marine Mammals), in which ongoing sea-level rise results in an increase in water depth and salinity (especially in the winter), and a decrease in wetlands.

As described in Section 4.25.6 (Wetland Resources and Waters of the U.S.), Delft3D Basinwide Modeling for the reasonably foreseeable projects indicates that wetland loss in the Barataria Basin would total 298,000 acres by 2070 if all modeled projects are completed (a negligible difference from the No Action Alternative itself). However, in addition to the reasonably foreseeable projects in the Delft3D Basinwide Model, about 4,500 acres of wetlands (marsh, swamp, and bottomland hardwoods) in the Barataria Basin are planned to be restored, which would allow for minor benefits to SAV abundance and the benthic community, as well as to the basin-wide food web from the increase in these resources.

Although the modeled and non-modeled projects combined are likely to provide a minor to moderate benefit to aquatic species and habitat during portions of the analysis period, these benefits may be negligible to minor by the end of the analysis period. By 2070, certain fish and crustacean species are anticipated to have population declines based on the projected habitat changes, but key prey for the BBES dolphins are not anticipated to have substantial declines. However, the loss of wetlands and increasing salinities over time would result in gradually increasing adverse impacts on prey availability and dolphin foraging success, depending on BBES dolphins' abilities to acclimatize to gradually changing conditions from 2020 to 2070.

The addition of 35 projects to the Barataria Basin may result in an increased volume and frequency of spills of hazardous materials, temporary increases in turbidity and sedimentation, increased vessel traffic and noise, modification of habitat, and other activities that may cause stress to the BBES dolphins. Impacts from hazardous material spills and turbidity/sedimentation would be minimized and mitigated to the maximum extent practicable through best management practices required through CWA Section 10, 401, and 404 permits, as well as through implementation of each project's SWPPP and SPCC. However, additional adverse impacts on BBES dolphins could occur from exposure to these stressors, depending on their severity. Although additional vessel traffic and noise from future projects have the potential to disturb marine mammals, these patterns of use would be similar to those activities that are currently ongoing in the basin.

Some of the reasonably foreseeable restoration projects will result in the conversion of hundreds of acres of open water into upland marsh habitat within the BBES stock area. As BBES dolphins have a high degree of site-fidelity, modification of large areas of habitat may result in adverse impacts on individuals that must acclimate to the modified environment. Projects that create new marsh in open water within the BBES stock boundaries (such as the Barataria Bay Rim Marsh Creation and Stabilization project and the two Caminada Headlands Back Barrier Marsh Creation projects) have a higher potential to cause stress over those projects that aim to restore degraded marsh. However, created marshes (especially the increased foraging areas associated with additional marsh edge) would have a short- to long-term benefit for BBES dolphins for the period of time that those marsh areas were available for use.

Under the first two to three decades of the analysis period, BBES dolphins would generally experience similar habitat and environmental conditions as recent historical trends (in other words, 2010 to 2020). Dolphins alive during this period would include those that had been directly exposed to DWH oil and may have more adverse reactions to additional stressors, such as those described above. After 2050 (when most of the directly exposed BBES dolphins are likely to have died), the Delft3D Basinwide Model projects that the aggregate effects from sea-level rise would likely affect BBES dolphins and their habitat. Overall, construction and operation of the reasonably foreseeable projects (including habitat changes described throughout the EIS for the No Action Alternative) would likely have gradually increasing minor, permanent, adverse impacts on BBES dolphins primarily from changes in individual usage patterns, salinity, and foraging activities.

4.25.11.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on marine mammals from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.11 Marine Mammals.

4.25.11.4.3 Overall Cumulative Impacts

The Delft3D Basinwide Model, when including both the applicable reasonably foreseeable projects and the MBSD Project action alternatives, projects moderate decreases in the cumulative average monthly salinity in the AOI (see Section 4.25.5 Surface Water and Sediment Quality, Table 4.25.5-3), but less wetland loss in the AOI (up to an additional 26,000 acres would be maintained or created under the 150,000 cfs

+ Terraces Alternative [see Section 4.25.6 Wetland Resources and Waters of the U.S., Table 4.25.6-1], and a likely similar, but smaller, gain associated with the other action alternatives), however these changes are unlikely to affect the overall major adverse impact determination for BBES dolphins.

The simultaneous construction/operation of the reasonably foreseeable projects with the MBSD Project action alternatives also introduces a higher, cumulative potential for HABs, contaminants, and low DO, which would affect BBES dolphins and their prey. The reasonably foreseeable projects would also contribute additional stressors related to potential spills of hazardous materials; increases in turbidity, sedimentation, vessel traffic and noise; and modification of habitat. Cumulatively, the MBSD Project action alternatives and the reasonably foreseeable projects would likely have a permanent, major, adverse impact on BBES dolphins.

4.25.12 Threatened and Endangered Species

This section addresses the cumulative impacts of the MBSD Project action alternatives on threatened, endangered, or special status species. Federally listed species with the potential to be affected by the MBSD Project action alternatives include the West Indian manatee, five species of sea turtles in their aquatic habitat (as well as the loggerhead sea turtle on nesting beaches), the pallid sturgeon, two shorebirds (piping plover and red knot), the black rail, and the giant manta ray. Other species of concern considered for cumulative impacts include the saltmarsh topminnow and bald eagle. Due to the diversity in life history and range of threatened and endangered species potentially affected by the MBSD Project action alternatives, cumulative impacts were independently reviewed in accordance with their general habitat requirements (either riverine, terrestrial, or marine/estuarine).

4.25.12.1 Geographic and Temporal Extent of Analysis

4.25.12.1.1 Riverine Species

One riverine species (the pallid sturgeon) has the potential to be impacted by the MBSD Project alternatives. The construction AOI for underwater noise for fish (the largest range of expected impacts in the Mississippi River), as described in Section 4.10.3.4 Aquatic Resources, is 2.9 miles. The operational AOI for riverine species includes the entire length of the Mississippi River within the boundaries of the Delft3D Basinwide Model domain (see Appendix E).

4.25.12.1.2 Terrestrial Species

Four terrestrial species (the piping plover, red knot, eastern black rail, and bald eagle) have the potential to be impacted by the MBSD Project alternatives. Reasonably foreseeable projects with the potential to impact terrestrial threatened and endangered species during construction are those that occur on terrestrial lands within 1 mile of the MBSD Project alternatives' footprint to account for facility construction and the human disturbance associated with these activities. Terrestrial vegetation is not projected to be affected outside of the construction footprint of the MBSD Project alternatives; however, all four species are birds with large potential ranges (including seasonal ranges). Therefore, the operational AOI assessed for special status terrestrial species includes the majority of the Project area (inside of the barrier islands) (see Section 4.12 Threatened and Endangered Species).

4.25.12.1.3 Marine/Estuarine Species

Seven marine/estuarine species (the West Indian manatee, five species of sea turtles, the giant manta ray, and the saltmarsh topminnow) have the potential to be impacted by the MBSD Project alternatives. The AOI associated with the marine/estuarine species' potential to be affected by construction of the MBSD Project alternatives is a 2-mile radius around in-water construction in the Barataria Basin, which accounts for the effective 2-mile ZOI for the potential propagation of underwater construction noise (see Section 4.11 Marine Mammals for details). To account for the generally wide-ranging movements of these species, the operational AOI assessed for marine/estuarine species includes the majority of the Project area (inside of the barrier islands) (see Section 4.12 Threatened and Endangered Species).

4.25.12.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to impact threatened and endangered species would be projects that impact terrestrial wildlife habitat and vegetation patterns, or surface waters (and thereby riverine and estuarine/marine species), including major industrial projects that include built structures and/or require a substantial amount of tree clearing or other landscape alterations, as well as flood control projects (for example, levees and channels). Vessel traffic in the Mississippi River and Barataria Bay also contributes to the underwater noise environments. Climate changes, such as sea-level rise, continue to increase tidal influence and circulation patterns of coastal waters. Further, anthropogenic effects, most notably the DWH oil spill, can and have degraded vegetation and water quality that provide habitat for threatened and endangered species and result in severe adverse health effects with long-term consequences on population levels. These types of projects and activities collectively contribute to the upland and aquatic environment in the Project area as described in Chapter 3, Section 3.12 Threatened and Endangered Species and their ongoing contribution to these habitats is reflected in the data presented therein. As such, the impact on threatened and endangered species from past or recently completed projects is captured in the analysis in Section 4.12 Threatened and Endangered Species.

4.25.12.2.1 Riverine Species

As identified in Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2, the reasonably foreseeable projects encompassed by the 2.9-mile construction AOI for the pallid sturgeon include the following:

- Tallgrass PLT[141] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- Mid-Breton Sediment Diversion (Map #4 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)

The operational AOI for riverine species includes the entire length of the Mississippi River within the boundaries of the Delft3D Basinwide Model domain (see Appendix E). In addition to those projects listed above, the operational AOI for riverine species includes the following reasonably foreseeable projects:

- Plaquemines LNG/Gator Express Pipeline (Map #10 in Figure 4.25.1-1)
- Braithwaite Methanol Plan (Map #22 in Figure 4.25.1-1)
- Pointe LNG[142] (Map #24 in Figure 4.25.1-1)

4.25.12.2.2 Terrestrial Species

Reasonably foreseeable projects within the 1-mile construction AOI for terrestrial species include the:

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)

The operational AOI assessed for terrestrial species includes the Project area (inside of the barrier islands) within the boundaries of the Delft3D Basinwide Model domain (see Appendix E).

[141] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

[142] Since publication of the Draft EIS, FERC has removed the planned Pointe LNG project from the pre-filing process. This project is no longer moving forward.

4.25.12.2.3 Marine/Estuarine Species

No projects are within the 2-mile construction AOI in the Barataria Basin and therefore no cumulative impacts on marine/estuarine threatened and endangered species would occur during construction.

Reasonably foreseeable projects that have been excluded from the cumulative impacts assessment for marine/estuarine species include projects that are on the Gulf-side of barrier islands or have negligible impacts on basin waters. Although the Mid-Breton Sediment Diversion is on the east bank of the Mississippi River, it is considered insofar as it would further minimize freshwater flows into the birdfoot delta. In addition, although new levee projects are considered for their potential to preclude freshwater input into the Barataria Basin, improvements to existing levee systems are not, as the loss of freshwater input at those locations is effectively part of the baseline environment.

With these considerations, a total of 37 projects (including the MBSD Project alternatives) have been considered with respect to cumulative impacts on marine/estuarine threatened and endangered species. These projects include 24 restoration projects, 7 hurricane/flood risk reduction projects, 2 major industrial projects, 2 recreational use projects, a municipal project, and a navigation project (see Table 4.25.1-1 and Figures 4.25.1-1 and 4.25.1-2). All of these projects would be located in the basin and the birdfoot delta, with the exception of the Mid-Breton Sediment Diversion, as discussed above.

4.25.12.3 Assessment of Cumulative Impacts during Construction

4.25.12.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

4.25.12.3.1.1 Riverine Species

Impacts on pallid sturgeon from reasonably foreseeable projects within the construction AOI would include dredging (and the subsequent turbidity and sedimentation), underwater noise from construction activities, and loss or modification of riverine habitat. These impacts would be mitigated through best management practices required through CWA Section 10, 401, and 404 permits, as well as through implementation of each project’s SWPPP and SPCC. Further, turbidity and suspended sediment loads are normally high in the Mississippi River, such that turbidity and sediment contributions from the reasonably foreseeable projects would be adverse, but negligible to minor, and ranging from temporary turbidity impacts on permanent loss of riparian habitat (shading) or riverbed habitat through structural placement. However, these projects would likely each require in-water construction, which could result in noise levels that are injurious to pallid sturgeon. Although the temporary nature of construction and the likely low numbers in the AOI suggest that any impact would be limited to few individuals, injury of any pallid sturgeon would result in a take under the Endangered Species Act. Therefore, the reasonably foreseeable projects would represent a potentially moderate adverse impact on the species. Because each of these projects has a federal nexus, they would be required to consult with the USFWS regarding potential impacts for the species, such that allowable impacts would not jeopardize its continued existence.

4.25.12.3.1.2 Terrestrial Species

Piping plovers and red knots would not be affected by reasonably foreseeable projects within the construction AOI based on their preferred habitat along barrier islands, and their area lack of nesting. Negligible to moderate impacts could occur on black rails if nests are present in suitable habitat, although these impacts are not expected based on the expectation of low density in the AOI. Although negligible effects on bald eagles could occur from clearing trees (which may be used for nesting), no bald eagles nests have been identified within the AOI and any encountered during construction of the reasonably foreseeable projects would be protected under Bald and Golden Eagle Protection Act.

4.25.12.3.1.3 Marine/Estuarine Species

As none of the reasonably foreseeable projects are within the aquatic species AOI for construction, no cumulative impacts are anticipated during construction. Impacts related to construction of the Project are discussed in Section 4.12 Threatened and Endangered Species.

4.25.12.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on threatened and endangered species from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.12 Threatened and Endangered Species.

4.25.12.3.3 Overall Cumulative Impacts

4.25.12.3.3.1 Riverine Species

Cumulative impacts on the pallid sturgeon from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would include disturbance or modifications of available habitat, particularly if these actions were to occur simultaneously. In addition, if in-water construction were to occur at all sites simultaneously, the ability of individuals to transit the Mississippi River without experiencing increased sound levels (whether they be injurious or behavioral levels) would decrease, resulting in a higher potential for take of an individual. Therefore, cumulative impacts on the species from construction of the reasonably foreseeable future projects combined with construction of the MBSD Project action alternatives would likely be moderate, adverse, and temporary to permanent without adequate mitigation.

4.25.12.3.3.2 Terrestrial Species

Cumulative effects from the MBSD Project action alternatives and reasonably foreseeable projects in the AOI would be predominantly restricted to potential impacts on potential nesting habitat and activities of the black rail. If present in habitat that is cleared during construction of any of the reasonably foreseeable projects, the species may incur adverse impacts; however, based on likely low density in the AOI, impacts are anticipated to be negligible.

4.25.12.3.3.3 Marine/Estuarine Species

As none of the reasonably foreseeable projects are within the aquatic species AOI for construction, no cumulative impacts are anticipated during construction. Impacts related to construction of the MBSD Project action alternatives are discussed in Section 4.12 Threatened and Endangered Species.

4.25.12.4 Assessment of Cumulative Impacts during Operations

4.25.12.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends Riverine Species

4.25.12.4.1.1 Riverine Species

Although multiple projects occur within the operational AOI for the Mississippi River, the largest potential for take of a pallid sturgeon would be from entrainment into the Mid-Breton Sediment Diversion, which could result in the movement of individuals into Breton Sound and out of the functional population in the Mississippi River. Once diverted into the Breton Sound Basin, it is presumed they would be unable to access the Mississippi River and would become functionally segregated from the listed population, resulting in moderate, adverse, and permanent impacts.

4.25.12.4.1.2 Terrestrial Species

Operation of the reasonably foreseeable projects is not expected to affect the piping plover or red knot based on their preferred habitat along barrier island beaches outside of the operational AOI and their lack of nesting in the Project area.

Impacts on the bald eagle and black rail would be related to marsh presence as it concentrates prey (bald eagle) and provides habitat (black rail). As described in Section 4.25.6 (Wetland Resources and Waters of the U.S.), Delft3D Basinwide Modeling for the reasonably foreseeable projects indicates that wetland loss in the Barataria Basin and birdfoot delta would total 298,000 and 55,000 acres, respectively, by 2070 if all modeled projects are completed. These projects would result in a negligible impact in the Barataria Basin and a moderate, permanent, adverse impact on the birdfoot delta over the No Action Alternative by 2070, which is projected to result in wetland losses in the Barataria Basin and birdfoot delta of 298,000 and 53,000 acres, respectively. In addition to the reasonably foreseeable projects in the Delft3D Basinwide Model, non-modeled projects would create about 4,500 acres of wetlands (marsh, swamp, and bottomland hardwoods) in the Barataria Basin. The combination of modeled and non-modeled projects combined is likely to provide a negligible to minor benefit to the two terrestrial species during portions of the analysis period, as the bald eagle has a varied diet that may shift with the changes in wetlands (where prey congregates) and use of the black rail of those marshes is unknown and anticipated to be low.

4.25.12.4.1.3 Marine/Estuarine Species

Impacts on the marine/estuarine species from the reasonably foreseeable projects would most likely occur from changes in wetland/SAV extent in the Barataria Basin, which would be primarily driven by sea-level rise and increasing salinity. As described above for the terrestrial species, the reasonably foreseeable projects would result in a negligible impact on wetlands in the Barataria Basin (+42 acres) and a moderate, permanent, adverse impact on wetlands in the birdfoot delta (–2,150 acres) compared to the No Action Alternative by 2070. However, 4,500 additional acres of wetlands (marsh, swamp, and bottomland hardwoods) in the Barataria Basin are planned to be restored that are not included in the Delft3D Basinwide Model, which would also allow for minor benefits to SAV abundance. The combination of modeled and non-modeled projects combined are likely to provide a minor to moderate benefit to aquatic species and habitat during portions of the analysis period, but these benefits may be negligible to minor by the end of the analysis period. All of the marine/estuarine species are likely to benefit from the increase in marsh and SAV (as compared to the No Action Alternative), although for different purposes. West Indian manatees (although rare in the basin), green and loggerhead sea turtles, and saltmarsh topminnows would likely experience the negligible to moderate, beneficial, short-term to permanent impacts associated with increased food sources (SAV and possibly crab) or the presence of quiet waters near marsh (saltmarsh topminnow). Kemp's ridley sea turtles (which feed on shrimp, crab, and other fauna) are likely to have beneficial, negligible to minor, and long-term to permanent impacts associated with the benefits to the food web that would occur from the increased marsh and SAV. The hawksbill and leatherback sea turtles would likely experience negligible effects due to their limited presence in the basin. Similarly, as operational effects (changes in salinity, temperature, and turbidity/nutrients) are expected to be very minor in the outer edges of the Project area where giant manta rays are expected to occur, the Project would have a negligible effect on the species.

4.25.12.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on threatened and endangered species from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.12 Threatened and Endangered Species.

4.25.12.4.3 Overall Cumulative Impacts

4.25.12.4.3.1 Riverine Species

The cumulative effect of operation of the MBSD Project action alternatives combined with operation of the other reasonably foreseeable projects (primarily the Mid-Breton Sediment Diversion) would be moderate to major, adverse, and permanent, as the Mid-Breton Sediment Diversion would also have a high potential for take of pallid sturgeons. However, any take authorized by the USFWS for the Project would be considered during the ESA permitting process for the Mid-Breton Sediment Diversion to ensure that the cumulative effect of this project does not jeopardize the continued existence of the species.

4.25.12.4.3.2 Terrestrial Species

As the MBSD Project action alternatives are not likely to substantially affect the piping plover or red knot based on their preferred habitat along barrier island beaches and their lack of nesting in the Project area, cumulative effects from the MBSD Project action alternatives and reasonably foreseeable projects on these species are not anticipated.

Impacts on the bald eagle and black rail would be related to marsh presence as it concentrates prey (bald eagle) and provides habitat (black rail). As discussed in Section 4.25.6 (Wetland Resources and Waters of the U.S.), if all of the reasonably foreseeable projects plus the MBSD Project action alternatives are built, the Delft3D Basinwide Model projects a 35.7 percent increase in total wetland area in the Barataria Basin by 2070 when compared with the No Action Alternative, although the model does not account for the initial wetland gains of smaller restoration projects, as described above. Although the model projects a slight increase in wetland losses in the birdfoot delta, there would be an overall gain in wetland habitat in the AOI. Therefore, there would likely be a negligible to minor, beneficial, long-term to permanent, impact on the black rail given the relative increase in potential habitat availability, although the use of this new habitat is unknown given the anticipated low species density.

The changes in marsh would likely represent a negligible benefit to bald eagles as their varied diet would allow for them to adjust their foraging strategies as prey congregation around available marsh increases or decreases. However, the MBSD Project action alternatives and other reasonably foreseeable projects in the Barataria Basin would likely increase contaminant levels in the water from increased diversion of waters from the Mississippi River, runoff from adjacent agricultural lands, and spills of hazardous chemicals (although the potential for spills would be minimized by implementation of the various projects' SWPPP and SPCC Plans, as applicable). If the increasing contaminants accumulate in aquatic prey species and bald eagles consume contaminated prey, there is the potential for adverse impacts on bald eagles, such as reduced reproductive success. Therefore, cumulative impacts on bald eagles would be negligible to moderate, adverse, and permanent.

Although cumulative impacts from the Mid-Barataria and Mid-Breton Sediment Diversion Projects only overlap spatially in the MBSD Project area within the Mississippi River and birdfoot delta (construction of infrastructure and the diversion of freshwater and sediments), impacts from each of these projects in their respective Project areas could result in additional cumulative impacts on certain species populations. For example, if contaminants in the Barataria and Breton Sound Basins both increase and result in accumulated contaminants in bald eagle prey, the detrimental effects of consuming this contaminated prey would occur over a wider range and thus have a larger impact on the population of bald eagles in southern Louisiana. Additional analysis of the cumulative impacts of these two projects will be included in a forthcoming EIS for the Mid-Breton Sediment Diversion Project.

4.25.12.4.3.3 Marine/Estuarine Species

Cumulative impacts on the marine/estuarine species from operation of the MBSD Project action alternatives and operation of the other reasonably foreseeable projects would most likely occur from changes in wetland/SAV extent in the Barataria Basin, which would be primarily driven by sea-level rise and changing salinity, as well as from changes in the food web, which would be primarily driven by changes in marsh coverage, water flow, temperature, and salinity.

As discussed in Section 4.25.6 (Wetland Resources and Waters of the U.S.), if all of the reasonably foreseeable projects plus the MBSD Project action alternatives are built, the Delft3D Basinwide Model projects a 35.7 percent increase in total wetland area in the Barataria Basin by 2070 (when compared with the No Action Alternative), although the model does not account for the initial wetland gains of smaller restoration projects (as described above). Although there would be a slight increase in wetland losses in the birdfoot delta, there would be an overall gain in wetland habitat in the AOI. West Indian manatees (although rare in the basin), green sea turtles, and saltmarsh topminnows would likely experience the negligible to moderate, beneficial, short-term to permanent impacts associated with increased food sources (SAV) or the presence of quiet waters near marsh (saltmarsh topminnow).

Although the increased marsh/SAV availability would be beneficial to the overall food web in the AOI, certain key species, including some prey species of the Kemp's ridley would be adversely affected by changes in temperature, salinity, and water flow, which would occur as a result of the MBSD Project action alternatives. Most notably, the brown shrimp population in the Barataria Basin is anticipated to decrease, while the white shrimp population is anticipated to have negligible to minor increases. If the shifting shrimp populations results in a shift of fishermen to focus on areas of the lower basin, it is possible that increased fisheries interactions with sea turtles would occur. Although fishing interactions (as well as general vessel activity from construction of reasonably foreseeable projects) could affect all species of sea turtles, the effects on hawksbill and leatherback turtles would likely experience negligible effects due to their expected presence only in areas near to, or outside of, the barrier islands. As the Kemp's ridley sea turtle, green, and loggerhead sea turtles may occur in higher abundance in the Barataria Basin (and are more likely to occur in the mid-basin), they may be more susceptible to fishing or vessel interactions, and could experience minor to moderate, adverse, temporary to permanent impacts from the proposed Project and other reasonably foreseeable projects. Estuarine projects in the lower basin, where the giant manta ray is anticipated to occur, include various marsh creation/restoration projects that would convert open waters to marsh habitat, removing that habitat from potential use. However, the giant manta ray is a wide-ranging species that could use adjacent suitable habitat, including waters offshore of the barrier islands; therefore, the species would likely experience negligible impacts from the proposed Project and other reasonably foreseeable projects.

4.25.13 Socioeconomics

4.25.13.1 Geographic and Temporal Extent of Analysis

The AOI for evaluating cumulative impacts on socioeconomics during the 5-year construction period includes the immediate vicinity (within 0.5-mile) of the MBSD Project construction footprint as well as the segments of LA 23 in the vicinity of and extending south of the construction footprint due to potential traffic delays and related impacts. The area of potential construction impacts on community cohesion and housing/property values would be within the immediate vicinity (about 0.5-mile) of the construction footprint, including the community of Ironton.

The AOI for evaluating cumulative impacts on socioeconomics during the 50-year analysis period of the MBSD Project includes the 10-parish Project area. The labor supply for the project construction as well as most of the direct and multiplier impacts associated with operational impacts would also likely include the 10-parish area.

4.25.13.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Key past and present trends with ongoing potential to impact socioeconomics include trends in industry development and employment in the region, population trends, changes in global markets and demand for imports and exports, as well as trends in sea-level rise and land subsidence, which are expected to lead to adverse impacts on socioeconomic resources through land loss and increasing risks of coastal storm hazards and flooding. In addition, specific past development and construction projects have affected socioeconomic resources throughout the Project area by providing short and long-term employment opportunities.

Recent natural and man-made disasters, including hurricanes (specifically Lili and Katrina[143]) as well the DWH oil spill have had major short-term and potentially permanent adverse impacts on socioeconomic resources, including dramatic reductions in population due to outmigration and destruction of properties and infrastructure. A

[143] Although Hurricane Ida occurred between the Draft EIS and Final EIS, this analysis was based on pre-Hurricane Ida data; post-Hurricane Ida data is not available as of the time of the Final EIS, see Section 4.26.4.1.1

number of ethnic and social groups reside in the coastal parishes and are supported by livelihoods based on the renewable and non-renewable natural resources of the region. As coastal land has been lost, these communities have been made more vulnerable to coastal hazards. The possibility of the recurrence of catastrophic events poses future threats to coastal communities. These trends and events have collectively contributed to the existing socioeconomic characteristics in the Barataria Basin and birdfoot delta as described in Chapter 3, Section 3.13 Socioeconomics. As such, the impact on socioeconomics from past or recently completed projects is captured in the analysis in Chapter 3, 3.13 Socioeconomics and Section 4.13 Socioeconomics.

Overall, the analysis in Chapter 3, Section 3.13 Socioeconomics and Section 4.13 Socioeconomics identifies a range of recent socioeconomic trends in the Project area. There has been a general decreasing trend in population in the coastal areas in the Project area over recent decades. Between 2000 and 2018, the population of the Project area, which is approximately 600,000 people, declined by 6.2 percent (U.S. Census Bureau 2020). This decline was driven by a large (about 30 percent) population decline in Orleans Parish following Hurricane Katrina in 2005, primarily related to job loss and relocation after the storm (Plyer and Ortiz 2011). Coastal properties and public infrastructure have been and continue to be threatened by tidal flooding, sea-level rise, and storm surge, which have resulted in negative impacts on adjacent economies.

A large portion of employment in coastal Louisiana centers on oil and gas production, commercial and recreational fisheries, marine construction, ship and boat manufacturing, tourism and recreation, and marine transportation. Oil and gas related coastal infrastructure density rapidly expanded between 1960 and 2010 (Hemmerling et al 2016).

The key reasonably foreseeable future projects that have the potential to contribute cumulative impacts on socioeconomics during construction in the AOI include the following below. The first three are located within or adjacent to the Project construction footprint. The remaining six are located south of the MBSD Project construction site along LA 23.

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[144] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)

[144] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)
- Large-Scale Marsh Creation and Component E- Planning (Map #8 in Figure 4.25.1-1)
- Delta LNG/Delta Express Pipeline (Map #9 in Figure 4.25.1-1)
- Plaquemines LNG/Gator Express Pipeline (Map #10 in Figure 4.25.1-1)

The key reasonably foreseeable projects that have the potential to contribute cumulative impacts on socioeconomics in the AOI during operations include all of the reasonably projects listed in Table 4.25.1-1.

4.25.13.3 Cumulative Impacts during Construction

4.25.13.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The reasonably foreseeable projects would affect socioeconomic resources within the AOI by generating economic activity and by increasing traffic and congestion temporarily, which would cause temporary business and other community interruptions.

The reasonably foreseeable projects with potential overlap with the construction phase of the MBSD Project action alternatives include major industrial projects that would require substantial construction workforces and use of construction trucks in Plaquemines Parish (see Section 4.25.22 [Land-Based Transportation]). Estimates of the construction workforce for many of the reasonably foreseeable projects are not available. The two projects with workforce estimates would require 2,600 to 4,200 construction workers in total (see Table 4.25.22-1). An additional 900 construction workers may be required for the NOLA Oil Terminal, however the actual total workforce needed is uncertain. Temporary, major, beneficial impacts associated with employment for these projects are also anticipated. The construction timeframes for reasonably foreseeable projects in the cumulative impact area for socioeconomic resources are likely to overlap with the MBSD Project action alternatives. Traffic associated with these projects could lead to increased travel volumes along LA 23, especially during peak commute times, particularly in southern Plaquemines Parish. If all of the foreseeable projects are conducted simultaneously, the traffic could nearly double. Construction impacts on land-based transportation from reasonably foreseeable projects are expected to be major, adverse, and temporary.

The reasonably foreseeable projects could also exacerbate marine traffic and noise impacts (see Section 4.25.16 [Recreation and Tourism] and Section 4.25.8 [Noise]). Depending on the amount of overlap of projects with each other, these projects could result in temporary moderate adverse impacts on socioeconomic resources as well as sales tax collection by delaying and disrupting business and resident activities in the AOI. Moderate adverse impacts on property values in localized areas and associated tax receipts would occur associated with construction activities.

These projects would also result in minor to moderate beneficial impacts on local economies by generating additional employment demand and economic activity in the area. This could include moderate to major, short-term, beneficial impacts on sales and use and income taxes, as well as public services associated with construction spending.

4.25.13.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on socioeconomics from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.13 Socioeconomics.

4.25.13.3.3 Overall Cumulative Impacts

Cumulative impacts from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would likely be temporary, major, and adverse on businesses and residents located near or traveling past the MBSD construction footprint due to traffic congestion and increased noise and dust. Moderate adverse impacts on property values in localized areas and associated tax receipts would occur associated with construction activities. There would also be temporary, major, beneficial cumulative impacts on job creation and the local economy. Temporary, major, beneficial impacts associated with employment for reasonably foreseeable future projects are anticipated. This could include moderate to major, short-term, beneficial impacts on sales and use and income taxes, as well as public services associated with construction spending.

4.25.13.4 Cumulative Impacts during Operations

4.25.13.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The impacts on socioeconomics from recently completed and ongoing projects and trends are factored into baseline conditions as presented in Section 4.13 Socioeconomics. Four reasonably foreseeable recreation-specific projects would improve access and site quality for recreational fishing, boating, hunting, and wildlife watching in the Barataria Basin, including improvements at Bayou Segnette State Park (north of the project site), Grand Isle State Park (Jefferson Parish), and two projects at Pass A Loutre WMA (birdfoot delta) (see Table 4.25.1-1). These projects would benefit socioeconomic resources to the extent that they attract additional visitors to these areas. Nine foreseeable hurricane and flood risk reduction projects in the basin could reduce future storm damages, including reduced business and residential property damages and reduced business and other community disruptions relative to the No Action Alternative in some areas, including the NOV-NFL Levee – La Reussite to Myrtle Grove, which is anticipated to increase flood protection to homes and business in the areas protected by that levee and to LA 23. Implementation of the proposed Project would enhance federal hurricane risk reduction (USACE 2019c).

About half (28) of the other reasonably foreseeable projects in the basin are restoration projects that aim to restore wetlands in the basin, which could generally benefit socioeconomic resources by enhancing fish populations and associated recreational and commercial fishing activities as well as by reducing socioeconomic risks associated with storm hazards. The reasonably foreseeable future restoration projects would result in a permanent, negligible to minor, benefit to the extent of wetlands in the Project area because wetland loss impacts from sea-level rise would eventually outpace these restoration benefits (see Section 4.25.6 [Wetlands and Waters of the U.S.]). The reasonably foreseeable restoration projects are also not expected to result in substantial beneficial impacts on most habitat characteristics such that they would have more than negligible impacts on aquatic fauna and recreational and commercial fishing (see Section 4.25.10 [Aquatic Resources]). As such, the reasonably foreseeable restoration projects would contribute negligible cumulative impacts on socioeconomics during MBSD Project action alternatives operations. While the life of other proposed marsh creation projects is limited, they would provide substantial benefits over the course of their life including fisheries production and storm surge risk reduction. Additional future projects are anticipated to continue those benefits, but those projects were not sufficiently developed to be evaluated in this document.

Operation of the nine reasonably foreseeable major industrial projects (see Table 4.25.1-1) are likely to result in minor to moderate beneficial, permanent impacts on economic activity in Plaquemines Parish. Two projects currently have estimates of the permanent workforce and would require 285 jobs total during operations of the projects. Adverse impacts of the operations of these projects on traffic and congestion is anticipated to be negligible (see Section 4.25.22 [Land-Based Transportation]).

In summary, the operations of reasonably foreseeable projects would provide minor to moderate adverse and minor to moderate beneficial effects to socioeconomic resources, associated primarily with hurricane and flood risk reduction projects and operations of major industrial projects in the Barataria Basin.

4.25.13.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on socioeconomics from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.13 Socioeconomics.

4.25.13.4.3 Overall Cumulative Impacts

The cumulative impacts from operation of the MBSD Project action alternatives combined with operation of reasonably foreseeable future actions on socioeconomics (including economy, employment, businesses and industrial activity; population; housing and property values; tax revenues; public services; community cohesion; and protection of children) are expected to range from minor to major adverse to minor beneficial and permanent, as described below. Ongoing trends in increasing sea-level rise, subsidence, flooding, and storm hazards in the Project area has and will likely continue to result in infrastructure damages, increased frequency of business disruptions and losses, and diminished employment opportunities. These have and will result in major, adverse, permanent impacts on many economic activities as well as resident populations. The operations of reasonably foreseeable projects would also provide minor to moderate adverse and minor beneficial effects to socioeconomic resources, associated primarily with hurricane and flood risk reduction projects and operations of major industrial projects in the Barataria Basin. The operations of major industrial projects would have permanent impacts from the ongoing economic activity and at least 285 jobs created by these projects with negligible traffic increases during operations.

4.25.14 Commercial Fisheries

4.25.14.1 Geographic and Temporal Extent of Analysis

The construction AOI for commercial fishing activities includes the immediate vicinity (within 0.5-mile) of the MBSD Project construction footprint as well as the segments of LA 23 in the vicinity of and extending south of the construction footprint due to potential traffic delays and related impacts.

The AOI associated with commercial fishing activities affected by operation of the MBSD Project action alternatives includes the Project area, including the entire Barataria Basin and the birdfoot delta. This area of operational impacts includes communities with economic ties to the commercial fishing industry, including residences of commercial fishers, businesses that supply the commercial fishing industry (such as ice and bait shops), gas stations, restaurants, marinas, as well as shippers, dealers, processors, and retail sales operations.

4.25.14.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

As described in Chapter 3, commercial fisheries comprise a multi-billion-dollar industry in the northern Gulf Coast region, and include large annual catch of large volumes of finfish, shrimp, oysters, and crab. The DWH oil spill in April 2010 adversely affected fishing throughout much of the Gulf, including the Barataria Basin. Reductions in commercial fisheries landings were observed in 2010 and area closures after the spill impacted the commercial fishing sector, though it generally rebounded in the following years (see Chapter 3, Section 3.14 Commercial Fisheries). Over a period of many decades, the commercial fishing industry has developed local supply chains and a range of seafood processors that support additional economic activity in the region. The level of participation has decreased over recent decades and the specific individuals engaged in these activities exhibit a high degree of turnover when compared to the economy as a whole. Despite recent changes in market-related conditions, extreme weather events, and the DWH oil spill, among other factors, the overall volume of catch in the Project area has been relatively steady since 2000. Over time, gradual and continual increases in salinity and decreases in marsh habitat in the Project area are anticipated to affect habitat suitability for commercially targeted species in the Project area. As sea levels rise, salinity is expected to increase, and marsh habitat is expected to decrease by approximately 80 percent (approximately 300,000 acres) in the basin and birdfoot delta by 2070, as described in detail in Section 4.6.5.1 Wetland Types and Extent in Wetland Resources and Waters of the U.S. These changes would affect the abundance and location of key species targeted commercially in the Project area, which would adversely affect the commercial fishing industry.

Gradual and continual sea-level rise and subsidence is also anticipated to increase the occurrence of storm surge and tidal flooding at fishing access points outside of federal levee systems (or roads leading to them) such as boat launches or marinas, making access to these sites increasingly more difficult over the 50-year analysis period. These changes could impact commercial fishing by increasing travel distances to, or closure of, certain water access points or maritime storm refuge areas. When access points become difficult or impossible to access, commercial fishers would be expected to modify their behavior and either substitute to alternative locations or forego trips entirely. Over time the reduction in accessibility may cause commercial fishers to exit the industry or substitute to areas outside the Project area. These past and present trends collectively contribute to the characterization of the Project area as described in Chapter 3, Section 3.14 Commercial Fisheries. The effect of these trends on commercial fishing in the Project area is reflected in the data presented in that section. As such the impact on commercial fishing from there past and present factors is captured in the analysis in Section 4.14 Commercial Fisheries.

The key reasonably foreseeable projects that have the potential to contribute cumulative impacts on commercial fisheries during construction in the AOI include the following listed below. The first three are located within or adjacent to the Project construction footprint. The remaining five are located south of the MBSD Project construction site along LA 23. These projects would affect commercial fishing activities by increasing traffic and congestion temporarily.

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[145] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)
- Large-Scale Marsh Creation and Component E- Planning (Map #8 in Figure 4.25.1-1)
- Delta LNG/Delta Express Pipeline (Map #9 in Figure 4.25.1-1)

[145] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

- Plaquemines LNG/Gator Express Pipeline (Map #10 in Figure 4.25.1-1)

The reasonably foreseeable projects that have the potential to contribute cumulative impacts on commercial fishing activities during operations include 42 projects listed in Table 4.25.1-1. The remaining nine projects in the table are major industrial projects unrelated to commercial fisheries that are likely to have negligible impacts on traffic and congestion (see Section 4.25.22 [Land-Based Transportation]) during operation, and as such are unlikely to affect commercial fisheries operations other than in a case of accidental spills.

4.25.14.3 Cumulative Impacts during Construction

4.25.14.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The reasonably foreseeable projects that would contribute to impacts within the AOI include major industrial projects that would require substantial construction workforces and demand for and use of construction trucks south of the MBSD Project action alternatives construction footprint on LA 23 in Plaquemines Parish (see Section 4.25.22 [Land-Based Transportation]). The construction timeframes for reasonably foreseeable projects in the AOI for commercial fisheries are likely to overlap at some point with the MBSD Project action alternatives. Traffic associated with these projects could lead to increased travel volumes along LA 23, especially during peak commute times, particularly in southern Plaquemines Parish. If all of the foreseeable projects are conducted simultaneously, the traffic could nearly double. The reasonably foreseeable projects in the AOI could also exacerbate marine traffic and noise impacts. This increase in traffic and waterway noise could delay or disrupt ongoing commercial fishing activities. Depending on the amount of overlap of projects with each other, these projects could result in temporary minor to moderate adverse impacts on commercial fishing activities by delaying and disrupting activities in the AOI.

4.25.14.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on commercial fisheries from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.14 Commercial Fisheries.

4.25.14.3.3 Overall Cumulative Impacts

Cumulative impacts from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives (depending on the amount of overlap of reasonably foreseeable projects with each other), would result in temporary minor to moderate adverse impacts on commercial fishing activities by delaying and disrupting activities in the AOI as well as increasing marine noise impacts. Limited changes to commercial fishing are expected to occur during the 5-year analysis period for construction of MBSD alternatives. Depending on the amount of overlap of projects with each other, reasonably foreseeable future projects could result in temporary minor to moderate adverse impacts on commercial fishing activities by delaying and disrupting activities in the AOI.

4.25.14.4 Cumulative Impacts during Operations

4.25.14.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The impacts on commercial fisheries from recently completed and ongoing projects and trends are factored into baseline conditions as presented in Section 4.14 Commercial Fisheries. Four reasonably foreseeable recreation-specific projects would improve access and site quality for recreational fishing, boating, hunting, and wildlife watching in the Barataria Basin. Because these projects focus on improving recreational amenities, some projects would not benefit commercial fishing activities (for example, Pass A Loutre Campground improvements). However, some projects include measures that would benefit fisheries, such as the protection of nearshore and marine habitats at Grand Isle State Park. These actions would have ancillary benefits on commercial fishing activities.

Nine hurricane and flood risk reduction projects in the basin could reduce future storm damages, including reduced business and residential property damages and reduced business and other community disruptions relative to the No Action Alternative in some areas. These reductions in flood risk could also benefit commercial fishing activities.

Many of the 28 restoration projects aim to restore wetlands in the basin, which could generally benefit commercial fishing activities by enhancing fish populations as well as by reducing disruptions associated with storm hazards. However, as described in Section 4.25.6 (Wetland Resources and Waters of the U.S.), despite the planned wetland restoration projects, wetland loss in the Barataria Basin and birdfoot delta over the long-term without the MBSD Project action alternatives would be similar to the No Action Alternative. While the birdfoot delta would experience benefits between 2020 and 2050, by 2070 the benefits of reasonably foreseeable projects decrease resulting in impacts similar to the No Action Alternative. The reasonably foreseeable restoration projects are also not expected to result in substantial impacts on most habitat characteristics such that they would have more than negligible impacts on aquatic fauna (see Section 4.25.10 [Aquatic Resources]). As such, the foreseeable restoration projects would contribute negligible cumulative impacts on commercial fishing activities during MBSD Project action alternatives operations.

In summary, the reasonably foreseeable projects would provide minor beneficial effects on commercial fishing resources, associated primarily with hurricane and flood risk reduction projects.

4.25.14.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on commercial fisheries from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.14 Commercial Fisheries.

4.25.14.4.3 Overall Cumulative Impacts

The cumulative impacts from operation of the MBSD Project action alternatives combined with operation of the reasonably foreseeable future actions on commercial fishing activities are expected to range from minor to major adverse to minor beneficial and permanent depending on the fishery. Over time, gradual and continual increases in salinity and decreases in marsh habitat in the Project area are anticipated to affect habitat suitability for commercially targeted species in the Project area. These changes would affect the abundance and location of key species targeted commercially in the Project area, which would adversely affect the commercial fishing industry. Reasonably foreseeable projects would also provide minor long-term beneficial effects on commercial fishing resources, associated primarily with hurricane and flood risk reduction projects.

4.25.15 Environmental Justice

4.25.15.1 Geographic and Temporal Extent of Analysis

The construction AOI for low-income and minority populations would include the immediate vicinity (within 0.5-mile) of the MBSD Project construction footprint as well as the segments of LA 23 in the vicinity of and extending south of the construction footprint due to potential traffic delays and related impacts. Construction impacts would occur over a 5-year period.

The AOI associated with low-income and minority populations affected by operation of the MBSD Project action alternatives includes the Project area, including the entire Barataria Basin and the birdfoot delta. This area includes low-income and minority communities that may be affected by changes in tidal flooding and flood hazards, as well as those with economic and social ties to the basin including, particularly, the commercial fishing industry.

4.25.15.2 Past, Present, and Reasonably Foreseeable Projects Considered

Past and existing processes that have contributed to current environmental justice conditions in the Project area include the effects of ongoing trends of sea-level rise, tidal flooding, and storm hazards on low-income and minority populations. For example, such changes in environmental conditions likely contribute to increases in flood insurance rates, as well as homeowners and automobile rates, that are more burdensome for low-income and minority populations in the AOI. In some cases, low-income and minority populations have adapted to environmental changes, for example by elevating structures. However, many of these populations live in small, unincorporated areas where infrastructure may be especially vulnerable to worsening environmental conditions. Additionally, past and ongoing outmigration of younger low-income and minority residents has left a more elderly and vulnerable population behind, although younger adults who have migrated inland may provide financial and housing support to elderly family members who remain in place. Past and ongoing declines in natural resource industries such as commercial fishing caused by multiple factors, including environmental changes and the effects of the DWH oil spill, have also contributed to current conditions for low-income and minority populations. A lack of data connecting low-income and minority populations to specific fisheries makes it difficult to precisely determine the effects of these changes on commercial fishing by these populations. However, low-income and minority fishers may be less likely to be able to adapt to such changes. Substituting to other fisheries, for example, may require long-distance travel or substantial equipment investments that are particularly onerous for low-income and minority fishers. Barriers such as economic challenges, age, educational background, or language may prevent low-income and minority populations from relocating or retraining for other industries or employment. These past and present trends collectively contribute to the characterization of the Project area as described in Chapter 3, Section 3.15 Environmental Justice and are their contribution to low-income and minority communities in the Project area is reflected in the data presented therein. As such the impact on low-income and minority communities from these past and present processes is captured in the analysis in Section 4.15 Environmental Justice.

The key reasonably foreseeable projects that have the potential to contribute cumulative impacts on low-income or minority populations during construction in the AOI include the following listed below. The first three are located within or adjacent to the Project construction footprint. The remaining six are located south of the Project construction site along LA 23. These projects have the potential to affect low-income and minority communities within the AOI both beneficially, by generating economic activity, and adversely, by increasing traffic and congestion temporarily, which would cause temporary business and other community interruptions.

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[146] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)

[146] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

- Large-Scale Marsh Creation and Component E- Planning (Map #8 in Figure 4.25.1-1)
- NOV-NF-W-05a.2, 06a.1, 06a.2 Projects (Map #7 in Figure 4.25.1-1)
- Delta LNG/Delta Express Pipeline (Map #9 in Figure 4.25.1-1)
- Plaquemines LNG/Gator Express Pipeline (Map #10 in Figure 4.25.1-1)

Reasonably foreseeable projects considered for cumulative impacts on low-income and minority populations during operations include all of the projects in the Project area (see Table 4.25.1-1).

4.25.15.3 Cumulative Impacts during Construction

4.25.15.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The reasonably foreseeable projects with the potential to overlap the construction phase of the MBSD Project action alternatives include some major industrial projects that would require substantial construction workforces and demand for and use of construction trucks in lower Plaquemines Parish (see Section 4.25.22 [Land-Based Transportation]). Estimates of the construction workforce are unavailable for many of the reasonably foreseeable projects. The two projects with workforce estimates would require 2,600 to 4,200 construction workers total (see Table 4.25.22-1). An additional 900 construction workers may be required for the NOLA Oil Terminal, however the actual total workforce needed is uncertain. The construction timeframes for reasonably foreseeable projects in the AOI are likely to overlap with the MBSD Project action alternatives. These projects have the potential to benefit low-income and minority populations south of the construction footprint on LA 23, to the extent that they draw construction labor for these projects from those communities. However, traffic associated with these projects could also lead to increased travel volumes along LA 23, especially during peak commute times, particularly in southern Plaquemines Parish, where a number of low-income and minority populations exist. The reasonably foreseeable projects in the AOI could also exacerbate water traffic and noise impacts around these communities.

In summary, the construction of reasonably foreseeable projects would likely result in minor adverse as well as minor to moderate beneficial effects to low-income and minority communities in the AOI.

4.25.15.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on low-income and minority populations from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.15 Environmental Justice.

4.25.15.3.3 Overall Cumulative Impacts

Cumulative impacts from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would likely be temporary, minor to moderate, and adverse on low-income and minority populations located near or traveling past the MBSD construction footprint due to traffic congestion and increased noise and dust. These impacts could particularly affect the community of Ironton, which is immediately south of the MBSD Project. There would also be the potential for temporary, minor, beneficial cumulative impacts on job creation and the local economy in some low-income and minority populations in the AOI, depending on the source of construction labor utilized.

4.25.15.4 Assessment of Cumulative Impacts during Operations

4.25.15.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Nine hurricane and flood risk reduction projects in the basin could reduce future storm damages, including business and residential property damages and business and other community disruptions relative to the No Action Alternative in some areas. The Lafitte Area Levee Repair and the Jean Lafitte Tidal Protection project may limit or reduce future adverse impacts of changes to tidal flooding in those communities.

Many of the 28 restoration projects that aim to restore wetlands in the basin, which could generally benefit low-income and minority communities by enhancing fish populations and associated recreational, subsistence, and commercial fishing activities as well as by reducing socioeconomic risks associated with storm hazards. However, as described in Section 4.25.6 (Wetland Resources and Waters of the U.S.), despite the reasonably foreseeable wetland restoration projects, wetland loss in the Barataria Basin and birdfoot delta over the long-term without the MBSD Project action alternatives would be similar to the No Action Alternative. While the birdfoot delta would experience benefits between 2020 and 2050, by 2070 the benefits of reasonably foreseeable projects decrease resulting in impacts similar to the No Action Alternative. The reasonably foreseeable restoration projects are also not expected to result in substantial impacts on most habitat characteristics such that they would have more than negligible impacts on aquatic fauna and recreational and commercial fishing (see Section 4.25.10 [Aquatic Resources]). As such, it is not clear that the other reasonably foreseeable projects would benefit low-income and minority communities in the cumulative AOI. While the life of other proposed marsh creation projects is limited, they would provide substantial benefits over the course of their life including fisheries production and storm surge risk reduction. Additional future projects are anticipated to continue those benefits, but those projects were not sufficiently developed to be evaluated in this document.

Finally, the operation of nine reasonably foreseeable major industrial projects are likely to result in increasing economic activities in affected areas, which should increase economic activity in the cumulative AOI. This activity could benefit low-income and minority communities in nearby areas. Two projects currently have estimates of the permanent workforce and would require 285 jobs total during operations of the projects. Adverse impacts of the operations of these projects on traffic and congestion is anticipated to be negligible (see Section 4.25.22 [Land-Based Transportation]).

In summary, the operations of reasonably foreseeable projects have the potential to result in result in minor to moderate adverse and as well as minor long-term or permanent beneficial effects to low-income and minority communities in the Barataria Basin.

4.25.15.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on low-income and minority populations from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.15 Environmental Justice.

4.25.15.4.3 Overall Cumulative Impacts

Cumulative impacts from operation of the reasonably foreseeable future projects combined with operation of the MBSD Project action alternatives would likely be disproportionately high and adverse to some low-income and minority populations from changes in tidal flooding, storm hazards, commercial fisheries, and subsistence fisheries. Low-income and minority populations have and will continue to be impacted by declines in natural resource industries, such as commercial fishing, that accompany changes in environmental conditions in the Project area such as increases in storm surge and flooding caused by sea-level rise, land subsidence, and the continued loss of wetlands.

4.25.16 Recreation and Tourism

4.25.16.1 Geographic and Temporal Extent of Analysis

The construction AOI for recreation and tourism would include the immediate vicinity (within 0.5-mile) of the MBSD Project construction footprint as well as the segments of LA 23 in the vicinity of and extending south of the construction footprint due to potential traffic delays and related impacts. Construction impacts would occur over a 5-year period.

The AOI associated with recreation and tourism affected by operation of the MBSD Project action alternatives includes the entire Project area, including the Barataria Basin and the birdfoot delta. Recreators choose among a range of sites throughout the Project area when they decide to engage in recreation. As conditions change at sites directly affected by the operation of the MBSD Project, recreators may substitute to other sites within the Project area.

4.25.16.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

The DWH oil spill in April 2010 adversely affected recreation and tourism throughout much of the Gulf, including the Barataria Basin. Reductions in shoreline use activities—including beach use, fishing, wildlife viewing, and hunting—were observed for up to 18 months following the spill between western Louisiana and the Florida Panhandle; impacts on boating, including boat-based fishing, were observed for up to three months in this area (Tourangeau et al. 2017). Recreation and tourism have recovered and stabilized in the AOI since the spill due to natural attenuation of oiling impacts as well as restoration actions that have restored habitats for species that support recreational fishing and hunting and projects, which have enhanced recreational access to the AOI. In the past five years, fishing and hunting license sales have remained relatively stable (Appendix H), along with motorboat registrations (see Chapter 3, Section 3.17.3 in Public Lands) and fishing effort (see Chapter 3, Section 3.16.2.3 in Recreation and Tourism). In the future, sea-level rise and subsidence would increase the occurrence of tidal flooding at recreational access points outside of federal levee systems such as boat launches, marinas, wildlife and bird watching sites, and roads leading to these access points, making access to these sites increasingly more difficult throughout the Barataria Basin over the 50-year analysis period, with major decreases in site accessibility due to flooding occurring by 2070.

The key reasonably foreseeable projects that have the potential to contribute cumulative impacts on recreation and tourism during construction in the AOI include the following listed below. The first three are located within or adjacent to the Project construction footprint. The remaining six are located south of the MBSD Project construction site along LA 23. These projects would affect recreation and tourism within the AOI by increasing traffic and congestion temporarily, which could adversely affect site accessibility.

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[147] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)

[147] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

- Large-Scale Marsh Creation and Component E- Planning (Map #8 in Figure 4.25.1-1)
- NOV-NF-W-05a.2, 06a.1, 06a.2 Projects (Map #7 in Figure 4.25.1-1)
- Delta LNG/Delta Express Pipeline (Map #9 in Figure 4.25.1-1)
- Plaquemines LNG/Gator Express Pipeline (Map #10 in Figure 4.25.1-1)

Because the AOI for recreation and tourism includes the entire Project area, all reasonably foreseeable projects (see Table 4.25.1-1) have been included in the cumulative impacts assessment for recreation and tourism.

4.25.16.3 Cumulative Impacts during Construction

4.25.16.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The reasonably foreseeable projects with potential overlap with the construction phase of the MBSD Project action alternatives include some major industrial projects that would require substantial construction workforces and demand for and use of construction trucks in Plaquemines Parish (see Section 4.25.22 [Land-Based Transportation]). The construction timeframes for reasonably foreseeable projects in the cumulative impact area for recreation and tourism are likely to overlap with the MBSD Project action alternatives. Traffic associated with these projects could lead to increased travel volumes along LA 23, especially during peak commute times, particularly in southern Plaquemines Parish, which may contribute to delays in accessing recreation sites. The following projects would result in more than 1,000 construction workers or truck trips per day: Tallgrass PLT; NOV-NF-W-05a.2, 06a.1, 06a.2 Projects; and Plaquemines LNG/Gator Express Pipeline. The reasonably foreseeable projects in the AOI could also exacerbate water traffic and noise impacts, both of which could adversely affect recreation experiences. In summary, the construction of reasonably foreseeable projects would likely result in minor adverse effects on recreation and tourism in the AOI.

4.25.16.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on recreation and tourism from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.16 Recreation and Tourism.

4.25.16.3.3 Overall Cumulative Impacts

Cumulative impacts on recreation and tourism from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would be temporary, minor, and adverse. Limited impacts on recreational fishing activities are expected to occur during the 5-year analysis period for construction of MBSD Project action alternatives. Depending on the amount of overlap of projects with each other, the combination of the MBSD Project action alternatives and reasonably foreseeable future projects could result in temporary minor to moderate adverse impacts on recreational activities by delaying and disrupting activities in the AOI.

4.25.16.4 Cumulative Impacts during Operations

4.25.16.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Three reasonably foreseeable recreation-specific projects would improve access and site quality for recreational fishing, boating, hunting, and wildlife watching in the Barataria Basin, including improvements at Bayou Segnette State Park (north of the project site), Grand Isle State Park (Jefferson Parish), and Pass A Loutre WMA (birdfoot delta).

Nine hurricane and flood risk reduction projects could reduce future storm damages and lead to fewer site and road closures over time and improve recreational access relative to the No Action Alternative in some areas.

Many of the 28 reasonably foreseeable restoration projects aim to restore wetlands in the basin, which could generally benefit socioeconomic resources by enhancing fish populations and associated recreational activities as well as by reducing disruptions associated with storm hazards. However, as described in Section 4.25.6 (Wetland Resources and Waters of the U.S.), despite the planned wetland restoration projects, wetland loss in the Barataria Basin and birdfoot delta over the long-term without the MBSD Project action alternatives would be similar to the No Action Alternative. While the birdfoot delta would experience benefits between 2020 and 2050, by 2070 the benefits of reasonably foreseeable projects decrease resulting in impacts similar to the No Action Alternative. The reasonably foreseeable restoration projects are also not expected to result in substantial impacts on most habitat characteristics such that they would have more than negligible impacts on aquatic fauna and recreational and commercial fishing (see Section 4.25.10 [Aquatic Resources]). As such, the foreseeable restoration projects would contribute negligible cumulative impacts on recreation and tourism. In the shorter term, projects have some potential to have minor adverse impacts on recreational boating by increasing wetlands in areas that boaters prefer for recreation.

Finally, the operation of nine reasonably foreseeable major industrial projects could lead to decreased recreation quality in the basin related to adverse impacts on visual resources or due to accidental releases. However, the operational impacts are likely to be negligible relative to the No Action Alternative given the modest anticipated impacts on viewsheds around these projects and relatively low likelihood of spills outside of the immediate project vicinities.

In summary, the reasonably foreseeable projects would likely provide minor adverse and minor to moderate beneficial effects to recreation and tourism, particularly to hunting and wildlife watching, associated with restoration and other improvements in wetlands in the Barataria Basin.

4.25.16.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on recreation and tourism from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.16 Recreation and Tourism.

4.25.16.4.3 Overall Cumulative Impacts of Reasonably Foreseeable Projects

Cumulative impacts from operation of the MBSD Project action alternatives combined with operation of the reasonably foreseeable future project on recreation and tourism are expected to range from minor to moderate adverse to minor beneficial over the long-term. In the future, sea-level rise and subsidence would increase the occurrence of tidal flooding at recreational access points outside of federal levee systems such as boat launches, marinas, wildlife and bird watching sites, and roads leading to these access points, making access to these sites increasingly more difficult throughout the Barataria Basin. Over time, gradual and continual increases in salinity and decreases in marsh habitat in the Project area are also anticipated to affect habitat suitability for recreationally targeted species in the Project area. The reasonably foreseeable projects would likely provide minor adverse and minor to moderate beneficial effects to recreation and tourism, particularly to hunting and wildlife watching, associated with the restoration and other improvements in wetlands in the Barataria Basin.

4.25.17 Public Lands

4.25.17.1 Geographic and Temporal Extent of Analysis

Public lands in the Project area include those lands designated for conservation purposes by state and federal agencies including wildlife management areas, national wildlife refuges, and state and national parks. During construction, minor, temporary, adverse indirect construction impacts on public lands would occur on LA 23 in the vicinity of and extending south of the MBSD Project construction footprint due to potential traffic delays for visitors accessing public lands via LA 23. The temporal extent of the analysis is the 5-year construction period.

During operations, the AOI for public lands would include the designated public lands themselves, which are located throughout the Barataria Basin and the birdfoot delta (see Chapter 3, Figure 3.16-1 in Section 3.16 Recreation and Tourism for locations of these public lands). The temporal extent of the analysis is the 50-year operational analysis period.

4.25.17.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Ongoing environmental trends including coastal erosion, subsidence, sea-level rise, saltwater intrusion, and storms have contributed to wetland loss in coastal Louisiana and specifically within the boundaries of public lands in the Project area. Wetland loss in public lands has had adverse impacts on aquatic and terrestrial wildlife that depend on them. Further, anthropogenic effects, most notably the DWH oil spill, can and have degraded vegetation and water quality that provide habitat for wildlife and result in severe adverse health effects with long-term consequences on population levels in public lands. Alternatively, past and present wetland restoration projects, including Mississippi River diversions and wetland restoration projects in Barataria Basin and the birdfoot delta contribute to wetland gains and help to offset ongoing wetland loss on public lands in the Project area. Restoration projects and activities collectively contribute to the public lands in the Project area as described in Chapter 3, Section 3.17 Public Lands and their ongoing contribution to public lands is reflected in the data presented therein. As such, the impact on public lands from past or recently completed projects is captured in the analysis in Section 4.17 Public Lands.

The key reasonably foreseeable projects that have the potential to contribute cumulative impacts on public lands during construction include the following listed below. The first three are located within or adjacent to the Project construction footprint. The remaining six are located south of the MBSD Project construction site along LA 23. These projects would affect visitation to public lands within the AOI by increasing traffic and congestion temporarily, which could adversely affect site accessibility.

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[148] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)
- Large-Scale Marsh Creation and Component E- Planning (Map #8 in Figure 4.25.1-1)
- NOV-NF-W-05a.2, 06a.1, 06a.2 Projects (Map #7 in Figure 4.25.1-1)

[148] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

- Delta LNG/Delta Express Pipeline (Map #9 in Figure 4.25.1-1)
- Plaquemines LNG/Gator Express Pipeline (Map #10 in Figure 4.25.1-1)

The foreseeable projects encompassed by the operations AOI are listed in Table 4.25.17-1 below.

Table 4.25.17-1
Reasonably Foreseeable Projects with
Cumulative Impacts on Public Lands during Operation of the MBSD Project

Project Name/Proponent (Mapped # in Figure 4.25.1-1)	Public Lands Impacted (Managing Agency)	In Delft3D Basinwide Model Reasonably Foreseeable Simulation?
Mid-Breton Sediment Diversion (4)	• Delta NWR (USFWS) • Pass A Loutre WMA (LDWF)	Yes
HSDRRS Mitigation - WBV (16)	• Jean Lafitte National Historical Park and Preserve – Barataria Preserve (NPS)	No
Shoreline Protection at Jean Lafitte National Historical Park and Preserve (23)	• Jean Lafitte National Historical Park and Preserve – Barataria Preserve (NPS)	No
Pass A Loutre Crevasses NRDA (43)	• Pass A Loutre WMA (LDWF)	No
Pass A Loutre Campground NRDA (44)	• Pass A Loutre WMA (LDWF)	No
Mississippi River Beneficial Use of Dredged Material Program (not mapped)	• Delta NWR (USFWS) • Pass A Loutre WMA (LDWF)	No

4.25.17.3 Cumulative Impacts during Construction

4.25.17.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The reasonably foreseeable projects with potential overlap with the construction phase of the MBSD Project action alternatives include some major industrial projects that would require substantial construction workforces and demand for and use of construction trucks in Plaquemines Parish (see Section 4.25.22 [Land-Based Transportation]). Traffic associated with these projects could lead to increased travel volumes along LA 23, especially during peak commute times, particularly in southern Plaquemines Parish, which may contribute to delays in accessing recreation sites. The following projects would result in more than 1,000 construction workers or truck trips per day: Tallgrass PLT; NOV-NF-W-05a.2, 06a.1, 06a.2 Projects; and Plaquemines LNG/Gator Express Pipeline. In summary, the construction of reasonably foreseeable projects would likely result in minor adverse impacts on visitation to public lands accessed via LA 23 due to construction traffic.

4.25.17.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on public lands from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.17 Public Lands.

4.25.17.3.3 Overall Cumulative Impacts

Depending on the amount of overlap of construction timeframes with each other, cumulative impacts on traffic from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would be temporary, minor, and adverse on visitation to public lands for motorists accessing public lands via LA 23.

4.25.17.4 Cumulative Impacts during Operations

4.25.17.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The impacts on public lands from recently completed and ongoing projects and trends are factored into baseline conditions as presented in Section 4.17 Public Lands. Public lands in the Project area that would sustain cumulative impacts by reasonably foreseeable projects listed in Table 4.25.17-1 include the Jean Lafitte National Historical Park and Preserve—Barataria Preserve, Delta NWR, and Pass A Loutre WMA, as described here (see Table 4.25.1-1 and Figure 4.25.1-1 for more information about these foreseeable projects):

- Mid-Breton Sediment Diversion: Mississippi River sediment diversion that would restore wetlands in Breton Sound. Would cause moderate, adverse, permanent decreases in wetlands in the birdfoot delta, which includes the Delta NWR and the Pass A Loutre WMA.

- HSDRRS Mitigation-WBV: Involves the restoration of approximately 1,540 acres of bottomland hardwood, marsh, and swamp in the Barataria Basin adjacent to the Jean Lafitte National Historical Park and Preserve—Barataria Preserve. This project would have minor, beneficial, permanent impacts on the Barataria Preserve by providing adjacent wetland habitat valuable for fish and wildlife species.

- Shoreline Protection at Jean Lafitte National Historical Park and Preserve Restoration: Involves the re-establishment of approximately 50 acres of SAV including a rock breakwater structure along the shorelines of Lake Cataouatche, Lake Salvador, and Bayou Bardeaux. This project would cause minor, beneficial, permanent impacts by decreasing wave action to allow for localized increases in SAV abundance valuable to fisheries, waterfowl, and wading birds.

- Pass A Loutre Crevasses: Involves the construction of five crevasses in natural spoil banks along passes within the Pass A Loutre WMA. This project would cause minor, beneficial, permanent impacts by providing recreational hunters, fishermen, and non-consumptive users access to wetlands that are currently inaccessible by boat. Once deltaic splays start to form, the area would provide prime waterfowl hunting and fishing habitat. The crevasses would also divert sediment-laden river water into shallow open ponds, enhancing habitat for protected species and terrestrial wildlife, including migratory birds (LA TIG 2018b).

- Pass A Loutre Campground: Improvements at five existing campgrounds in the Pass A Loutre WMA would provide minor, beneficial, permanent impacts on recreation by enhancing the experience of campground users in the WMA.

- Mississippi River Beneficial Use of Dredged Material Program: CEMVN uses dredged material from the maintenance of federal navigation channels to create or restore coastal habitat in Louisiana. Between 1996 and 2018, material dredged to maintain Southwest Pass created 9,656 acres of wetlands and other restoration projects in the birdfoot delta. This project would have moderate, beneficial, permanent impacts on the Delta NWR and Pass A Loutre WMA by increasing wetland habitat within and adjacent to these public lands.

4.25.17.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on public lands from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.17 Public Lands.

4.25.17.4.3 Overall Cumulative Impacts

The cumulative impacts on public lands from operation of the reasonably foreseeable projects combined with the operation of the MBSD Project action alternatives would be minor, permanent, and beneficial on wetlands and ecosystem habitat in the Jean Lafitte Natural Historical Park and Preserve—Barataria Preserve and minor to moderate, permanent, and adverse on public lands in the birdfoot delta due to wetland and ecosystem habitat loss.

Overall cumulative impacts on the Jean Lafitte Natural Historical Park and Preserve—Barataria Preserve would be minor, permanent, and beneficial. Operation of the MBSD Project action alternatives on their own would mainly cause negligible to minor impacts on this preserve due to negligible to minor, adverse impacts on wetland habitat. However, when combined with the above restoration projects, which would increase the extent of wetland habitat, the ability of state and federal agencies to meet conservation and recreational objectives at the preserve would be improved.

In the birdfoot delta, relative sea-level rise is projected to cause major, permanent, adverse reductions in wetland acreages in the birdfoot delta by 2070 (see Section 4.6 Wetlands and Waters of the U.S. for more information about wetland impacts under the No Action Alternative). Based on the Delft3D Basinwide Model output, the combined cumulative impacts of the MBSD Project action alternatives and the foreseeable projects, including the Mid-Breton Sediment Diversion Project, would be moderate, permanent, and adverse by causing a combined additional loss of 2,056 acres of wetlands by 2070 as compared to the No Action Alternative (see Section 4.25.6 [Wetland Resources and Waters of the U.S.] for more information about cumulative impacts on wetlands in the Project area). Most of these wetland losses would occur within the boundaries of or adjacent to the Delta NWR and Pass A Loutre WMA.

Wetland increases in the birdfoot delta may occur in the future from reasonably foreseeable restoration projects not included in the Delft3D Basinwide Model output, including periodic beneficial use of dredged material occurring as part of CEMVN's maintenance dredging in Southwest Pass, and the Pass A Loutre WMA Crevasses project. As part of its responsibilities under the Fish and Wildlife Coordination Act and as operator of the Delta NWR, the USFWS recommended the creation of crevasses to build land in the birdfoot delta to offset MBSD Project-induced wetland losses of 926 acres in the Delta NWR and 37 acres in the Pass A Loutre WMA (see Appendix T USFWS Coordination Act Report of the Final EIS). In response to USFWS' Coordination Act Report Recommendation, CPRA agreed that, "Within 5 years of the commencement of Project operations, CPRA or the LA TIG will provide $10,000,000 of additional funding for wetland preservation and restoration work in the Delta NWR and the Pass A Loutre WMA to offset modeled acres of indirect wetland losses in those areas. That funding may be accomplished through additional funding through the CWPPRA program, through additional restoration work sponsored by the LA TIG (for example, construction of the E&D work discussed in the DWH LA TIG's Restoration Plan and Environmental Assessment #7), or through a direct contribution for additional work. The funding would be proportioned between the Delta NWR and PAL [Pass A Loutre] WMA based on the magnitude of the predicted wetland loss in each area."

These benefits may offset some of the wetland losses in the birdfoot delta public lands projected to occur by 2070. However, this offset would not affect the overall cumulative impact determination of moderate, permanent, and adverse cumulative impacts.

4.25.18 Land Use and Land Cover

4.25.18.1 Geographic and Temporal Extent of Analysis

The AOI associated with land use and land cover for both the 5-year construction period and the 50-year operational analysis period is the immediate vicinity of the MBSD Project construction footprint, generally within 0.5 mile to encompass any large areas with specialized or recreational uses that support land- and/or water-based uses that could be impacted by the projects' changes in land use and land cover.

4.25.18.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to impact land uses and the landscape in the Project area include development by the oil and gas industry, as well as larger-scale landscape changes. In addition to meteorological events and anthropogenic effects (for example, conversion of historic land cover types to agriculture), landscape changes from navigation and flood protection have resulted in extensive wetland loss and barrier island erosion in the Barataria Basin and the larger delta. These projects collectively contribute to the characterization of the Project area as described in Chapter 3, Section 3.18 Land Use and Land Cover and their contribution to the landscape is reflected in the 2016 NLCD data presented therein. As such, the impact on land use land cover from past or recently completed projects is captured in the analysis in Section 4.18 Land Use and Land Cover.

The reasonably foreseeable projects encompassed by the construction and operations AOI for land use and land cover include the following:

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[149] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)

4.25.18.3 Assessment of Cumulative Impacts during Construction and Operations

4.25.18.3.1 Past, Present, and Reasonably Foreseeable Projects

Construction of the reasonably foreseeable projects would involve the removal of existing vegetation, forest lands, and wetlands (see Table 4.25.18-1) and would also impact agricultural and open lands, as described below. The conversion of these land use types to developed land would be a direct, minor to moderate, permanent adverse impact on land use and land cover.

- The NOV-NF-W-05a.1 Project would include constructing three new floodwalls and a 6.3-mile-long levee. Construction of the levee is estimated to require about 500 acres comprised predominately of agricultural and open lands (about 74 percent) and would be concurrent with the MBSD Project action alternatives.[150] The project would require a nominal amount of tree

[149] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

[150] A conservative 380-foot (100-meter) buffer was applied.

clearing and some in-water work. Additional impacts from construction of the levee, floodwalls, and contractor yards and access to support construction activities would occur on open land. A portion of these impacts on land use and land cover from the project would occur within the construction and operational AOI for land use and land cover MBSD Project action alternatives.

- The Tallgrass PLT oil facility would be constructed on a 200-acre site and would require about 292 acres comprised of open water, wetlands, forest land, agricultural, and developed land during construction. The site would require vegetation and tree clearing, as well as filling in open water with fill material, to convert the site from current uses to developed land for accommodation of the terminal.

- Construction of Plaquemines Holdings, LLC's loading dock would impact a total of 2.7 acres, including 0.76 acre of open water and 0.4 acre of wetlands. The remaining 1.6 acres would be composed of agricultural and developed land to accommodate the shore-based built structures. The project's water-based features would require permanent fill of 0.01 acre of non-vegetated water bottom for riprap around the pilings and 0.2 acre of wetlands within the permanent rights-of-way for the pipeline and access road.

Table 4.25.18-1
Other Actions within the Geographic and Temporal Scope for Cumulative Impacts on Land Use and Land Cover

Action (Mapped # in Figure 4.25.1-1)	Location (Parish)	Existing Land Use(s)	Planned/Proposed Land Use	Active Farming on Property?
NOV-NF-W-05a.1 Project (1)	Plaquemines	Forest Land, Agricultural, Open Land, Wetlands, Open Water, Developed	Open Land, Developed	Cattle Grazing
Tallgrass PLT (2)	Plaquemines	Forest Land, Agricultural, Open Land, Wetlands, Open Water, Developed	Open Land, Developed	No
Loading Dock on Mississippi River (3)	Plaquemines	Wetlands, Open Water, Developed	Wetlands, Open Water, Developed	No

As discussed in Chapter 3, Section 3.18 Land Use and Land Cover, CPRA's 2017 Coastal Master Plan outlines the state's focus on projects that would aid in maintaining the coast and restoring lost resources. All three of these projects are located in Plaquemines Parish within a floodplain district that allows certain uses, including industrial uses, subject to approval. Although the NOV-NF-W-05a.1 Project would be more consistent with the state's 2017 Coastal Master Plan, as compared to the Tallgrass PLT or Loading Dock on Mississippi River projects, none of these projects are expected to result in re-zoning of the corresponding project site.

Similar to the MBSD Project action alternatives, best management practices to minimize construction impacts are likely to be implemented during construction of the other projects in accordance with applicable permits. As described in Chapter 3, Sections 3.18 Land Use and Land Cover and 3.21 Navigation, the area of the diversion complex and these other projects is a mix of residential, commercial, and industrial uses. Further, as described in Chapter 3, Section 3.16 Recreation and Tourism, no recreation or special use areas are located on, or immediately adjacent to, these project sites. If these three projects are completed, they would convert about 795.7 acres of land in Plaquemines and Jefferson Parishes from the current land uses to developed land. The NOV-NF-W-05a.1 Project is currently expected to be constructed at the same time as the MBSD Project action alternatives. Construction timeframes were not available from publicly available files for the other projects.

4.25.18.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on land use and land cover from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.18 Land Use and Land Cover.

4.25.18.3.3 Overall Cumulative Impacts

Cumulative impacts of the reasonably foreseeable future actions combined with the MBSD Project action alternatives would convert more than 2,100 acres of land in Plaquemines and Jefferson Parishes from the current land uses to developed land. Following construction, about 1,300 acres would be encumbered by the project facilities for these projects resulting in moderate, permanent, adverse cumulative impacts on existing land use.

As the MBSD Project action alternatives and other reasonably foreseeable projects would not substantially change the character of the AOI, which is a mix of residential, commercial, and industrial uses, and are consistent with Jefferson and Plaquemines Parish zoning regulations, the cumulative impacts from construction and operation of the MBSD Project action alternatives combined with other reasonably foreseeable projects on land use and land cover are expected to be minor to moderate and temporary to permanent.

4.25.19 Aesthetic and Visual Resources

4.25.19.1 Geographic and Temporal Extent of Analysis

The AOI associated with visual resources affected by construction of the MBSD Project is considered to be the distance from which active construction areas would be visible. Based on the types of construction equipment and topography of the construction footprint of the MBSD Project action alternatives, construction activities could be visible to visual receptors within about 0.25 mile of the construction footprint. Impacts during construction would also occur for visual receptors along the road and waterways that would be used to transport equipment and construction personnel to the construction site. The temporal extent of the analysis is the 5-year construction period.

The AOI associated with visual resources affected by operation of the MBSD Project is the viewshed from which the delta formation in the basin and from which the built structures associated with the diversion complex and their lighting are visible to residents and visitors. The temporal extent of the analysis is the 50-year analysis period.

4.25.19.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to contribute to the characteristics of the current viewshed in the Project area would be major industrial projects that include built structures and/or require a substantial amount of tree clearing or other landscape alterations. In addition to meteorological events and anthropogenic effects (for example, conversion of historic land cover types to agriculture), landscape changes from navigation and flood protection have resulted in extensive wetland loss and barrier island erosion in the Barataria Basin and the larger delta. These projects collectively contribute to the existing viewshed as characterized in Chapter 3, Section 3.19 Aesthetic and Visual Resources. As such, the impact on the viewshed from past or recently completed projects is captured in the analysis in Section 4.19 Aesthetic and Visual Resources.

As identified in Table 4.25.1-1 and on Figures 4.25.1-1 and 4.25.1-2, the foreseeable projects encompassed by the construction impact area for visual resources include the following:

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)
- Tallgrass PLT[151] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)

Because the AOI affected by operation of the MBSD Project is the viewshed from which Project features are visible to residents and visitors, for any one structure, the distance would be based on the specific facility design, including color scheme and dimensions. Therefore, the foreseeable projects encompassed by the operational AOI for visual resources associated with the diversion complex would be the same as those for construction listed above while the hurricane and flood risk reduction projects and restoration projects have the greatest potential to contribute to cumulative impacts in the basin (see Table 4.25.19-1). Detail on the individual restoration and hurricane and flood risk reduction projects is presented in Table 4.25.1-1.

[151] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

Table 4.25.19-1
Other Actions with the Potential to Cumulatively Impact Aesthetic and Visual Resources

Action (Mapped # in Figure 4.25.1-1)	Range of Distances from Operation Footprint Boundary (in miles)	Notable Features that would be Readily Visible
NOV-NF-W-05a.1 Project (1)	0.0	Three new floodwalls and 6.3-mile-long levee
Tallgrass PLT (2)	0.3 mile	Export terminal, storage tanks, rail offloading facility, and a dock
Loading Dock on Mississippi River (3)	0.3 or 0.7 mile	Loading dock, pipe rack, and a raised road.
Restoration Projects[a] (not mapped)	0.0 – throughout basin	Diversion complex, Containment Dikes, Levees
Hurricane and Flood Risk Reduction Projects (not mapped)	0.3 – throughout basin	Floodwalls, Flood Gates, Drainage Structures, Levees, Pump Stations,

[a] These projects would also restore and/or create shoreline, wetlands, marsh, and/or habitat within the Barataria Basin.

4.25.19.3 Assessment of Cumulative Impacts during Construction

4.25.19.3.1 Past, Present, and Reasonably Foreseeable Projects

Reasonably foreseeable projects with the greatest potential to contribute to cumulative impacts on visual receptors would involve activities such as ground disturbance, removal of existing vegetation, use of heavy equipment, and/or the construction of infrastructure. These activities could cause temporary, minor and adverse impacts similar to those described for the MBSD Project action alternatives below, temporarily disrupting the viewshed. Three of the projects in Table 4.25.19-1 would be within the AOI for visual resources: the NOV-NF-W-05a.1 Project, the Energy Plaquemines Liquid Terminal, and the Loading Dock on Mississippi River. Construction of the NOV-NF-W-05a.1 Project is expected to be concurrent with the MBSD Project action alternatives and would tie-in to the diversion complex; alternatively, the timing of construction of the Tallgrass PLT facility is currently unknown.

The Tallgrass PLT facility would include development of a 200-acre site to accommodate the terminal facility, which would generally have greater impacts on visual receptors than the modifications and improvements for the NOV-NF-W-05a.1 Project. Changes in the viewshed for visual receptors associated with the Tallgrass PLT project may be minimized if construction of the NOV-NF-W-05a.1 Project and MBSD Project action alternatives are completed prior to commencement of its construction. Similar mitigation measures as those described below for the Project would likely be implemented during construction of these projects in accordance with applicable permits.

4.25.19.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on aesthetic and visual resources from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.19 Aesthetic and Visual Resources.

4.25.19.3.3 Overall Cumulative Impacts

The cumulative impacts from construction of the MBSD Project action alternatives combined with the construction of the other reasonably foreseeable projects on visual resources would be temporary, moderate and adverse. Concurrent construction of the MBSD Project action alternatives and reasonably foreseeable projects would result in changes in the existing viewshed over a larger area and possibly over a longer period.

4.25.19.4 Assessment of Cumulative Impacts during Operations

4.25.19.4.1 Past, Present, and Reasonably Foreseeable Projects

Other projects with the greatest potential impact on visual receptors would include those that result in built structures that permanently alter the existing viewshed in the vicinity of the Project's diversion complex; these include the Tallgrass PLT, NOV-NF-W-05a.1 Project, and the Loading Dock on Mississippi River. Other projects with the greatest potential impact on visual receptors within the delta formation area in the basin include the 11 hurricane and flood risk reduction projects and 24 restoration projects listed in Table 4.25.1-1.

Once constructed, the Tallgrass PLT project would include an export terminal facility, oil storage tanks, a dock, and a rail offloading facility, which would generally have greater impacts on visual receptors in proximity to the diversion complex than a low-profile drainage canal and levee system or loading docks. Collectively these projects would require the conversion of an estimated 91 acres of forest land to open or developed land. These changes in the viewshed would result in long-term to permanent, minor to moderate, adverse impacts on visual resources. Changes in the viewshed for visual receptors associated with the Tallgrass Energy Plaquemines Liquid Terminal may be minimized if the NOV-NF-W-05a.1 Project and MBSD Project action alternatives are built first, as over time these features would become part of the existing viewshed.

The restoration and hurricane and flood risk reduction projects would generally involve low-profile infrastructure and/or the creation, restoration, or protection of marsh, swamp, and other habitat that would occur gradually and generally in areas where visual receptors are present only intermittently. Similarly, operational impacts on the existing viewshed within the Barataria Basin from wetland creation and restoration would be gradual, occurring over the 50-year analysis period in areas where visual receptors are present only intermittently. Whether these changes in the viewshed are perceived as beneficial or adverse would depend on the perspective of the individual receptor; for example, the increase in wetlands may be perceived as beneficial for those individuals participating in wildlife viewing, where water-based users may find the loss of open water to be adverse.

4.25.19.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on aesthetic and visual resources from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.19 Aesthetic and Visual Resources.

4.25.19.4.3 Overall Cumulative Impacts

Operation of the MBSD Project action alternatives and reasonably foreseeable projects would require the conversion of about 232 acres of forest land to open or developed land resulting in long-term to permanent, moderate, adverse cumulative impacts on visual resources. While the newly built structures associated with these projects would be visible as new features in the viewshed, they would generally be consistent with the existing landscape.

Permanent, minor to moderate, cumulative impacts on the existing viewshed within the Barataria Basin would occur from wetland creation and restoration during operation of the MBSD Project action alternatives and other restoration projects. As discussed above, whether these changes in the viewshed are perceived as beneficial or adverse depends on the individual’s perspective.

As the MBSD Project action alternatives and other projects would not substantially change the character of the AOI, which is a mix of residential, commercial, and industrial uses, and are consistent with parish zoning regulations, the cumulative impacts on visual resources from operation of the MBSD Project action alternatives combined with other reasonably foreseeable projects within the 0.25-mile AOI are expected to be minor to moderate, permanent, and adverse; while the cumulative impacts on visual resources within the Barataria Basin would likely be negligible.

4.25.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction

4.25.20.1 Geographic and Temporal Extent of Analysis

The AOI for assessment of the cumulative impacts from construction of the MBSD Project action alternatives and reasonably foreseeable projects on public health and safety includes the entire Project construction footprint and the 100-year and 500-year floodplain within which the MBSD Project action alternatives would be constructed, and specifically the area afforded flood risk reduction between the NOV-NF-W-05a.1 Project and MR&T Levees from La Reussite to Myrtle Grove. This AOI was selected because the potential public health and safety impacts associated with construction of the MBSD Project action alternatives would be limited to the populated area inside these two levee systems. Construction impacts on risk reduction levees would be negligible and are therefore not assessed for cumulative impacts.

The AOI for public health and safety during operations would be the entire MBSD Project action alternatives area, both populated and non-populated, as projects in non-populated areas can have indirect impacts on populated areas. For example, restoration projects in non-populated areas can have an impact on storm surge elevations which ultimately reach populated portions of the Project area.

4.25.20.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

Past or recently completed projects with ongoing potential to impact public health and safety would be projects that have altered floodplains, either increasing or decreasing the risk of riverine, tidal or storm surge related flooding. For example, major industrial projects have increased public risk by producing, storing, or transporting contaminants within the 100-year floodplain, which could be released into the environment if subjected to flooding. Projects such as construction and maintenance of federal risk reduction levees have both decreased risk by providing structural barriers to riverine, tidal, and storm surge related flooding but increased risk by contributing to land loss on the flood side of these levee systems through alteration sediment deposition patterns and by increasing local subsidence inside levee systems through alteration of drainage patterns. In combination with regional subsidence and sea-level rise, these projects collectively contribute to the existing level of risk to public health and safety posed from flooding in the Project area, as characterized in Chapter 3, Section 3.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction. As such the impact on public health and safety from these past or recently completed projects is captured in the analysis in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction.

The following reasonably foreseeable projects are encompassed by the construction AOI for public health and safety. The new alignment of the NOV-NF-W-05a.1 Project was included in the baseline topography of the ADCIRC Model for all alternatives and the reasonably foreseeable simulation. Therefore, the impacts associated with the presence of this levee on its new alignment in combination with the MBSD Project action alternatives are addressed in the operational impacts discussion for the MBSD Project action alternatives related to public health and safety, storm hazards, and flooding. However, the cumulative impacts related to this levee reach, as well as inundation impacts between the NOV-NF-W-05a.1 levee reach and existing back levee, are considered in this cumulative impacts analysis.

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)

- Tallgrass PLT[152] (Map #2 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- NOLA Oil Terminal (Map #5 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)

As the AOI for public health and safety during operations includes the entire MBSD Project action alternatives area, all reasonably foreseeable projects listed in Table 4.25.1-1 and shown in Figures 4.25.1-1 and 4.25.1-2 are included in the cumulative impacts analysis below. Table 4.25.1-1 notes which of the reasonably foreseeable projects were included in the Delft3D Basinwide Model simulation for cumulative impacts; the Delft3D Basinwide Model and the coupled ADCIRC/SWAN model were used to evaluate the impacts of these reasonably foreseeable projects on water levels and storm hazards, respectively. All reasonably foreseeable projects included in the models are restoration projects with the exception of the NOV-NF-W-05a.1 Project, which is a hurricane and flood risk reduction project. Foreseeable projects planned inside the levee system were not included in the quantitative analysis as they would not have impacts on water levels, storm surge, or wave heights; the impacts of these projects are considered qualitatively.

4.25.20.3 Cumulative Impacts during Construction

4.25.20.3.1 Floodplains

4.25.20.3.1.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Construction of the five reasonably foreseeable projects would alter the 100-year and 500-year floodplains but are assumed to maintain (or avoid impacting) existing flood risk reduction or stormwater drainage systems during construction. Thus, these floodplain alterations would not be expected to affect the risk of flooding, current floodplain functions (as per EO No. 11988), or public health and safety. Additionally, if the existing level of drainage and federal flood risk reduction is maintained during construction of these reasonably foreseeable projects, there would be no anticipated change to the FEMA FIRM designation or base flood elevations.

Construction activities associated with the use of heavy equipment would create the potential for inadvertent releases of contaminants (fuel, oil, and other construction materials) in the construction footprint of the reasonably foreseeable projects. Although the risk of inadvertent releases would be minimized by applicable environmental

[152] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

regulations, including SPCC Plans, releases may still occur. The intensity and spatial extent of any impact on public health and safety from inadvertent releases of contaminants would depend upon the nature of the release, ranging from minor spills with no impact outside of the construction footprint, to larger releases that migrate outside the construction footprint, causing minor to moderate adverse impacts on public health and safety.

4.25.20.3.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on floodplains from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction.

4.25.20.3.1.3 Overall Cumulative Impacts

Overall, floodplain alteration from construction of the MBSD Project action alternatives combined with the construction of these reasonably foreseeable projects would have no cumulative impact on public health and safety. Cumulative impacts on public health and safety from potential inadvertent releases of contaminants from the combined projects have the potential to range from no impact to moderate and adverse, depending upon the nature and timing of any release in relation to the nature and timing of any other construction-related releases.

4.25.20.3.2 Storm Hazards

4.25.20.3.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Construction activities associated with the five reasonably foreseeable projects could potentially span multiple years and hurricane seasons and would carry the risk of storm event- or hurricane-related surge or rainfall inundation of the construction site. It is assumed that project owners would implement SPCC Plans, SWPPPs, and accident prevention plans during construction to reduce the risk of construction-related contamination or mobilization of construction equipment, which would minimize the risk of these impacts on public health and safety during construction.

4.25.20.3.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on storm hazards from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction.

4.25.20.3.2.3 Overall Cumulative Impacts

Cumulative impacts on public health and safety from potential construction site inundation and related release of contaminants or debris during construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would likely range from minor to moderate and adverse, depending on the scope of inundation, nature of the release, and whether multiple construction sites have such releases during a given storm event.

4.25.20.4 Cumulative Impacts during Operations

4.25.20.4.1 Floodplains and Tidal Flooding

4.25.20.4.1.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Although the Delft3D Basinwide Model projects that the reasonably foreseeable projects in the AOI would have a negligible impact on non-storm water levels within the Barataria Basin and birdfoot delta as compared to the No Action Alternative, some of the reasonably foreseeable projects not included in Delft3D Basinwide Model are expected to have a minor, beneficial cumulative impact on tidal flooding in populated areas. For example, the Bayou Grande Cheniere Marsh & Ridge Restoration may provide localized reductions in tidal flood risk to the adjacent community of Grand Bayou. Similarly, flood risk reduction projects such as the Jean Lafitte Tidal Protection Project may reduce the local incidence of tidal flooding in the immediate vicinity (within 0.5-mile) of the project through construction or rehabilitation of non-federal levee reaches. Therefore, the other reasonably foreseeable restoration and flood risk reduction projects would be expected to have a negligible to minor (localized), beneficial cumulative impact on tidal flood-associated risks to public health and safety.

Communities inside of the levee systems would be expected to potentially experience less efficient water drainage due to sea-level rise, which could lead to increased rain-induced flooding over time. This increased flooding could have similar indirect impacts on public health and safety as the indirect impacts of tidal flooding, including interruption of water supply, sanitation and wastewater infrastructure, and release of contaminants that could be injurious to public health and safety. These impacts would be adverse, intermittent but permanent, and would range from minor to major depending on the infrastructure impacted. None of the reasonably foreseeable projects would impact this potential flooding.

4.25.20.4.1.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on floodplains and tidal flooding from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction.

4.25.20.4.1.3 Overall Cumulative Impacts

Cumulative impacts from increased water levels and associated increases in tidal flooding in communities outside the federal levee system during operation of the MBSD Project action alternatives combined with the reasonably foreseeable projects would range from negligible to major, adverse, depending on community location and the diversion flow capacity. In communities with adjacent restoration or risk reduction projects, these projects may decrease the rate at which the community experiences increased tidal flooding impacts from operation of the diversion.

The magnitude of increase in the projected tidal flooding inundation frequency in communities outside of the federal levee system is related to the magnitude of diversion flow. The cumulative impact of the 50,000 cfs Alternatives and reasonably foreseeable projects would be less than the Applicant's Preferred Alternative and reasonably foreseeable projects, ranging from negligible to minor. The cumulative impact of the 150,000 cfs Alternatives and reasonably foreseeable projects would be greater than the Applicant's Preferred Alternative and reasonably foreseeable projects, ranging from minor to major. These cumulative impacts would be long-term but not permanent; as the influence of relative sea-level rise increases, the intensity of the adverse impact of the diversion and beneficial impact of the reasonably foreseeable projects would decrease over time as compared to the No Action Alternative. The influence of sea-level rise would also decrease the differences between the intensity of cumulative impacts including the 50,000 cfs, Applicant's Preferred, and 150,000 cfs Alternatives over time.

4.25.20.4.2 Storm Hazards

4.25.20.4.2.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The cumulative impact of the reasonably foreseeable projects on public health and safety from storm hazards is projected to be adverse and beneficial, ranging from negligible to minor (localized) in communities outside of federal levee systems as compared to the No Action Alternative. The ADCIRC/SWAN model projects that surge elevations and wave heights would increase or decrease in areas near some of the reasonably foreseeable restoration projects relative to No Action Alternative conditions, on the order of ± 0.0 to 0.2 feet in surge elevation and ± 0.0 to 0.3 feet in wave height (see detailed results in Appendix P). These increases and decreases could be caused by the altered topography and hydrology associated with projects such as the Bayou Grande Cheniere Marsh & Ridge Restoration, Bayou L'Ours Marsh Terracing, and Spanish Pass Ridge and Marsh Restoration, and could cause localized decreases in storm surge north of these projects and localized increases in storm surge south of these projects. Changes in storm surge could have minor adverse or beneficial impacts on communities outside federal levee systems near these restoration projects, such as Grand Bayou. Because the adverse and beneficial impacts of these restoration projects are localized, they would have negligible impacts on communities outside federal levee systems that are farther from these restoration projects, such as Myrtle Grove.

The NOV-NF-W-05a.1 levee reach will be constructed on an alignment that is farther inland than the existing non-federal back levee, and the existing back levee will be left in place (see Figure 4.25.4-1 above). If the back levee is overtopped by storm surge and/or waves during a storm event, inundation of the area between these two levees could occur. The NOV-NF-W-05a.1 levee reach design includes sluice gates that will allow water between these two levees to drain into the area on the protected side of the NOV-NF-W-05a.1 levee reach, to be pumped out of the area through the Wilkinson Canal Pump Station. However, in order not to overwhelm the drainage system and increase water levels in the protected side of the NOV-NF-W-05a.1 levee reach, the area between the NOV-NF-W-05a.1 levee reach and back levee will have to be drained slowly and thus would be subject to higher water levels for an extended period of time. The presence of the NOV-NF-W-05a.1 levee reach will have a beneficial impact on public health and safety by providing an increased level of storm risk reduction as compared to that afforded currently by the back levee alone. However, because the NOV-NF-W-05a.1 levee reach is designed to provide storm risk reduction up to the 4 percent AEP (25-year) storm, the protected side of the NOV-NF-W-05a.1 levee reach could still experience inundation during storms affecting this area that are greater than the 4 percent AEP (25-year) storm.

4.25.20.4.2.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on storm hazards from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction.

4.25.20.4.2.3 Overall Cumulative Impacts

Cumulative impacts on public health and safety from storm hazards in communities outside the federal levee system during operation of the MBSD Project action alternatives combined with the reasonably foreseeable projects would range from negligible to moderate, depending on community location and the diversion flow capacity. Restoration projects north of the MBSD Project action alternatives may further decrease surge elevation and wave height; for example, the Shoreline Protection at Jean Lafitte National Historical Park and Preserve, and Large-Scale Marsh Creation Component E- Planning project may further reduce storm hazard impacts in communities that would also experience reduced surge and wave heights due to the MBSD Project action alternatives. Conversely, the Bayou Grande Cheniere Marsh & Ridge Restoration may slightly reduce the magnitude of increased storm surge expected in Grand Bayou due to the MBSD Project action alternatives. In communities near the MBSD Project immediate outfall area, the intensity of the cumulative impacts would be more influenced by, and more similar to, the intensity of impacts of the MBSD Project action alternatives alone. The adverse impacts of the MBSD Project related to increased storm surge in areas immediately south of the immediate outfall area would increase the risk of overtopping and inundation on the protected side of the NOV-NF-W-05a.1 levee reach, despite the increased level of protection provided by this levee. In communities farther from the immediate outfall area, the intensity of the cumulative impacts would be less influenced by the MBSD Project action alternatives, and more similar to the intensity of impacts of the reasonably foreseeable projects without the MBSD Project action alternatives.

The magnitude of increase or decrease in storm hazard risk in communities outside of the federal levee system is related to the magnitude of diversion flow. The cumulative impact of the 50,000 cfs Alternatives and reasonably foreseeable projects would be less than the Applicant's Preferred Alternative and reasonably foreseeable projects. The cumulative impact of the 150,000 cfs Alternatives and reasonably foreseeable projects would be greater than the Applicant's Preferred Alternative and reasonably foreseeable projects, as restoration projects would be expected to have a less detectable benefit. These cumulative impacts would be long-term but not permanent; as the influence of relative sea-level rise increases, the intensity of the adverse impact of the diversion and beneficial impact of the reasonably foreseeable projects would decrease over time as compared to the No Action Alternative. The influence of sea-level rise would also decrease the differences between the intensity of cumulative impacts of the reasonably foreseeable projects in combination with the 50,000 cfs, Applicant's Preferred, and 150,000 cfs Alternatives over time (see detailed results in Appendix P).

4.25.20.4.3 Risk Reduction Levees

4.25.20.4.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Communities located within levee systems are inherently less susceptible to tidal flooding and storm hazards than communities located outside of levee systems. The reasonably foreseeable risk reduction projects that include construction or repair of levee systems in the MBSD Project action alternatives area (such as the Lafitte Area Levee Repair and St. Charles West Bank Hurricane Protection Levee Initiative) could therefore reduce the risk of tidal flooding and/or storm hazards for communities inside these levee systems, such as Luling. Altered hydrology associated with reasonably foreseeable restoration projects (such as the Spanish Pass Ridge and Marsh Restoration and Bayou L'Ours Marsh Terracing) could in some cases reduce projected overtopping of levees by reducing storm surge elevation and wave height. These projects would thus have a minor beneficial impact on public health and safety for communities behind existing or new levee systems, as the benefit would likely be measurable but localized. Construction of the NOV-NF-W-05a.1 levee reach may reduce the risk of storm hazards in the area on the protected side of this levee, as the levee height will be higher than the existing back levee and the area between the NOV-NF-W-05a.1 levee reach and the back levee could act as a floodwater storage area, slightly lessening the impact of surge and wave action on the NOV-NF-W-05a.1 levee reach. However, the land between the NOV-NF-W-05a.1 levee reach and existing back levee may see increased durations of storm inundation if the back levee is overtopped by storm surge and/or waves.

4.25.20.4.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on risk reduction levees from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.20 Public Health and Safety, Including Flood and Storm Hazard Risk Reduction.

4.25.20.4.3.3 Overall Cumulative Impacts

Cumulative impacts on public health and safety from storm hazards in communities inside federal levee systems during operation of the MBSD Project action alternatives combined with operation of the reasonably foreseeable projects would be beneficial and adverse, and range from negligible to minor, depending on a given storm's characteristics and the level of risk reduction provided by infrastructure such as levees and floodwalls for a given populated area. Restoration projects north of the MBSD Project action alternatives may further decrease surge elevation and wave height; for example, the Shoreline Protection at Jean Lafitte National Historical Park and Preserve project may further reduce storm hazard impacts in communities that would also experience reduced surge and wave heights due to the MBSD Project action alternatives. Conversely, the Bayou Grande Cheniere Marsh & Ridge Restoration may slightly reduce the magnitude of increased storm surge expected in Grand Bayou due to the MBSD Project action alternatives. In communities near the immediate outfall area, the intensity of the cumulative impacts would be more influenced by, and more similar to, the intensity of impacts of the MBSD Project action alternatives alone. The role of the area between the NOV-NF-W-05a.1 levee reach and existing back levee in reducing storm surge and wave action impacts on communities on the protected side of the NOV-NF-W-05a.1 levee reach will depend upon the intensity and track of a given storm. The adverse impacts of the MBSD Project related to increased storm surge in areas immediately south of the immediate outfall area would increase the risk of overtopping and inundation on the protected side of the NOV-NF-W-05a.1 levee reach, despite the increased level of protection provided by this levee. In communities farther from the immediate outfall area, the intensity of the cumulative impacts would be less influenced by the MBSD Project action alternatives, and more similar to the intensity of impacts of the reasonably foreseeable projects without the MBSD Project action alternatives.

4.25.21 Navigation

4.25.21.1 Geographic and Temporal Extent of Analysis

The temporal extent of the cumulative impacts analysis for construction is 2022 through 2026. The temporal extent of the analysis during operations is the 50-year operational analysis period.

4.25.21.1.1 Maintenance Dredging

Construction impacts of the MBSD Project action alternatives on maintenance dredging in both the Mississippi River and the Barataria Basin federal channels would be negligible and are therefore not assessed for cumulative impacts.

The operational AOI for maintenance dredging in the Mississippi River includes the navigation channel from Venice to the Gulf. The operational AOI for maintenance dredging in the Barataria Basin includes the three federal navigation channels in the basin: the Barataria Bay Waterway, GIWW, and Bayou Lafourche.

4.25.21.1.2 Commercial Navigation Traffic

The construction AOI for marine traffic in the Mississippi River associated with construction of the proposed training walls and cofferdam would be within about 1 mile upstream and downstream of the proposed Project construction footprint in the river. The construction impacts on marine traffic in the Barataria Basin due to barge deliveries of construction materials would be very minor (10 barge deliveries monthly) and are therefore not assessed for cumulative impacts.

The operational AOI for the MBSD Project action alternatives on commercial navigation traffic in the Mississippi River is the Mississippi River from New Orleans to the Gulf. The operational AOI on the safety and efficiency of shallow-draft vessels transiting past the diversion site in the Mississippi River is within 200 feet of the intake structure due to cross-currents induced by the rerouting of Mississippi River water into the intake structure during operations. The MBSD Project action alternatives would have negligible impacts on marine traffic in the Barataria Basin and are therefore not assessed for cumulative impacts. Operation of the MBSD Project action alternatives would induce a negligible increase in waterborne traffic in the Barataria Basin federal navigation channels. Therefore, cumulative impacts on commercial traffic in the basin during operations are not assessed for cumulative impacts.

4.25.21.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

The key past and present projects and trends that have ongoing impacts on navigation in the Project area include channelization of the Mississippi River, ongoing dredging operations, subsidence, and sea-level rise. Regional, national, and global economic trends related to cargo imports and exports as described in Section 4.21 Navigation play a key role in commercial navigation traffic trends in the river and basin. The ongoing impacts on navigation from past or present projects and trends are captured in the analysis in Section 4.21 Navigation.

The reasonably foreseeable projects encompassed by the construction AOI in the Mississippi River include:

- Tallgrass PLT[153] (Map #1 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- Mid-Breton Sediment Diversion (Map #4 in Figure 4.25.1-1)

[153] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

The foreseeable projects with impacts encompassed by the operations AOI in the Mississippi River navigation channel include:

- Tallgrass PLT (Map #1 in Figure 4.25.1-1)
- Loading Dock on Mississippi River (Map #3 in Figure 4.25.1-1)
- Mid-Breton Sediment Diversion (Map #4 in Figure 4.25.1-1)
- Baton Rouge to Gulf Channel Deepening (Map #41 in Figure 4.25.1-1)

4.25.21.3 Cumulative Impacts during Construction

4.25.21.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on navigation from past or present projects and trends are captured in the analysis in Section 4.21 Navigation. The construction of the Tallgrass PLT, Loading Dock on Mississippi River, and Mid-Breton Sediment Diversion would not require more than negligible increases in marine traffic during construction for the delivery of construction materials. Therefore, the foreseeable projects would not contribute appreciably to cumulative impacts on traffic in the Mississippi River during construction.

4.25.21.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on navigation from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.21 Navigation.

4.25.21.3.3 Overall Cumulative Impacts

Reasonably foreseeable projects would not appreciably contribute impacts on marine traffic in the Mississippi River during the 5-year construction period. Therefore, cumulative impacts on navigation traffic in the river during construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would not appreciably differ from those impacts of the MBSD Project action alternatives alone: temporary, minor, adverse impacts on the safety and efficiency of shallow-draft vessels transiting past the cofferdam and protection cells in the river.

4.25.21.4 Cumulative Impacts during Operations

4.25.21.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The ongoing impacts on navigation from past or present projects and trends are captured in the analysis in Section 4.21 Navigation. The additional impacts of the reasonably foreseeable projects identified in the operations AOI are presented here.

The construction and operation of the Tallgrass PLT, Loading Dock on Mississippi River, and Mid-Breton Sediment Diversion would not require more than negligible increases in marine traffic on the Mississippi River during construction or operations. Therefore, the foreseeable projects would not contribute appreciably to cumulative impacts on navigation safety and efficiency of shallow-draft vessels transiting past the intake structure during diversion operations.

The Mid-Breton Sediment Diversion Project would increase erosion upstream of the Mid-Breton diversion structure and increase deposition downstream. The driving force for these changes would be the reduced flow and consequently slower water velocity downstream of diversions from the rerouting of the water through the diversion. Upstream of diversions, erosion is expected to increase due to the increased water surface slope induced when the diversion is open (flowing greater than the 5,000 cfs base flow). These impacts would represent minor to moderate, permanent, increases in dredging in Southwest Pass. Additional analysis of the impacts of the Mid-Breton Sediment Diversion Project will be included in a forthcoming EIS for that project.

The Baton Rouge to Gulf Channel Deepening would decrease bed elevations from RM 13.4 AHP to RM 22 BHP (this includes Southwest Pass) from 45 to 50 feet for deep-draft navigation. However, Southwest Pass would not require additional maintenance dredging after construction beyond the typical maintenance dredging requirements for the channel (USACE 2018l).

4.25.21.4.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on navigation from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.21 Navigation.

4.25.21.4.3 Overall Cumulative Impacts

Reasonably foreseeable projects would not appreciably contribute impacts on marine traffic in the Mississippi River during Project operations. Therefore, cumulative impacts on navigation safety and efficiency in the river during operations would not appreciably differ from those impacts of the MBSD Project action alternatives alone: intermittent but permanent, moderate, and adverse impacts on the safety and efficiency of shallow-draft vessels transiting past the intake structure during operations.

The combined cumulative impacts from operation of the MBSD Project action alternatives and operation of the foreseeable projects on dredging in the Mississippi River from Venice to the Gulf would be moderate to major, adverse, and permanent. When Mid-Breton Sediment Diversion operations are added to those of the MBSD operations, dredging requirements in Southwest Pass would increase as compared to the MBSD Project action alternatives operating alone. As is sometimes done for material dredged in Southwest Pass, some of the increased dredged material may be placed into the HDDA and subsequently used beneficially to create and restore coastal habitat in compliance with USACE engineering regulations. Additional analysis of the cumulative impacts of these two projects will be included in a forthcoming EIS for the Mid-Breton Diversion Project once the impacts of the Mid-Breton Sediment Diversion are better understood through EIS development.

Deepening the channel from 45 to 50 feet for the Baton Rouge to Gulf Channel Deepening Project would not impact maintenance dredging requirements.

4.25.22 Land-Based Transportation

This section addresses the cumulative impacts of the MBSD Project action alternatives on land-based transportation. Operation and maintenance of the Project is expected to have negligible cumulative impacts on roadway transportation and is not included in the cumulative impact analysis below.

4.25.22.1 Geographic and Temporal Extent of Analysis

The AOI for evaluating cumulative impacts on land-based transportation during the 5-year construction period of the Project includes the immediate vicinity (an approximately 1.5-mile section of LA 23) near the MBSD Project action alternatives construction footprint, and local roads south of New Orleans due to increases in roadway traffic for construction deliveries and worker commutes.

4.25.22.2 Past, Present, and Reasonably Foreseeable Future Projects Considered

A list of the past, present, and reasonably foreseeable projects in the AOI for assessing cumulative impacts on land-based transportation is provided in Table 4.25.22-1. Past or recently completed projects with ongoing potential to contribute to land-based transportation would be major industrial projects, developments by the oil and gas industry, restoration projects, and activities related to the fishing industry. These collectively contribute to the roadway transportation and traffic conditions characterized in Chapter 3, Section 3.22 Land-Based Transportation. As such the impact on land-based transportation from these past or present recently completed projects is captured in the analysis in Section 4.22 Land-Based Transportation.

Table 4.25.22-1
Reasonably Foreseeable Projects with Cumulative Impacts on Land-based Transportation during Construction of the Proposed MBSD Project

Project (Mapped # in Figure 4.25.1-1)	Distance and Direction from Project	Estimated Construction Period or Start Date	Construction Concurrent with MBSD Construction?	Construction Workforce/ Truck Traffic	Operation Workforce
NOV-NF-W-05a.1 Project (1)	0.0 miles/crosses MBSD diversion channel	2021 - 2026	Yes	Unavailable but expected to be minimal	Unavailable but expected to be minimal
Tallgrass PLT[154] (2)	0.3 mile/ Adjacent to northern construction footprint boundary	Unavailable	Unavailable	1,200 construction workers	35
Loading Dock on Mississippi River (3)	0.3 mile north	Unavailable	Unavailable	Unavailable	Unavailable
NOLA Oil Terminal (5)	1.5 mile south	2020 - 2025	Yes	Unavailable	Unavailable
NOV-NF-W-05a.2, 06a.1, 06a.2 Projects (7)	3.4 miles south	2020 - 2025	Yes	1,400 truck trips per day	Unavailable
Delta LNG/Delta Express Pipeline (9)	4.2 miles south	2021 - 2024	Yes	Unavailable	Unavailable
Plaquemines LNG/Gator Express Pipeline (10)	5.0 miles south	2019 - 2023	Yes	1,400 to 3,000 construction workers	250

The reasonably foreseeable projects with the greatest potential to contribute to cumulative impacts on road-based transportation during construction of the MBSD Project action alternatives are shown in Table 4.25.22-1.

4.25.22.3 Cumulative Impacts during Construction

4.25.22.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Reasonably foreseeable projects (excluding the MBSD Project action alternatives) that may impact land-based transportation in the AOI are shown in Table 4.25.22-1. Construction activities associated with these projects that would have the greatest impact on land-based transportation would include material deliveries and worker commutes causing increased traffic delays, congestion, and reduced road capacity. The LA 23 corridor is used to transport personnel, equipment, and material to the mouth of the Mississippi River for offshore oil and gas platforms and also provides

[154] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

the only access in and out of Plaquemines Parish. The roadway is also a designated State of Louisiana hurricane evacuation route. LA 23 currently has an existing traffic average of 9,300 vehicles per day near the AOI, and a LOS of A or B with no major queuing or delays (see Section 4.22 Land-Based Transportation).

Most of the reasonably foreseeable projects in the AOI are major industrial projects that would require a construction workforce and construction truck traffic similar to (or potentially greater than) the MBSD Project action alternatives. In addition, the construction timeframes for these projects are likely to overlap at some point. It is anticipated that the Tallgrass PLT project could have up to 1,200 construction workers and the Plaquemines LNG/Gator Express Pipeline project could have up to 3,000 construction workers, which would increase traffic volumes within the AOI. Traffic volumes would also increase due to construction truck traffic hauling materials associated with these projects. The Delta LNG/Delta Express Pipeline project scope is similar to the Plaquemines LNG/Gator Express Pipeline project and it is assumed the workforce and construction traffic would be of similar size. Although the workforce associated with construction of the NOLA Oil Terminal is unknown, it is estimated to be about 900 workers (similar to the workforce expected at the nearby Gulf Coast Methanol Complex). In addition, the construction of the NOV-NFL Levee segments could add additional truck traffic to the roadway delivering construction and borrow materials, estimated at up to 1,400 truck trips per day. All of these reasonably foreseeable projects would require substantial amounts of construction materials and equipment that are likely to be primarily delivered by heavy trucks. The cumulative amount of material deliveries and the number of construction workers commuting through the AOI could substantially increase the number of vehicles using LA 23, potentially increasing the current existing AADT by 50 percent at some point during the MBSD construction period and thereby potentially reducing roadway capacity and LOS. Therefore, construction impacts on land-based transportation from reasonably foreseeable projects are expected to be major, adverse, and temporary.

4.25.22.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on roadway transportation from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.22 Land-Based Transportation.

4.25.22.3.3 Overall Cumulative Impacts

Cumulative impacts on traffic from construction of the reasonably foreseeable future actions combined with construction of the MBSD Project action alternatives would likely be major, adverse, and temporary and could cause substantial traffic delays on LA 23, especially during commute periods for construction workers. As described above, most of the reasonably foreseeable projects in the AOI are major industrial projects that would require a construction workforce and construction truck traffic similar to (or potentially greater than) the MBSD Project action alternatives. The construction timeframes for these projects are likely to overlap with the MBSD Project action alternatives at some point. The cumulative amount of material deliveries and the number of construction workers commuting to worksites within the AOI could substantially increase the number of vehicles using LA 23, potentially doubling the current existing traffic at some point during the MBSD Project action alternatives' construction period, thereby potentially reducing roadway capacity and LOS.

4.25.23 Hazardous, Toxic, and Radioactive Waste

The MBSD Project action alternatives would not directly, indirectly, or cumulatively impact HTRW in the Project area. Potential cumulative impacts on water and sediment quality if spills were to occur from reasonably foreseeably industrial projects adjacent to the proposed MBSD Project location are addressed above in Section 4.25.12 (Surface Water and Sediment Quality).

4.25.24 Cultural Resources

4.25.24.1 Geographic and Temporal Extent of Analysis

The AOI associated with cultural resources affected by construction of the Project action alternatives includes those projects that fall within and adjacent to the Construction Impacts APE defined for the MBSD Project. The timeframe for impacts is the 5-year construction period.

The cumulative impact area associated with cultural resources affected by operation of the Project action alternatives includes those actions that fall within and adjacent to the Operational Impacts APE defined for the MBSD Project. The timeframe for impacts is the 50-year operational analysis period.

4.25.24.2 Past, Present, and Reasonably Foreseeable Future Projects Consider

Natural events such as storm events, subsidence, sea-level rise, and coastal erosion may have impacts on cultural resources in the construction and operations APEs. In addition to natural impacts, past and present human actions have ongoing potential to impact cultural resources including projects involving construction, excavation, dredging, and other landscape alterations. Impacts on cultural resources from past or recently completed projects are discussed in Section 4.24 Cultural Resources.

Cultural resources that may be affected by construction include a portion of the St. Rosalie Plantation (16PL107), a portion of the Ironton Plantation (16PL105), and two unnamed cemeteries. The reasonably foreseeable projects that overlap the Construction Impacts APE for cultural resources include:

- NOV-NF-W-05a.1 Project (Map #1 in Figure 4.25.1-1)

- Tallgrass PLT[155] (Map #2 in Figure 4.25.1-1)
- Gulf Coast Methanol Complex (Map #6 in Figure 4.25.1-1)

The reasonably foreseeable projects that overlap the Operational Impacts APE for cultural resources are shown in Table 4.25.24-1 below.

Table 4.25.24-1
Reasonably Foreseeable Projects within the Geographic and Temporal Scope for Cumulative Impacts on Cultural Resources during Operations

Project (Mapped # in Figure 4.25.1-1)	Distance from Operational Boundary
Gulf Coast Methanol Complex (6)	West bank of Mississippi River, downriver
Large-Scale Marsh Creation and Component E- Planning (8)	4.1 miles
Plaquemines LNG/Gator Express Pipeline (10)	5.0 miles
Long-Distance Sediment Pipeline, Phase 2 (11)	5.2 miles
Lafitte Area Levee Repair (12)	6.6 miles
Northeast Turtle Bay Marsh Creation and Critical Area Shoreline Protection (13)	9.1 miles

4.25.24.3 Cumulative Impacts during Construction

4.25.24.3.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

Before construction may occur, all reasonably foreseeable projects would need to obtain federal and state authorizations. Each reasonably foreseeable project requires compliance with Section 106 of the NHPA, and compliance with the Louisiana Unmarked Human Burial Sites Preservation Act (R.S. 8:671-681) and the Louisiana Historic Cemetery Preservation Act (R.S. 25:931-943) if human remains are confirmed present.

If historic properties and cemeteries with documented human remains are confirmed and may be found to extend within the MBSD Construction Impacts APE, direct impacts may include excavation, dredging, dredged material placement, construction of the diversion structure, site modification, stormwater runoff, and spills or leaks of hazardous materials. For historic properties with significance tied to the landscape (for example, setting, association, feeling), indirect impacts may include both temporary and permanent changes to those conditions resulting from construction, such as noise and the viewshed.

[155] Since publication of the Draft EIS, the Tallgrass/PLT facility's sponsors PPHTD/PLT have withdrawn their Joint Permit application (LDNR CUP number P20180379 and DA Permit number MVN-2012-0123-EPP), and terminated the MOU (originally dated April 24, 2019) between CPRA and PPHTD/PLT pertaining to the facility. The mooring dolphins in the river may be used by a future operator, in which case the cumulative impacts assessed for the Tallgrass/PLT facility may still apply.

4.25.24.3.2 Incremental Impacts of the MBSD Project Action Alternatives

Potential impacts on cultural resources from construction of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.24 Cultural Resources.

4.25.24.3.3 Overall Cumulative Impacts

Based on the completion of any recent unpublished studies for other reasonably foreseeable projects, it is currently unclear whether there exists a potential for direct impacts on cultural resources during construction of the reasonably foreseeable projects and the MBSD Project action alternatives. Since the other reasonably foreseeable projects in and adjacent to the MBSD Construction Impacts APE are pending agency review, and the Section 106 process for those projects is incomplete, it is unknown whether impacts may occur within the AOI.

4.25.24.4 Cumulative Impacts during Operations

4.25.24.4.1 Past, Present, and Reasonably Foreseeable Future Projects and Trends

The AOI associated with cultural resources affected by operation of the MBSD Project action alternatives includes a 70,630-acre area within the Barataria Basin defined as the Operational Impacts APE. As federal undertakings, each reasonably foreseeable project, including the MBSD Project action alternatives, requires compliance with Section 106 of the NHPA, and compliance with the Louisiana Unmarked Human Burial Sites Preservation Act (R.S. 8:671-681), if human remains are discovered.

4.25.24.4.2 Incremental Impacts of the MBSD Project Action Alternatives

A draft PA for the MBSD Project detailing the mitigation of adverse effects to historic properties and the alternative mitigation plan agreed to by the Applicant and consulting parties for impacts within the Operational Impacts APE is attached as Appendix K. Potential impacts on cultural resources from operation of the MBSD Project action alternatives are summarized in Chapter 2, Table 2.9-1 and detailed in Section 4.24 Cultural Resources.

4.25.24.4.3 Overall Cumulative Impacts

Potential direct impacts on cultural resources during operation of the reasonably foreseeable projects and MBSD Project action alternatives may include excavation, dredging, dredged material placement, land gain, land loss, and erosion resulting from changes in flow velocity.

Federal and state authorizations for each project are contingent on the management of impacts on historic properties. The CEMVN has determined that the MBSD Project action alternatives would have an adverse effect on historic properties within the Operational Impacts APE. However, since the effects of the other reasonably foreseeable projects in and adjacent to the MBSD Operational Impacts APE are not fully known, it is not possible to complete a cumulative impacts analysis at this time.

4.25.25 Cumulative Impacts Analysis 2022 Addendum

In May 2022, after publication of the Draft EIS, the USACE conducted a search to identify any new reasonably foreseeable projects that, cumulatively with the proposed MBSD Project, have the potential to significantly alter the environmental landscape in addition to those previously assessed in the Draft EIS. Following the four-step identification, screening and evaluation methodology outlined in Section 4.25.1.1 Methodology for Assessing Cumulative Impacts, the USACE identified, screened and evaluated new reasonably foreseeable projects for their potential to significantly affect the environmental landscape that was presented in the Draft EIS (see Section 4.25.1 through 4.25.24) and concluded that none would significantly change the cumulative impacts determinations presented therein. Nevertheless, the process yielded five additional reasonably foreseeable projects that would likely be constructed at some point during construction and/or operation of the MBSD Project and would have more than negligible cumulative impacts on resources impacted by the MBSD Project. To provide a complete picture of MBSD cumulative effects to the decision maker(s) and the public, these five projects and their potential cumulative impacts are discussed below. For the Final EIS, the USACE did not otherwise update the previously-identified reasonably foreseeable projects in the Draft EIS in Sections 4.25.1 through 4.25.24 (for example, with construction status) except in instances where it became aware from news reports, new DA permit applications, or other sources that there was a change in those projects, in which cases a footnote has been added describing the updated status of the project.

Table 4.25.25-1 lists the five new reasonably foreseeable projects, their distance from the MBSD Project action alternatives, and the resources on which each could have more than negligible cumulative impacts during the construction and/or operations of the MBSD Project. Figure 4.25.25-1 shows the geographic location of the five projects in relation to the MBSD Project action alternatives.

Table 4.25.25-1
Reasonably Foreseeable Future Projects Considered in the 2022 Cumulative Impacts Analysis Addendum

Project Name/Proponent	Project Type	Closest Distance to Project Location	Description	Resources Cumulatively Impacted[a]
Plaquemines New Orleans to Venice Levee – La Reussite to West Pointe A La Hache levee reaches (05a.1, 05a.2,06a.1, 06a.2) /USACE	Flood and Storm Damage Risk Reduction	0 miles/ crosses MBSD diversion channel	Construct or modify four New Orleans to Venice risk reduction levee reaches and infrastructure to the 50-year Level of Risk Reduction (LORR) on the west bank of Plaquemines Parish.	Public health and safety, Socioeconomics, Environmental Justice, Air Quality, Noise, Land-Based Transportation
Mississippi River Levee and Channel Improvements Revetment (Myrtle Grove and Alliance reaches)/USACE	Mississippi River and Tributaries (MR&T) Channel Stabilization and Riverbank Protection	0 miles/ crosses MBSD construction footprint along the banks for the Mississippi River	Replace and extend revetment along the right-descending (west) bank of the Mississippi River from RM 57 to 63.8 AHP	Navigation
Louisiana Coastal Area (LCA) Beneficial Use of Dredged Material (BUDMAT) Program, Barataria Bay Water Waterway/USACE	Navigation/ Restoration	5 miles	Restore marsh in coastal Louisiana by maximizing the beneficial use of dredged material from the operation and maintenance (O&M) of the federally authorized Barataria Bay Waterway within Jefferson Parish, Louisiana.	Navigation, Wetlands
Gateway Terminal/Louisiana 23 Asset Management Company, LLC	Major Industrial	10 miles	Construct a new container export terminal in Plaquemines Parish. The project includes riverine structures and terminal infrastructure.	Navigation
Louisiana International Terminal (LIT)/Port of New Orleans	Major Industrial	22 miles	Construct a new commercial container terminal, including an approximate 3,500-linear foot wharf on the Mississippi River in Violet, St. Bernard Parish, Louisiana	Navigation

[a] Based on overlapping timeframe of construction/geographic AOI of each resource. A geographic area AOI was defined and assessed for each resource in Sections 4.2 through 4.24

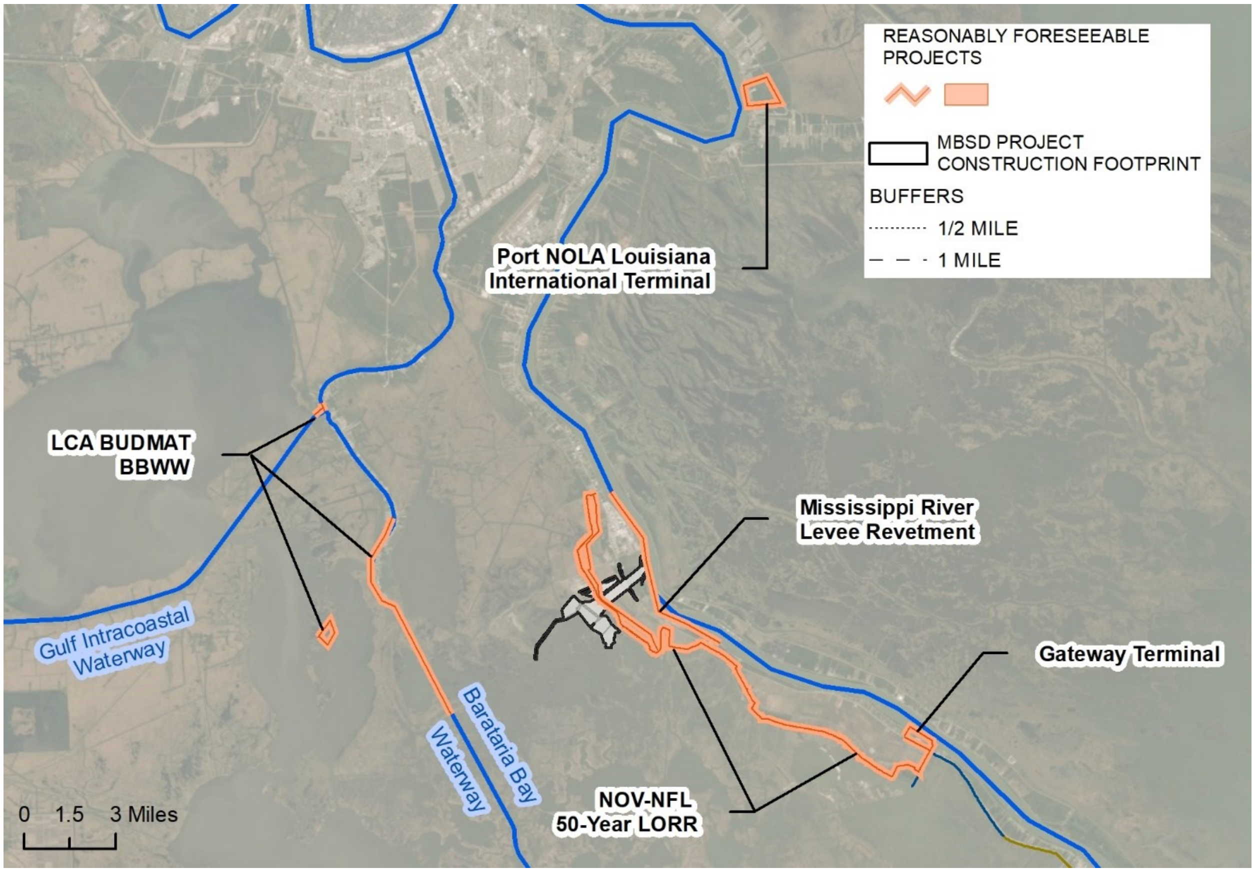


Figure 4.25.25-1. Map of 2022 Reasonably Foreseeable Projects with Potential Cumulative Impacts

4.25.25.1 Plaquemines New Orleans to Venice Incorporation of Non-Federal Levees Risk Reduction Project – La Reussite to West Pointe A La Hache Levee Reaches – Construction to 50-year LORR

The Draft EIS cumulative impacts analysis included construction of portions of the reasonably foreseeable Plaquemines New Orleans to Venice (NOV) Incorporation of the Non-Federal Levee (NFL) Project, a USACE flood risk reduction levee that would cross the MBSD diversion channel and would be constructed to the 4 percent (25-year) LORR.[156] In a change since the Draft EIS, USACE has approved completing the

[156] While the text in Section 4.25.20.2 in the cumulative impacts analysis of the Draft EIS referenced the Plaquemines NOV Project La Reussite to Myrtle Grove (NOV-NF-W-05a.1) levee reach, Figure 4.25.1-1, Map of Projects with Potential Cumulative Impacts, included that reach as well as the Myrtle Grove to Woodpark reach (NOV-NF-W-05a.2), the Woodpark to Pointe Celeste reach (NOV-NF-W-06a.1) and the Point Celeste to West Pointe A La Hache (NOV-NF-W-06a.2) reach. To clarify, the Draft EIS and Final EIS cumulative impacts analysis includes all four levee reaches.

Plaquemines NOV-NFL risk reduction levee and associated infrastructure to the 2 percent (50-year) LORR.[157]

As assessed in the Draft EIS, Plaquemines NOV-NFL Levee construction and modifications up to the 4 percent (25-year) LORR were projected to contribute beneficial cumulative impacts during MBSD operations on public health and safety, socioeconomics, and environmental justice due to an increased level of storm surge risk reduction for communities and businesses on the protected side of the levee. Even so, it found that the protected side of the Plaquemines NOV-NFL Levee could still experience storm surge inundation during storms affecting this area that are greater than a 25-year storm. Cumulatively with the proposed MBSD, the NOV-NFL Project would have negligible impacts on communities and businesses outside of flood protection levees.

The Draft EIS cumulative impacts assessment also determined that the Plaquemines NOV-NFL Project levee reaches would contribute temporary, minor to moderate, adverse cumulative impacts on air quality during construction due to the operation of combustion-powered equipment and fugitive dust; truck and barge deliveries of construction materials and equipment; and workers traveling to and from the Project (see Section 4.25.7 Air Quality). Further, as described in Section 4.25.8 Noise, the project would contribute temporary, minor, adverse cumulative impacts on noise receptors in proximity to work areas during construction due to the use of internal combustion engines associated with general construction equipment. The most prevalent noise-generating equipment and activity for reasonably foreseeable projects and the MBSD Project would be pile driving. However, the four NOV-NFL Levee reaches would not include pile driving. The NOV-NFL Project would also contribute temporary, minor to moderate, adverse cumulative impacts on traffic congestion on LA 23 mainly associated with truck deliveries of substantial amounts of construction materials. Traffic congestion could result in delays for community residents, including residents of Ironton, and other users of LA 23, which serves as the primary hurricane evacuation route (see Section 4.25.22 Land-Based Transportation) for west-bank Plaquemines Parish residents.

With the 2022 reasonably foreseeable design update of the NOV-NFL Levee to the 2 percent (50-year) LORR, the potential for overtopping of the levee during tropical storms and hurricanes would be reduced, representing additional beneficial cumulative impacts on public health and safety, socioeconomics, and communities with environmental justice concerns (including the community of Ironton) through increased hurricane and flood risk reduction for communities and businesses on the protected side of the levee. The design upgrade to the 2 percent (50-year) LORR would have

[157] Work to construct, modify or replace the Plaquemines NOV/NFL Project to the 50-year LORR would use appropriations provided by the Disaster Relief Supplemental Appropriations Act of 2022 (Public Law 117-43). The work would require a new project partnership agreement with the non-Federal sponsors, CPRA and Plaquemines Parish Government.

negligible cumulative impacts on public health and safety, socioeconomics, and environmental justice for communities outside of federal levee systems.

The foreseeable design update to the 2 percent (50-year) LORR would entail constructing a larger levee, requiring an increased volume of borrow material to be transported to the construction site and a longer construction duration, which in turn would increase the duration of adverse cumulative impacts on air quality and noise associated with the use of combustion-powered equipment and adverse impacts due to increased traffic. A longer construction duration would also increase the duration of adverse cumulative impacts on nearby communities, including Ironton, and other roadway users related to LA 23 traffic congestion associated with truck deliveries and workforce traffic. These additional incremental impacts would not appreciably change the overall cumulative impacts determination previously provided in the Draft EIS for these resources. Because the NOV-NFL Project and the MBSD have overlapping construction footprints and because the MBSD would alter a portion of the NOV-NFL Project after its construction, the increased duration of construction for the 2 percent (50-year) LORR for the NOV-NFL Project may impact the timing of construction completion of the MBSD Project, if permitted.

4.25.25.2 Louisiana Coastal Area (LCA) Beneficial Use of Dredged Material (BUDMAT) Program, Barataria Bay Water Waterway

The LCA BUDMAT, Barataria Bay Waterway project entails dredging approximately 764,000 cubic yards of material from the Barataria Bay Waterway Federal Navigation Channel[158] to create approximately 75 acres of fresh-intermediate marsh (USACE 2019e). For the construction of the beneficial use site, material dredged from the Barataria Bay Waterway and an access channel would be loaded onto barges, transported to a designated pump-out location adjacent to the site, and then hydraulically offloaded using a temporary pipeline (USACE 2019e, Appendix E 404[b][1]).

As assessed in the Environmental Assessment for the project (USACE 2019e), the LCA BUDMAT project would have temporary, minor, adverse impacts on navigation traffic in the Barataria Basin. Dredges and disposal pipelines may cause minor and temporary interference of navigation by blocking sections of the Barataria Bay Waterway, but are not expected to interfere significantly with shipping traffic. Dredging operations would be closely coordinated with representatives of the navigation industry, and a Notice to Mariners would be posted by the USCG. Beneficial use of dredged material placed in BA-1 East (located in the narrow corridor of wetlands that separates Bayou Perot and Bayou Rigolettes) could cause minor, temporary disruptions to small vessels using the nearby waterways. Portions of BA-1 East may become inaccessible to some watercraft as wetland vegetation eventually colonizes the area; however, the shallow nature of the area currently limits most vessel access. Therefore, this

[158] This federally maintained channel was dredged 10 times via either hydraulic or mechanical dredging from 1996 to 2018, averaging 254,742 cubic yards per year accumulation (USACE 2019a; see Chapter 3, Section 3.21.2.1 Maintenance Dredging).

reasonably foreseeable project is not expected to contribute appreciably to cumulative impacts on navigation traffic in the Barataria Basin during construction or operation of the MBSD Project, and therefore would not change the overall cumulative impacts determination previously provided in the Draft EIS.

Constructing the approximately 75-acre marsh creation site in BA-1 East, when added to other past, present, and reasonably foreseeable ecosystem restoration and mitigation projects in the basin, would help slow the loss of wetlands. This would not appreciably change the cumulative impacts determination for basin wetlands in the Draft EIS, which determined that the MBSD Project action alternatives in combination with other reasonably foreseeable projects would contribute major, permanent, beneficial impacts on wetlands in the Barataria Basin.

4.25.25.3 Mississippi River Levee Myrtle Grove and Alliance Revetment Installation

The Mississippi River Levee Myrtle Grove and Alliance Revetment Installation, a new MR&T reasonably foreseeable project, would include work in the Mississippi River from RM 57 to RM 63.8 AHP, which is an area that would cross the MBSD Project construction area in the river (see Figure 4.25.25-1). The 1976 MR&T Mississippi River Levees and Channel Improvement Final EIS describes the work as follows:

> To date, the most economical and effective means of protecting the banks to prevent caving and erosion is [placement of] revetment composed of an articulated concrete mattress under water and stone (riprap) paving above the low water placed on a stripped and graded bank. The mattress is composed of sections of 20 concrete blocks or slabs, each 4 feet long, 14 inches wide, and 3 inches thick, cast into unit squares 4 feet wide and 25 feet long, using corrosion-resistant fabric to hold the blocks together and provide flexibility. These unit squares are assembled on the launching ways of a specially designed mat sinking plant, fastened together with machine-applied wire wraps to form a mattress 140 to 156 feet in width. After the first launch is anchored to the bank and lowered by moving the barge out into the river, another launch is assembled on the deck, fastened to the first, and the barge again moved out into the river. This method of assembly is repeated until a mattress is long enough to extend to the deepest point in the channel. The procedure is then repeated with each succeeding mattress overlapping the previous mattress until the desired degree of protection is obtained. Normally, the river bank is revetted from the upstream point of river current attack to where the channel crosses to the opposite bank (USACE 1976).

The revetment installation would include the use of specialized barge units, which may pose minor, temporary traffic impacts on shallow-draft vessels transiting past this site during concurrent MBSD Project construction of the temporary cofferdam and intake structure. Although this project would contribute additional minor impacts on navigation in the Mississippi River due to increases in navigation traffic, the overall cumulative impacts determination for navigation during construction of the MBSD Project would not change appreciably from the Draft EIS.

4.25.25.4 Gateway Terminal Project and Louisiana International Terminal (LIT) Project

The Louisiana 23 Development Company, LLC has submitted a permit application to the USACE for a Section 10/404 permit and Section 408 permissions to construct the Gateway Terminal, a commercial container terminal on the right-descending (west) bank of the Mississippi River near RM 50 AHP, approximately 10 miles downriver from the MBSD Project (see Figure 4.25.25-1). This project would cause a minor increase in vessels transiting to and from the terminal site during its construction. During operations, the Gateway Terminal project would increase both shallow and deep-draft vessels transiting up- and downriver from the terminal site, causing minor increases in navigation traffic, including in the vicinity of the proposed MBSD Project.

The Port of New Orleans has submitted a permit application to the USACE for a Section 10/404 permit and Section 408 permissions to construct the LIT, a new commercial container terminal, including an approximately 3,500-linear foot wharf on the Mississippi River. The project would be constructed on the left descending (east) bank of the Mississippi River at RM 83 AHP, approximately 22 miles upriver from the MBSD Project (see Figure 4.25.25-1). Construction of the LIT project would require a minor increase in vessels transiting to and from the LIT site. The proposed LIT is expected to increase the volume of shallow-draft vessels that would call on the new container terminal during concurrent operation with the MBSD Project.

4.25.25.4.1 **Cumulative Impacts of the Gateway Terminal and LIT Projects and MBSD**

After publication of the Draft EIS, the Applicant submitted MBSD 60 percent design updates, which reduced the MBSD construction footprint in the river. Based on the reduced river footprint, USACE has revised the impact determination on navigation safety and efficiency in the Mississippi River during construction from “temporary, moderate, and adverse” to “temporary, minor, and adverse” (see Section 4.21.4.1.2.2 Traffic in the Final EIS).[159]

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[159] Also since publication of the Draft EIS, permit/certification applications for the Draft EIS reasonably foreseeable projects Tallgrass/PLT and Pointe LNG have been withdrawn. As described in the Draft EIS cumulative impacts analysis (see Section 4.25.21.3 Cumulative Impacts during Construction), these then-reasonably foreseeable projects would have caused no more than negligible increases in marine traffic during their construction for the delivery of construction materials. The withdrawn permit/certification applications make them no longer reasonably foreseeable and they would therefore have no potential for cumulative impacts on navigation or other resources. Footnotes describing the withdrawal of the Tallgrass/PLT and Pointe LNG permit applications have been added to Section 4.25.1 Methodology for Assessing Cumulative Impacts.

However, the reasonably foreseeable Gateway Terminal and LIT (as well as the Mississippi River Levee Myrtle Grove and Alliance Revetment Installation during its construction) are expected to increase the volume of shallow-draft vessels transiting past the proposed MBSD Project cofferdam enough to result in an overall cumulative impacts determination on navigation of temporary, moderate, and adverse during MBSD construction.

As assessed in Section 4.21.4.2.2.2 Traffic, MBSD Project operations would have intermittent but permanent, moderate, and adverse impacts on the safety and efficiency of shallow-draft vessels transiting past the diversion structure due to cross-currents extending about 200 feet into the river for the rerouting of river water from the Mississippi River into the intake channel. MBSD operations would have negligible impacts on deep-draft vessels transiting within the limits of the Mississippi River navigation channel.

The reasonably foreseeable future projects assessed in the Draft EIS cumulative impacts for navigation during MBSD operations were determined to contribute negligible impacts on traffic volumes, safety, and efficiency in the Mississippi River (see Section 4.21.4.2.2.2 Traffic). However, the proposed Gateway Terminal Project and LIT Project are expected to increase the volume of shallow-draft vessels that would call on the new container terminals during concurrent operations with the MBSD Project. These projects would contribute minor adverse impacts on navigation safety and efficiency in the river during MBSD Project operations. The overall cumulative impacts determination on Mississippi River navigation during MBSD operations would not appreciably differ from the anticipated impacts of the MBSD Project action alternatives alone, which would be intermittent but permanent, moderate, and adverse due to cross-currents extending about 200 feet into the river due to the rerouting of river water into the intake channel.

4.26 ADDITIONAL CONSIDERATIONS IN PLANNING

4.26.1 Relationship Between Short-term Use of the Human Environment and Long-term Productivity

NEPA requires that an EIS discuss “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). The human environment includes the “natural and physical environment and the relationship of people with that environment” (40 CFR 1508.14).

As discussed throughout Chapter 4, the MBSD Project action alternatives would result in various short-term impacts in the Project area including, but not limited to, construction of the diversion structure and initial habitat changes during the start-up of operations, such as initial changes in wetland soils where sediments would be deposited in the Barataria Basin. These short-term changes in the human environment would affect people through changing land use/agricultural practice at the site of the diversion structure, modifying existing soils and associated ecological communities, and modifying flow velocities in the Mississippi River (thereby modifying shallow-draft boating practices in areas near the diversion structure).

Over the long-term, operation of the Project would re-establish sustainable deltaic processes between the Mississippi River and the Barataria Basin through the delivery of sediment, fresh water, and nutrients. These longer-term processes would allow the continued existence of up to a projected 26,000 acres of marsh in the Barataria Basin that would otherwise be lost. Although operation of the Project would result in long-term decreases in productivity for certain key species (such as oysters and brown shrimp) as well as marine mammals, the long-term productivity of aquatic life as a whole in the Barataria Basin, compared to the No Action Alternative, would increase through increased nutrient input and the maintenance of habitat that provides nursery and juvenile habitat for several key finfish and shellfish species, such as red drum and white shrimp.

4.26.2 Irreversible and Irretrievable Commitment of Resources

Under NEPA, a review of irreversible and irretrievable impacts that result from development of the MBSD Project is required (40 CFR 1500–1508). Irreversible commitments of resources are those resulting from impacts on resources so they cannot be completely restored to their original condition. Irretrievable commitments of resources are those that occur when a resource is removed or consumed and would therefore never be available to future generations for their use.

The action alternatives would require irreversible and irretrievable commitments of resources, including the expenditure of funding, energy, labor, and materials. The action alternatives would also irreversibly and irretrievably commit some lands, including wetlands, to uplands or developed lands within the footprint of the diversion structure as the structure is unlikely to be dismantled and restored. In addition, operation of the Project would result in changes to the bathymetry of the Barataria Basin (where sediments would be deposited), the Mississippi River (downstream of the diversion structure) and the birdfoot delta (where sedimentation would decrease). Decreases in sedimentation in the birdfoot delta would result in increases in the rate and extent of wetland loss over time that would be irreversible. Although original construction and initial operations of the MBSD Project action alternatives may induce changes in land use, no appreciable additional changes are expected to result from the proposed maintenance actions.

Although there are unavoidable adverse impacts from operation of the MBSD Project (see Section 4.26.3), some of these impacts would be reversible (such as increased flood risks near the diversion structure, and decreased salinities in the outfall) because the diversion structure could be permanently closed, curtailing further fresh water and sediment flow into the Barataria Basin. If permanently closed, conditions within the Barataria Basin would eventually return to a state that would be similar to pre-diversion conditions (for example, higher salinities and decreased turbidity), although original conditions would have continued to change naturally under the No Action Alternative and pre-diversion conditions would likely not be fully attainable.

4.26.3 Unavoidable Adverse Impacts

All alternatives evaluated have unavoidable adverse environmental impacts that are discussed throughout Chapter 4. Although adverse (as well as beneficial) impacts occur across most resources, many impacts begin as minor impacts at the onset of operations (or during construction) and raise to moderate or major levels over time. Conversely, some impacts may be higher at the onset of operations and decrease over time as ecosystems and the human populations adjust. In addition, some impacts could be episodic and intermittent based on the frequency of occurrence (such as inundation due to tidal flooding and storm events). It is also true that moderate to major changes in some habitat characteristics (such as salinity) would occur, but these changes are only adverse or beneficial insofar as they affect other resources including plants, animals, or people, either directly or indirectly. For some impacts, mitigation measures and best practices as described in Section 4.27 Mitigation Summary are identified as options that can be used to avoid, reduce, minimize or mitigate unavoidable adverse impacts, where applicable. As all adverse impacts are disclosed throughout Chapter 4, the discussion provided below focuses on summarizing the moderate or major adverse impacts that are reasonably anticipated to occur over time.

4.26.3.1 No Action Alternative

The No Action Alternative would have unavoidable adverse impacts from the unmitigated loss of coastal marsh from sea-level rise, which would subsequently result in moderate to major adverse impacts on wetland and SAV coverage, as well as the populations of various aquatic and wetland-associated animal species that use the existing marsh as nursey habitat. Similarly, the existing species assemblages would likely shift during saltwater encroachment, which would have up to major adverse impacts on those species that are less or intolerant of saline environments. Notably, economically important shellfish (oysters, brown shrimp, white shrimp, and blue crab), as well as largemouth bass, were individually assessed species that would be anticipated to experience moderate to major adverse impacts from habitat changes under the No Action Alternative. The decreases in certain aquatic life populations would further affect the human population, and particularly that portion of the human population that is associated with the inshore fishing industry in the Barataria Basin.

4.26.3.2 Action Alternatives

4.26.3.2.1 Barataria Basin

All action alternatives would result in changes to the general character of the Barataria Basin, including, but not limited to, salinity, temperature, land accretion, and water quality. As discussed above, these changes are generally either adverse or beneficial depending on habitat tolerances of area plants, animals, and people, with moderate to major adverse impacts anticipated to occur only on those plants and animals that are unable to tolerate the modified habitat, and subsequently to the people that rely on the area plants and animals for economic, recreational, or other purposes. In many cases, adverse impacts on Barataria Basin resources are higher near the immediate outfall area, where salinity, temperature, water level, and sedimentation impacts are greatest, and decrease with distance from the outfall.

Individual aquatic species may experience moderate or major, adverse impacts where altered salinities and temperatures are outside of a species' optimal range, especially in areas closer to the diversion outfall where these impacts are typically more pronounced. Similarly, increased turbidity in the outfall may result in up to moderate adverse impacts for species that are less tolerant of turbidity. The MBSD Project action alternatives would likely initially result in major adverse impacts on SAV in the basin from a relatively quick decrease in salinity, which may result in die-offs of species intolerant of the new salinity regime early in the Project analysis period; however, these impacts would be offset by the major benefits to SAV that are anticipated once the salinity regimes stabilize and new freshwater or intermediate communities become established.

Up to major adverse impacts may occur on recruitment of larval brown shrimp near the immediate outfall area, where high diversion flows overlap with peak larval transport periods for individual species. All action alternatives would likely have major adverse impacts on the Barataria Basin population of oysters (predominantly from salinity changes, and sedimentation) and brown shrimp (predominantly from changes in salinity and precluded larval recruitment). Due to the anticipated decrease in these populations, the MBSD Project action alternatives are expected to cause up to major adverse impacts on oyster and shrimp fisheries (and fishermen) within the Barataria Basin.

Additional species that would likely incur moderate to major impacts from operation of an action alternative include the BBES stock of dolphins (major adverse, and largely related to decreases in salinity), pallid sturgeon (moderate, related to underwater noise during construction and potential entrainment into Barataria Bay), bald eagle (negligible to moderate adverse, depending on presence and the potential uptake of contaminants), and the green, Kemp's ridley, and loggerhead sea turtles (up to moderate adverse and related to presence in the Barataria Basin and potential increases in negative interactions between turtles and fishing gear). On December 13, 2021, the USFWS and NMFS individually issued Biological Opinions, which determined that the Project would not jeopardize the continued existence of pallid sturgeon (USFWS) and green, Kemp's ridley, and loggerhead sea turtles (NMFS).

In addition, all action alternatives would have up to moderate adverse impacts from the spread of invasive wetland and aquatic plant species in the Barataria Basin, and potentially major adverse impacts from the introduction or range expansion of aquatic invasive animals. Further, up to moderate impacts could occur on upland forested vegetation and terrestrial wildlife species from the removal of forested habitat in the footprint of the diversion structure, although these impacts would be localized.

Operation of the action alternatives would also result in up to moderate adverse impacts on population, housing, and property values, tax revenues, and community cohesion in communities outside of flood protection due to increased tidal flooding and outmigration (within 10 miles to the north and 20 miles to the south of the immediate outfall area). The MBSD Project action alternatives could also lead to up to major adverse impacts on low-income and minority populations from acceleration of increases in tidal flooding, storm hazards, and impacts on commercial and subsistence fisheries.

The MBSD Project action alternatives would increase water levels during operation, which would have up to major adverse impacts on public health and safety by increasing the frequency of tidal flooding in communities outside levee protection, with the greatest impacts on communities closest to the diversion outfall, and potential impacts decreasing with distance from the outfall area. Similarly, up to moderate adverse impacts would occur on communities outside of federal levee systems south of the diversion (including Myrtle Grove and Grand Bayou) associated with the risk of storm hazards.

The action alternatives would also cause unavoidable moderate adverse impacts on maintenance dredging operations from Venice to the Gulf of Mexico due to the increased sedimentation in these areas, which would require increased dredging. Finally, following construction, there would be unavoidable moderate adverse impacts on the visual character of the area around the diversion structure.

4.26.3.2.2 Birdfoot Delta

All action alternatives would have unavoidable moderate adverse impacts on the birdfoot delta through the decrease in freshwater flow and sediment deposition. Decreases in sedimentation in the birdfoot delta would result in decreased land building and an increased rate and extent of wetland loss over time which, as described for the Barataria Basin, would affect various species populations that utilize marsh habitat. Due to the loss of wetlands in the birdfoot delta, moderate adverse impacts on the Delta NWR and Pass A Loutre WMA would also occur.

4.26.3.2.3 Mississippi River

Unavoidable moderate adverse impacts on marine traffic efficiency and safety would occur for shallow-draft vessels transiting the Mississippi River near RM 60.7 AHP during the 50-year analysis period because the rerouting of river water from the Mississippi River into the diversion intake channel during operations may induce cross-currents extending about 200 feet into the river. In addition, up to moderate adverse impacts on fish could occur during in-river construction.

4.26.4 Consideration of Incomplete or Unavailable Information

The CEQ guidelines require that when an agency is evaluating reasonably foreseeable significant adverse impacts on the human environment in an EIS and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking (40 CFR 1502.22). In the event that there is information relevant to reasonably foreseeable significant adverse impacts that cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known

(40 CFR 1502.22(a)), the regulations instruct that the following should be included in the EIS:

- a statement that such information is incomplete or unavailable;
- a statement of the relevance of such information to evaluating reasonably foreseeable significant adverse impacts;
- a summary of existing information that is relevant to evaluating the reasonably foreseeable significant adverse impacts; and
- the agency's evaluation of such impacts based on theoretical approaches or research methods generally accepted in the scientific community.

In the analysis, this EIS identifies those areas where information is unavailable and whether existing information can support an adequate evaluation of the environmental consequences of the alternatives. The direct, indirect, and cumulative impacts analyses are based on readily available information; however, those data gaps that still exist are identified, in accordance with the above CEQ guidelines and are summarized for each resource below.

4.26.4.1.1 Summary of Incomplete or Unavailable Information for Resources Areas

As noted in Chapter 3, Section 3.1.3 Climate, in August 2021 Hurricane Ida made landfall at the southwestern corner of the Project area with maximum wind speeds of almost 150 MPH; storm surge reached between 9 and 12 feet in Barataria Bay. Hurricane Ida caused catastrophic damage in southeast Louisiana, including wetland losses immediately following the storm based on reviews of available satellite imagery; however, reliable data to assess any changed conditions in the Project area post-Hurricane Ida, including potential changes to land, wetland and open water acreages, and to socioeconomic measurements (such as employment and population levels) are not currently available for use in the EIS. Because landscapes and populations affected by hurricanes may take years to recover, early data (even if it were available) may not be representative of later conditions. For example, one recent study on the effects of prior hurricanes noted that while hurricanes can have immediate adverse impacts on wetland biomass and area, general recovery was observed within two years (Mo et al. 2020). Another recent study noted that post-hurricane demographic changes could occur over a series of years and would depend on a variety of factors, including location and pre-hurricane population density and stability (Fussell et al. 2018).

A summary of other incomplete or unavailable information is listed for each of the resource areas below.

Geology and Soils: Regarding the potential for fault movement in the Project area, there is an increasing awareness that geologic faulting can be a significant contributor to land loss in Louisiana (Gagliano 2005a, Gagliano et al. 2003a,b, Dokka 2006). McLindon et al. (2017) suggest that the high historical rates of wetland loss in the Project area may be indicative of possible surficial impacts of the Ironton fault. However, there is insufficient information on which to evaluate the impact of faulting on the proposed Project or the impact of the proposed Project on future fault movement.

Although additional seismic data and sediment cores could be collected to map historical subsurface faults and to document recurrence intervals of past subsurface fault movements, this information would not enable predictions of the occurrence, location, magnitude, or timing of future fault movements in the Project area with any certainty. This uncertainty is due to the following factors: (1) there are no surficial fault lines indicating recent episodic activity in the Project area, and (2) there is insufficient understanding of the factors that could trigger elevation changes at the surface if a fault were present, with or without the proposed Project. Furthermore, the potential consequences of faulting would be similar among all alternatives; therefore, gathering additional information on these potential impacts is not essential to a reasoned choice among alternatives.

Surface Water and Coastal Processes: Numerous assumptions were utilized in development of the Delft3D Basinwide Model. As discussed in Appendix E, all models are a simplified representation of actual processes and thus how a system would respond to external drivers, and as such have varying degrees of limitations and uncertainties. One external driver with strong influence over the model's output is the assumed rate of sea-level rise. Because the actual rate over the 50-year analysis period of the Project is unknown, reasonable assumptions were informed by the current scientific literature. Although the Delft3D Basinwide Model was developed with a certain set of assumptions such as the rate of sea-level rise (see Appendix E), the information provided by the combination of literature review and model outputs is sufficient to support sound scientific judgements and informed decision making related to the Project and its impacts on surface water and coastal processes. No other incomplete or unavailable information related to the analysis of impacts on surface water and coastal processes was identified.

Surface Water and Sediment Quality: Limited water quality data on atrazine were available for both the Mississippi River and the Barataria Basin. The USEPA has no surface water or aquatic life water quality criteria for atrazine; therefore, impacts on water quality based on atrazine concentrations cannot be determined. The available data indicate that atrazine concentrations are similar in the river and the basin and are well below the primary drinking water standard. There is no reason to believe that introduction of Mississippi River water into the basin would have significant impacts on atrazine concentrations in the basin.

Data on the quality of suspended sediments in the Mississippi River were not available. Sediment quality data from sediment deposits within the Mississippi River were used to approximate the quality of sediments that would be deposited in the basin during Project operations. Use of these data assumes that the suspended sediments moving through the diversion would be similar in quality to deposited sediments sampled upriver of the proposed diversion. Based on this assumption, there is no indication that the quality of sediments that would be carried by the Mississippi River via the proposed diversion complex would cause adverse discernible or measurable impacts on sediment quality in the Barataria Basin.

Although the Delft3D Basinwide Model was developed with a certain set of assumptions, such as the rate of sea-level rise (see Appendix E), the information provided by the combination of literature review and model outputs is sufficient to support sound scientific judgements and informed decision making related to the Project and its impacts on water and sediment quality.

Wetlands: The quantitative assessment of impacts on wetland types extent is based on anticipated habitat changes that are expected to occur during construction and operation of the MBSD Project (for example, changes in salinity and emergent vegetation coverage); however, the degree and spatial extent of wetland changes associated with operation of the Project is not fully known. While research on sediment diversions is limited, studies have documented the impacts of freshwater diversions on wetlands.

Quantitative assessments of the value of wetlands established, enhanced, or lost from the proposed Project were determined using the Wetland Value Assessment (WVA) Methodology for Coastal Marsh Community Models, developed by the CWPPRA Environmental Work Group to determine the suitability of marsh and open-water habitats in the Louisiana coastal zone. The intent of the model is to define an optimal combination of habitat conditions for fish and wildlife species living in Louisiana coastal marsh ecosystems, and uses outputs from the Delft3D Basinwide Model. Although the Delft3D Basinwide Model and WVA were developed with a certain set of assumptions, such as the rate of sea-level rise (see Appendix E and CWPPRA Environmental Work Group 2006), the information provided by the combination of literature review and model outputs is sufficient to support sound scientific judgements and informed decision making related to the Project and its impacts on wetlands.

The extent of introduction or spread of invasive plants and animals that could occur during construction and operation of the MBSD Project action alternatives is unknown. The USACE believes that the overall costs of obtaining this information would be exorbitant or the means to obtain it are not known. However, the information provided by literature review is considered sufficient to support sound scientific judgements and informed decision making related to the Project.

Terrestrial Wildlife and Habitat: The assessment of impacts on wetland-associated terrestrial wildlife is based on anticipated habitat changes that are expected to occur during construction and operation of the MBSD Project (for example, changes in salinity and emergent vegetation coverage); however, the degree and spatial extent of habitat changes associated with operation of the Project is not fully known. Changes in habitat value to key species was determined through the use of HSI models, which use outputs from the Delft3D Basinwide Model. Although the Delft3D Basinwide Model was developed with a certain set of assumptions, such as the rate of sea-level rise (see Appendix E), the information provided by the combination of literature review and model outputs is sufficient to support sound scientific judgements and informed decision making related to the Project and its impacts on terrestrial wildlife and habitat.

The extent of introduction or spread of invasive plants and animals that could occur during construction and operation of the MBSD Project action alternatives is unknown. The USACE believes that the overall costs of obtaining this information would be exorbitant or the means to obtain it are not known. However, the information provided by literature review is considered sufficient to support sound scientific judgements and informed decision making related to the Project.

Aquatic Resources: The assessment of impacts on aquatic resources (fish, invertebrates, the benthic community, and aquatic vegetation) is based on published literature regarding the impacts of the anticipated habitat changes that are expected to occur during construction and operation of the MBSD Project (for example, changes in salinity, emergent vegetation coverage, and water temperature); however, the degree and spatial extent of habitat changes associated with operation of the Project is not fully known. Therefore, the USACE and LA TIG developed and assessed multiple model scenarios for the Project that included higher (150,000 cfs) and lower (50,000 cfs) flow regimes, and wetter and drier hydrograph years to ascertain the span of potential impacts. Although the Delft3D Basinwide Model (and further, the HSI models, which use Delft3D Basinwide Model outputs) was developed with a certain set of assumptions (see Appendix E), the information provided by the combination of literature review and model outputs is sufficient to support sound scientific judgements and informed decision making related to the Project and its impacts on aquatic resources.

There are also unknowns regarding the potential for HABs to occur from the increased nutrient input into the Barataria Basin. Shifts in the planktonic community are anticipated based on the inflow of fresh water from the Mississippi River; however, it is unknown if phytoplankton blooms associated with this input would become HABs. A review of currently available data acknowledges the scientific community's lack of understanding regarding plankton community shifts under varying environmental conditions (Bargu et al. 2019), which leads the USACE to believe that the overall costs of obtaining this information are exorbitant or the means to obtain it are not known. Although information on the occurrence of potential HABs is unavailable, the USACE acknowledges the potential for up to major adverse impacts to occur on the estuarine community from frequent and/or large HABs, if they were to occur.

The EIS assesses potential impacts on species groups (and on key species) from both individual habitat changes and combinations of habitat changes. However, the USACE acknowledges that the estuarine community is subject to many factors that influence the abundance and diversity of species. Therefore, it is possible that unknown factors could result in further impacts (either beneficial or adverse) that have not been assessed. However, the USACE, with input and agreement from the applicable federal and state agencies, has assessed data from other (albeit smaller) diversions in

Louisiana estuaries to extrapolate how overall impacts may affect the estuarine community.

The extent of introduction or spread of invasive plants and animals that could occur during construction and operation of the MBSD Project action alternatives is unknown. The USACE believes that the overall costs of obtaining this information would be exorbitant or the means to obtain it are not known. However, the information provided by literature review is considered sufficient to support sound scientific judgements and informed decision making related to the Project.

Additional information, extrapolations, and assumptions are presented in Section 4.10 Aquatic Resources and references therein, and in the Essential Fish Habitat Assessment (see Appendix N). Overall, the USACE used the best available information to predict potential impacts on aquatic resources, and the analysis provided in this EIS is sufficient to support sound scientific judgements and informed decision making related to the effects of the MBSD Project action alternatives.

Marine Mammals: There is still much to be learned about marine mammal behavior, physiology, and pathology, and the models used to forecast environmental conditions require assumptions and generalizations with different levels of confidence. The assumptions used in the Delft3D Basinwide Model, for which outputs informed the potential impacts on marine mammals, are noted in Appendix E and in Section 4.11.3.1 General Caveats to Impact Analysis Approach in Marine Mammals.

The specific movement patterns of BBES dolphins are not fully understood, although individual dolphins appear to stay in relatively small areas in spite of unfavorable habitat changes. Therefore, it is unknown whether the BBES stock boundaries, or an individual dolphin’s home range, would shift as a result of Project operations, and if so, how they would shift (either further north into the Barataria Basin or into other stock boundaries). Furthermore, if the potential HABs and increase in contaminants from the Applicant’s Preferred Alternative do manifest (see Aquatic Resources section above), BBES dolphins would be less resilient to these stressors due to the low-salinity exposure (and vice versa).

In addition, assessing the impacts of any given stressor, let alone the impacts of multiple interactive stressors, to long-lived, large-bodied, social, intelligent animals in a marine environment is difficult. Because of the uncertainties associated with multiple stressors, the EIS assessed the BBES stock using salinity:survival dose-response curve on unhealthy population. This dose-response curve was the result of expert elicitation to determine the response for “an average BSE dolphin,” which means that some dolphins will be more robust and others will be less robust than the theoretical average BSE dolphin. It is also unclear how long it will take dolphins to recover from sublethal effects of prolonged exposure to low-salinity waters, or how repeated annual exposure to low-salinity waters would affect dolphins, as the models only look at single years for each decade/alternative combination.

Although the above information is unavailable, USACE and NOAA extrapolated or drew assumptions from what is known about similar stocks and/or situations, including recently collected data that is currently being assessed by NOAA for a 2019 UME in the Northern Gulf of Mexico related to high freshwater influx into Northern Gulf of Mexico waters. Additional information, extrapolations, and assumptions are presented in Section 4.11 Marine Mammals of this EIS and references therein. Overall, the USACE and NOAA used the best available information to predict potential impacts on marine mammals, and the analysis provided in this EIS is sufficient to support sound scientific judgements and informed decision making related to the operation of the MBSD Project and action alternatives.

Threatened and Endangered Species: USACE, in coordination with USFWS, relied on the best available scientific information to predict the presence of threatened and endangered species in the Project area and the likely effects of the Project on such species. A thorough evaluation of the Project's likely effects on threatened and endangered species is included in a Biological Assessment (BA) prepared by USACE and submitted to the USFWS to initiate formal consultation. The analysis in the BA, including its evaluation of effects to pallid sturgeon, is incorporated by reference and briefly summarized in Section 4.12. The potential presence of threatened and endangered species in the Project area was determined through the review of available literature, as well as expert opinions; however, the abundance and exact locations of habitat use for these species are not always known.

Due to uncertainty as to the abundance of pallid sturgeon in the Lower Mississippi River, the Barataria Basin, and the Project area, USACE and USFWS extrapolated or drew assumptions from what is known about pallid sturgeon populations in other portions of the Mississippi River, as well as the results of the limited sampling available in the Lower Mississippi River, to create a Population Viability Assessment (PVA). The PVA provides a conservative estimate for the level of impacts of the diversion on pallid sturgeon. Additional information, extrapolations, and assumptions are presented in Section 4.12, Threatened and Endangered Species, of this EIS and refences therein, as well as in the BA that has been prepared concurrent with the preparation of this EIS. Together, these analyses, while acknowledging uncertainty, provide a scientific basis for predicting the occurrence of pallid sturgeon in the Project area and the effects the Project and other reasonably foreseeable projects are likely to have on the species. Overall, the USACE and USFWS used the best scientific information to predict potential impacts on pallid sturgeon, and the analysis provided in this EIS is sufficient to support sound scientific judgements and informed decision making related to the operation of the MBSD Project and action alternatives.

With respect to sea turtles, it is anticipated that potential changes in fishing practices by the commercial shrimp fishery in the Barataria Basin could increase interactions between sea turtles and commercial fishing vessels. The specific changes in fishing practices, as well as the extent of sea turtle use of the Barataria Basin (especially in the mid-basin) is not fully known. Furthermore, if the potential HABs and increase in contaminants from the Applicant's Preferred Alternative do manifest (see Aquatic Resources section, above), they could adversely affect sea turtles. However, the USACE, NOAA, and the USFWS used the best available information to predict potential impacts on sea turtles, and the analysis provided in this EIS is sufficient to support sound scientific judgements and informed decision making related to the operation of the MBSD Project action alternatives.

Population density of black rails in the Project area is unknown, but is anticipated to be low. However, the EIS used the best available information to predict potential impacts on the black rail, and the analysis provided in this EIS is sufficient to support sound scientific judgements and informed decision making related to the operation of the MBSD Project action alternatives.

Regarding the bald eagle, there is incomplete information regarding the potential for increased contaminants from diverted Mississippi River water to affect bald eagle prey (and therefore bald eagles if consuming contaminated prey). This incomplete information is applicable for both the proposed Project and for the planned Mid-Breton Diversion Project, which could result in cumulative impacts on bald eagles. However, the USACE has assessed data from other (albeit smaller) diversions in Louisiana estuaries to extrapolate how contaminant levels may change as a result of Project operations. Therefore, the analysis provided in this EIS is sufficient to support sound scientific judgements and informed decision making related to the operation of the MBSD Project action alternatives.

Additional information, extrapolations, and assumptions for impacts on threatened and endangered species are presented in Section 4.12 and references therein, in the BA (see Appendix O).

Socioeconomics: The socioeconomic impact analysis relies on understanding the physical changes that will occur both under the No Action Alternative and the Applicant's Preferred Alternative as well as an understanding of the responses of individuals and industries to these changing conditions. Limitations that apply to the Public Health and Safety, Commercial Fisheries, and Recreation and Tourism sections also apply to the analysis of socioeconomic impacts. As described in those sections, uncertainties exist with regard to both the physical changes that are anticipated as well as the responses by individuals to those changes in conditions. The analysis therefore provides primarily a qualitative assessment of the intensity of the likely changes to socioeconomic conditions.

The analysis provided in this EIS is sufficient to support sound judgements and informed decision making related to the operation of the MBSD Project action alternatives.

Commercial Fisheries: Because changes in the abundance of fish is uncertain and is discussed qualitatively in this EIS, conducting a quantified analysis of the future impacts of the alternatives on fish catch was not possible. Further, the commercial fishing industry is faced with a great deal of uncertainty related to general economic factors such as fuel costs, prices, competition from imports, and consumer preferences for seafood harvested from the region relative to import products. The specific future behavior of fisherman in response to these changing economic conditions under the No Action Alternative, as well as under the Applicant's Preferred Alternative, are similarly uncertain. As such, the analysis provides quantitative information to assist decision makers in understanding the scale of the changes that may occur, and describes important factors that are likely to influence the extent of future impacts. The analysis provided in this EIS is sufficient to support sound judgements and informed decision making related to the operation of the MBSD Project action alternatives.

Environmental Justice: Data indicating the prevalence and distribution of unique vulnerabilities that could lead to disproportionately high and adverse impacts from changes in tidal flooding and storm hazards on low-income and minority populations are not available. Such information would allow for more precise characterization of potential impacts on low-income and minority populations. For commercial fishing, there is a lack of data correlating the fisheries harvest with specific low-income and minority populations. There is also a lack of data on the frequency and intensity of subsistence fishing and hunting by low-income and minority populations. Because such information is unavailable, the precise extent to which impacts on fisheries or wildlife would affect low-income and minority populations is uncertain. As such, the analysis provides quantitative and qualitative information to assist decision makers in understanding the scale of the impacts that may occur, and describes important factors that are likely to influence the extent of future impacts.

The analysis provided in this EIS is sufficient to support sound judgements and informed decision making related to the operation of the MBSD Project action alternatives.

Recreation and Tourism: Changes in environmental conditions that would impact recreation site accessibility and conditions for recreational fishing, hunting, wildlife viewing, boating, and visitation to non-governmental recreation areas are generally assessed qualitatively for this EIS (that is, using the categories negligible, minor, moderate, or major) rather than quantitatively (for example, a change in the abundance of a particular fish species over time). Accordingly, the recreation and tourism analysis is also mostly qualitative, reflecting the level of specificity in the input information, though quantitative results are provided where possible. The analysis provided in this EIS is sufficient to support sound judgements and informed decision making related to the operation of the MBSD Project action alternatives.

Public Health and Safety, Including Flood and Storm Hazard Risk Reduction: The tidal flooding analysis utilized data available at the time of the analysis to develop inundation threshold elevations for three example communities (see Appendix P). This data included land elevation data from 2013 and preliminary FIRMs for two of the three communities. Similarly, for the storm surge and wave analysis, modeled levee elevations were based on available current and future elevation and design data at the time of the analysis. More recent elevation data may more accurately reflect current land and levee elevations for the example communities and levee systems analyzed. However, because the intent of this analysis is to compare inundation frequencies and levee overtopping risk between alternatives rather than estimating the actual frequency of inundation and levee overtopping, and because all alternatives utilized the same elevation data, the relative difference between alternatives, including the No Action Alternative, would likely not differ significantly if newer elevation data were used. In addition, although the ADCIRC model (which used Delft3D Basinwide Model outputs) was used for analysis and developed with a certain set of assumptions (see Appendix P), the information provided by the combination of literature review and model outputs is sufficient to support sound scientific judgements and informed decision making related to the Project and its impacts on public health and safety.

Navigation: To project dredging impacts in the Lower Mississippi River from operation of the proposed Project, the USACE relied on modeling results from Delft3D Basinwide, AdH, and HEC-6T models (Brown et al. 2019, Thomas et al. 2018) that have limitations that allowed for a primarily qualitative interpretation. One notable limitation is that they do not fully simulate sedimentation dynamics associated with the salt wedge that migrates upriver from the Gulf. The position of the salt wedge in Southwest Pass, which requires maintenance dredging to allow passage of deep-draft vessels, is a function of the river discharge, and hence any changes in the discharge with the proposed Project would alter the position of the wedge. Although the models do not explicitly simulate the influence of the salt wedge on the distribution of fine sediment deposition within Southwest Pass, the USACE found the models useful for qualitatively investigating Project impacts on dredging in the Lower Mississippi River. The USACE does not believe that this limitation is essential to a reasoned choice among alternatives. The information provided by the combination of literature review and model outputs is sufficient to support sound scientific judgements and informed decision making related to the Project and its impacts on navigation.

4.27 MITIGATION SUMMARY

Mitigation is an important aspect of the permit application review. Under the CWA Section 404(b)(1) Guidelines, mitigation for impacts is a three-tiered system: avoidance, minimization, and compensatory mitigation. These guidelines dictate that a CWA Section 404 permit can only be issued if the applicant has taken all appropriate and practicable measures to minimize potential adverse impacts on the aquatic ecosystem. “Practicable” means available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. Avoidance of impacts on aquatic resources involves selecting the least-damaging project type, spatial location, and extent compatible with achieving the purpose of the project. Minimization involves managing the severity of a project’s impact on resources. If impacts cannot be avoided or minimized, compensatory mitigation should be provided.

The avoidance, minimization, and compensatory mitigation for MBSD Project impacts described in this section are based on the understanding of anticipated impacts described in Section 4.1 through 4.24, and summarized in Chapter 2, of this EIS. Some of these avoidance and minimization measures were considered in making the impact determinations, such as those required under applicable permits. The impact analyses for each resource indicate whether any avoidance or minimization measures were considered in making the impact determinations.

This section has been updated since public release of the Draft EIS to reflect updates made by CPRA to the Final Mitigation and Stewardship Plan. CPRA's Final Mitigation and Stewardship Plan (see Appendix R1) identifies:

- mitigation measures that will offset unavoidable adverse impacts on jurisdictional waters of the U.S. and ensure the Project is not contrary to the public interest, pursuant to Section 404 of the CWA and Sections 9 and 10 of the RHA;
- conservation measures to avoid and minimize potential effects to species listed as threatened or endangered under the federal ESA;
- conservation recommendations provided by NMFS to conserve, avoid, and/or minimize adverse effects to EFH;
- recommendations provided by the USFWS under the FWCA; and
- stewardship actions proposed by CPRA to address project-related changes to the environment.

To ensure that the environmental impacts associated with the implementation of these measures are appropriately assessed, a discussion of the environmental review requirements for each of these measures is provided in Appendix R3 and R4. The associated environmental review requirements are addressed in one of three ways in Appendix R3 and R4:

- **No environmental impact or negligible environmental impact; no additional analysis needed:** These measures have either no environmental impacts or negligible environmental impacts and, therefore, do not require additional review;
- **Environmental impacts are addressed in the MBSD EIS; no additional analysis needed:** The impacts of these measures fall within the range of environmental impacts fully considered in this EIS and therefore do not require additional environmental review;
- **Impact analysis is provided in Appendix R4:** Measures with definable environmental impacts are addressed by the analysis provided in Appendix R4; and
- **Additional analysis may be required in the future:** Some measures include components that cannot be fully analyzed because the scope, scale, and/or location of the actions are not fully known at this time. For these measures, preliminary analyses are presented in Appendix R4 and it is noted

that, if required, future environmental analyses will be conducted once relevant details become available.

4.27.1 Avoidance and Minimization

The 75,000 cfs Alternative was designed and selected by the Applicant as its Preferred Alternative from other reasonable alternatives to minimize incidental environmental impacts while meeting the purpose and need for the Project. The construction footprint by design is constrained to minimize excavation and fill activities in the Mississippi River riparian wetland area. In the Barataria Basin, the selected construction access routes (to allow access channels for vessels, equipment, and material transport) would be designed to avoid or minimize wetland impacts to the greatest extent practicable, along with minimizing the excavation footprint and subsequent volume of material displaced. The placement of soils in areas adjacent to channel excavation would be done in a manner to minimize the disruption of water circulation and material would be left in place as habitat enhancement or backfilled into the impacted access channel.

If the Project is permitted, approved, and funded, CPRA has stated that it would implement certain BMPs during Project construction and operation to avoid and minimize impacts on jurisdictional wetlands, waters of the U.S., and other resources to the maximum extent practicable. Table 4.27-1 includes the BMPs that CPRA has committed to implement as part of the Project if approved. For several measures, only the headings are included in Table 4.27-1; for those measures, additional details are included in Appendix R1.

Table 4.27-1 Best Management Practices					
Resource(s) for Intended Impact Avoidance/ Minimization	**Measure**	**Project Phase**	**Included in Monitoring and Adaptive Management (MAM) Plan**	**Permit/ Approval Condition**	**Agency with Jurisdiction**
Land Resources (upland areas within the Construction Footprint)	Environmental Inspections (Section 1.II.A-N)	Construction	No	Yes	USACE
	Preconstruction Planning (Section 1.III.A-D), including: Construction Work Areas Interior Drainage Systems Road Crossings and Access Points Disposal and Hazardous Substance Planning	Construction	No	Yes	USACE
	Construction (Section 1.IV.A-G), including: Approved Area of Disturbance Topsoil Interior Drainage Systems Road Crossings and Access Points Dust Management Temporary Erosion Control Other Provisions	Construction	No	Yes	USACE
	Construction Close-Out (Section 1.V.A-C), including: Cleanup Final Stabilization and Revegetation Soil Compaction Mitigation	Construction	No	Yes	USACE
	Post-Construction Activities and Documentation (Section 1.VI.A-B), including: Monitoring and Maintenance Documentation	Post-construction; Operation	No	Yes	USACE

Table 4.27-1
Best Management Practices

Resource(s) for Intended Impact Avoidance/ Minimization	Measure	Project Phase	Included in Monitoring and Adaptive Management (MAM) Plan	Permit/ Approval Condition	Agency with Jurisdiction
Wetland and Water Resources	Environmental Inspection (Section 2.II.A-I)	Construction	No	Yes	USACE
	Preconstruction Planning (Section 2.III.A-D), including: Waste Disposal Plan Spill Control Plan Disposal of Excavated Materials for Beneficial Use Vessel Access In-Water Construction (Mississippi River and Barataria Basin) (Section 2.IV.A-C), including: Notifications Construction in the River Construction in the Basin	Construction	No	Yes	USACE
T&E Species, and Bald Eagle and Colonial Wading Birds	Environmental Inspections (Section 3.II.A-E)	Construction	No	Yes	USACE
	Preconstruction Planning (Section 3.III.A-C)	Construction	No	Yes	USACE
	In-Water or Land-Based Construction Measures/Requirements (Section 3.IV.A-G), including: Location Changes Pile Driving Dredging Nesting Birds Pallid Sturgeon West Indian Manatee Basin Dredging and In-transit Vessel Requirements	Construction	No	Yes	NOAA NMFS & USFWS
Cultural Resources	Unanticipated Discovery Plan	Construction	No	Yes	USACE

CPRA has also identified potential avoidance and minimization measures that could be implemented if future circumstances warrant. CPRA's O&M responsibilities for the Project include implementation of a MAM Plan which identifies baseline and operational monitoring of key environmental parameters, project performance measures, and triggers for management changes. CPRA plans to monitor Project and ecosystem variables in order to evaluate the Project success, Project performance, and ecological changes to inform Project operations, including decisions as to whether implementation of certain mitigation measures is necessary or practical. Implementation of the MAM Plan will be the responsibility of CPRA's MBSD Adaptive Management Team and Data Management Team, with assistance and oversight from an Operations Management Team and Executive Team. Resource agencies, parish governments, and other stakeholders will have the opportunity to inform and advise the MAM Plan implementation through a Stewardship Group and Stakeholder Review Panel, and technical focus groups and peer review groups made up of subject matter experts will be utilized as needed to inform MAM Plan implementation. Appendix R describes the MAM Plan including the governance structure in more detail.

Some of these optional MAM-triggered measures, as well as other avoidance and minimization measures proposed by CPRA, fall outside the jurisdiction of USACE or other cooperating agencies, therefore limiting their enforceability. Additionally, agencies with jurisdiction over resources potentially impacted by the Project will require implementation of certain avoidance or minimization measures as conditions for their approval of the Project. In order to clarify the nature of each measure's implementation intent and requirements, Table 4.27-2 provides the following information for each measure or suite of measures:

- a brief description of the measure(s);
- the resource(s) for which the measure is intended to avoid or minimize impacts on;
- the Project phase in which the measure would be implemented (such as preconstruction, construction, operation);
- whether the measure is included in the MAM Plan;
- whether the measure would be included as a 404(b)(1)/Section 10 permit condition, Section 408 permission condition, or condition of approval under another applicable law or regulation;
- the agency with lead jurisdiction over enforcement of the condition, or where the condition is not required, the agency with knowledge or expertise regarding implementation of the measure; and
- whether the proposed stewardship measures are anticipated to be new programs or would augment a proposed, existing, or past program.

Appendix R1 and R2 provide additional details regarding the activities associated with each measure and Appendix R3 and R4 provides a discussion of the environmental review requirements of specific Mitigation and MAM measures.

Environmental Justice

It should be noted that, consistent with CEQ's guidance regarding outreach and engagement to low-income and minority populations, CPRA engaged in additional outreach to the low-income and minority populations potentially impacted by increases in tidal flooding and storm hazards, as well as those low-income and minority populations reliant on commercial or subsistence fishing, prior to issuance of the Draft and Final EIS to seek their input on additional or alternative mitigation measures. Refinements to proposed mitigation measures based in part on feedback received from CPRA's outreach are reflected in Section 6.3.2, Section 6.3.3, and Section 6.3.8 of the Final Mitigation and Stewardship Plan in Appendix R1. For additional details regarding these measures, see the Final Mitigation and Stewardship Plan in Appendix R1.

Table 4.27-2
Avoidance and Minimization Measures

Measure	Resource(s) for Intended Impact Avoidance/ Minimization	Project Phase	Included in MAM Plan	Permit/ Approval Condition	Program Status	Agency with Jurisdiction or Responsibility for Program
Spill Prevention, Control, and Countermeasure Plan	All	Construction and Operation	No	Yes	N/A	LDEQ
CPRA would place suitable, excess material dredged and excavated during construction of the Project in three beneficial use areas in the immediate outfall area near the proposed outfall transition feature	Wetlands/Waters of the U.S.	Construction	No	Yes	N/A	USACE
$10,000,000 in additional funding for crevasse creation to offset wetland losses in Delta NWR and Pass A Loutre WMA	Wetlands/ Waters of the U.S.	Operation	No	No	N/A	USFWS
CPRA will coordinate the location of Mississippi River Aids to Navigation (ATON) associated with the MBSD structure with the USCG.	Navigation	Construction and Operation	No	Yes	N/A	USCG
Whenever flow through the structure is started or stopped, on-site personnel shall notify the USCG via a Navigation Bulletin so that traffic is informed of the Project's operating condition.	Navigation	Operation	No	Yes	N/A	USCG
Before raising or lowering any gate at the entrance to the diversion channel, the operator should check the vicinity of the inflow, conveyance and outflow channels for boats, fishermen, and swimmers and alert them to clear the area. Methods for these alerts may include horns, lights and/or audio messages.	Navigation	Operation	No	Yes	N/A	CPRA
Monitoring in outfall area in the Barataria Basin to assess the Project’s impacts on bathymetry as needed.	Navigation	Operation	Yes	Yes	N/A	USACE

Table 4.27-2 Avoidance and Minimization Measures						
Measure	**Resource(s) for Intended Impact Avoidance/ Minimization**	**Project Phase**	**Included in MAM Plan**	**Permit/ Approval Condition**	**Program Status**	**Agency with Jurisdiction or Responsibility for Program**
If Project operations lead to aggradation in the Barataria Waterway to a degree that inhibits navigation, CPRA will take one or more of the following actions to mitigate the Project impact: • adjust operations of the Project; • conduct maintenance dredging of the waterway to provide sufficient depths for the safe transit of watercraft or to maintain authorized depths for navigation; or • implement outfall management measures to limit the loss of sediments to the waterway.	Navigation	Operation	Yes	Yes	N/A	USACE
If Project operations lead to aggradation within Wilkinson Canal to a degree that inhibits navigation, and as long as Wilkinson Canal is being used for that purpose, CPRA may take one or more of the following actions to mitigate the Project impact: • adjust operations of the Project; • with approval from the underlying landowner, conduct maintenance dredging of the canal to provide sufficient depths for the safe transit of watercraft for navigation; or • provide alternative boat access to Myrtle Grove and Woodpark communities.	Navigation	Operation	Yes	No	N/A	USACE

Table 4.27-2
Avoidance and Minimization Measures

Measure	Resource(s) for Intended Impact Avoidance/ Minimization	Project Phase	Included in MAM Plan	Permit/ Approval Condition	Program Status	Agency with Jurisdiction or Responsibility for Program
Mitigation for Project-induced inundation including (varies by community): • road and lane improvements; • funding for boat dock/boat house elevation; • septic or sewerage treatment system improvements; • Project Servitude Agreements (compensation); • bulkhead improvements; • funding for elevation of residences; • voluntary individual buyouts; and • floating gardens, community connecting sidewalks, ridge restoration.	Public Health & Safety and Environmental Justice	Construction and Operation	No	No	N/A	CPRA
Interim risk reduction measures would be designed and built to provide the same LORR currently provided by the NOV-NFL and MR&T Levee systems, and would remain in place until the construction of the Project is completed to the point that it provides the required LORR.	Public Health & Safety	Construction	No	Yes	N/A	CPRA and USACE
Establish new public seed ground in lower Barataria Basin	Commercial Oyster Fishery	Operation	Yes	No	New	LDWF
Enhance public and private oyster grounds	Commercial Oyster Fishery/ Environmental Justice	Pre-operation and Operation	Yes	No	New program adapted from previous programs	LDWF
Create or enhance oyster broodstock reefs	Commercial Oyster Fishery	Operation	Yes	No	Companion to NRDA program	LDWF
Alternative Oyster Aquaculture (AOC)	Commercial Oyster Fishery/ Environmental Justice	Pre-operation and Operation	Yes	No	New program building off existing statewide effort	Louisiana Seafood Future

Table 4.27-2
Avoidance and Minimization Measures

Measure	Resource(s) for Intended Impact Avoidance/ Minimization	Project Phase	Included in MAM Plan	Permit/ Approval Condition	Program Status	Agency with Jurisdiction or Responsibility for Program
Marketing to support the oyster industry	Commercial Oyster Fishery	Pre-operation and Operation	No	No	New	Louisiana Seafood Future
Marketing to support the finfish industry	Commercial Finfish Fishery	Pre-operation and Operation	No	No	New	Louisiana Seafood Future
Marketing to support the crab industry	Commercial Crab Fishery	Pre-operation and Operation	No	No	New	Louisiana Seafood Future
Grant program to equip fishing vessels with refrigeration and support gear change/improvements	Commercial Shrimp Fishery/ Environmental Justice	Pre-operation and Operation	No	No	New	Louisiana Seafood Future
Marketing to support the Louisiana shrimp industry	Commercial Shrimp Fishery	Pre-operation and Operation	No	No	New	Louisiana Seafood Future
Assistance with Federal considerations/shrimp management policy	Commercial Shrimp Fishery	Pre-operation or Operation	No	No	New	CPRA
Workforce and business training for commercial fishers	All Commercial Fisheries/ Environmental Justice	Pre-operation	No	No	New	TBD
Subsistence fishing access	Socioeconomics/ Environmental Justice	Pre-operation	No	No	New	CPRA
Project operations considerations	Commercial Fisheries	Operation	Yes	No	New	CPRA
Enhanced resource sampling	Commercial Fisheries	Pre-operation and Operation	Yes	No	New	CPRA
USFWS/NMFS ESA Reasonable and Prudent Measures and Terms and Conditions	Threatened and Endangered Species	Construction, Pre-operation and Operation	No	Yes	N/A	USFWS/NMFS
Fish and Wildlife Coordination Act Report Recommendations	Multiple Wildlife Resources	Construction, Pre-operation and Operation	No	No	N/A	USFWS
Operational minimization measures	Marine Mammals	Operation	Yes	No	N/A	CPRA

Table 4.27-2 Avoidance and Minimization Measures						
Measure	**Resource(s) for Intended Impact Avoidance/ Minimization**	**Project Phase**	**Included in MAM Plan**	**Permit/ Approval Condition**	**Program Status**	**Agency with Jurisdiction or Responsibility for Program**
Statewide Stranding Program	Marine Mammals	Operation	No	No	Augment existing program	NOAA
Human interaction/ Anthropogenic stressor reduction	Marine Mammals	Operation	No	No	New	CPRA
Contingency Fund for Unusual Mortality Events or Episodic Mortality Event Response	Marine Mammals	Operation	No	No	Augment existing program	NOAA
EFH Conservation Recommendations	EFH	Pre-operation and Operation	Yes	No	N/A	NMFS
Road crossing and access point maintenance	Environmental Justice	Construction	No	No	New	CPRA
Construction-related dust management	Environmental Justice	Construction	No	No	New	CPRA
Ironton community liaison and Community Communications Plan	Environmental Justice	Preconstruction and Construction	No	No	New	CPRA
Public shoreline access, watercraft launching, recreational enhancements	Environmental Justice	Pre-operation	No	No	N/A	CPRA
Community outreach and engagement to low-income and minority populations	Environmental Justice	Preconstruction	No	No	New	USEPA/CPRA
Implementation of measures in the NHPA 106 Programmatic Agreement; includes details regarding alternative mitigation for potential cultural resource impacts	Cultural Resources	Construction and Operation	No	Yes	N/A	USACE/ SHPO
Implementation of Adaptive Management	Several	Operations	Yes	No	N/A	CPRA

4.27.2 Compensatory Mitigation

4.27.2.1 Jurisdictional Wetlands and Waters of the U.S.

After consideration of all enforceable avoidance and minimization measures outlined in this section, Section 404 requires CPRA to offset any remaining unavoidable impacts on jurisdictional wetlands or special aquatic sites with compensatory mitigation. Federal and state agencies have established different functional habitat assessment methods to evaluate compensatory mitigation requirements. LDNR and USFWS use the WVA method. CEMVN Regulatory Division typically uses the Louisiana Rapid Assessment Method (LRAM) as it is an easy-to-use tool for permit applicants. For its water resources projects, CEMVN uses the WVA method. While different, both the WVA and LRAM are accepted standardized tools to consistently quantify adverse and beneficial impacts when determining compensatory mitigation requirements in a consistent manner.

Users of both the WVA and LRAM can input information about the acreage and overall quality of the impacted wetland or special aquatic site to determine compensatory mitigation requirements. For the MBSD EIS, the WVA was used to calculate Project impacts and benefits from construction and operation of the proposed Project. The outputs of the WVA are provided in AAHUs.

CEMVN Regulatory evaluated the WVAs to consider all MBSD Project components associated with construction of the proposed Project. Construction of the proposed Project would include excavation within the 204.2 acres of jurisdictional wetlands and 307.2 acres of open water. CPRA proposes to use excess excavated material in several ways, including beneficial use areas adjacent to the Project outfall feature. CPRA proposes to repurpose 2.0 mcy of excavated material to create 375 acres of emergent marsh and nourish 92 acres of existing marsh during Project construction.

Details regarding these beneficial use areas are provided Chapter 2, Section 2.8.1.1 Project Design Features. This marsh creation through beneficial use of excavated material, according to WVA modeling, would at minimum provide equivalent AAHUs to the identified AAHUs anticipated to be lost due to direct impacts from Project construction. The proposed Project beneficial use wetland creation features would be constructed concurrently with overall construction of the proposed Project. Table 4.27-3 offers a comparison of the jurisdictional wetland impacts compared to the projected benefits in AAHUs for these beneficial use wetland creation areas.

CPRA is not relying on diversion marsh creation performance to replace the permanent loss of wetlands that would result from Project construction. However, Table 4.27-3 provides wetland benefits in AAHUs over the Project’s 50-year analysis period in addition to the beneficial use marsh creation areas to summarize the total projected benefits in AAHUs of the proposed Project.

CPRA's MAM Plan includes monitoring and triggers for management actions to ensure adequate creation and/or maintenance of marsh.

Table 4.27-3
Summary of Wetland Impact and Benefits

Wetland Type	Impact		Benefits			
	Acres	AAHUs	Acres of Beneficial Use Marsh Creation	AAHUs	Net Acres from Diversion at Year 50	AAHUs
Bottomland Hardwood	-26.1	-14.9	0	0	0	0
Wet Pasture	-163.4	-66.9	0	0	0	0
Intermediate Marsh	-3.6	-20.3	401.9	158.4	14,772	10,108
Brackish Marsh	0	0	0	0	-1,620	-6,260
TOTAL	**-193.1**	**-102**	**401.9**	**158.4**	**13,151**	**3,848**

USACE's determination in its permitting decision whether to require compensatory mitigation would be made in accordance with 33 CFR §320.4(r), 33 CFR Part 332 and applicable USACE guidance, including the 1990 USEPA and USACE Memorandum of Agreement (MOA) Concerning the Determination of Mitigation. Any potential compensatory mitigation requirements will be discussed in the ROD.

4.27.3 Potential Permit Special Conditions

DA permits contain standard general conditions applicable to all permits (see 33 CFR Part 325, Appendix A). Other special conditions may be included in a DA permit, depending on the type of permit (such as Section 404, Section 10, or Section 408) and the circumstances particular to the proposed work. If a DA permit is proffered for the Mid-Barataria Sediment Diversion, it may contain the following general and special conditions; CEMVN has not determined what special conditions would be required if a permit is granted and in that event, the following conditions are subject to change.

1. The time limit for completing the work authorized ends on December 31, 2027. If CPRA finds that they need more time to complete the authorized activity, CPRA shall submit a request for a time extension to this office for consideration at least 1 month before the above date is reached.

2. CPRA must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. CPRA is not relieved of this requirement if they abandon the permitted activity, although CPRA may make a good faith transfer to a third party in compliance with General Condition 4 below. Should CPRA wish to cease to maintain the authorized activity or desire to abandon it without a good faith transfer, they must obtain a modification of this permit from this office, which may require restoration of the area.

3. If CPRA discovers any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, they must follow the provisions for Unanticipated Discovery set forth in the NHPA Programmatic Agreement.

4. If CPRA sells the property associated with this permit, they must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for the project, CPRA must comply with the conditions specified in the certification as special conditions to this permit. For CPRA's convenience, a copy of the certification will be attached if it contains such conditions.

6. CPRA must allow representatives from USACE to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of the permit.

7. The permitted activity must not interfere with the public's right to free navigation on all navigable waters of the United States.

8. CPRA must install and maintain, at their expense, any safety lights, signs and signals required by the U.S. Coast Guard, through regulations or otherwise, on the Project's fixed structures. To receive a U.S. Coast Guard Private Aids to Navigation marking determination, at no later than 90 days prior installation of any fixed structures in navigable waters and/or prior to installation of any floating private aids to navigation, CPRA is required to contact the Eighth Coast Guard District (dpw), 500 Poydras St. Suite 1230, New Orleans, LA 70130, (504)671-2330 or via email to: D8oanPATON@uscg.mil. For general information related to Private Aids to Navigation please visit the Eighth CG District web site at: http://www.atlanticarea.uscg.mil/district-8/district-divisions/waterways/PATON.

9. CPRA understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, CPRA will be required, upon due notice from USACE, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

10. If the authorized project, or future maintenance work, involves the use of floating construction equipment (barge mounted cranes, barge mounted pile-driving equipment, floating dredge equipment, dredge discharge

pipelines, etc.,) in the waterway, CPRA is advised to notify the Eighth Coast Guard District so that a Notice to Mariners, if required, may be prepared. Notification with a copy of the permit approval and drawings should be emailed to: D8MarineInfo@uscg.mil, or mailed to the Commander (dpw), Eighth Coast Guard District, Hale Boggs Federal Building, 500 Poydras Street, Room 1230, New Orleans, Louisiana 70130, about 1 month before CPRA plans to start work. Telephone inquiries can be directed to the Eighth Coast Guard District, Waterways Management at (504) 671-2118.

11. The Corps of Engineers may suspend, modify, or revoke this permit if it is found in the public interest to do so.

12. CPRA is advised of the requirements set forth in the attached Memorandum for Record and the associated special conditions. All responsibilities and compliance related to the subject conditions are hereby directed to and have oversight by the USACE Navigation Office, Operations Manager, ODB, Michelle Kornick, with this District. Should CPRA have any questions on the requirements and restrictions stipulated, they shall contact the ODB Assistant Operations Manager, Heather Jennings, who may be reached at 504-862-1253 or Heather.L.Jennings@usace.army.mil.[114]

13. This permission only authorizes CPRA, the requester, to undertake the activity described herein under the authority provided in Section 14 of the RHA of 1899, as amended (33 USC 408). This permission does not obviate the need to obtain other federal, state, or local authorizations required by law. This permission does not grant any property rights or exclusive privileges, and CPRA must have appropriate real estate instruments in place prior to construction and/or installation.

14. Without prior written approval of the USACE, CPRA must neither transfer nor assign this permission nor sublet the premises or any part thereof, nor grant any interest, privilege or license whatsoever in connection with this permission. Failure to comply with this condition will constitute noncompliance for which the permission may be revoked immediately by USACE.

15. The United States will in no case be liable for:

    a. any damage or injury to the structures or work authorized by this permission that may be caused or result from future operations undertaken by the United States, and no claim or right to compensation will accrue from any damage; or

[114] Navigation, federal project, and other Special Conditions germane to the Section 408 review are in review and not included at this time.

b. damage claims associated with any future modification, suspension, or revocation of this permission.

16. The United States will not be responsible for damages or injuries which may arise from or be incident to the construction, maintenance, and use of the project requested by CPRA, nor for damages to the property or injuries to their officers, agents, servants, or employees, or others who may be on CPRA's premises or project work areas or the federal project(s) rights-of-way. By accepting this permission, CPRA hereby agreed to fully defend, indemnify, and hold harmless the United States and USACE from any and all such claims, subject to any limitations in law.

17. Any damage to the water resources development project or other portions of any federal project(s) resulting from CPRA's activities must be repaired at CPRA's expense.

18. The determination that the activity authorized by this permission would not impair the usefulness of the federal project and would not be injurious to the public interest was made in reliance on the information CPRA provided.

19. This office, at its sole discretion, may reevaluate its decision to issue this permission at any time circumstances warrant, which may result in a determination that it is appropriate or necessary to modify or revoke this permission. Circumstances that could require a reevaluation include, but are not limited to, the following:

    a. CPRA fails to comply with the terms and conditions of this permission;

    b. the information provided in support of CPRA's application for permission proves to have been inaccurate or incomplete; or

    c. significant new information surfaces which this office did not consider in reaching the original decision that the activity would not impair the usefulness of the water resources development project and would not be injurious to the public interest.

20. CPRA is responsible for implementing any requirements for mitigation, reasonable and prudent alternatives, or other conditions or requirements imposed as a result of environmental compliance.

21. Work/usage allowed under this permission must proceed in a manner that avoids interference with the inspection, operation, and maintenance of the federal project.

22. In the event of any deficiency in the design or construction of the requested activity, CPRA is solely responsible for taking remedial action to correct the deficiency.

23. The right is reserved to the USACE to enter upon the premises at any time and for any purpose necessary or convenient in connection with government purposes, to make inspections, to operate and/or to make any other use of the lands as may be necessary in connection with government purposes, and CPRA will have no claim for damages on account thereof against the United States or any officer, agent or employee thereof.

24. CPRA must provide copies of pertinent design, construction, and/or usage submittals/documents. USACE may request that survey and photographic documentation of the alteration work and the impacted project area be provided before, during, and after construction and/or installation.

25. CPRA may be required to perform an inspection of the federal project with the USACE, prior to use of the structure, to document existing conditions.

26. USACE shall not be responsible for the technical sufficiency of the alteration design nor for the construction and/or installation work.

27. Mechanized land clearing, filling, or tracking of jurisdictional wetland areas outside the project area for access, staging, and/or implementation of the proposed work is not authorized.

28. CPRA shall employ siltation controls around all construction sites that require earthwork (clearing, grading, dredging and/or deposition of fill material) such that eroded material is prevented from entering adjacent wetlands and/or waterways.

29. Many local governing bodies have instituted laws and/or ordinances in order to regulate dredge and/or fill activities in floodplains to assure maintenance of floodwater storage capacity and avoid disruption of drainage patterns that may affect surrounding properties. CPRA's project involves dredging and/or placement of fill, therefore, CPRA must contact the local municipal and/or parish governing body regarding potential impacts on floodplains and compliance of the proposed activities with local floodplain ordinances, regulations, or permits.

30. If rutting or disturbance to ground surface occurs in jurisdictional areas during construction, steps shall be taken to return pre-project elevations and contours immediately following that occurrence. This includes hauling in appropriate material and stabilizing damaged areas if necessary. If any hydrologic connections are created from equipment moving across shorelines or banklines, these areas must be immediately stabilized and restored to pre-project conditions by hauling in appropriate fill material, if necessary. As-built drawings of any such repair/restoration must be provided to this office no later than 90-days following completion of such work. If it is later determined that permanent impacts on wetland areas have occurred within the project footprint from such repair/restoration efforts,

compensatory mitigation or on-site restoration may be required by this office.

31. If the authorized project requires any additional work that requires a 404/10 permit or 408 permission and that is not expressly permitted herein, CPRA must apply for an amendment to this authorization.

32. CPRA shall, in coordination with USACE, contact the USFWS and LDWF for additional consultation if: 1) the scope of location of the proposed project is changed significantly, 2) new information reveals that the action may affect listed species or designated critical habitat, 3) the action is modified in a manner that causes effects to listed species or designated critical habitat, or 4) a new species is listed or critical habitat designated. Additional consultation as a result of any of the above conditions or for changes not covered in this consultation should occur before changes are made or finalized.

33. Gate operation that would significantly increase or decrease the velocity through the structure should be implemented by CPRA over several hours to allow fish sufficient time to migrate back to the river or swim away from the structure (USFWS Biological Opinion (BO) Reasonable and Prudent Measures (RPM) 1).

34. CPRA should notify the Service's Louisiana Ecological Services Office (337-291-3126) of any proposed changes to the proposed action described in the biological opinion, so that re-initiation of consultation under Section 7 of the ESA can proceed as quickly and efficiently as possible (USFWS BO Term and Condition (TC) 1. RPM 1.)

35. CPRA and the USACE will coordinate with the Service to develop a Fish Monitoring and Removal Plan for pallid sturgeon. This plan will need to be completed and Service approved prior to the construction of the cofferdam (USFWS BO RPM 2).

36. CPRA shall develop a plan to be implemented for the proposed MBSD that identifies potential avoidance and minimization measures for pallid sturgeon. Live sturgeon captured in the structure or the cofferdam area should be tagged and returned to the river (USFWS BO TC 2. RPM 2)

37. Dredging (cutterhead/suction) in the Mississippi River would be conducted using dredge operational parameters coordinated with the Service (USFWS BO RPM 3).

38. Should dredging (cutterhead/suction dredge) activities be necessary in the Mississippi River, the following operational parameters would be included as conditions of the permit and in the design of the project:

a. The cutterhead must remain completely buried in the bottom material during dredging operation. If pumping water through the cutterhead is necessary to dislodge material or to clean the pumps or cutterhead, etc., the pumping rate will be reduced to the lowest rate possible until the cutterhead is at mid-depth, where the pumping rate can then be increased.

b. During dredging, the pumping rates will be reduced to the slowest speed possible while the cutterhead is descending to the channel bottom (USFWS BO TC 3. RPM 3).

39. CPRA shall ensure that USFWS BO terms and conditions are accomplished and completed as detailed in its Incidental Take Statement (ITS) including the completion of reporting requirements (USFWS BO RPM 4).

40. Upon locating a dead, injured, or sick individual of an endangered or threatened species, CPRA must notify the Louisiana Ecological Services Office at Lafayette, Louisiana at (337) 291-3100 and the USACE within 48 hours. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury (USFWS BO TC 4. RPM 4).

41. A report describing the actions taken to implement the terms and conditions of the USFWS BO ITS shall be submitted to the Project Leader, U.S. Fish and Wildlife Service, 200 Dulles Drive, Lafayette, LA 70506, within 60 days of the completion of project construction. This report shall include the dates of work, assessment, and actions taken to address impacts on the pallid sturgeon, if they occurred (USFWS BO TC 5. RPM 4).

42. CPRA shall conduct monitoring of the diversion structure for the entrainment of pallid sturgeon, once the diversion is in operation. This monitoring should be conducted yearly, once flows through the MBSD revert to base flow after maximum flow conditions. This report should include the amount of pallid sturgeon captured in the diversion structure throughout the year, time of year they were captured, flow volumes, and how the captures coincide with the flow (USFWS BO Monitoring and Reporting Requirement, MRR 1).

43. CPRA will submit a monitoring report to the Service after maximum flow conditions have occurred. This report should include any data sheets, maps, and the findings of the pallid sturgeon monitoring efforts (USFWS BO MRR 2).

44. Monitoring Brown Shrimp Fishing Effort in the Action Area: CPRA shall monitor the annual trip ticket data collected by LDWF for area 211 and provide an annual report to NMFS Protected Resources Division (PRD), sent to the following address (takereport.nmfsser@noaa.gov). The federal action agencies may specify if they would also like to receive these reports

from the project proponent. The reports shall reference the Consultation Identification Number for this consultation (SERO-2021-00433), and shall provide the raw trip ticket data, as well as the 3-year running average of brown shrimp fishing trips. The first report shall be provided within 1 year of the commencement of MBSD operations, using the previous 3 years' data to calculate the 3-year running average (NMFS BO TC 1. RPM 1).

45. Monitoring Salinity Conditions in the Lower Barataria Basin: CPRA shall develop, in coordination with NMFS (Southeast Regional Office [SERO] and Southeast Fisheries Science Center [SEFSC]), fund and implement a monitoring program and analytical design that will allow NMFS to determine if seasonal salinity conditions under actual project operations are within the expected range projected by the model relied upon and analyzed in the NMFS BO. The final monitoring design must establish measurable triggers that will indicate when salinity conditions have exceeded the levels anticipated and analyzed in the NMFS BO, and would thus trigger the requirement to reinitiate consultation on the proposed project. The monitoring plan must be fully developed and approved by NMFS PRD prior to the commencement of MBSD operations. Once the monitoring plan design has been developed and approved, it must be integrated into the existing MAM Plan for the proposed project. The monitoring plan shall be implemented prior to, or immediately following commencement of MBSD operations. An annual report of the data and analytical output from this monitoring shall be sent to NMFS at the following address (takereport.nmfsser@noaa.gov). The first report shall be submitted to NMFS within 1 year of the commencement of monitoring. The federal action agencies may specify if they would also like to receive these reports from the project proponent. The reports shall reference the Consultation Identification Number for this consultation (SERO-2021-00433) (NMFS BO TC 1. RPM 2).

46. Monitor Sea Turtle Habitat Use and Abundance in the Action Area: CPRA shall develop, in coordination with NMFS SEFSC, fund and implement a monitoring plan designed to study sea turtle distribution and habitat use to increase the body of knowledge and understanding of distribution, relative abundance, and seasonal and spatial sea turtle habitat use in the action area before project operations and to monitor how project operations affect distribution, relative abundance, and seasonal and spatial sea turtle habitat use of the action area. This sea turtle monitoring plan must include 3 years of field work prior to implementation of MBSD operations, 3 years of field work immediately following implementation of MBSD operations, and 1 year of data analysis. The field work must include trawl vessel surveys, satellite tagging, health assessment, and data analysis. This study would include deploying up to 240 satellite tags (target of 40 per year), some or all equipped with specialized salinity sensors, and conducting transect surveys to better understand sea turtle abundance and distribution. Turtle monitoring and tagging field work is be conducted in selected areas of the

lower Barataria Basin, from the area below the proposed outfall, down to and including the passes and inlets around the barrier islands and the Gulf-side shallow water habitat adjacent to the barrier islands at the southern end of Barataria Bay. The monitoring plan must receive final approval by NMFS PRD, and shall include the following components:

a. Field Work: Conduct 6 years of field work (3 years prior to implementation of MBSD operations and 3 years after operations start) employing the following methods:

   i. Transect surveys – Direct capture of sea turtles using otter trawl and skimmer trawl vessels using standardized seasonal 30-minute transects during spring, summer, and autumn of each year to obtain a statistically appropriate sample size in the action area. Turtles will be captured using skimmer trawls in shallow areas (<10 feet), focusing on salt marsh habitat where we expect to find smaller juvenile sea turtles, and larger otter trawl vessels using paired otter trawls in depths > 10 feet. Appropriate scientific research and collection permits will be required for these activities.

   ii. Health assessments – turtles captured in trawl surveys will be measured, weighed, tagged with flipper and passive integrated transponder (PIT) tags, tissue sampled (for genetic analysis and stable isotopes), and blood sampled (for blood chemistry analyses). Environmental data (salinity, water temperature, etc.) will be collected in conjunction with sea turtle capture efforts. Turtles will be released at or near the capture site.

   iii. Satellite tagging – up to 240 turtles (target of 40 per year, with selection based on appropriate size and condition), captured in the trawl surveys will be satellite tagged to monitor location, dive behavior, salinity, and temperature. Salinity sensor-equipped satellite tags will be used on a portion of these turtles to better understand habitat use patterns relative to salinity regimes and if shifts in salinity affect behavior.

   iv. Annual and seasonal estimates of relative abundance will be generated from the trawl data at the conclusion of each year's sampling.

b. Analysis and Modeling: Conduct 1 year of data analysis, including the following:

   i. Estimate habitat use by overlaying NMFS satellite tracking data on available GIS benthic habitat layers, as well as salinity information collected by the satellite tags. Additionally, data from any current in-water environmental monitoring stations could be used to provide additional supplemental environmental data. In addition, NMFS plans to coordinate with other research groups, such as benthic researchers studying lower trophic level organisms to provide abundance and species composition data for key prey organisms to further understand habitat use and sea turtle distribution.

ii. Complete development of a predictive model for sea turtle species habitat use and distribution in relation to physical and biological habitat characteristics and salinity level parameters. The model can be used to assess the overlap of sea turtle distribution with known and emerging threats to prioritize the type and location of restoration activities and to evaluate their effectiveness.

iii. Adaptive Management of Monitoring Activities: Due to the scarcity of information on sea turtle activity and use of the study area, there is uncertainty regarding the expected results and efficacy of the monitoring of sea turtle habitat use and abundance in the action area required herein (number of turtles that may be captured, number that may be suitable for tagging, etc.). There are also many extrinsic factors that may impact monitoring efficacy and results, such as hurricanes and annual hydrologic conditions affecting the basin. Due to these uncertainties, it may be necessary to adjust monitoring targets and methodologies (gear, locations, effort, etc.) during the study period to ensure the monitoring efforts are optimized to effectively discern the effects of the project on sea turtles. An adaptive management team consisting of up to 3 state (CPRA) and 3 federal (NMFS SEFSC, NMFS PRD, and NOAA Restoration Center [RC]) representatives (along with any technical experts invited by these entities) will meet at least once a year to review progress and results of the monitoring activities. The USACE may also participate on this team if they wish. This team may make recommendations on any necessary changes to the monitoring and tagging activities, locations, timing, or level of effort, based on current information and monitoring/tagging results to date. Any proposed changes to the sea turtle monitoring activities must be approved by NMFS PRD before implementation.

c. Project Outputs/Deliverables: Data collected will be used to analyze habitat use in relation to physical and biological habitat characteristics and salinity level parameters. Outputs include:

i. satellite tagging datasets;

ii. transect survey data;

iii. health assessment data;

iv. modeling outputs; and

v. technical report synthesizing data (NMFS BO TC 1. RPM 3).

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