2023 COASTAL MASTER PLAN

HISTORIC STORM RUN – BARRY

SUPPLEMENTAL MATERIAL H6.3

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COASTAL PROTECTION AND RESTORATION AUTHORITY

This document was developed in support of the 2023 Coastal Master Plan being prepared by the Coastal Protection and Restoration Authority (CPRA). CPRA was established by the Louisiana Legislature in response to Hurricanes Katrina and Rita through Act 8 of the First Extraordinary Session of 2005. Act 8 of the First Extraordinary Session of 2005 expanded the membership, duties, and responsibilities of CPRA and charged the new authority to develop and implement a comprehensive coastal protection plan, consisting of a master plan (revised every six years) and annual plans. CPRA's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration master plan.

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LIST OF ABBREVIATIONS

ADCIRC ..... ADVANCED CIRCULATION (MODEL)
CLARA ..... COASTAL LOUISIANA RISK ASSESSMENT (MODEL)
CPRA ..... COASTAL PROTECTION AND RESTORATION AUTHORITY
FEMA ..... FEDERAL EMERGENCY MANAGEMENT AGENCY
FWA ..... FUTURE WITH ACTION
FWOA ..... FUTURE WITHOUT ACTION
HSDRRS ..... HURRICANE AND STORM DAMAGE RISK REDUCTION SYSTEM
SLR ..... SEA LEVEL RISE
SWAN ..... SIMULATING WAVES NEARSHORE (MODEL)

1.0 INTRODUCTION

The historical storm analysis conducted for the 2023 Coastal Master Plan simulates and presents the potential coastal flood risk and damage that would result from five Atlantic tropical storms that directly impacted Louisiana from 2005 to 2021 were they to make landfall under current and future conditions. The simulated storms examined for this analysis include Hurricane Rita (2005), Hurricane Ike (2008), Hurricane Isaac (2012), Hurricane Barry (2019), and Hurricane Ida (2021). This document describes the current and future coastal flood risk and damage that would result from a Hurricane Barry-like storm, a Category 1 storm that made landfall in southcentral Louisiana in the summer of 2019.

The Advanced Circulation (ADCIRC) and Simulating Waves Nearshore (SWAN) models were used to simulate surge and wave heights for each of the five historical hurricanes analyzed. The ADCIRC+SWAN model geometries used in this analysis and throughout Louisiana's 2023 Coastal Master Plan are derived from those used in both the 2012 and 2017 Coastal Master Plans, with incremental upgrades. As part of Louisiana's 2023 Coastal Master Plan, an extensive model validation and calibration study was conducted by Cobell and Roberts (2021) to ensure that the parameters used within these models were most appropriate from those currently found within the modeling community and available literature. ADCIRC+SWAN model version v55.00 was used in this work.

Flood depth and damage results from each of the storms described in this analysis were simulated with the Coastal Louisiana Risk Assessment (CLARA) model. An introduction to the CLARA model can be found in Johnson et al. (2021), Fischbach et al. (2012), and Johnson et al. (2013). The CLARA model uses high-resolution hydrodynamic storm surge and wave output from ADCIRC+SWAN. It estimates flood depth exceedances; direct economic damage exceedances across different asset types, including residential, commercial, and industrial structures; expected annual damage dollars; and expected annual structural damage in the Louisiana Coastal Zone. However, this analysis only considers a single storm run rather than a probabilistic storm suite, so the results are simply estimates of direct economic damage associated with the historical storm.

Results are presented for current conditions, a future without action (FWOA) in Year 50, as well as a future with action (FWA) in Year 50 that simulates the anticipated impacts of the 2023 Coastal Master Plan. Current conditions are represented with the initial conditions (Year 0) assumptions. Projected future conditions, including sea level rise (SLR), were analyzed under the lower environmental scenario (S07) developed and used in the 2023 Coastal Master Plan. Both the FWOA and FWA represent a single projected future condition with changing environmental and population conditions. This scenario represents one of many possible futures for the Louisiana coast and should be interpreted as a plausible projection rather than a likely prediction for future flood risk outcomes.

2.0 DESCRIPTION

Hurricane Barry made landfall on July 13, 2019, as a Category 1 storm over southcentral Louisiana, approximately 11.5 mi east-southeast of Pecan Island, an unincorporated community of 300 residents located in Vermilion Parish (Figure 1). The storm produced widespread flooding from a combination of heavy rainfall and storm surge to the south and east of the storm's center. The highest measured storm surge was 6.13 ft above normal tide levels, recorded near Eugene Island in Atchafalaya Bay (Cangialosi et al., 2019). This location also reported sustained winds of 71 mph and gusts up to 85 mph. The combined effect of the surge and tide produced inundation levels of 4 to 6 ft above ground level along the central Louisiana coast in and around Vermilion and Atchafalaya bays. Beyond the central Louisiana coast, lower levels of inundation were recorded, with flood depths of 2 to 4 ft above ground occurring along both the southeastern Louisiana coast and west of Vermilion Bay to Calcasieu Lake.

There were no reports of deaths associated with Hurricane Barry, although flood damage associated with the storm was widespread. Across the state, first responders rescued 93 people from flood waters in 11 coastal parishes. According to the National Hurricane Center, dozens of homes experienced major flooding, and more than 20 rescues were conducted in Calcasieu Parish (Cangialosi et al., 2019). In St. Mary Parish, numerous trees and power lines were downed, and many homes and businesses reported wind damage. At one point, more than 300,000 people in Louisiana were without power. While strong winds and significant flooding from Hurricane Barry were largely confined to the southcentral portion of the Louisiana coast, minor wind damage and rainfall flooding were widespread across much of the southern portion of the state.

On August 14, 2019, following a joint federal, state, and local preliminary damage assessment of the impacted areas, Governor John Bel Edwards requested a major disaster declaration. On August 27, President Donald Trump declared Hurricane Barry a major disaster. This declaration made public assistance available for emergency work and the repair of facilities damaged by Hurricane Barry in Allen, Iberia, Lafourche, Plaquemines, St. Mary, Terrebonne, and Vermilion parishes. It also provided for debris removal and emergency protective measures in Ascension, Assumption, East Baton Rouge, East Feliciana, Iberville, Jefferson, Orleans, St. Charles, St. Helena, St. John the Baptist, Tangipahoa, and West Feliciana parishes (FEMA, 2019). There was no significant damage reported in the New Orleans metropolitan area. In Mississippi, there was minor flooding in beach areas near Biloxi, but no significant damage to homes, roadways, or businesses was reported (Cangialosi et al., 2019).

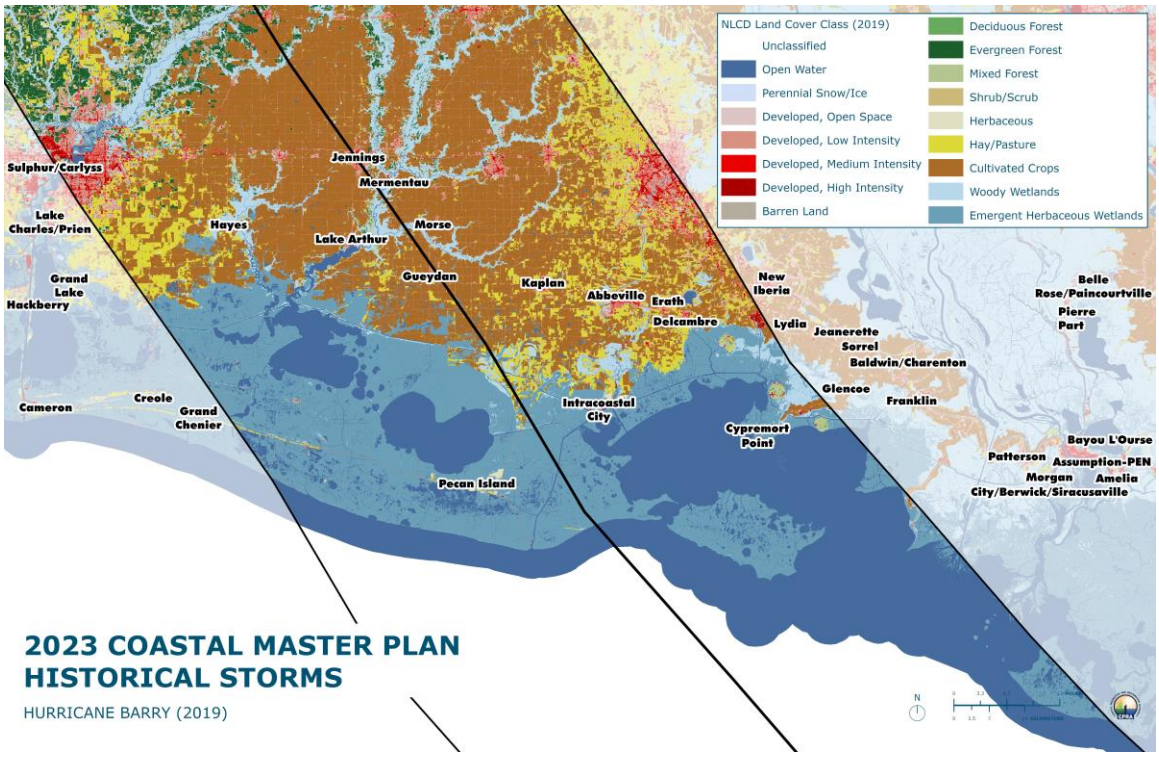

Figure 1. Storm track of Hurricane Barry and communities within a 50 km buffer of the storm's center.

3.0 STORM SURGE AND WAVES

The ADCIRC+SWAN model was used to simulate storm surge and wave height associated with Hurricane Barry for initial conditions, a FWOA, and a FWA, all of which assumed S07 conditions. Results for initial conditions (Year 0), a FWOA (Year 50), and a FWA (Year 50) are presented below along with localized results for several key communities/locations.

3.1 INITIAL CONDITIONS

Current sea level conditions were used to project storm impacts for initial conditions. Under these conditions, ADCIRC+SWAN simulations show that if a Hurricane Barry-like storm were to make landfall in Year 0, following the same track, the anticipated surge would be greatest to the east of the storm track (Figure 2). While landfall would occur in the southcentral portion of Louisiana's coast near the boundary of the Chenier Plain and Central Coast regions, simulations show that the highest surge levels would occur slightly to the east of these regions, in the Atchafalaya Region. Simulations show that the highest expected storm surge, an estimated 16 to 18 ft, would be found in the northern portion of the Atchafalaya Basin within the West Atchafalaya Floodway portion of the Lower Atchafalaya Basin Floodway System.

ADCIRC+SWAN results also show local high water surface elevations ranging from 8 to 10 ft resulting from a Hurricane Barry-like storm in Year 0 across several locations along the southcentral and southeast Louisiana coast. The area near Braithwaite in the Breton Sound Basin, located at the junction of the Hurricane and Storm Damage Risk Reduction System (HSDRRS) levees and Mississippi River levees in Plaquemines Parish, is expected to experience high water surface elevations as storm water from the east piles against the levees. These increased water surface elevations are expected to impact several communities across the Pontchartrain/Breton Region, from the fishing villages of Delacroix and Yscloskey in St. Bernard Parish to Braithwaite on the east bank of the Mississippi River in Plaquemines Parish. Similar water elevations are projected for locations in the southern portion of the Terrebonne Region as it approaches the Gulf of Mexico; an area dominated by a series of lakes, bays, and coastal marshes.

Between Terrebonne Bay and the Mississippi River as well as most of the Pontchartrain Basin, including lakes Borgne, Pontchartrain, and Maurepas, a Hurricane Barry-like storm would be expected to generate surge levels of 4 ft or less in Year 0. Projected peak water surface elevations in Lake Salvador and many of the other interior lakes and waterways between Bayou Lafourche and the Mississippi River would be minimal. Storm surge and wave-induced water surface elevation increases

would be minimal, particularly to the west of Vermilion Bay, where model results show inundation levels of 2 ft or less.

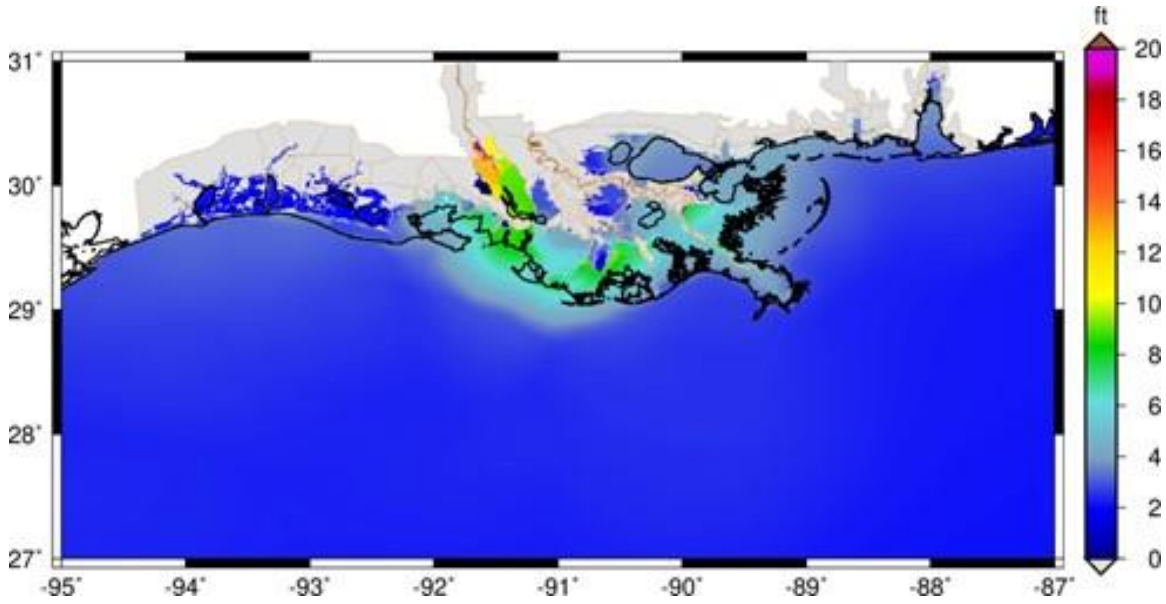

Figure 2. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm simulated in Year 0.

3.2 FUTURE WITHOUT ACTION

Storm surge and wave simulations under S07 show that were a Hurricane Barry-like storm to make landfall in Year 50 in a FWOA, the greatest expansion of the floodplain compared to Year 0 is projected to occur in the interior of the Atchafalaya Basin, between the East and West Atchafalaya Basin Protection Levees, encompassing portions of Iberia, St. Martin, and St. Mary parishes (Figure 3). ADCIRC+SWAN simulations also show an expansion of the floodplain in the locations surrounding Lac Des Allemands and Bayou Lafourche, north of Larose and to the immediate east of the Atchafalaya Basin. Much of the low-lying land between lakes Palourde and Verret and the Houma–Thibodaux metropolitan statistical area is projected to experience high water surface elevations from a Hurricane Barry-like storm in Year 50 in a FWOA.

In addition to the expansion of the floodplain in locations to the immediate east of the storm track, overall water surface elevation and wave heights generated by the storm are expected to increase across the coast in Year 50 in a FWOA. In this simulation, the projected water surface elevations in the southern portion of the Terrebonne Region, as it approaches the Gulf of Mexico, are expected to range

from 10 to 12 ft in height, an increase of approximately 2 ft over Year 0. Similar increases are projected across the Louisiana coast, from the Chenier Plain Region in the west to the Pontchartrain/Breton Region in the east.

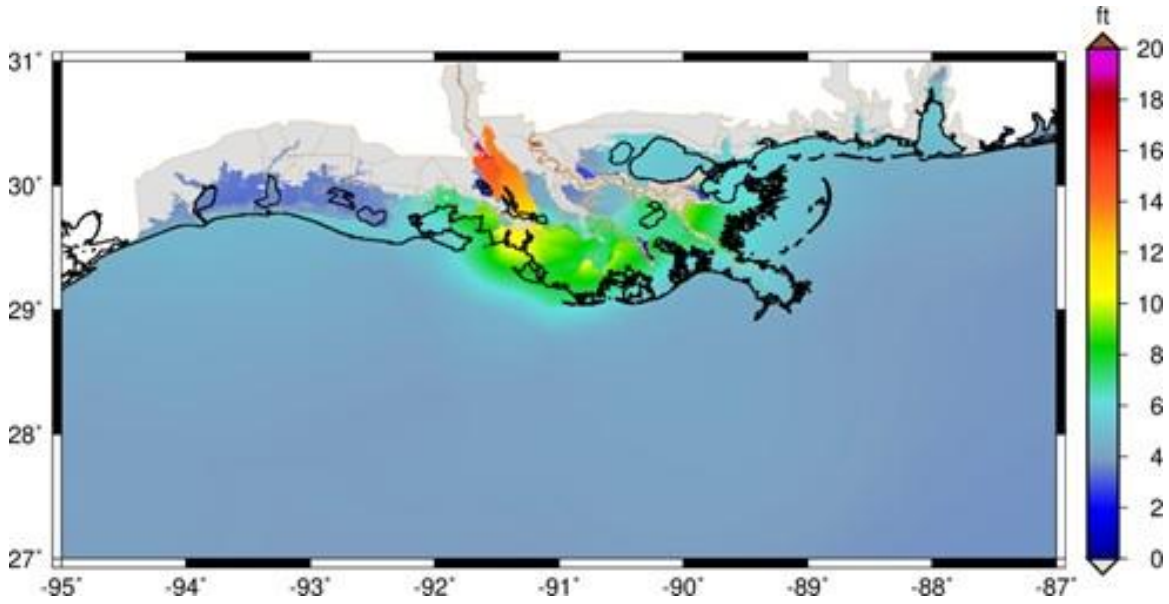

Figure 3. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm simulated in the FWOA, S07, Year 50.

3.3 FUTURE WITH ACTION

In the FWA simulation, ADCIRC+SWAN results show few large-scale differences from the FWOA simulation within the Atchafalaya Basin (Figure 4). The greatest projected reduction in water surface elevation and wave heights is anticipated for the portion of Terrebonne Parish behind the Morganza to the Gulf project. This project includes a 98-mi alignment consisting of grass-covered earthen levees, 22 floodgates on navigable waterways, 23 environmental water control structures, nine road gates, and fronting protection for four existing pump stations. Much of this area is projected to experience an average of 8 to 10 ft of water above surface from a Hurricane Barry-like storm in Year 50 in a FWOA. In a FWA, locations behind the Morganza to the Gulf project levees may see projected water surface elevations of 2 ft or less (Figure 5). ADCIRC+SWAN results show an increase in water surface elevations on the Gulf-facing side of the levee system, as the storm piles water up against the elevated levee features. Similar water piling impacts are observed in a FWA along elevated roadways

crossing the coastal zone, most notably along Highway 90.

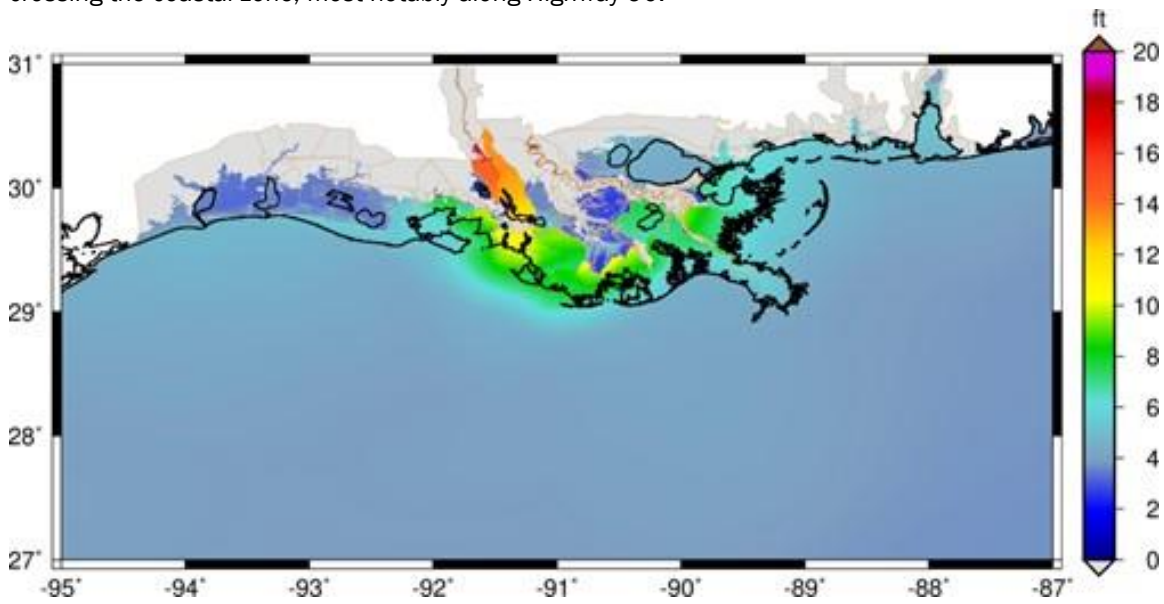

Figure 4. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm simulated in the FWA, S07, Year 50.

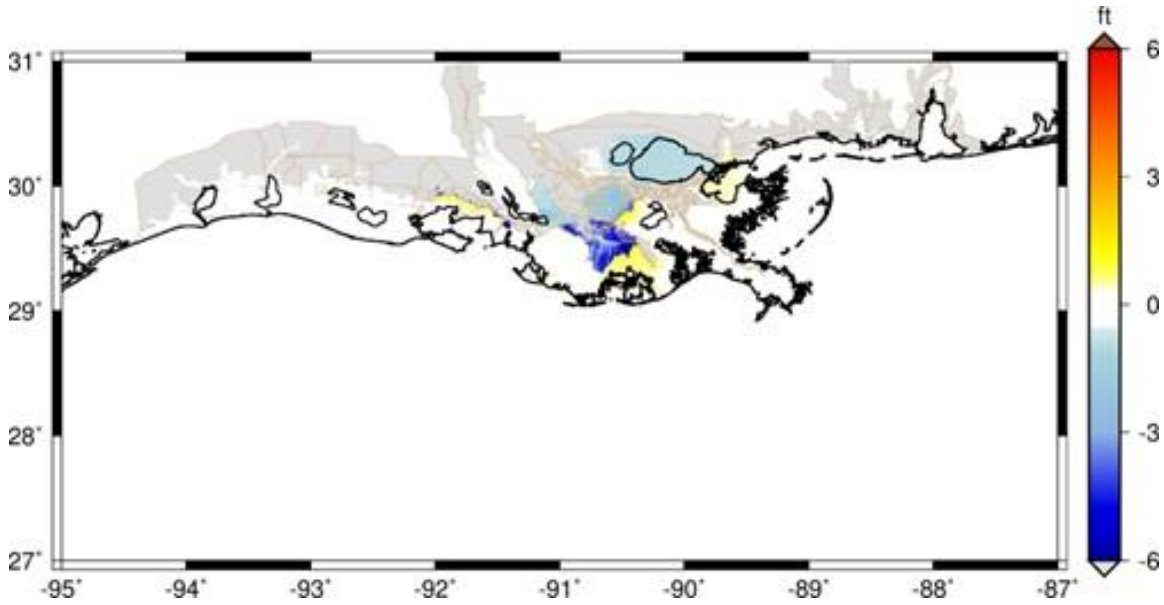

Figure 5. Change in peak water surface elevation (ft, NAVD88) between FWOA and FWA for a Hurricane Barry-like storm simulated in S07, Year 50.

3.4 LOCAL STORM SURGE AND WAVE IMPACTS

In a more granular analysis of the anticipated local impacts of a Hurricane Barry-like event in Year 50, both FWA and FWOA simulations reveal the impacts of local landscape features on exacerbating or reducing the impacts of storm surge and waves. Several communities across coastal Louisiana were analyzed for high tide flooding impacts (see Attachment H3: High Tide Flooding Report). Within each community, local stakeholders identified and verified several key locations of community importance. To assess the local impacts of a Hurricane Barry-like storm, water surface elevations were projected under initial conditions as well as into the future under both FWOA and FWA.

On average, hurricane-force winds tend to extend forward and to the right about 50 to 100 km from the eye and 25 to 50 km to the left (Keim et al., 2007). Of the communities examined for this analysis, only one was located within 50 km of the center line of the storm: Delcambre, a town located along the Delcambre Canal (also known as Bayou Carlin) in Iberia and Vermilion parishes. Located to the east of a Hurricane Barry-like storm's center line within the 50 km high wind zone, Delcambre is projected to experience high peak water surface elevations in Years 0 and 50. ADCIRC+SWAN simulations show that peak water surface elevations resulting from a Hurricane Barry-like storm would be limited to locations along the Delcambre Canal, which could experience between 2 and 3 ft of flooding by Year 50 in a FWOA (Table 1). Beyond the canal, however, model results show no anticipated flooding. By Year 50 in a FWA, the projected water above surface along the Delcambre Canal would be reduced to approximately 1 ft, lower than levels expected in Year 0.

Table 1. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Delcambre, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Delcambre	Bayou Carlin Cove Boat Landing	1.6	2.1	1.0
Delcambre	Delcambre High School	N/A	N/A	N/A
Delcambre	Delcambre Local Road Link - E Main St and S President St	1.6	2.1	1.0
Delcambre	Vermilion Parish Library - Delcambre Branch	N/A	2.1	N/A

To the east of Delcambre, just outside the 50 km buffer, ADCIRC+SWAN results project minimal water above surface from a Hurricane Barry-like storm making landfall in Year 0 in the St. Mary Parish community of Amelia, with approximately 0.4 ft projected along a segment of East Main Street (Table 2). By Year 50 in a FWOA, however, model results project values exceeding 2.5 ft in all key locations examined in this analysis. Unlike the simulation results for Delcambre, ADCIRC+SWAN simulations for

Amelia show that in a FWA, planned protection and restoration actions would not be expected to impact the peak water surface elevations that a Hurricane Barry-like storm could generate in Year 50.

Table 2. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Amelia, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Amelia	Amelia Branch Library	N/A	2.6	2.7
Amelia	Amelia Local Road Link - Duhon Blvd	0.4	2.8	2.7
Amelia	J S Aucoin Elementary School	N/A	2.7	2.7

In coastal Terrebonne Parish, most of the communities, including Dulac, Dularge, Chauvin, and Montegut, are located atop distributary ridges. ADCIRC+SWAN results project that a Hurricane Barry-like storm making landfall in Year 0 would be expected to generate peak water surface elevations of approximately 1 ft at most of the key locations in Dulac, including the Dulac Community Center (Table 3). By Year 50 in a FWOA, over 2 ft of water surface elevation would be expected in Dulac at each of the key locations, including segments of two important local roadways, Grand Caillou Road and Shrimpers Row. However, model results show that the Morganza to the Gulf project and other restoration and protection measures are projected to reduce peak water surface levels at all locations. In Year 50 in a FWA, each of the key locations would be expected to experience less than 1 ft of water above surface from a Hurricane Barry-like storm. Grand Caillou Road, a key evacuation route for Dulac residents, is simulated to have water surface levels reduced to less than 1.5 ft.

Table 3. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Dulac, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Dulac	Dulac Community Center	1.0	2.2	1.0
Dulac	Dulac Evacuation Link - Grand Caillou Rd	N/A	2.3	1.4
Dulac	Dulac Local Road Link - Shrimpers Row and Bayou Guillaume Rd	1.0	2.2	0.9
Dulac	Holy Family Catholic Church	1.0	2.2	0.8

In Grand Isle, the only populated barrier island in Louisiana, ADCIRC+SWAN results show that the peak water surface elevations resulting from a Hurricane Barry-like storm in Year 0 are expected to be less than 1 ft at all key locations examined (Table 4). By Year 50 in a FWOA, model results project an increase of approximately 0.5 ft at all locations. This includes flooding along the transportation network, both on the island and on the mainland, across the causeway over Caminada Pass. In a FWA,

the implementation of planned protection and restoration projects is projected to have minimal impact on these expected water surface elevations.

Table 4. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Grand Isle, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Grand Isle	Grand Isle Community Center	0.9	1.5	1.4
Grand Isle	Grand Isle Evacuation Link - LA1	0.9	1.5	1.5
Grand Isle	Grand Isle Local Road Link - Oak Ln at Louisiana Ave	0.9	1.5	1.5
Grand Isle	Grand Isle State Park	0.9	1.5	1.5

To the east of the Mississippi River in the Pontchartrain/Breton Region, ADCIRC+SWAN simulations show that a Hurricane Barry-like storm is expected to generate water surface elevations similar to those observed the regions to the west of the river. In the small St. Bernard Parish fishing community of Delacroix, model results project peak water surface elevations of nearly 2 ft at all key locations in Year 0 (Table 5). By Year 50 in a FWOA, this value is projected to increase by approximately 0.5 ft. This includes water above surface at locations along the town's transportation network, including roadways and boat docks. In a FWA, the implementation of planned protection and restoration projects would not be expected to significantly alter the water surface elevations resulting from a Hurricane Barry-like storm in Year 50.

Table 5. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Delacroix, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Delacroix	Delacroix Evacuation Link - Delacroix Hwy	1.9	2.4	2.4
Delacroix	Delacroix Island Pier	1.9	2.4	2.4
Delacroix	Delacroix Local Road Link - Delacroix Hwy	2.0	2.4	2.4

In the Pontchartrain Basin, ADCIRC+SWAN results show that the projected water surface elevations resulting from a Hurricane Barry-like storm making landfall in Year 0 are likely to be confined to locations adjacent to Lake Pontchartrain and other tidally influenced waterways. In Slidell, a North Shore city located at the eastern edge of St. Tammany Parish, ADCIRC+SWAN results project that many key locations would not be expected to experience any notable water above surface, particularly those located in the high density developed downtown area (Table 6). To the west of downtown Slidell, locations and roadways along Bayou Liberty near the wetland fringe of Lake Pontchartrain are projected to see just over 1 ft of water above surface from a Hurricane Barry-like storm in Year 0. By

Year 50 in a FWOA, these locations, as well as those located along the nearby Bayou Bonfouca, are projected to experience an additional 0.5 ft of water above surface. In a FWA simulation, ADCIRC+SWAN results project that peak water surface elevations will be reduced to less than 1 ft, levels lower than those projected for Year 0.

Table 6. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Slidell, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Slidell	Bayou Liberty Marina	1.2	1.7	0.9
Slidell	Our Lady of Lourdes Church	N/A	N/A	N/A
Slidell	Salmen High School	N/A	N/A	N/A
Slidell	Slidell Local Road Link - Bayou Liberty Rd near Galatas Ln	1.2	1.7	0.9
Slidell	Slidell Municipal Marina at Heritage Park	N/A	1.7	N/A
Slidell	St Genevieve Church	1.2	1.7	0.9

As with Slidell, the anticipated peak water surface elevations resulting from a Hurricane Barry-like storm in Mandeville are expected to be limited to locations immediately adjacent to Lake Pontchartrain. In Year 0, projected water surface elevations of just over 1 ft are expected at locations outside of the developed core of Mandeville, along the lakefront (Table 7). While located slightly off the immediate lakefront, the Fontainebleau State Park Visitors Center is connected to the lakefront by a large expanse of cypress swamp and coastal streams. As a result, ADCIRC+SWAN simulations project similar water surface elevations at this location. By Year 50 in a FWOA, the projected peak water surface elevations at each of these locations are projected to increase by 0.5 ft. In a FWA in Year 50, model results show that planned projection and restoration actions are projected to reduce peak water surface elevations slightly, to levels midway between those observed in Year 0 and in Year 50 in a FWOA.

Table 7. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Mandeville, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Mandeville	Fontainebleau State Park Visitors Center	1.2	1.7	1.4
Mandeville	Lakeshore Dr	1.2	1.7	1.4
Mandeville	Mandeville Evacuation Link - Florida St and Jackson Ave	N/A	N/A	N/A
Mandeville	Mandeville Local Road Link - Monroe St and Ramon St	N/A	N/A	N/A
Mandeville	West Lakefront Children's Park	1.2	1.7	1.4

Only one community west of the storm track was examined in this analysis, Cameron, located in the Chenier Plain Region south of Calcasieu Lake along the Calcasieu Ship Channel. ADCIRC+SWAN results project that areas located atop the elevated chenier ridges, such as the local recreational facility, would not be expected to experience any water above surface from a Hurricane Barry-like storm in Year 0, while locations off of the chenier ridges and along the local waterways would be expected to experience less than 1 ft of water above surface (Table 8). By Year 50, each of these locations, except the local recreational facility, are projected to experience peak water surface elevations of 1 to 1.5 ft in a FWOA. In a FWA, ADCIRC+SWAN simulations project that planned protection and restoration actions would not notably alter projected water surface elevations in Year 50.

Table 8. Peak water surface elevation (ft, NAVD88) for a Hurricane Barry-like storm at key locations in Cameron, Louisiana

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Cameron	Cameron Clerk of Court	N/A	1.3	1.2
Cameron	Cameron Evacuation Link - LA27	N/A	1.1	1.0
Cameron	Cameron Ferry West Landing	0.8	1.2	1.2
Cameron	Cameron Parish Library	0.8	1.5	1.5
Cameron	Cameron Parish Recreation District No. 6 Facility	N/A	N/A	N/A

4.0 FLOOD DEPTH

The CLARA model was used to estimate flood depths associated with a Hurricane Barry-like storm for initial conditions, a FWOA, and a FWA, all of which assumed S07 conditions. Results for initial conditions (Year 0), a FWOA (Year 50), and a FWA (Year 50) are presented below.

4.1 INITIAL CONDITIONS

While the storm surge and wave results show inundation and water levels over both land and water, the CLARA results focus on flood depth over land surfaces. In Year 0, CLARA simulations modeling the impacts of a Hurricane Barry-like storm across the Louisiana coast largely follow the results of the storm surge and wave results, with impacts concentrated in communities along the Terrebonne and Breton Sound basins (Figure 6). In the Terrebonne Basin, flood depths are greatest in the locations fringing Terrebonne Bay outside of the levee features in the region, including the Larose to Golden Meadow system in Lafourche Parish. In Breton Sound, a Hurricane Barry-like storm making landfall in Year 0 is projected to result in elevated flood depths in proximity to Braithwaite in Plaquemines Parish, located at the junction of the HSDRRS levees and the Mississippi River levees where flooding is likely to result from a piling of water against these levees. Expected flood depths across the southwestern coast are anticipated to be negligible for this storm event, with minor flooding potentially resulting along some of the region's chenier ridges. This pattern is mirrored across the coast, with higher flood depths expected in areas adjacent to high elevation locations on the landscape, such as levees.

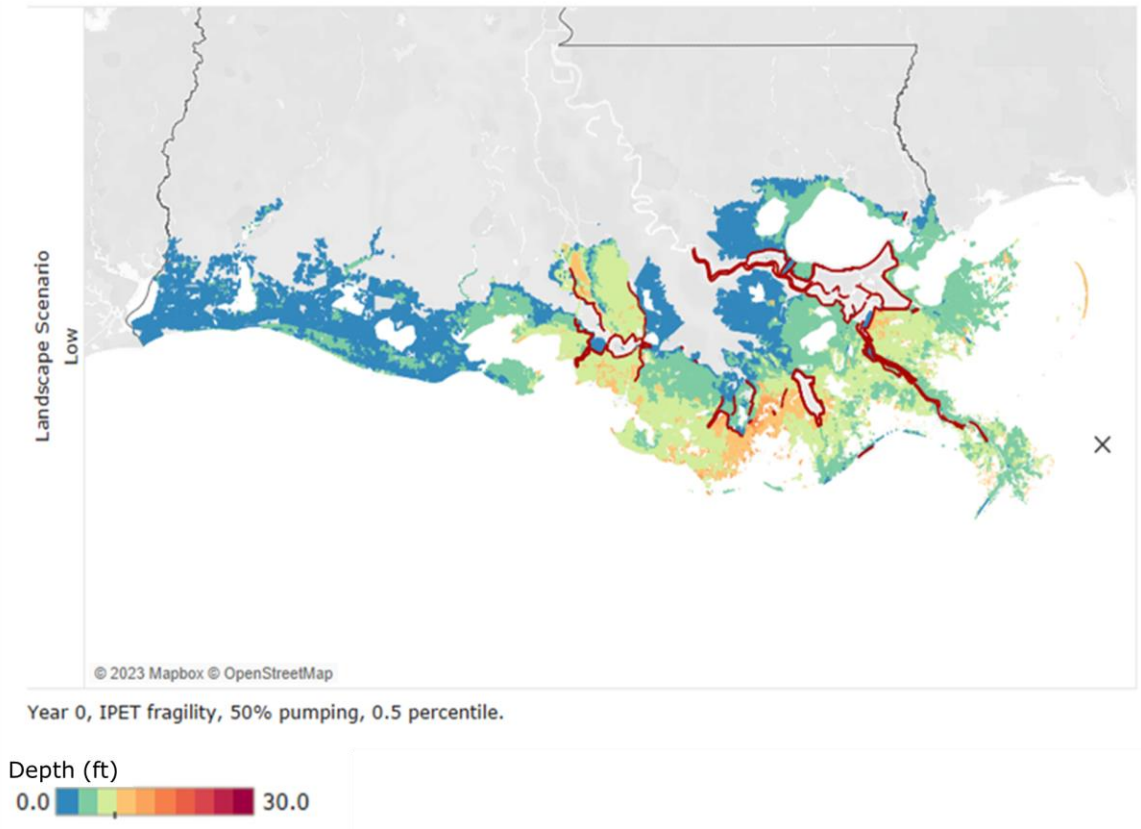

Figure 6. Modeled maximum flood depth for a Hurricane Barry-like storm simulated under initial conditions.

4.2 FUTURE WITHOUT ACTION

In Year 50 in a FWOA, the Hurricane Barry-induced current water elevation patterns are expected to intensify, with maximum flood depths expected to increase in the existing floodplain, as observed in the storm surge and wave analysis. CLARA simulations show that much of this increase in flood depth will occur in the Atchafalaya, Terrebonne, and Central Coast regions, the locales immediately to the east of Hurricane Barry's track line (Figure 7). In addition to increasing flood depths, the floodplain is expected to expand more inland, particularly in the low elevation locations between the eastern edge of the Atchafalaya Basin and the elevated lands atop Bayou Lafourche in the Terrebonne Region and between Bayou Lafourche and the Mississippi River in the Barataria Region. Much of this projected expansion is across the forested wetlands surrounding Lac Des Allemands including the Lac Des Allemands Swamp. Less substantial change to the extent of the floodplain resulting from a Hurricane Barry-like storm in Year 50 in a FWOA is expected to occur in the Pontchartrain Basin around lakes Pontchartrain and Maurepas. Additionally, the forested wetlands located on the land bridge between

these two lakes are expected to experience an increase in flood depths. To the west of the storm track in the Chenier Plain Region, CLARA simulations show that flood depths from a Hurricane Barry-like storm in Year 50 in a FWOA are expected to increase over the depths seen in Year 0, with the marshes and estuarine lakes of the regions allowing the storm surge and waves to penetrate further inland beyond the chenier ridges.

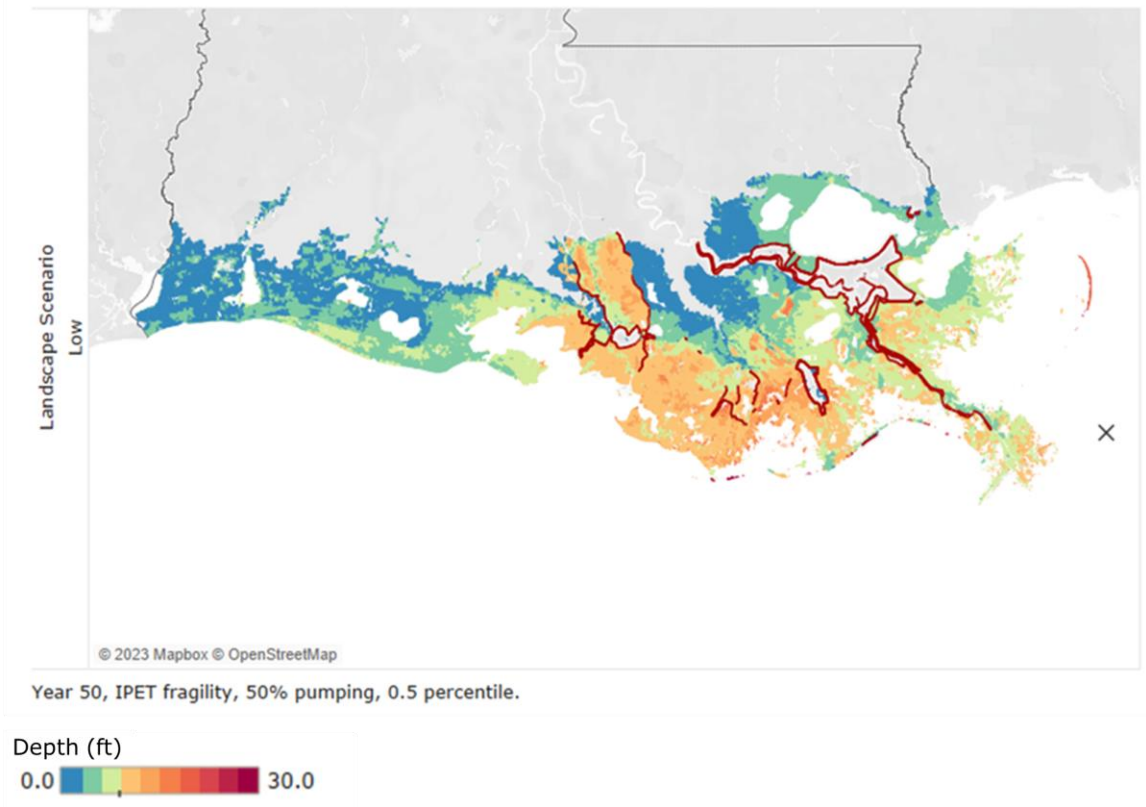

Figure 7. Modeled maximum future flood depth for a Hurricane Barry-like storm simulated in the FWOA, S07, Year 50 with current levee alignments.

4.3 FUTURE WITH ACTION

In a FWA in Year 50, much of the increase in flood depths resulting from a Hurricane Barry-like event is reduced from the levels projected in the FWOA simulations for Year 50, particularly in the Pontchartrain/Breton Region (Figure 8). While the anticipated expansion of the floodplain around lakes Pontchartrain and Maurepas is still observed in the model results, the level of flooding is expected to be very similar to those observed in Year 0.

This same pattern holds for the Chenier Plain Region, where anticipated protection and restoration actions would do little in terms of altering the impacts of a Hurricane Barry-like event in Year 50. CLARA results show that in a FWA, some, but not all, of the floodplain expansion in the locations surrounding Lac Des Allemands and Bayou Lafourche north of Larose would be reduced by anticipated protection and restoration actions. Areas south of the Larose to Golden Meadow system are also expected to see flood depth reductions to levels similar to those observed in Year 0.

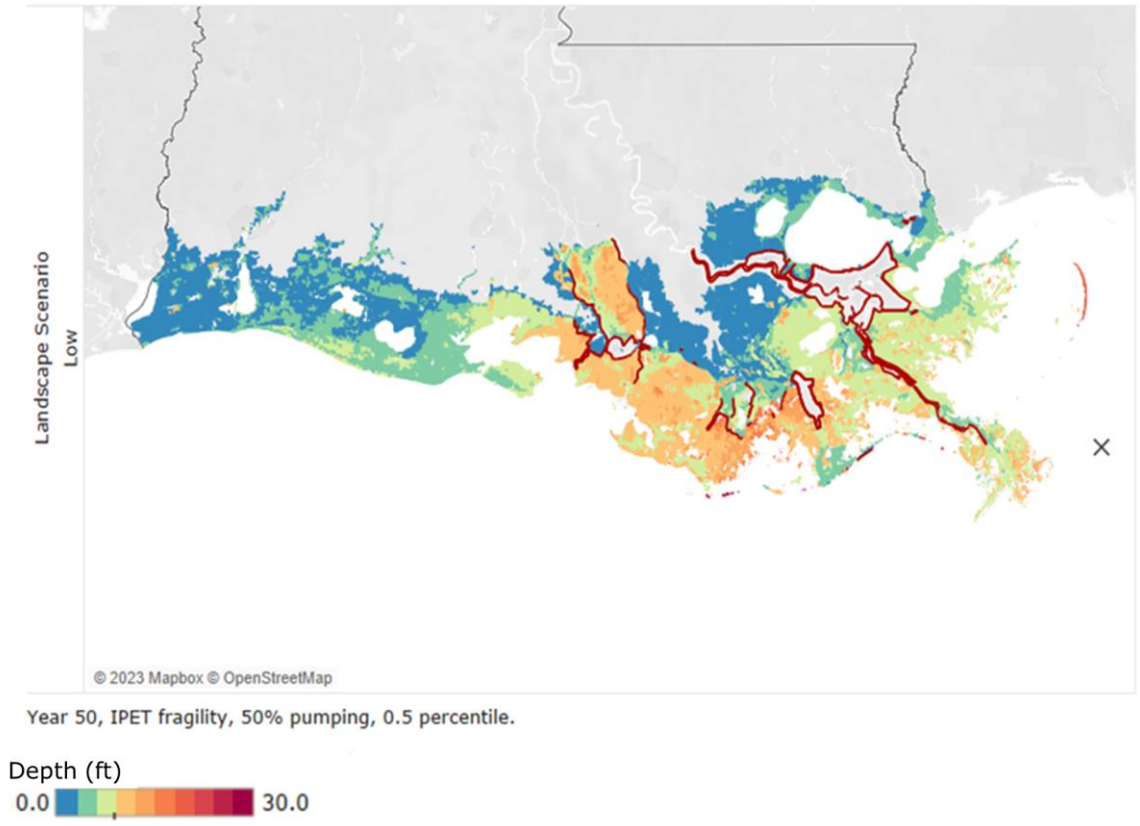

Figure 8. Modeled maximum future flood depth for a Hurricane Barry-like storm simulated in the FWA, S07, Year 50.

5.0 DAMAGES

The CLARA model was used to estimate direct economic damage associated with a Hurricane Barry-like storm for a FWOA and a FWA under S07 conditions. Results for Year 50 are presented below.

5.1 FUTURE WITHOUT ACTION

CLARA simulations for a Hurricane Barry-like storm generally show that the distribution of economic damage is tied to the density of population and residential structures. Most direct economic damage from flooding resulting from a Hurricane Barry-like storm in Year 50 is expected to be concentrated in the densely populated areas around Houma and nearby communities such as Bayou Cane and Bayou Blue (Figure 9). In addition, a Hurricane Barry-like storm is expected to result in relatively high levels of damage along Bayou Lafourche, particularly in Thibodaux and the smaller communities located along the west bank of the bayou within the Larose to Golden Meadow system. South of Golden Meadow, outside the protection levee system, high levels of damage are anticipated in and around Port Fourchon, a high value industrial area.

Beyond these Terrebonne Region communities, a Hurricane Barry-like storm would be expected to result in moderate levels of economic damage in the Pontchartrain Basin, with the highest levels found the Slidell/Eden Isle/Pearl River and Mandeville/Covington/Madisonville/Abita Springs areas on the north shore of Lake Pontchartrain. CLARA simulations show that both New Orleans and New Orleans East are expected to experience relatively high levels of economic damage and damage to structures in Year 50 in a FWOA. While the ADCIRC+SWAN results show that water surface elevation and wave heights are not expected to be as high in these locations as in others across the coast, CLARA results show that the density of population and development will likely result in a greater number of damaged structures, even if the degree of damage is not as high as other impacted communities.

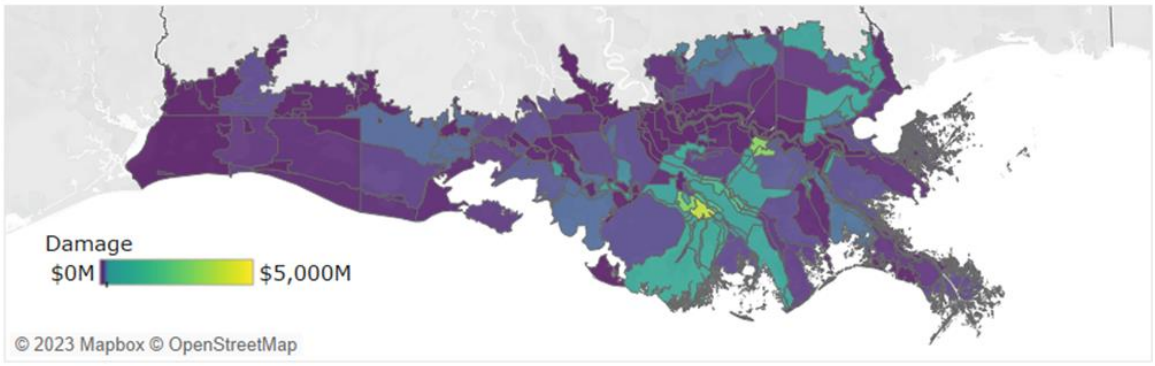

Figure 9. Modeled future economic damage for a Hurricane Barry-like storm simulated in the FWOA, S07, Year 50.

5.2 FUTURE WITH ACTION

CLARA simulations show that planned protection and restoration actions would have minimal impact on changing the overall coastwide damage footprint of a Hurricane Barry-like storm in Year 50. However, significant reductions in damage are observed in Houma and the surrounding communities such as Bayou Cane and Bayou Blue in Terrebonne Parish, as well as in Luling and Boutte, two census designated places in St. Charles Parish that comprise a portion of the New Orleans metropolitan area (Figure 10). When the difference between damage dollars in a FWOA and a FWA is directly compared, Houma, Bayou Cane, Bayou Blue, and Luling/Boutte show the greatest level of anticipated damage reduction (Figure 11).

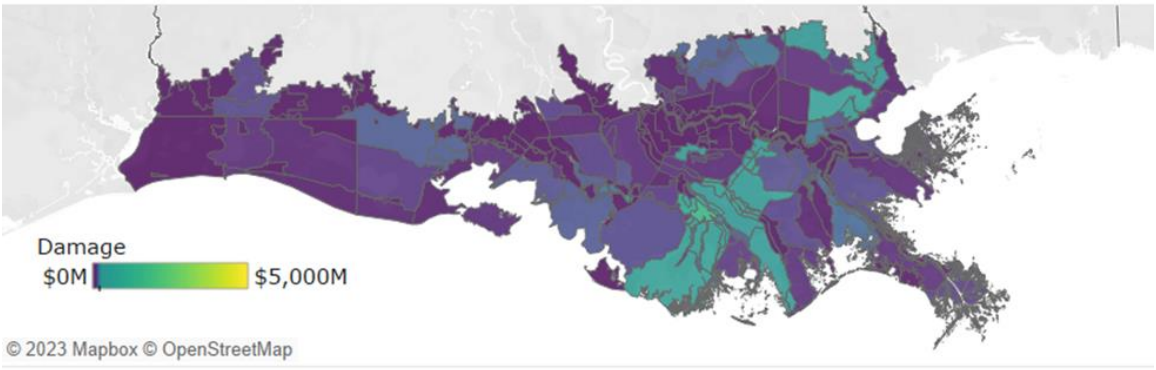

Figure 10. Modeled future economic damage for a Hurricane Barry-like storm simulated in the FWA lower scenario in Year 50.

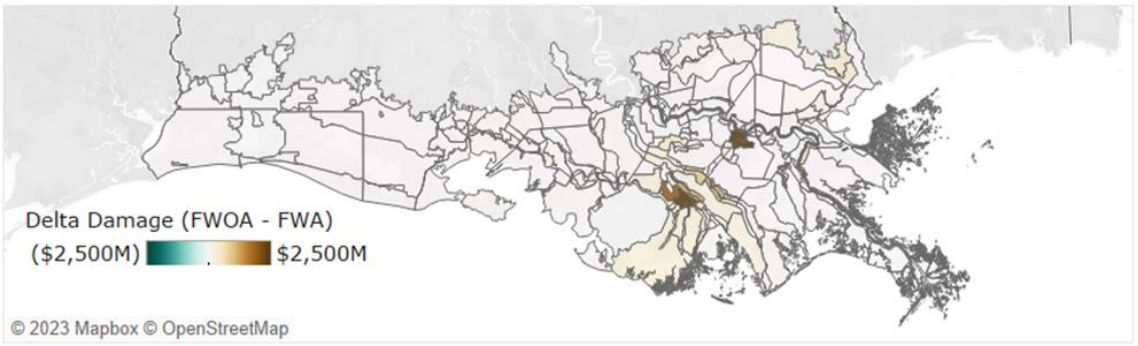

Figure 11. Change in modeled future economic damage between FWOA and FWA for a Hurricane Barry-like storm simulated in S07, Year 50.

While CLARA results show that the highest projected damage reduction resulting from a Hurricane Barry-like event in a FWA relative to a FWOA is expected to occur in the areas around Houma, Luling, and Boutte, other locations with relatively high levels of damage reduction are expected to include locations along Bayou Lafourche (including communities within and outside the Larose to Golden Meadow system) and many of the bayou communities in Terrebonne Parish south of Houma. On the east side of the Mississippi River Bird's Foot Delta, Slidell, and Mandeville, densely populated North Shore communities that comprise a portion of the New Orleans–Metairie metropolitan statistical area, are also projected to experience relatively high levels of risk reduction from planned protection and restoration actions.

Coastwide, CLARA results show that planned protection and restoration actions would effectively reduce the total amount of future economic damage from a Hurricane Barry-like storm by over $18.3 billion were the storm to make landfall in Year 50 (Table 9). Reflecting the social and economic profile of the potentially impacted areas, the highest level of both damage and damage reduction is expected to be in single family and other small residential units (e.g., manufactured homes and duplexes), followed by commercial and industrial structures.

Table 9. Modeled future asset damage and damage reduction from a Hurricane Barry-like storm in S07, Year 50

	Small Residential	Large Residential	Commercial and Industrial	Public and Educational	Grand Total
FWOA (Year 50)	$20,324M	$303M	$9,927M	$1,009M	$31,563M
FWA (Year 50)	$8,075M	$86M	$4,866M	$214M	$13,242M
Reduction in Damage Between FWOA and FWA (Year 50)	$12,248M	$217M	$5,061M	$795M	$18,321M

As seen in the surge and wave analyses, flood depth and damage resulting from a Barry-like storm event show a large amount of spatial variation in communities across the coast (Table 10). Unlike the surge and wave results, however, the amount of expected economic damage is not purely a function of biogeophysical factors. The exposure of assets and associated economic damage is directly tied to the degree of human development and population exposed to flood impacts. Because the track of Hurricane Barry brings the storm onshore near Pecan Island, a sparsely populated region of Louisiana's coast, high damage levels would be expected to occur in communities immediately to the east of the storm track, such as Amelia, Delcambre, and Dulac in Year 0, with these levels increasing dramatically by Year 50 in both a FWOA and a FWA.

In terms of total coastwide damage dollars, damage levels in the sparsely populated portions of the coast are more than offset by those experienced in the more densely populated areas facing comparatively lower levels of flood exposure. For example, CLARA results show that, despite the relatively low flood depths expected from a Hurricane Barry-like storm, Lake Pontchartrain's North Shore communities in St. Tammany Parish, including Mandeville and Slidell, the high population density of this area will result in significant increases in flood damage relative to the expected surge and wave levels. In a FWA, planned protection and restoration actions implemented in this area would be expected to result in significant damage reduction across the North Shore.

Table 10. Modeled total damage and change in damage to select coastal communities from a Hurricane Barry-like storm in S07

Community	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)	Change in Damage Between FWOA and FWA (Year 50)
Amelia	$20M	$479M	$293M	39%
Cameron	$59M	$95M	$84M	11%
Delacroix	$13M	$4M	$4M	-
Delcambre	$10M	$94M	$15M	84%
Dulac	$114M	$230M	$123M	47%
Grand Isle	$44M	$52M	$41M	22%
Mandeville/Covington/ Madisonville/Abita Springs	$120M	$411M	$198M	52%
Slidell/Eden Isle/Pearl River	$103M	$664M	$230M	65%

6.0 REFERENCES

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