2023 COASTAL MASTER PLAN

HISTORIC STORM RUN – RITA

SUPPLEMENTAL MATERIAL H6.2

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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	SIMULTAING 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 Rita-like storm, a Category 3 storm that made landfall in 2005 near Johnson Bayou, Louisiana, an unincorporated community of approximately 300 residents located atop a chenier ridge in Cameron Parish.

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 Rita made landfall on September 24, 2005, as a Category 3 storm near Johnson Bayou, Louisiana, an unincorporated community of approximately 300 residents located atop a chenier ridge in Cameron Parish. The storm produced sustained winds as high as 115 mph (National Weather Service, 2005), and the communities of Cameron, Creole, Grand Chenier, Hackberry, and Holly Beach were significantly damaged or destroyed (FEMA, 2006).

Hurricane Rita produced storm surge values of 12 to 18 ft throughout Cameron Parish, causing the complete destruction of many structures and significant beach erosion in the area of landfall. Water was also pushed into Calcasieu Lake, which caused flooding in Grand Lake and other shoreline communities. The Calcasieu River experienced surge; causing additional flooding in parts of Lake Charles. Vermilion, Iberia, and St. Mary parishes experienced storm surge inundation of up to 12 ft, and the storm surge in southern Jefferson and southern Terrebonne parishes resulted in levee breaches and overtopping. Because Hurricane Rita occurred shortly after Hurricane Katrina, removal of floodwaters took longer than anticipated (Knabb et al., 2006b). The storm also produced heavy rains (5 to 9 in in some cases). There was one reported death directly associated with Hurricane Rita in Lake Charles (Knabb et al., 2006a).

On September 24, 2005, President George W. Bush declared a major disaster under the Stafford Act in order to provide federal assistance for individuals and households, as well as public assistance to state and local governments and certain nonprofits across the State of Louisiana. This declaration also made it possible for all Louisiana parishes to apply for assistance through the Hazard Mitigation Grant Program (HMGP; FEMA, 2006).

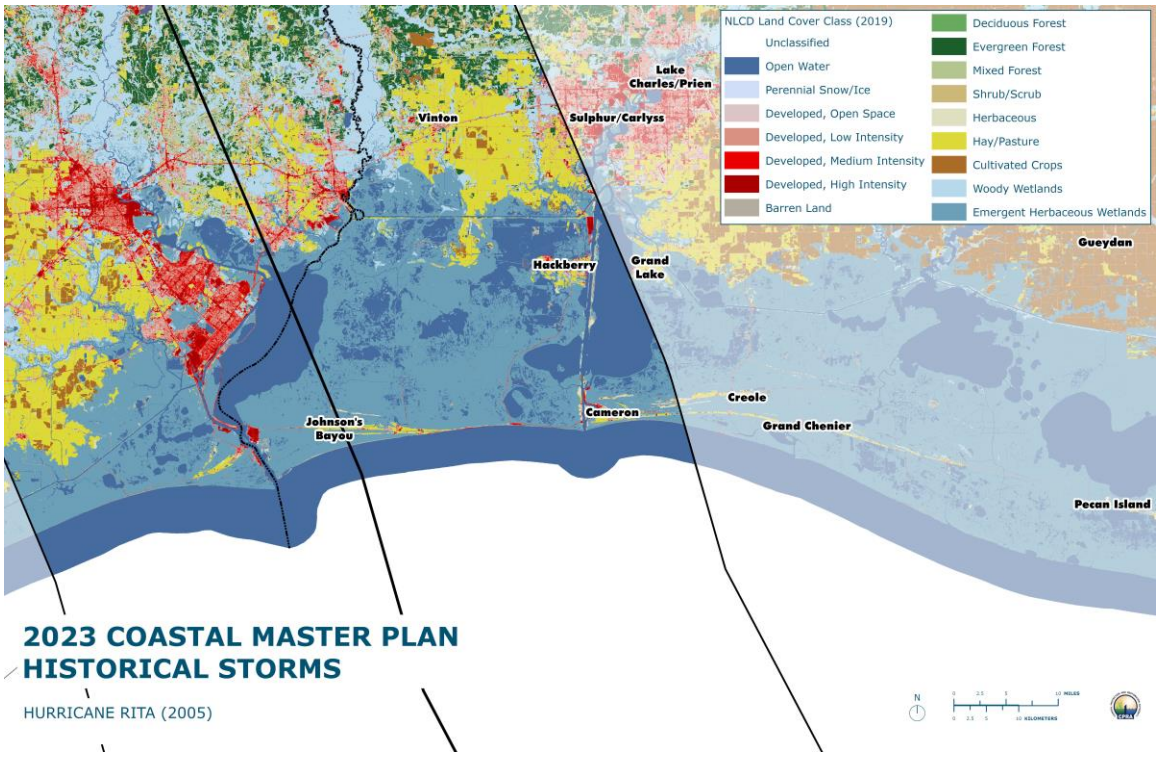

Figure 1. Storm track of Hurricane Rita and Louisiana communities within a 50 km buffer of the storm's center.

3.0 STORM SURGE AND WAVES

The ADCIRC+SWAN model was used to simulate storm surge and wave height associated with Hurricane Rita 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 Rita-like storm were to make landfall in Year 0 following the same track, the projected water surface elevations would be greatest directly to the south of Calcasieu Lake in Cameron Parish (Figure 2). Simulations show that projected water surface elevations ranging from 14 to 16 ft would extend across the full length of Cameron Parish, from the Sabine River nearly to White Lake.

The strength and track of a Hurricane Rita-like storm occurring in Year 0 is projected to result in significant water surface elevations far inland from the coastline. This is a result of the surge and waves flowing though the interlinked system of estuarine lakes, coastal marshes, bayous, and canals and over the chenier ridges that comprise the landscape of coastal southwest Louisiana. ADCIRC+SWAN simulations show water surface elevations of 10 to 12 ft extending inland to the southern shores of Grand Lake and White Lake. Additionally, model simulations project similar levels of water elevation north of Calcasieu Lake proximate to Lake Charles/Prien and Sulphur/Carlyss, two densely populated cities in Calcasieu Parish.

In addition to extending inland, ADCIRC+SWAN simulations project water surface elevations of 10 to 12 ft extending eastward, as far as Vermilion and Iberia parishes. As a result of the counterclockwise flow of the wind and waves from a Hurricane Rita-like storm, similar levels of water surface elevation are predicted to extend inland through Vermilion Bay, with the floodplain extending to the northern and western shores of the bay. To the east of the Mississippi River Bird's Foot Delta, this same wind and wave flow pattern is projected to result in a local area of high water surface elevation in Breton Sound. This occurs where the water is constrained by the Hurricane and Storm Damage Risk Reduction System (HSDRRS) levees and the Mississippi River levees, resulting in water piling and exceeding 10 ft in elevation in the area around the community of Braithwaite.

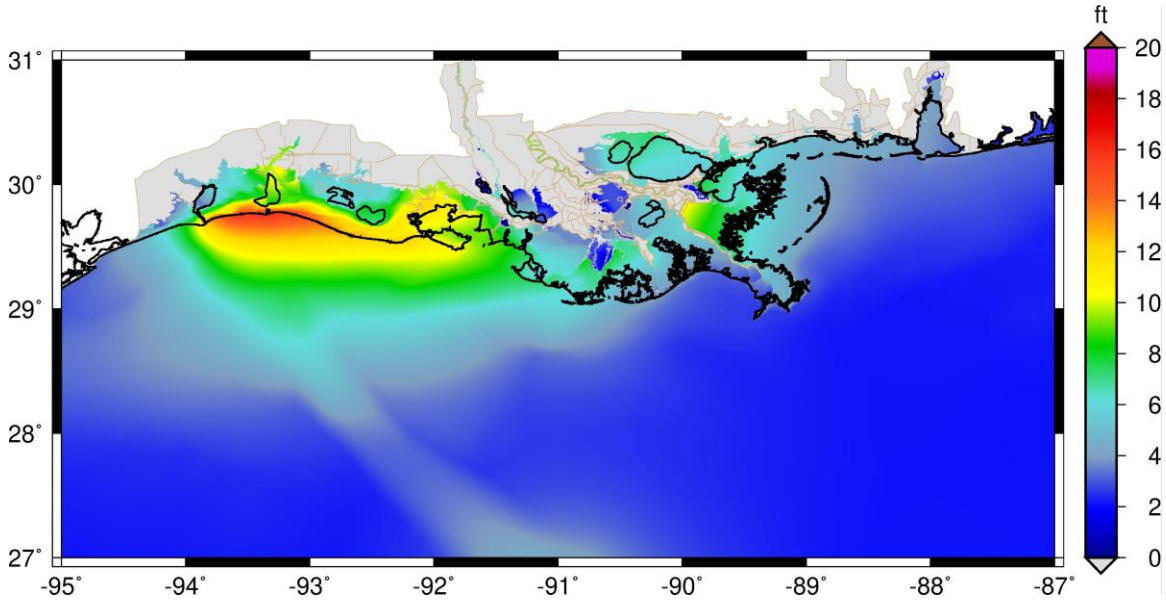

Figure 2. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-like storm simulated in Year 0.

3.2 FUTURE WITHOUT ACTION

ADCIRC+SWAN simulations show that were a Hurricane Rita-like storm to make landfall in Year 50 in a FWOA, a similar spatial pattern of impacts is projected, with a slight expansion of the floodplain expected within the Atchafalaya Basin and in the upper Barataria Basin. This is particularly apparent between the levees and banks of Bayou Lafourche and the Mississippi River in the forested wetlands containing Lac Des Allemands and the Lac Des Allemands Swamp (Figure 3). Beyond the expected expansion of the floodplain, ADCIRC+SWAN simulations project heightened water surface elevations from a Hurricane Rita-like storm in Year 50 in a FWOA relative to Year 0. Simulations show that projected water surface elevations ranging from 14 to 16 ft would extend further eastward, encompassing much of Vermilion Bay and the land along its western and northern shores. Similar water surface elevations are projected in Calcasieu Parish near Lake Charles/Prien and Sulphur/Carlyss. Notable increases in water surface elevations to levels approaching 12 ft are projected for many inland areas in the Chenier Plain Region, particularly along Calcasieu Lake and the unincorporated communities surrounding it, including Hackberry and Grand Lake. Similar increases are expected in and around White Lake. Finally, notable increases in water surface elevations are projected in the wetlands around Braithwaite and in Breton Sound between Lake Borgne and the Mississippi River levees in Plaquemines Parish.

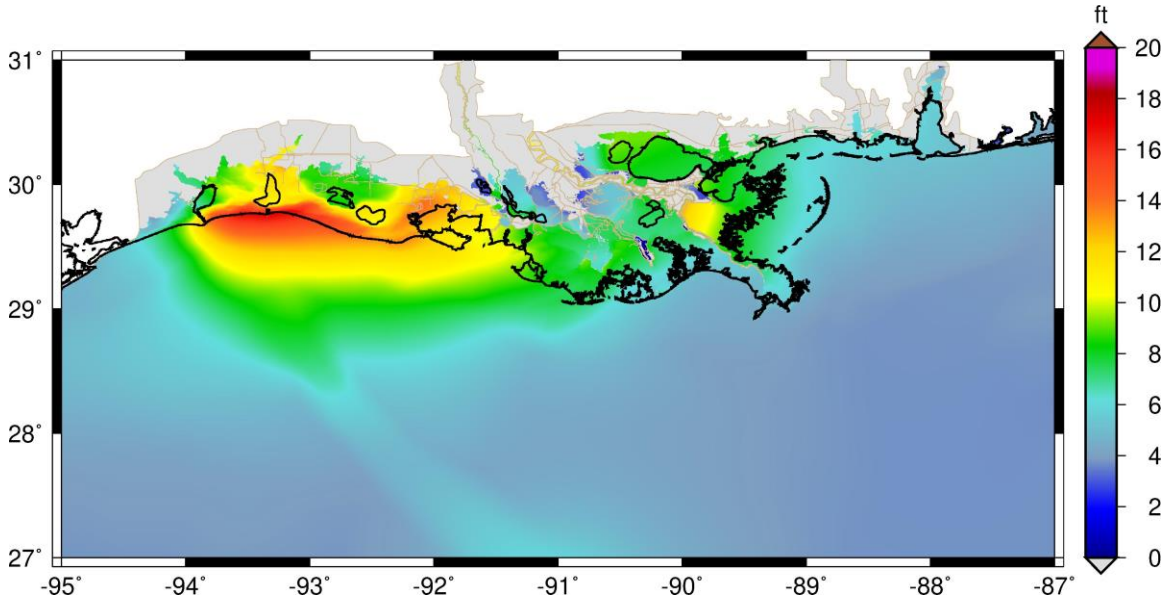

Figure 3. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-like storm simulated in the FWOA, S07, Year 50.

3.3 FUTURE WITH ACTION

In a FWA simulation for Year 50, ADCIRC+SWAN model results show that much of the area around a Rita-like storm's landfall location in western Cameron Parish is projected to see relatively minor reductions in water surface elevation relative to a FWOA. This is most notable in the area between Sabine Lake and Calcasieu Lake and in the area surrounding Grand Lake (Figure 4). These locations are projected to see overall reductions in water surface elevation of 1 to 2 ft (Figure 5). Further to the east in the Terrebonne Region, larger reductions in water surface elevation are projected to result in a FWA, most notably in the locations behind the Morganza to the Gulf project levees in Terrebonne and Lafourche parishes, including Houma and Thibodaux/Lafourche Crossing/Bayou Country Club. ADCIRC+SWAN simulations also project high reductions in water surface elevation in the upper Barataria Basin north of Highway 90, particularly throughout the communities in and around the Lac Des Allemands Swamp and the River Parish community of Luling/Boutte.

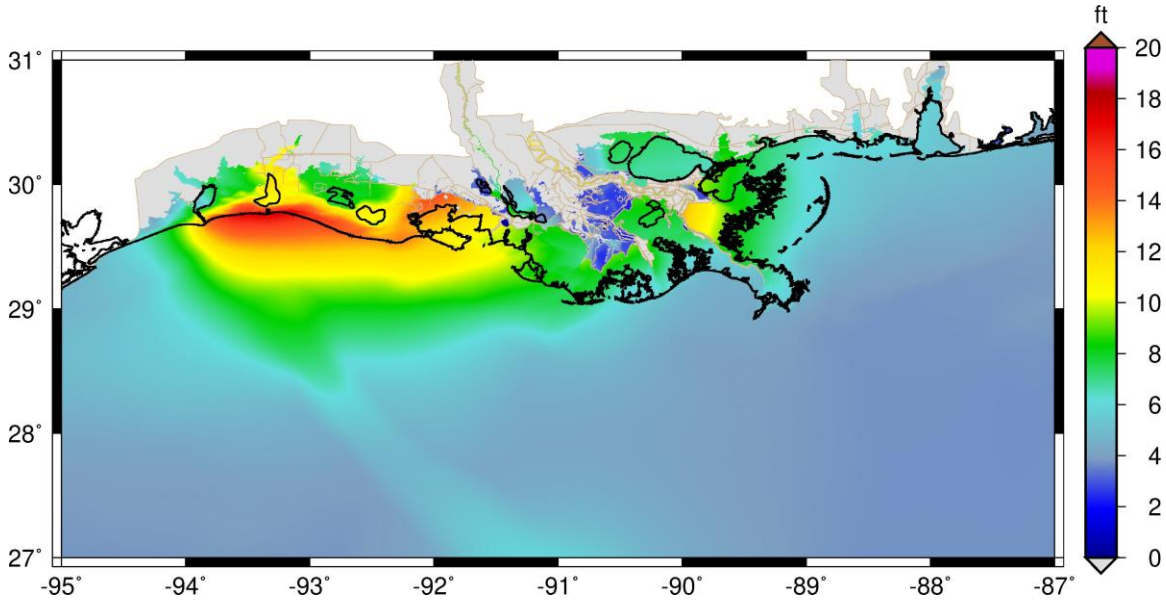

Figure 4. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-like storm simulated in the FWA, S07, Year 50.

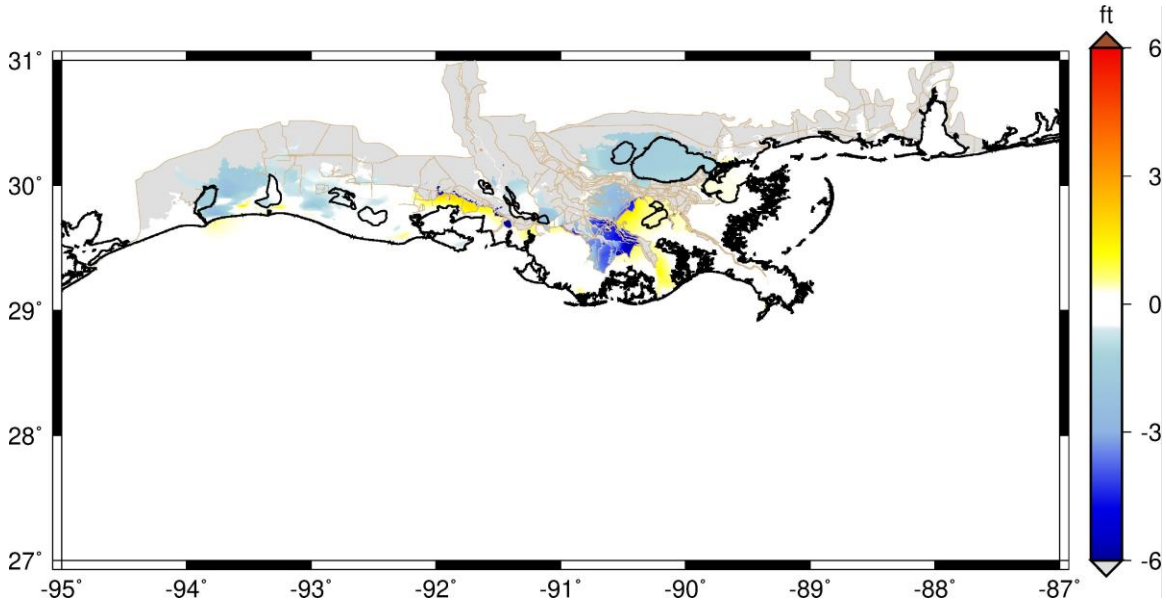

Figure 5. Change in peak water surface elevation (ft, NAVD88) between FWOA and FWA for a Hurricane Rita-like storm simulated in S07, Year 50.

3.4 LOCAL STORM SURGE AND WAVE IMPACTS

In a more granular analysis of the anticipated local impacts of a Hurricane Rita-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, a number of key locations of community importance were identified and verified by local stakeholders. To assess the local impacts of a Hurricane Rita-like storm, water surface elevations were projected under initial conditions at Year 0 as well as Year 50 under both FWOA and FWA simulations.

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 of the storm track (Keim et al., 2007). Because the track of a Hurricane Rita-like storm would bring it onshore at the southwest corner of the state, only the community of Cameron, located south of Calcasieu Lake in Cameron Parish, would be expected to fall within this zone of maximum wind impacts. In Cameron, ADCIRC+SWAN results project peak water surface elevations of 4 ft or higher in Year 0 at each of the key locations analyzed, including those located atop relative high ground and chenier ridges, such as local recreation facility (Table 1). ADCIRC+SWAN simulations show that planned protection and restoration actions in the 2023 Coastal Master Plan are not projected to alter these patterns. In Year 50 in a FWOA, the projected peak water surface elevations resulting from a Hurricane Rita-like storm are expected to approach and even exceed 5 ft throughout Cameron. In a FWA, ADCIRC+SWAN results show that planned protection and restoration projects would have negligible impacts on the expected peak water surface elevations.

Table 1. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-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	4.10	4.51	4.55
Cameron	Cameron Evacuation Link - LA27	4.39	4.92	4.95
Cameron	Cameron Ferry West Landing	3.94	4.37	4.38
Cameron	Cameron Parish Library	4.26	4.66	4.73
Cameron	Cameron Parish Recreation District No. 6 Facility	4.76	5.16	5.17

Further to the east of a Hurricane Rita-like storm's track, the local impacts of flooding are less pronounced, though still notable. In Delcambre, ADCIRC+SWAN results show that the projected peak water surface elevation resulting from a Hurricane Rita-like storm in Year 0 would exceed 3 ft at all locations analyzed, including those located away from the Delcambre Canal, a common source of flooding in the community. By Year 50 in a FWOA, peak water surface elevations are projected to

approach 4 ft (Table 2). In a FWA, the projected water surface elevations along the Delcambre Canal would be reduced to approximately 1 ft of inundation and eliminated completely in other areas by Year 50.

Table 2. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-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	3.11	3.85	0.97
Delcambre	Delcambre High School	3.03	3.79	N/A
Delcambre	Delcambre Local Road Link - E Main St and S President St	3.07	3.82	1.00
Delcambre	Vermilion Parish Library - Delcambre Branch	3.05	3.81	N/A

A Hurricane Rita-like storm making landfall in Year 0 is projected to have minimal impacts in the St. Mary Parish community of Amelia, located to the south of Lake Palourde. ADCIRC+SWAN results in a FWOA at Year 50 project less than 0.4 ft of water surface elevation along Duhon Boulevard, while key locations such as the library and elementary school are not projected to experience any water above surface in Year 0 (Table 3). In Year 50, ADCIRC+SWAN simulations project that water surface elevations from a Hurricane Rita-like storm will exceed 2 ft in a FWOA. In a FWA, planned protection and restoration projects are projected to slightly reduce the peak water surface elevations resulting from a Hurricane Rita-like storm in Amelia by less than 0.5 ft.

Table 3. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-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	2.12	1.87
Amelia	Amelia Local Road Link - Duhon Blvd	0.36	2.24	1.89
Amelia	J S Aucoin Elementary School	N/A	2.18	1.87

In coastal Terrebonne Parish most of the communities, including Dulac, Dularge, Chauvin, and Montegut, are located atop a number of distributary ridges. A Hurricane Rita-like storm would be expected to generate peak water surface elevations of less than 1 ft at all key locations analyzed in Dulac, with the exception of Grand Caillou Road, which is not expected to see any water above surface from this storm (Table 4). ADCIRC+SWAN simulations for Year 50 in a FWOA project approximately 2 ft of water surface elevation in Dulac at each of the key locations including each of the two roadways examined. In a FWA, model results show that the Morganza to the Gulf project and other restoration and protection measures are projected to decrease water surface elevations from a Hurricane Rita-like

storm in Year 50 by approximately 1 ft for all the key locations examined. Grand Caillou Road, a key evacuation route for Dulac residents, is simulated to have water surface levels reduced to 1 ft.

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

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Dulac	Dulac Community Center	0.75	1.95	1.07
Dulac	Dulac Evacuation Link - Grand Caillou Rd	N/A	2.12	1.05
Dulac	Dulac Local Road Link - Shrimpers Row and Bayou Guillaume Rd	0.75	1.97	0.87
Dulac	Holy Family Catholic Church	0.75	1.96	0.87

A Hurricane-Rita like storm is expected to result in approximately 1 ft of water above surface at all key locations in Grand Isle, the only populated barrier island in Louisiana, in Year 0 (Table 5). This includes water over key locations along the transportation network, both on the island and on the mainland, across the causeway over Caminada Pass. In a FWOA, ADCIRC+SWAN results project an increase of approximately 0.5 ft at all key locations examined in Year 50 over those observed in Year 0. In a FWA, the implementation of planned protection and restoration projects would not be expected to reduce the expected water surface elevations.

Table 5. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-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	0.99	1.49	1.57
Grand Isle	Grand Isle Evacuation Link - LA1	1.15	1.66	1.80
Grand Isle	Grand Isle Local Road Link - Oak Ln at Louisiana Ave	1.00	1.53	1.61
Grand Isle	Grand Isle State Park	1.02	1.55	1.60

In the Breton/Pontchartrain Region, the projected water surface elevations resulting from a Hurricane Rita-like storm for Delacroix, a small fishing community located along Bayou Terre-aux-Boeufs to the east of the Mississippi River, in Year 0, exceed 2.5 ft, similar to those projected for communities located to the west of the river. This includes flooding along the town's transportation network, including roadways and boat docks. By Year 50 in a FWOA, these values are projected exceed 3 ft, an increase of over 0.5 ft in each location (Table 6). In a FWA, the implementation of planned protection and restoration projects would not be expected to significantly alter these peak water surface

elevations.

Table 6. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-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	2.59	3.17	3.21
Delacroix	Delacroix Island Pier	2.63	3.22	3.27
Delacroix	Delacroix Local Road Link - Delacroix Hwy	2.63	3.21	3.26

Finally, ADCIRC+SWAN simulations show notable water surface elevations resulting from a Hurricane Rita-like storm for communities located on the north shore of Lake Pontchartrain, including Slidell and Mandeville. Simulations show that if a Hurricane Rita-like storm were to make landfall in Year 0 following the same track, a handful of key locations located in downtown Slidell would experience no flooding (Table 7). Outside the downtown area of Slidell, locations located along Bayou Bonfouca and Bayou Liberty are projected to experience water surface elevations approaching 2 ft in Year 0. By Year 50 in a FWOA simulation, these levels are all projected to rise to nearly 2.5 ft. ADCIRC+SWAN simulations show similar levels of water surface elevation projected in Year 50 for those locations in downtown Slidell that were not projected to have any water above surface in Year 0. In Year 50 in a FWA, model simulations demonstrate that water surface elevations in these locations would be eliminated and other locations in Slidell are projected to see peak water surface elevations from a Hurricane Rita-like storm reduced to less than 1 ft.

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

Community	Name	Initial Conditions (Year 0)	FWOA (Year 50)	FWA (Year 50)
Slidell	Bayou Liberty Marina	1.93	2.49	0.87
Slidell	Our Lady of Lourdes Church	N/A	2.42	N/A
Slidell	Salmen High School	N/A	2.42	N/A
Slidell	Slidell Local Road Link - Bayou Liberty Rd near Galatas Ln	1.93	2.49	0.88
Slidell	Slidell Municipal Marina at Heritage Park	1.92	2.47	N/A
Slidell	St Genevieve Church	1.94	2.50	0.87

In Mandeville, the projected water surface elevations from a Hurricane Rita-like storm in Year 50 are similar to those observed in Slidell under FWOA conditions (Table 8). In both a FWOA and FWA, a Hurricane Rita-like storm would be expected to result in 2 to 3 ft of water above surface at locations along the shores of Lake Pontchartrain. In much of the unpopulated area of Fontainebleau State Park,

which contains several streams and cypress swamp land and is outside of the developed core of Mandeville, simulations project flooding during future storm events like Hurricane Rita, both with and without action.

Table 8. Peak water surface elevation (ft, NAVD88) for a Hurricane Rita-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	2.04	2.61	2.21
Mandeville	Lakeshore Dr	2.03	2.61	2.20
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	2.08	2.65	2.25
Mandeville	West Lakefront Children's Park	2.03	2.61	2.20

4.0 FLOOD DEPTH

The CLARA model was used to estimate flood depths associated with a Hurricane Rita-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. CLARA results show that the expected flood depths resulting from a Hurricane Rita-like storm across the southwestern coast are anticipated to reach 13 ft along the coastline of Cameron Parish and further inland along shore of Calcasieu Lake in Year 0 (Figure 6). Further inland from these areas, expected flood depths are generally lower, though in Cameron and Calcasieu parishes, flood depths as high as 10 ft are projected as far north as Lake Charles.

CLARA results show several other areas projected to experience flood depths approaching 13 ft across the coast. In southwest Louisiana, this includes the area around Vermilion Bay and West Cote Blanche Bay in Iberia and St. Mary parishes, respectively, which includes the entirety of the uninhabited Marsh Island. Further to the east, CLARA results project similar flooding levels along the shores of Terrebonne Bay and in the wetland areas of Breton Sound between the Mississippi River, the HSDRRS levees, and Lake Borgne.

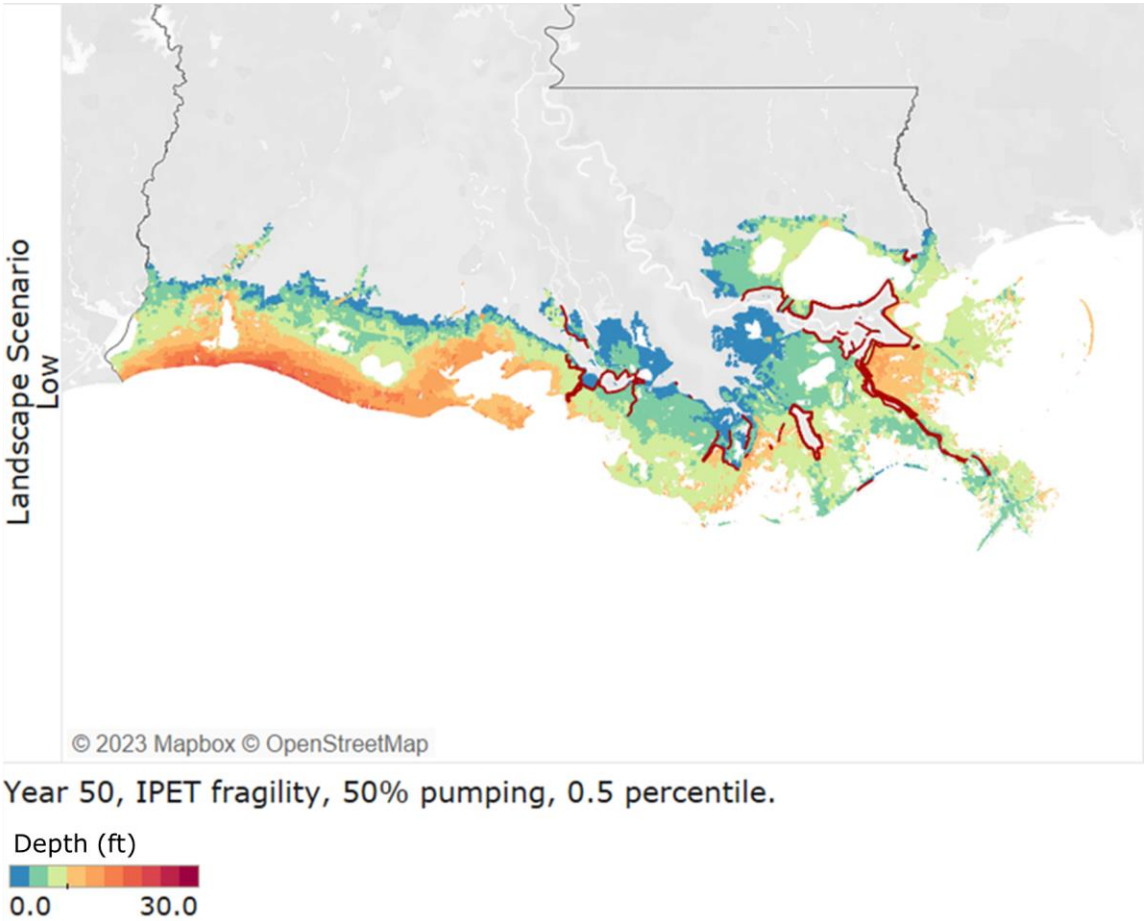

Figure 6. Modeled maximum flood depth for a hurricane Rita-like storm simulated under initial conditions.

4.2 FUTURE WITHOUT ACTION

In Year 50 in a FWOA, the flood depth patterns projected for a Hurricane Rita-like storm are expected to intensify relative to the Year 0 results, similar to the water surface elevation patterns observed in the ADCIRC+SWAN results. The increase in flood depths is most pronounced along the coast of Cameron Parish and around Vermilion Bay. In these locations, CLARA results show flood depths increasing by approximately 2 ft over Year 0 levels in a FWOA (Figure 7). Similar increases in flood depths are projected across the coast in all regions, with only the area surrounding the Wax Lake Delta in the Central Coast Region remaining relatively unchanged in a FWOA. Beyond the Chenier Plain Region, the increased flood depths are most notable in the southern Terrebonne Region and in the Breton/Pontchartrain Region between the Mississippi River and Lake Borgne.

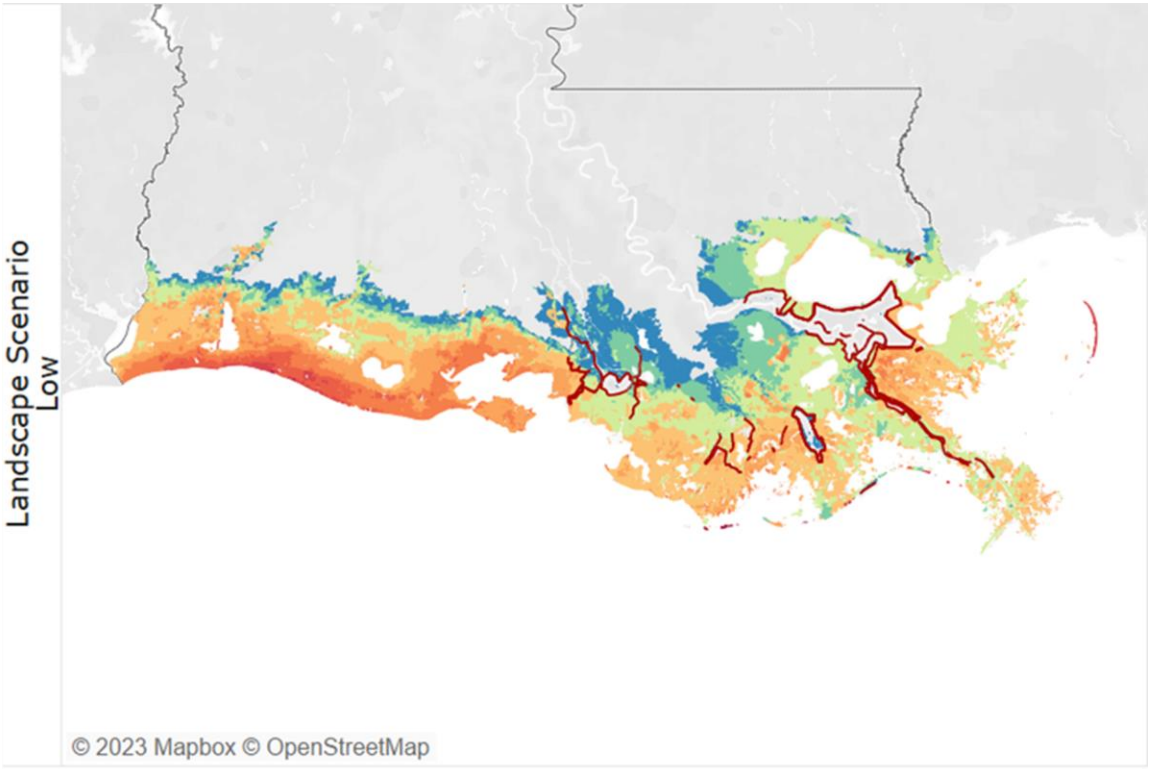

Figure 7. Modeled maximum future flood depth for a Hurricane Rita-like storm simulated in the FWOA, S07, Year 50 with current levee alignments.

4.3 FUTURE WITH ACTION

In a FWA in Year 50, CLARA results show that the impacts of a Hurricane Rita-like storm are similar to those observed in a FWOA in the southwestern part of the state where flooding is more severe (Figure 8). In Cameron Parish, two locations are projected to see notable reductions in flooding: the area to the east of Sabine Lake and the Sabine River, including much of the Sabine National Wildlife Refuge and much of the area surrounding Grand Lake. Further to the east in the Terrebonne Region, CLARA results show notable decreases in flood depths in two localized areas in Year 50 in a FWA. One is located to the west of the Houma–Bayou Cane–Thibodaux metropolitan statistical area, including the bayou community of Dulac at the eastern edge of the Terrebonne Region. In a FWA in Year 50, CLARA simulations project lower flood depths from a Hurricane Rita-like storm for locations south of the

Larose to Golden Meadow levee system, including Port Fourchon.

Beyond reducing impacts at the coastline, CLARA results project reductions in flood depths in inland locations in a FWA. Much of this reduction is projected in the vicinity of Lac des Allemandes, where CLARA results show decreases approaching 2.5 ft. Similar reductions are expected in Lafourche and Jefferson parishes between Bayou Lafourche and the Mississippi River. In the Breton/Pontchartrain regions, notable reductions in flood depths are projected for much of the land around Lake Maurepas and along the north shore of Lake Pontchartrain.

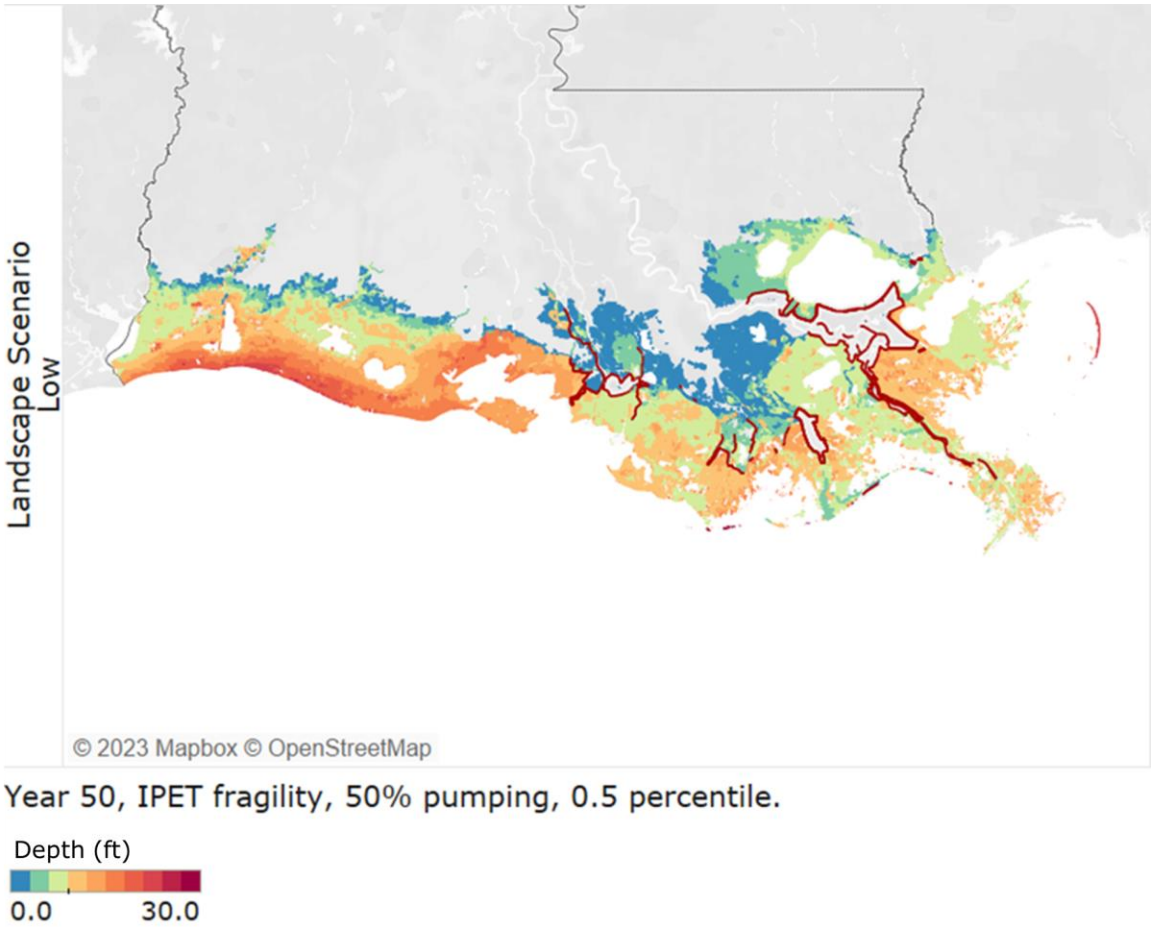

Figure 8. Modeled maximum future flood depth for a Hurricane Rita-like storm simulated in the FWA, S07, Year 50.

5.0 DAMAGES

The CLARA model was used to estimate direct economic damage associated with a Hurricane Rita-like storm for a FWOA and a FWA under SO7 conditions. Results for Year 50 are presented below.

5.1 FUTURE WITHOUT ACTION

CLARA simulations for a Hurricane Rita-like storm generally show that the distribution of economic damage is tied to the density of population and residential structures. While CLARA results found that flood depths from a Hurricane Rita-like storm in Years 0 and 50 were highest in Cameron Parish, the expected damages in this area are expected to be low due to the sparse population and relatively undeveloped nature of the area (Figure 9). Expected flood damage would be highest in many of the more populous locations east of the storm's landfall in Vermilion Parish, including communities in the Acadiana region to the west of Lafayette and the communities that comprise the Houma–Bayou Cane–Thibodaux metropolitan statistical area in the Terrebonne Region. CLARA results also project relatively high damage levels in most of the communities located along Bayou Lafourche as well as in the vicinity of Port Fourchon. Finally, many locations in the New Orleans metropolitan region are expected to experience relatively high levels of damage from a Hurricane Rita-like event in Year 50 in a FWOA due, in large part, to high population density and development. This includes New Orleans East, Mandeville, and Slidell. Overall, CLARA results show that three areas are projected to have notably high levels of damage. The highest expected damages are projected in Slidell, followed by the city of Houma, and the River Parish community of Luling/Boutte.

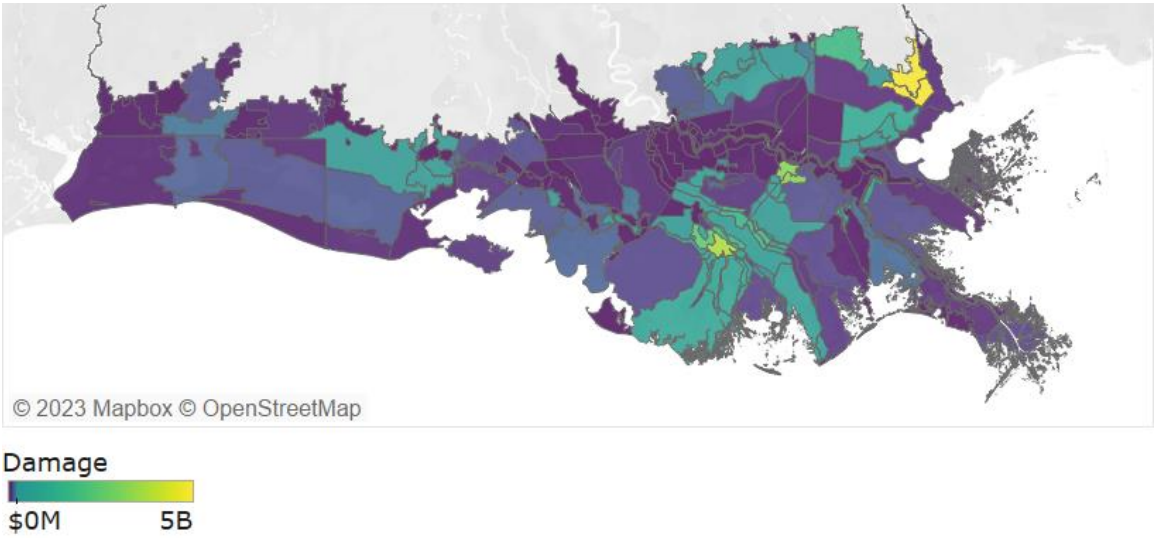

Figure 9. Modeled future economic damage for a Hurricane Rita-like storm simulated in the FWOA, S07, Year 50.

5.2 FUTURE WITH ACTION

In a FWA simulated in Year 50, CLARA results show that planned protection and restoration actions would have minimal impact on changing the overall coastwide damage footprint of a Hurricane Rita-like storm. However, significant reductions in damage are projected in Houma and the surrounding communities, as well as in Luling and Boutte, two census designated places located 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, Slidell, and Luling/Boutte, the locations with the highest projected damages in a FWOA, show the highest level of anticipated damage reduction (Figure 11).

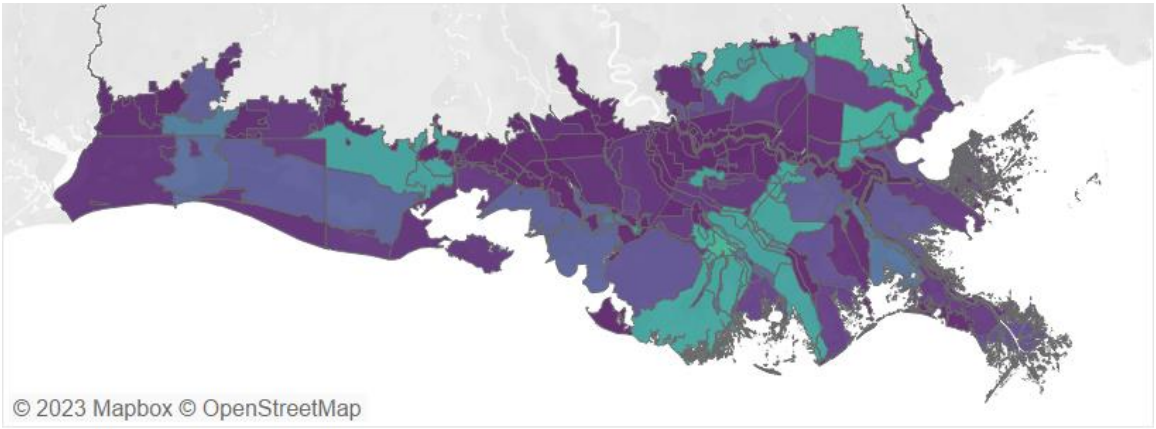

Figure 10. Modeled future economic damage for a Hurricane Rita-like storm simulated in the FWA, S07, Year 50.

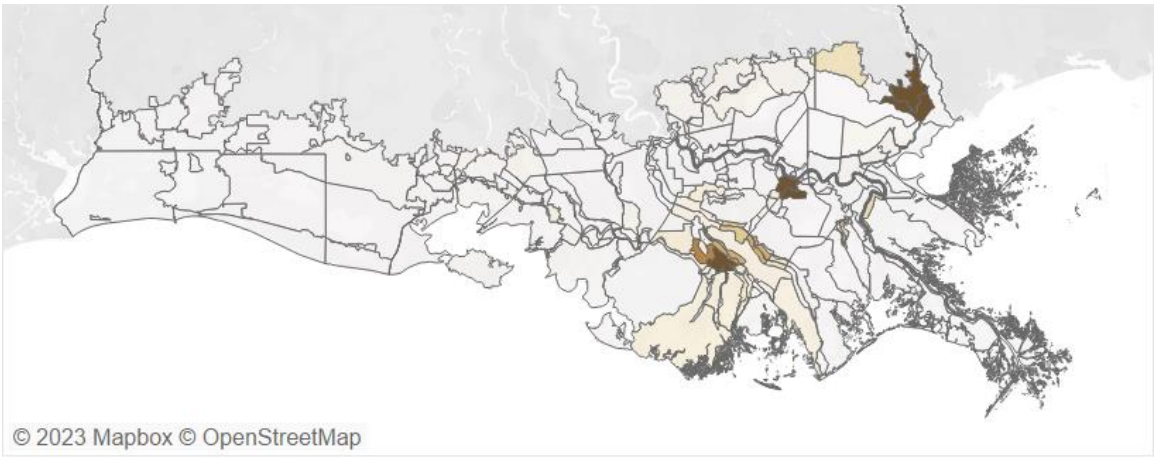

Figure 11. Change in modeled future economic damage between FWOA and FWA for a Hurricane Rita-like storm simulated in S07, Year 50.

Coastwide, CLARA results show that planned protection and restoration actions would effectively reduce the total amount of future economic damage from a Hurricane Rita-like storm by over $22.3 billion were the storm to make landfall in Year 50 (Table 9). Reflecting the social and economic profile of the potentially impacted areas, CLARA results project that 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 Rita-like storm in S07, Year 50

	Small Residential	Large Residential	Commercial and Industrial	Public and Educational	Grand Total
FWOA (Year 50)	$26,351M	$381M	$10,848M	$1,429M	$39,009M
FWA (Year 50)	$10,666M	$116M	$5,655M	$249M	$16,688M
Reduction in Damage Between FWOA and FWA (Year 50)	$15,684M	$264M	$5,193M	$1,180M	$22,321M

Mirroring the results of the ADCIRC+SWAN simulations, CLARA results found that the projected flood depth and damage resulting from a Rita-like storm event show a large amount of spatial variation in communities across the coast (Table 10). Unlike the ADCIRC+SWAN results, however, the amount of expected economic damage projected by CLARA 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 a Hurricane Rita-like storm would make landfall in Cameron Parish, the projected damage to each structure is expected to be relatively high. CLARA results project lower, but still notable, levels of damage in other communities with higher populations located farther from landfall, such as Delcambre and Dulac (Table 10). The expected damage under FWOA conditions for all of these communities is expected to sharply increase under FWOA conditions. However, CLARA simulations show that unlike Cameron, Delcambre and Dulac are projected to experience notable reductions in damage under FWA conditions.

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 most densely populated areas facing higher levels of flood exposure. For example, given the high population density of Lake Pontchartrain's North Shore communities in St. Tammany Parish, including Mandeville and Slidell, CLARA results project that a Hurricane Rita-like storm making landfall in Year 0 or in Year 50 will result in significant increases in flood damage relative to the expected surge and wave levels, despite this storm making landfall in southwest Louisiana. In a FWA, planned protection and restoration actions implemented in this area would be expected to result in significant damage reductions.

Table 10. Modeled total damage and change in damage to select coastal communities from a Hurricane Rita-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	$6M	$7M	$7M	-3%
Cameron	$180M	$323M	$329M	2%
Delacroix	$18M	$7M	$7M	2%
Delcambre	$15M	$112M	$17M	-85%
Dulac	$52M	$217M	$129M	-40%
Grand Isle	$62M	$59M	$61M	3%
Mandeville/Covington/Madisonville/ Abita Springs	$715M	$1,700M	$1,093M	-36%
Slidell/Eden Isle/Pearl River	$813M	$5,131M	$1,391M	-73%

6.0 REFERENCES

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