PortNOLA LIT
Flooding and Sea Level Rise Vulnerability Assessment Report

PortNOLA
Louisiana International Terminal

AECOM
Project number: 60664665

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Mr. Chris Gilmore
Director of Engineering
PortNOLA
1350 Port of New Orleans Pl
New Orleans, LA 70130

Quality information

Prepared by	Checked by	Verified by	Approved by
Brent Jones, PE *Structural Engineer* Jonathan McDowell, PE *Civil Engineer*	Taylor Nordstrom, PE *Coastal Engineer*	Bruce Lelong, PE *Design Manager*	Tom Hunter *Project Manager*

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Prepared for:

Mr. Chris Gilmore
Director of Engineering
PortNOLA
1350 Port of New Orleans Place
New Orleans, LA 70130

Prepared by:

Brent Jones, PE
Structural Engineer
O: 504.799.1367
M: 337.802.7583
E: brent.jones@aecom.com

Jonathan McDowell, PE
Civil Engineer
O: 225.922.5934
M: 504.450.9904
E: jonathan.mcdowell@aecom.com

AECOM
1555 Poydras St., Suite 1200
New Orleans, LA 70112
www.aecom.com

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1. Introduction

1.1 Purpose and Scope

AECOM has completed a technical review of current and future required design elevations for riverine and hurricane flood protection of the Mississippi River Levee (MRL) system within the vicinity of the proposed PortNOLA Louisiana International Terminal (LIT). The project site is located in St. Bernard Parish along the East Bank of the Mississippi River near River Mile 83. The wharf structure will be located over water, sited in the river with access bridge ramps providing connection to the landside terminal. Establishment of required design grades for both riverine and flood protection in the current and future conditions is critical to proper layout of terminal connections and operations while also reducing the risk to hurricane, riverine and interior flooding.

In addition to riverine and hurricane flood protection, a review of interior flood protection and drainage requirements has been performed to evaluate the basis of design parameters of the landside terminal features. Included in this review is confirmation of design storm events for sizing of drainage elements, Federal Emergency Management Agency (FEMA) base flood hazard elevation and recommended elevations for features of the landside terminal.

This technical memorandum summarizes the findings of the study and notes recommended design criteria and elevations for the LIT project. Risk analysis as dictated by the US Army Corps of Engineers (USACE) will be performed by others at a later date and will be documented in a separate report.

2. Waterfront Structure Design Elevations

2.1 Current and Future Riverine and Hurricane Flood Protection

The U.S. Army Corps of Engineers *Elevations for Design of Hurricane Protection Levees and Structures Report, Version 2.0*, 2014 (2014 DER) provides detailed documentation of the coastal and hydraulic engineering that has been performed to establish the required design elevations of the levee protection system within the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (GNO HSDRRS). Specifically, the report provides design elevations for the Lake Pontchartrain and Vicinity (LPV) reach of the GNO HSDRRS system which includes the project site. As referenced in the 2014 DER, the project site is located along the East Bank levee, River Mile 83 denoted as “83E-L” (Figure 1).

Design elevations are provided for two conditions:

- 1% Design Elevation which provides risk reduction from a hurricane event that would produce a 1% annual exceedance probability surge elevation and associated waves. This level of protection meets the hydraulic requirements for levee certification in accordance with the National Flood Insurance Program (NFIP). These design elevations are noted in Table 1 taken from the 2014 DER as provided below.
- 0.2% Resiliency Elevation which provides protection such that levees, and structures do not catastrophically breach when design criteria are exceeded from a hurricane event that would produce a 0.2% annual exceedance probability surge elevation and associated waves. Design for resilience also includes provisions for design of future conditions. These elevations are noted in Table 2 taken from the 2014 DER as provided below.

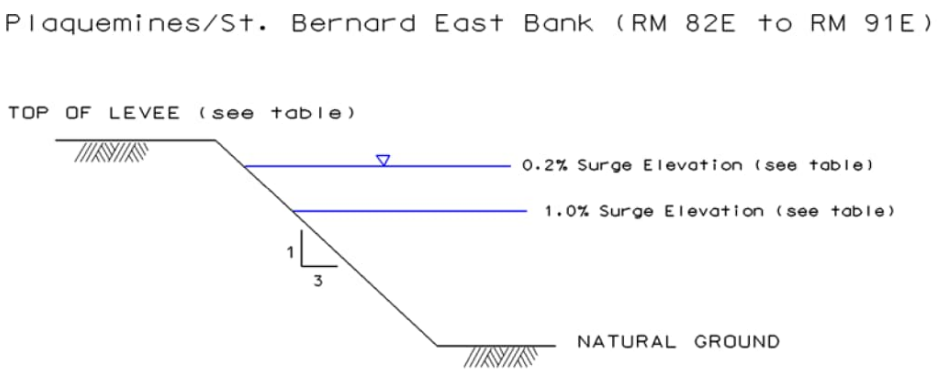

Figure 1. Typical Levee Design Cross-Section (RM 82E – RM 91E) – Plaquemines/St. Bernard Parish East Bank

Plaquemines/St. Bernard Parish East Bank (RM 82E to RM 91E) 1% Design Elevations							
Segment	Name	Type	Condition	Depth at Toe (ft)	Elevation (ft)	Overtopping Rate q50 (cfs/s per ft)	Overtopping Rate q90 (cfs/s per ft)
82E-L	St. Bernard EB	Levee	Existing	7.5	18.5	0.001	0.020
82E-L	St. Bernard EB	Levee	Future	10.3	21.0	0.001	0.022
83E-L	St. Bernard EB	Levee	Existing	6.4	18.5	0.001	0.020
83E-L	St. Bernard EB	Levee	Future	9.2	21.0	0.001	0.022

Table 1. Plaquemines/St. Bernard Parish East Bank (RM 82E – RM 91E) – 1% Design Information

Plaquemines/St. Bernard Parish East Bank (RM 82E to RM 91E) Resiliency Analysis (0.2% Event)						
Segment	Name	Type	Condition	1% Design Elevation (ft)	Best Estimates During 0.2% Event: Surge Level (ft)	Best Estimates During 0.2% Event: Overtopping Rate (cfs/s per ft)
82E-L	St. Bernard EB	Levee	Existing	18.5	17.9	1.130
82E-L	St. Bernard EB	Levee	Future	21.0	20.8	2.313
83E-L	St. Bernard EB	Levee	Existing	18.5	17.9	1.123
83E-L	St. Bernard EB	Levee	Future	21.0	20.7	2.246

Table 2. Plaquemines/St. Bernard Parish East Bank (RM 82E – RM 91E) – 0.2% Resiliency Information

The above referenced tables provide both data for what is termed the “current” design elevation and “future” design elevation at a 50% confidence level. In accordance with the 2014 DER, “current” refers to the required design elevation in year 2007 whereas the “future” design elevation is in year 2057 (50 years extrapolated into the future from 2007). The “future” condition includes estimated changes in surge elevation and wave characteristics due to regional subsidence and eustatic sea level rise – illustrated in Figure 2 below (GRR 2021). For LIT, construction completion of Phase 1 “opening day” is estimated to be 2028 and the basis of design life for the terminal is to be 50-years which places the “future” condition at year 2078 (an additional 21 years beyond the “future” conditions indicated in the 2014 DER). Therefore, the “future” elevations noted in Table 1 and 2 above do not represent the recommended future designs for this project with 50-year service life of year 2078 and are provided only for reference, as the figures are taken directly from the 2014 DER.

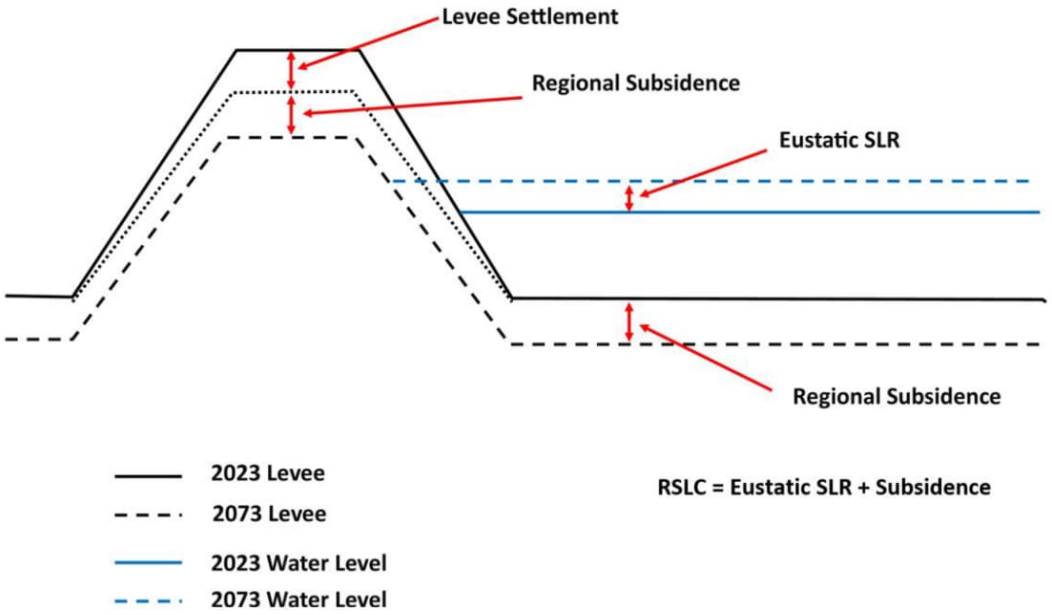

Figure 2. Reference Example of Combined Effect of Settlement, Subsidence and Sea Level Rise on Levee Systems

To determine the project-specific “future” condition at the required basis of design year 2078, guidance from the recently published U.S. Army Corps of Engineers *Lake Pontchartrain & Vicinity, Louisiana General Re-Evaluation Report with Integrated Environmental Impact Statement,* 2021 (2021 GRR) was reviewed. This document provides criteria relative to relative sea level change (RSLC) which is defined as the local change in sea level relative to the elevation of the land at a specific point on the coast. RSLC includes a combination of eustatic sea level rise and regional subsidence. The 2021 GRR considers three scenarios for RSLC including low, intermediate, and high from 2023 to 2123. The variation in RSLC for each scenario is represented graphically in Figure 3 below.

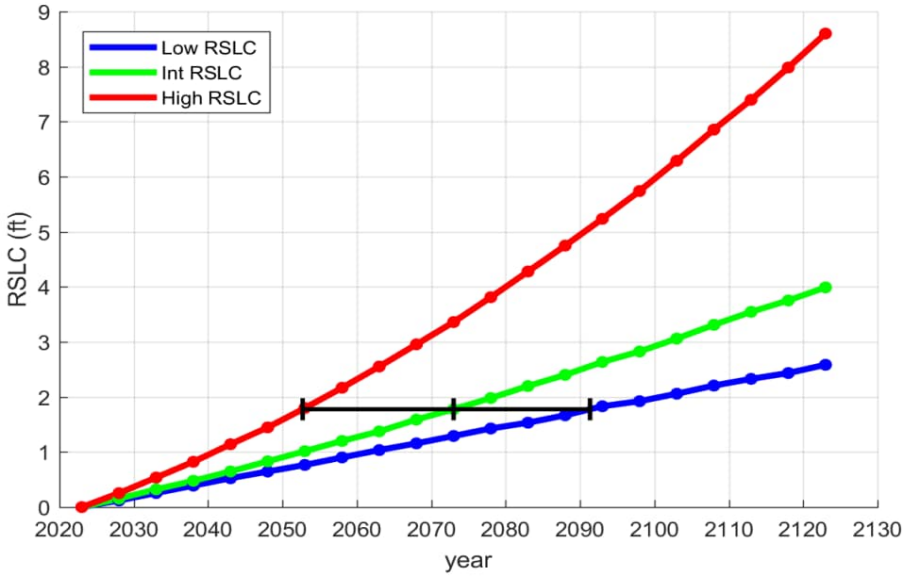

Figure 3. Reference Low, Intermediate and High RSLC Projections

Following the procedures outlined in the 2021 GRR, average RSLC projections utilizing data from seven regional USACE gage stations can be estimated using USACE and NOAA criteria. Averaging the gage data instead of using the nearest gage to the project site is recommended due to the uncertainties with the tidal gage method used to estimate RSLC. A graphical reference of this including the seven regional gage locations is noted in Figure 4.

Location	Rate of Ground Movement (mm/yr)	Subsidence over 50 Years (ft)	Projected RSLC from 2023 to 2073		
			Low (ft)	Int (ft)	High (Ft)
Lake Pontch West End (85625)	7.11	1.2	1.4	1.9	3.5
Rigolets (85700)	3	0.5	0.7	1.2	2.9
IHNC (76160)	8.77	1.4	1.7	2.2	3.8
Bayou Barataria (82750)	5.3	0.9	1.2	1.6	3.2
IHNC lock (01340)	5.1	0.8	1.1	1.6	3.2
MS River Carrolton (01300)	5.4	0.9	1.2	1.7	3.2
MRGO Shell Beach (85800)	8.5	1.4	1.7	2.2	3.7
average:	6.2	1.0	1.3	1.8	3.4

Figure 4. Reference RSLC Projections Using Seven Regional Gages

To aid in the determination of these parameters for a given time period, a web-based calculator has been developed by USACE which utilizes criteria outlined in EM 1165-2-212 *Sea-Level Change Consideration for Civil Works Programs.* AECOM utilized this calculator (Version (2022.72) to determine the estimated range of RSLC for the 2028 – 2078 terminal life of 50 years. For these calculations, a subsidence rate of 6.2 mm/yr was used as per Appendix C – Hydrology & Hydraulics of the 2021 GRR, which is the average rate of ground movement averaged over the seven regional gage locaitons. The following estimates were calculated:

- RSLC from year 2028 – 2078 (50-years)
  - NOAA High: 4.4 ft
  - USACE High: 3.6 ft
  - NOAA Intermediate/High: 3.0 ft
  - USACE Intermediate: 1.9 ft
  - NOAA Intermediate Low: 1.9 ft (Note same as USACE Intermediate)
  - USACE Low: 1.3 ft
  - NOAA Low: 1.3 ft (Note same as USACE Low)

The next step in determining the "future" required design elevation for hurricane flood protection of the MRL at the project site is then to project the "current" levee design elevation outlined in the 2014 DER to final basis of design project year 2078 (2028 opening day + 50 year service life). Per PortNOLA's guidance, the USACE High scenario was selected to estimate the year 2078 elevations. Since the available design elevations in Tables 1 and 2 are from HSDRSS conditions existing in 2007, the RSLC from 2007 – 2078 needs to be calculated first and added to the 2007 design elevations to obtain the future 2078 elevations. The following Table 3 shows the RSLC values for the three USACE scenarios calculated using the web-based calculator mentioned above. Note that one may recover the 2028 – 2078 values as shown in the table above by subtracting the 2027 (used as an approximation, as 2028 is not shown due to the table being digitized at every 5 years) values from 2078. For example, for the High scenario, the RSLC between 2028 – 2078 is 5.0-1.4=3.6 ft. Note that the table uses a 6.2mm/yr subsidence rate as explained above and shows discrete results every 5 years as computed using the web-based USACE calculator and following USACE EC 1165-2-212 curves, shown as continuous lines in Figure 5 below.

USACE Curves computed using criteria in USACE EC 1165-2-212

Gauge User Entered Values All values are in feet			
Year	USACE Low	USACE Int	USACE High
1992	0.0	0.0	0.0
1997	0.1	0.1	0.1
2002	0.3	0.3	0.3
2007	0.4	0.4	0.5
2012	0.5	0.6	0.7
2017	0.6	0.7	0.9
2022	0.8	0.9	1.1
2027	0.9	1.0	1.4
2032	1.0	1.2	1.6
2037	1.2	1.3	1.9
2042	1.3	1.5	2.2
2047	1.4	1.7	2.5
2052	1.6	1.9	2.9
2057	1.7	2.1	3.3
2062	1.8	2.2	3.6
2067	1.9	2.4	4.0
2072	2.1	2.6	4.4
2077	2.2	2.8	4.9
2078	2.2	2.9	5.0

Table 3. RSLC for USACE Scenarios Plaquemines

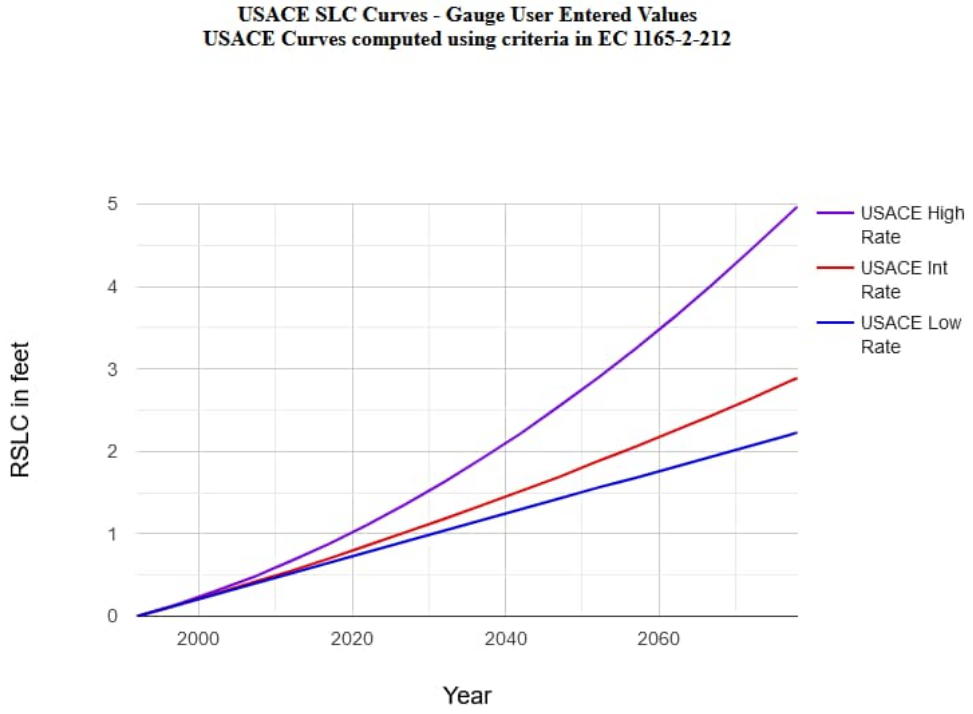

Figure 5. USACE RSLC Curves for 1992-2078 Time Period

Following this approach, the RSLC from 2007 – 2078 becomes:

- RSLC from year 2007 – 2078 (71 years)
  - USACE High: 5.0 ft (at 2078) – 0.5 ft (at 2007) = 4.5 ft

Therefore, given the above criteria, the following design elevations are estimated for the project site:

- "Current" Levee Design Elevation (year 2007) = 18.5 ft, NAVD88
- "Future" Design Elevation (year 2078) = 18.5 ft + 4.5 ft
  = **23.0 ft, NAVD88**

It should be noted that the current levee design elevation from USACE considers wave runup and overtopping rates. To estimate the future levee design height, RSLC is added to the composite design elevation in "current" conditions and does not account for any specific change or increase to runup and overtopping rates. Also, the "current" levee design elevation provides protection from riverine flooding only and not specifically protection from hurricane events and storm surge. Rather, this elevation is established by USACE from the 1973 MRL project grade. The "future" hurricane and storm protection elevations for the levee system have not yet been published by USACE; therefore, AECOM recommends the above referenced procedure to estimate the future conditions in the absence of additional models or data available to account for the impacts from hurricanes and storm surge.

The design team including AECOM, PortNOLA and HDR have previously met with USACE April 4, 2022, to discuss this issue. During the meeting, it was informally noted that USACE is targeting a levee raising and flood wall extension project with a "future" flood protection design elevation in the order of 22.5 ft, NAVD88. Therefore, the recommended future design elevation of 23.0 ft, NAVD88 for the project appears to be justified. Final future flood protection elevation must be confirmed in writing with USACE early in the design phase to ensure proper level of protection is provided and constructed in this project and to avoid rework should the criteria be revised by USACE.

2.2 Minimum Waterfront Structure Design Elevation

In addition to hurricane flood protection requirements of the MRL system, protection against riverine flooding of the river must also be established. AECOM has reviewed the criteria at the location of the LIT site with the U.S. Army Corps of Engineers and they have provided the following based on historical records of 1973:

- Levee Design Elevation = 19.7 ft, NAVD88 (4-feet above flowline)
- MS River Flowline = 15.7 ft, NAVD88
- Minimum Elevation Bottom of Structure = 16.7 ft, NAVD88
- Minimum Elevation Top of Structure = 16.7 ft, NAVD88 + Structure Depth

Note that top elevation of the wharf and access bridge ramp structures for the LIT project will be variable depending on overall depth of structure based on design requirements but in all cases will be set with the bottom of primary structure at minimum elevation 16.7 ft, NAVD88. Ancillary features such as fender panel assemblies, concrete extension at face of wharf to mount fender panels and utility vaults will by their nature extend below the 16.7' elevation. The top of structure design elevation will also consider drainage slopes of 1% minimum and grade elevations required for the access bridge ramps. Preliminary design of the wharf updated at 30%-level indicates that the maximum depth of the primary structure will be on the order of 6 ft. Therefore, the top of structure should be approximately 22.7 ft, NAVD88 minimum. The 30% design sets the top of wharf at riverside face to be 24.0 ft and with a 1% drainage slope over the full proposed 220-foot overall width of wharf, the top elevation of the wharf at the landside edge is 26.2 ft, NAVD88. These elevations are also 1-ft above the future flood protection height of 23.0, NAVD88 such that the top of wharf deck will be protected from flooding during hurricane event with a minimum of 1-ft of additional freeboard.

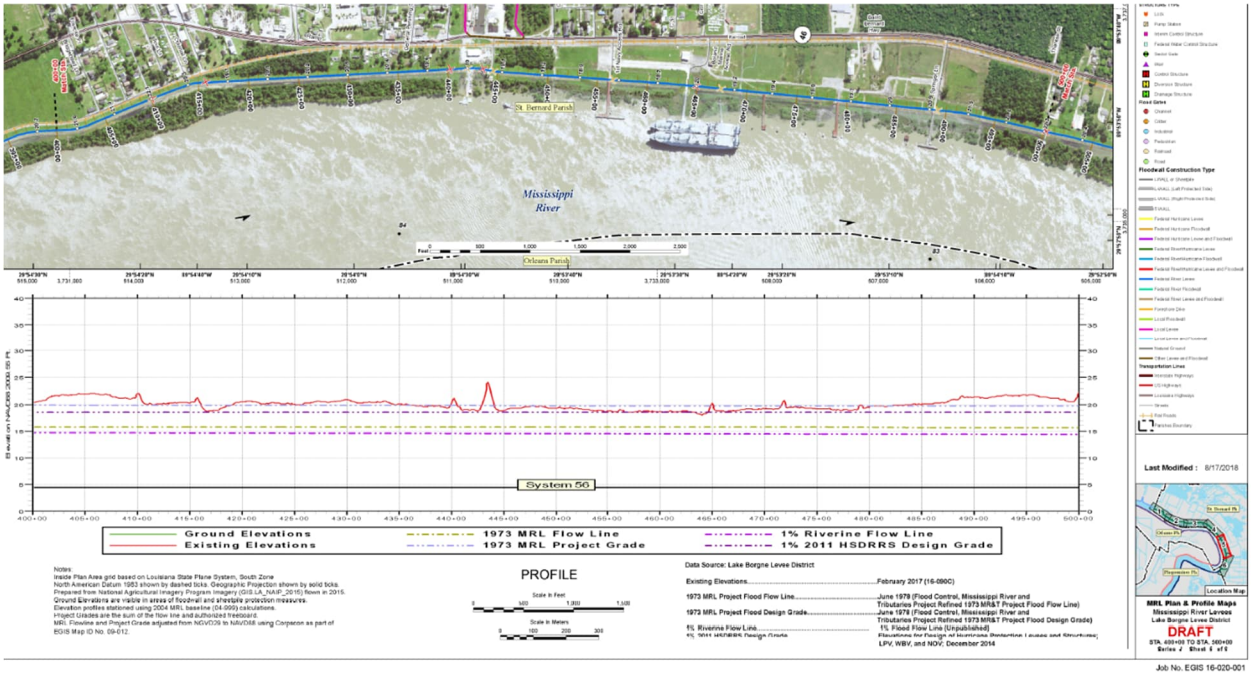

Figure 6. MRL Plan & Profile Indicating 1973 Flowline and Levee Project Grades

As can be seen, the minimum elevations for the top of structure required for riverine flood protection are lower than those required for hurricane storm protection. The hurricane storm protection elevations will therefore control the required design elevation of structures and ramps crossing and/or supported atop the levee. However, as previously stated, an important design parameter related to these elevations is that the low chord of primary structures within the river must also generally be sited one foot above the MS River Flowline per USACE criteria. Therefore, all major components of the wharf and access bridge ramps must

be set with “low chord” elevation and depth of structure such that the river flowline is not excessively impeeded.

Note that obstruction to the flow of water due to the presence of port structures projecting into the river or on the river bed (e.g., piles, dolphins, etc.) can cause slight water level rise along the left descending bank in the near-field area of the terminal. While the rise in water level is not significant from a flood design standpoint, the local changes in velocity may be of interest for port vessel traffic. A numerical model resolving the port structures in the river stream flow will be applied to evaluate such effects during the design phase and outlined in a future deliverable.

3. Interior Flood Protection

3.1 FEMA Flood Requirements

FEMA establishes the 1% Annual Exceedance Probability (AEP) flood elevation (100-year flood), also known as the “Base Flood Elevation” (BFE) for areas that have a 1% chance of equaling or exceeding this elevation in any given year. Special Flood Hazard Areas subject to inundation by the 1% annual chance of flood are defined in Zones A, AE, AH, AO, AR, A99, V and VE. Zone X is defined as “other flood areas,” including those with 0.2% annual chance of flood, areas of 1% annual chance of flood with average depth of less than 1-ft or with drainage areas less than 1-square mile, and areas protected by levees from 1% annual chance of flood.

For the LIT site location, the National Flood Insurance Program (NFIP), Flood Insurance Rate Map (FIRM) is described by Map No. 22087C0494D with an effective date of December 21, 2017 (included in Appendix A.2 of this report). Figure 7 below provides an illustrative example of the FIRM that shows the variation in FEMA Flood Zone and BFE across the site. Areas of the site that are closer to the MRL and East St. Bernard Highway are defined as Zone X, whereas areas of the site toward the east, near and along Judge Perez Dr., are defined as Zone AE. The lowest Zone AE BFE is noted to be 1 ft at the eastern edge of the site and the highest Zone AE BFE is noted to be 5 ft at the western edge of the site near the MRL.

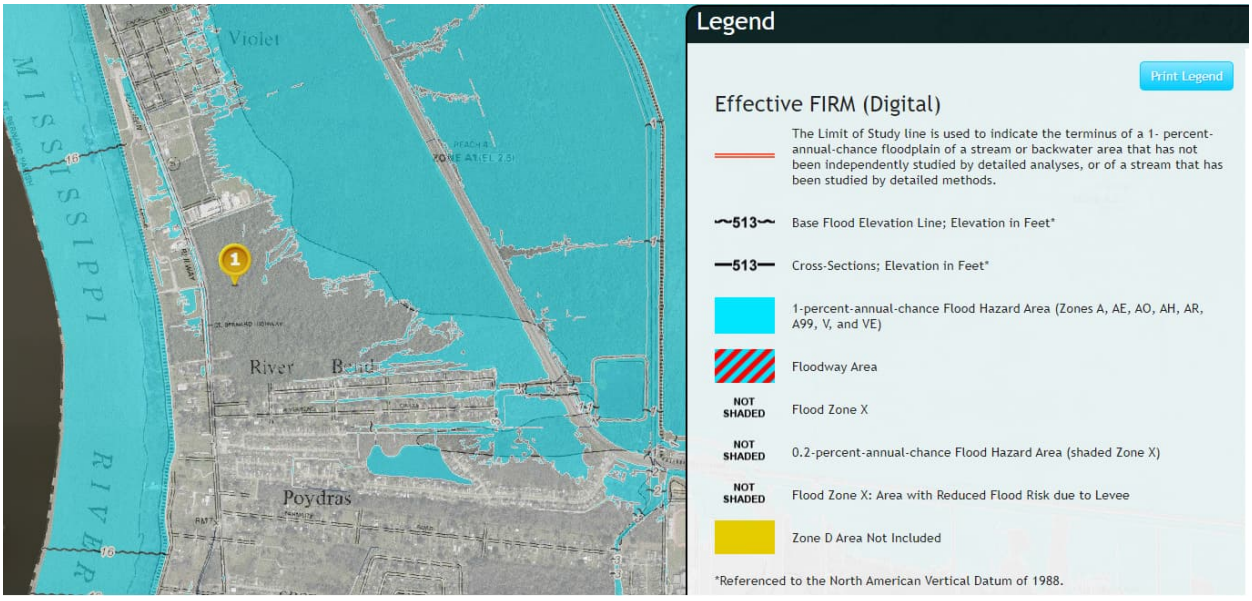

Figure 7. Project Site FEMA Digital FIRM

In addition to Mississippi River federal levee system on the west side of the site, the east side of the site is bounded by the Lake Borgne Basin Levee District (LBBLD), the HSDRRS levee fronting the Mississippi River Gulf Outlet canal (MRGO), and the non-federal, 40-Arpent Canal back levee (see Figure 8).

Consideration of the back levees with regard to interior drainage and flood mitigation will be included in the design. A key component of the proposed drainage system for the terminal development will be to design and construct a drainage network and associated pump stations necessary to adequately drain and protect the site without direct reliance on adjacent Parish infrastructure such as existing pump stations.

Figure 8. Levee System Surrounding Project Site

3.2 Landside Terminal Building and Site Structure Design Elevations

Design elevation for building and site structures at the landside terminal will consider the BFE established in the FEMA FIRM for the site as well as additional freeboard. Freeboard is an additional height above BFE used as a factor of safety against flooding to compensate for potential unknown factors that could contribute to flood heights greater than that calculated for a given site and flood event.

Freeboard above base flood elevation is not specifically required by FEMA NFIP standards; however, guidance for freeboard is provided in other reference documents and codes. The following references provide freeboard design guidance relevant to the LIT site:

- International Building Code, 2021 referencing ASCE 24-14 *Flood Resistant Design and Construction*
  - Freeboard defined by use or occupancy of buildings and structures per Table 2-1 below. Generally defined from 1-low risk, 2-moderate risk, 3-high risk, and 4-essential structures.

Table 2-1 Minimum Elevation of the Top of Lowest Floor—Flood Hazard Areas Other Than Coastal High Hazard Areas,[a] Coastal A Zones,[a] and High Risk Flood Hazard Areas[a]

Flood Design Class[b]	Minimum Elevation, Relative to Base Flood Elevation (BFE) or Design Flood Elevation (DFE)
1[c]	DFE
2[d]	BFE + 1 ft or DFE, whichever is higher
3[d]	BFE + 1 ft or DFE, whichever is higher
4[d]	BFE + 2 ft or DFE, or 500-year flood elevation, whichever is higher

- St. Bernard Parish Code Revisions, Chapter 10.5-32 – Specific Standards
  - *"Nonresidential construction. New construction and substantial improvements of any commercial, industrial or other nonresidential structure shall either have the lowest floor (including basement)* ***elevated to or above the base flood elevation plus an additional eighteen (18) inches of freeboard.****"*
- Louisiana Coastal Master Plan, 2017
  - *In response to recent devastating flood events and the ongoing challenges facing the National Flood Insurance Program, there has been an increased focus across the nation on lowering communities' future flood risk in order to lower future disaster recovery costs. In January 2015, President Obama issued Executive Order 13690, which proposed a new Federal Flood Risk Management Standard. The goal of the policy is to lessen the impacts of climate change and to increase the resilience of communities. Federal agencies are afforded flexibility in determining how to implement the recommended standards, which include several methods for determining the floodplain:*
    - *Utilizing data and methods informed by best available, actionable climate science that integrates current and future changes in flooding.*
    - ***Building 2-feet above the 100-year (1% annual chance) BFE for most standard projects and 3-feet above BFE for critical buildings, such as hospitals and evacuation centers.***
    - *Building to the 500-year (0.2% annual chance) flood elevation for critical infrastructure.*

The typical practice for Louisiana Department of Transportation and Development (LADOTD) roadways is to set the lowest elevation of the road pavement at 1 foot above the 50-year design storm elevations for roads with annual average daily traffic (AADT) above 3,000 vehicles per day. All roads providing access to the LIT should be designed to the same criteria.

The Norfolk Southern Railway Company requires that ditches adjacent to their railroad bed be able to hold a 100-year design storm. Culverts crossing railroad tracks shall have a minimum diameter of 36 inches. The minimum elevation of the railyard will be set such that the BFE will be provided at the top of subgrade. Throughout the extents of the loading platform, the rails shall be flat or 0% grade. Lead tracks approaching the yard shall be constructed to raise the tracks into the yard.

The minimum elevation of the container yard shall be 1 foot above the BFE. Finished floor elevations of buildings shall be 2 feet above BFE or at least 1 foot above the site elevation in the vicinity of the building, whichever is higher.

Additionally, critical infrastructure as identified in coordination with the Port and Terminal Operator shall be considered as essential structures and the minimum elevation shall be established as 3 feet above BFE or the 500-year flood elevation, whichever is higher. Examples of critical and essential infrastructure include electrical systems, communications, operations buildings, and emergency standby power systems.

These criteria are summarized below in Table 4.

Recommended Design Criteria for Landside Terminal Building and Site Structures		
System Feature	Guidance	Design Criteria
Elevation of roadways	LADOTD	1 ft above 50-year design storm elevation
Railroad bed ditch conveyance	Norfolk Southern Railway Company	100-year design storm
Railroad culverts		36” minimum diameter
Elevation of railyard		Top of subgrade to match BFE
Elevation of container yard	IBC 2021 and ASCE 24-14	1 ft above BFE
Finished floor elevations	IBC 2021 and ASCE 24-14	2 ft above BFE or 1 ft above grade, whichever is higher
Critical and essential infrastructure	CPRA 2017 Master Plan	3 ft above BFE or 500-year flood elevation, whichever is higher

Table 4. Recommended Design Criteria for Landside Terminal

Refer to the Louisiana International Terminal Drainage Report for additional information and criteria.

3.3 Impact of Future Conditions on Interior Drainage and Flooding

The intent of the project design will be to provide an interior drainage system that is sized appropriately for current and future conditions (year 2028 and 2078, respectively) of rainfall and stormwater management. Refer to the Louisiana International Terminal Drainage Report for additional information and criteria.

4. Interior Drainage

4.1 General Approach

The general approach to drainage will be to apply relevant codes, standards, guidelines, data, and methods for conducting the drainage study to identify improvements for construction of the terminal and to comply with Authority Having Jurisdiction (AHJ) design standards.

Refer to the Louisiana International Terminal Drainage Report for additional information and criteria.

5. Closing

The above information represents the results of AECOM’s flooding and sea level rise vulnerability study and the proposed basis of design for the LIT project. The criteria and recommendations herein are not intended to be all-inclusive and may be updated and/or revised as more data becomes available throughout the design phase. With Port and the program management team (PMT) concurence, these parameters will be documented in the project Basis of Design (BOD) Report for reference in the project design phases.

Should you have any questions or comments, please do not hesitate to contact us.

6. References

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U.S. Army Corps of Engineers (USACE), Engineering Manual 1165-2-212, *Sea-Level Change Considerations for Civil Works Programs,* 1 October 2011. Retrieved from: https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html

Yarnell, D.L., U.S. Dept. of Agriculture, *Rainfall Intensity-Frequency Data,* 1935.

Appendix A Reference Data

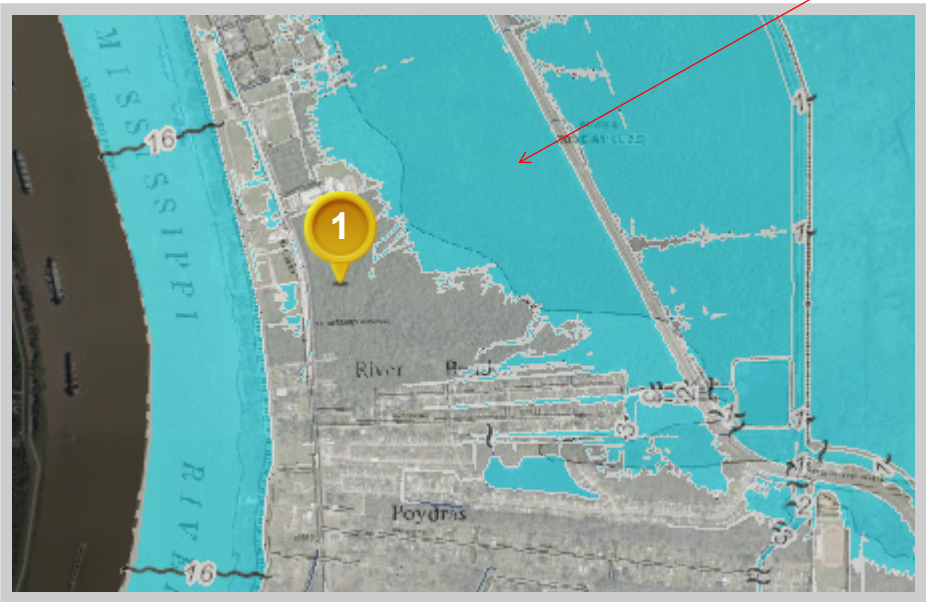
A.1 FEMA FIRM Reference Data

Email Print

Louisiana Flood Map

LIT

See Larger Map on Next Page for approximate Port property boundary



Visible Layers

- Effective FIRM
- Historical FIRM
- Bing Aerial

Point Coordinates

Point #	Lat., Long.
1	29.8867, -89.895

Flood information in this table is from the: Effective FIRM

Point	Panel ID	Flood Zone	BFE	Ground Elevation	LOMR
1	22087C0494D 12/21/2017	X-0.2 PCT ANNUAL CHANCE FLOOD HAZARD	out	2.9	N/A

Flood information in this table is from the: Historical FIRM

Point	Panel ID	Flood Zone	BFE	Ground Elevation	LOMR
1	No digital data.			2.9	

1. ***Ground Elevation*** *is provided by USGS's elevation web service which provides the best available data for the specified point. If unable to find elevation at the specified point, the service returns an extremely large, negative value (-1.79769313486231E+308).*

Floodplain data that is shown on this map is the same data that your flood plain administrator uses. This web product is not considered an official FEMA Digital Flood Insurance Rate Map (DFIRM). It is provided for information purposes only, and it is not intended for insurance rating purposes. Please contact your local floodplain administrator for more information or to view an official copy of the FIRM or DFIRM.

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0 North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map Louisiana State Plane south zone (FIPSZONE 1702). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided and/or extracted in digital format from the LaDOTD, USGS, NLCOG, Louisiana Office of State Lands, St. Bernard Parish GIS Department, and the NGS.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

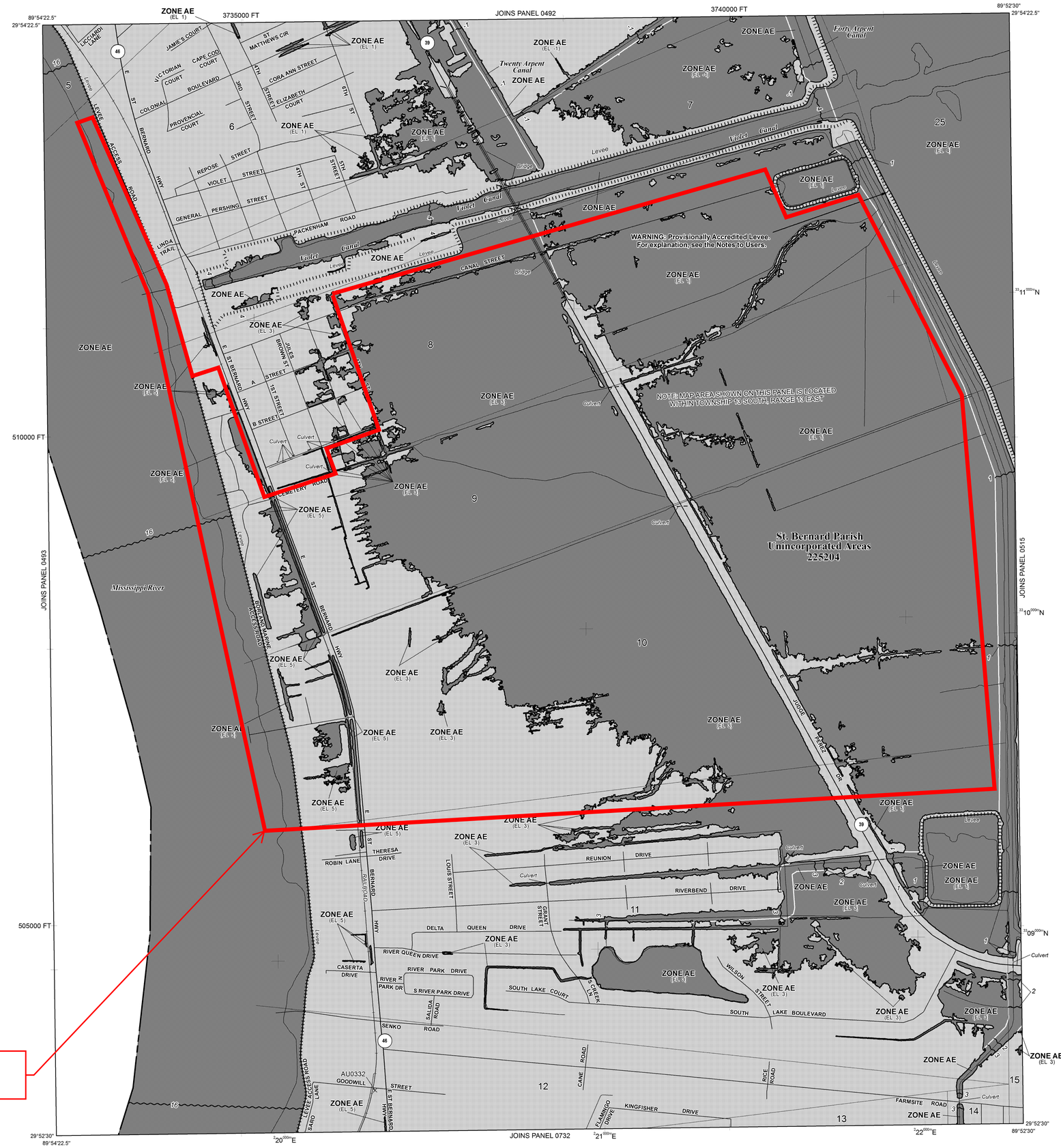
Please refer to the separately printed **Map Index** for an overview map of the parish showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, or how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange (FMIX) at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/national-flood-insurance-program.

Accredited Levee Notes to Users: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA website at http://www.fema.gov/national-flood-insurance-program.

Provisionally Accredited Levee Notes to Users: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicate the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at http://www.fema.gov/national-flood-insurance-program.



All areas landward of the Mississippi River Levee or inside the HSDRRS levees on this panel are protected from the Mississippi River and Gulf of Mexico 1% annual chance flood by levee, dike, or other structure subject to failure during larger floods. Overtopping or failure of any levee system is possible. For additional information, see the "Accredited Levee Note" in Notes to Users.

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
	Limit of Moderate Wave Action
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

A A	Cross section line
23 23	Transect line
	Culvert, Flume, Penstock or Aqueduct
	Road or Railroad Bridge
	Footbridge
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
2476000mN	1000-meter Universal Transverse Mercator grid values, zone 16N
600000 FT	5000-foot grid values: Louisiana State Plane coordinate system, South zone (FIPSZONE 1702), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF PARISHWIDE FLOOD INSURANCE RATE MAP
December 21, 2017

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to parishwide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0494D

FIRM

FLOOD INSURANCE RATE MAP

ST. BERNARD PARISH, LOUISIANA
(ALL JURISDICTIONS)

PANEL 494 OF 1250

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ST. BERNARD PARISH	225204	0494	D

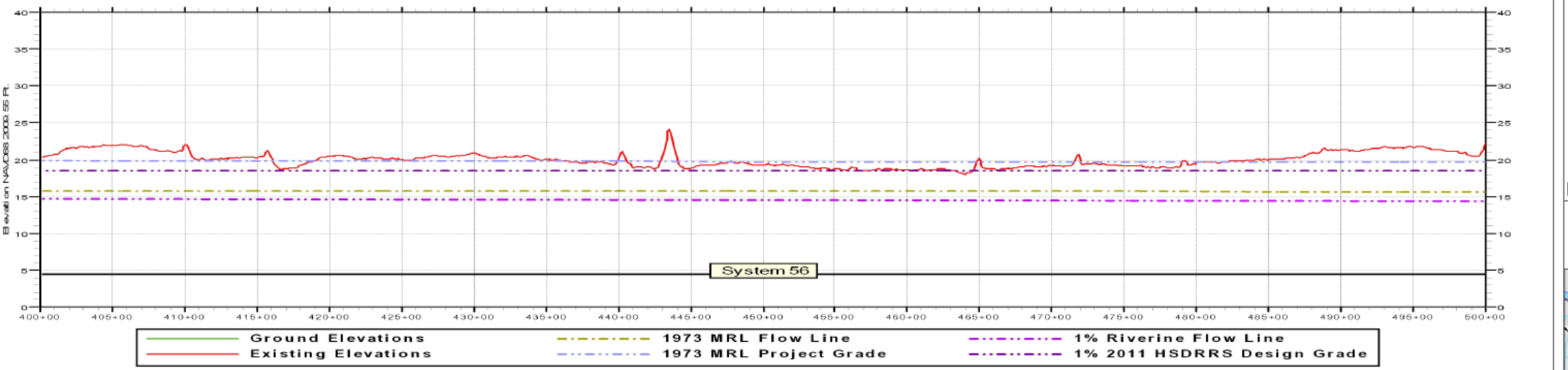
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
22087C0494D

EFFECTIVE DATE
DECEMBER 21, 2017

Federal Emergency Management Agency

29°54'30"N 515,000 3,731,000 | 29°54'20"N 514,000 89°54'40"W | 29°54'10"N 513,000 | 29°54'0"N 512,000 | 89°54'30"W 511,000 | 29°53'40"N 510,000 3,733,000 | 29°53'30"N 89°54'20"W | 29°53'20"N 508,000 | 29°53'10"N 507,000 | 89°54'10"W 506,000 | 29°52'50"N 505,000



Notes:
Inside Plan Area grid based on Louisiana State Plane System, South Zone
North American Datum 1983 shown by dashed ticks. Geographic Projection shown by solid ticks.
Prepared from National Agricultural Imagery Program Imagery (GIS.LA_NAIP_2015) flown in 2015.
Ground Elevations are visible in areas of floodwall and sheetpile protection measures.
Elevation profiles stationed using 2004 MRL baseline (04-999) calculations.
Project Grades are the sum of the flow line and authorized freeboard.
MRL Flowline and Project Grade adjusted from NGVD29 to NAVD88 using Corpscon as part of EGIS Map ID No. 09-012.

PROFILE

Scale in Feet
0 500 1,000 1,500

Scale in Meters
0 100 200 300

Data Source: Lake Borgne Levee District

Existing Elevations.....February 2017 (16-090C)

1973 MRL Project Flood Flow Line.....June 1978 (Flood Control, Mississippi River and Tributaries Project Refined 1973 MR&T Project Flood Flow Line)

1973 MRL Project Flood Design Grade.....June 1978 (Flood Control, Mississippi River and Tributaries Project Refined 1973 MR&T Project Flood Design Grade)

1% Riverine Flow Line.....1% Flood Flow Line (Unpublished)

1% 2011 HSDRRS Design Grade.....Elevations for Design of Hurricane Protection Levees and Structures; LPV, WBV, and NOV; December 2014

Structure Type
- Lock
- Pump Station
- Interim Control Structure
- Federal Water Control Structure
- Sector Gate
- Weir
- Control Structure
- Diversion Structure
- Drainage Structure

Flood Gates
- Channel
- Critter
- Industrial
- Pedestrian
- Railroad
- Road

Floodwall Construction Type
- I-WALL or Sheetpile
- L-WALL (Left Protected Side)
- L-WALL (Right Protected Side)
- T-WALL

- Federal Hurricane Levee
- Federal Hurricane Floodwall
- Federal Hurricane Levee and Floodwall
- Federal River/Hurricane Levee
- Federal River/Hurricane Floodwall
- Federal River/Hurricane Levee and Floodwall
- Federal River Levee
- Federal River Floodwall
- Federal River Levee and Floodwall
- Foreshore Dike
- Local Floodwall
- Local Levee
- Local Levee and Floodwall
- Natural Ground
- Other Levee and Floodwall

Transportation Lines
- Interstate Highways
- US Highways
- Louisiana Highways
- Streets
- Rail Roads
- Parishes Boundary

Last Modified : 8/17/2018

MRL Plan & Profile Maps
Mississippi River Levees
Lake Borgne Levee District
DRAFT
STA. 400+00 TO STA. 500+00
Series 4 Sheet 5 of 9

Job No. EGIS 16-020-001

AECOM
1555 Poydras St., Suite 1200
New Orleans, LA 70112
www.aecom.com