PIANC

AIPCN-France

Système de protection de la Nouvelle Orléans contre les tempêtes cycloniques : Katrina, ses impacts et le nouveau système de défense en voie d'achèvement

Geoffroy Caude , Président AIPCN

PIANC

AIPCN-France

Le diaporama ci-après a été présenté par Geoffroy Caude à la section française AIPCN-France le 24 février 2012

Il reprend notamment des éléments présentés lors de la conférence SmartRivers 2011 de PIANC et lors des journées scientifiques et techniques du CETMEF en 2006

Des informations complémentaires sont disponibles sur le site suivant du ministère de la Défense des USA:

http://www.mvn.usace.army.mil/hps2/

Système de protection de la Nouvelle Orléans contre les tempêtes cycloniques : Katrina , ses impacts et le nouveau système de défense en voie d'achèvement

sources CETMEF JST 2006
John Headland Moffat and Nicholl
AIPCN Smart Rivers 2011

Geoffroy Caude , Président AIPCN

Sommaire

1- Le cyclone Katrina

2- Le système de protection anti-cyclonique antérieur

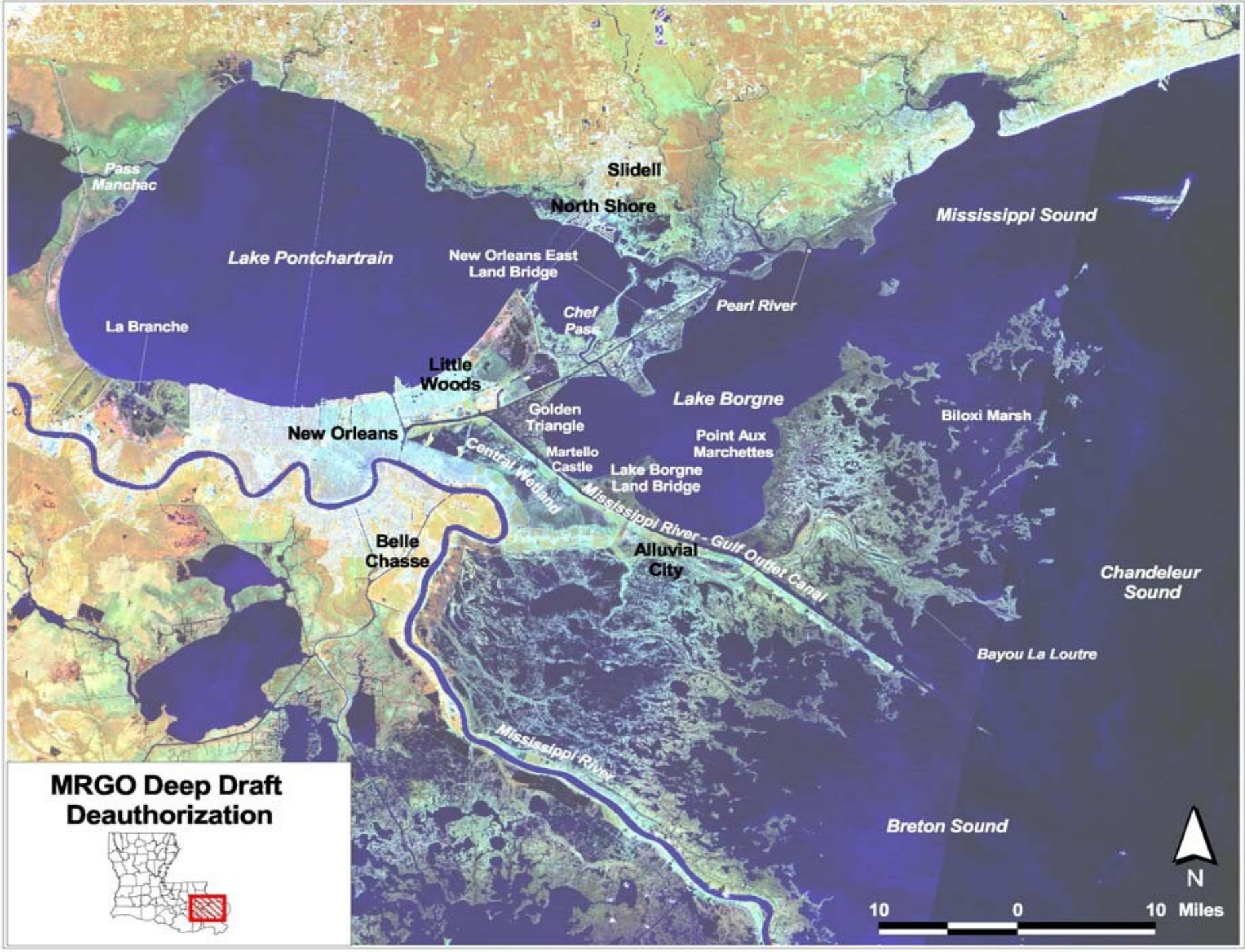
3 - Effets du cyclone Katrina

4- Le projet de GNOHSRRS

5- Les travaux et leurs conditions de succès

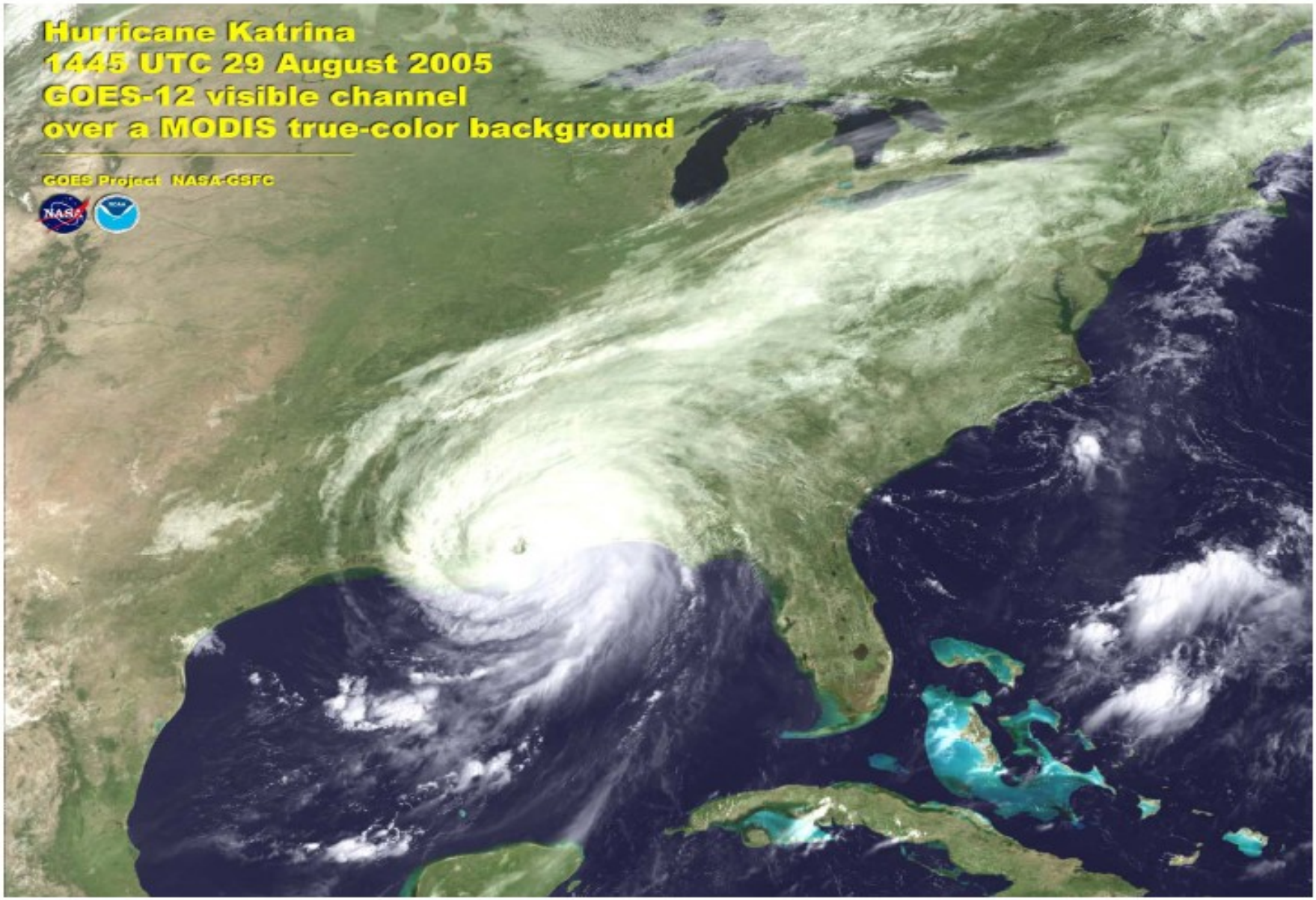
6- Des questions à approfondir

Plan de situation de la côte de Louisiane

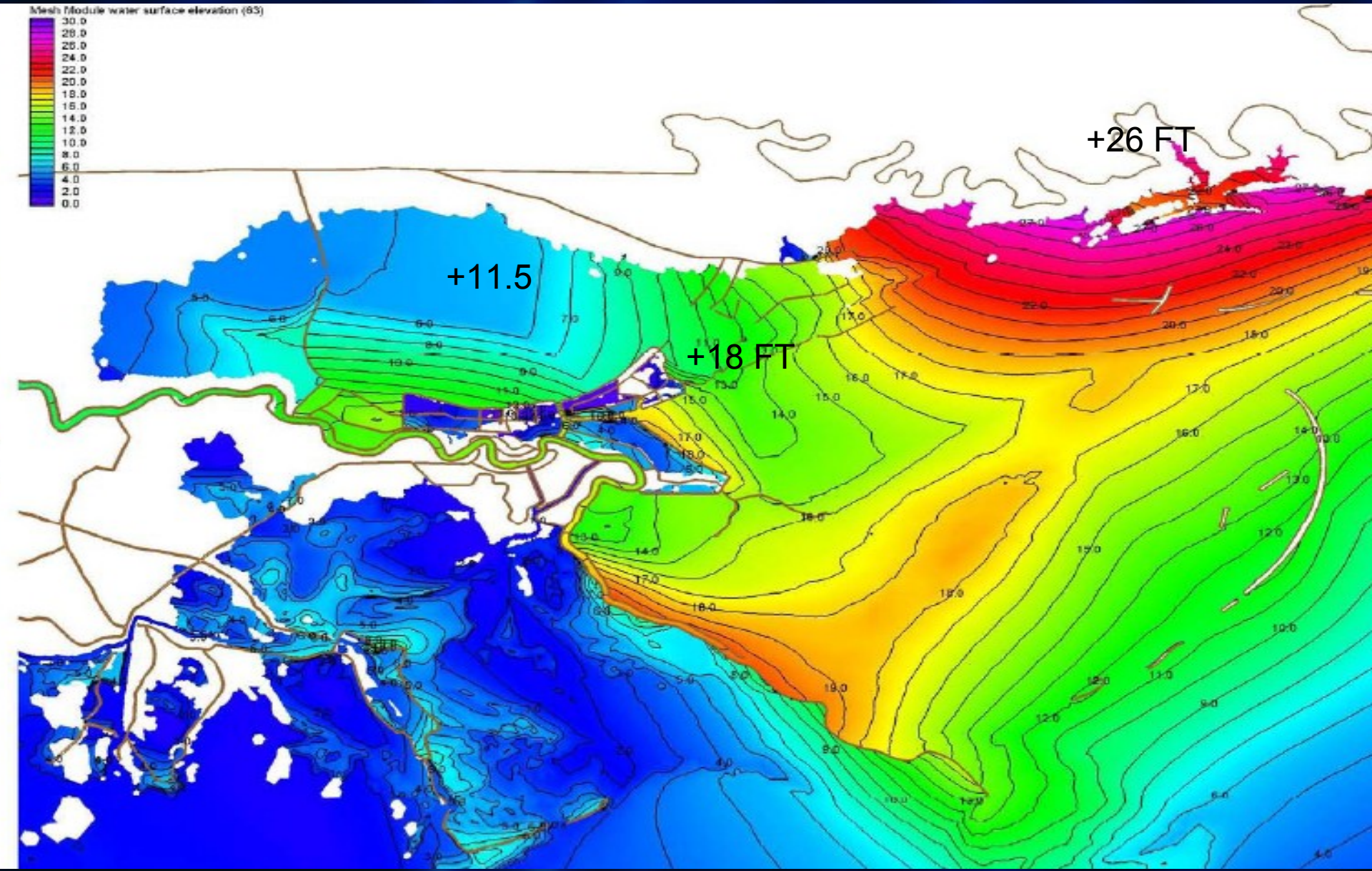

Pass Manchac
Slidell
North Shore
Mississippi Sound
Lake Pontchartrain
New Orleans East Land Bridge
Pearl River
Chef Pass
La Branche
Little Woods
Lake Borgne
Golden Triangle
Biloxi Marsh
New Orleans
Point Aux Marchettes
Martello Castle
Lake Borgne Land Bridge
Central Wetland
Mississippi River - Gulf Outlet Canal
Belle Chasse
Alluvial City
Chandeleur Sound
Bayou La Loutre
Mississippi River
Breton Sound
MRGO Deep Draft Deauthorization
N
10 0 10 Miles


Mississippi River-
Gulf Outlet, LA
New Orleans
Mi. 60
Lake
Borgne
36' x 500'
Channel
Jetties
Breton
Sound
Mississippi
River
38' x 600'
Channel
Gulf of
Mexico

1- Le cyclone Katrina



Niveau des surcotes cycloniques exprimé en pieds



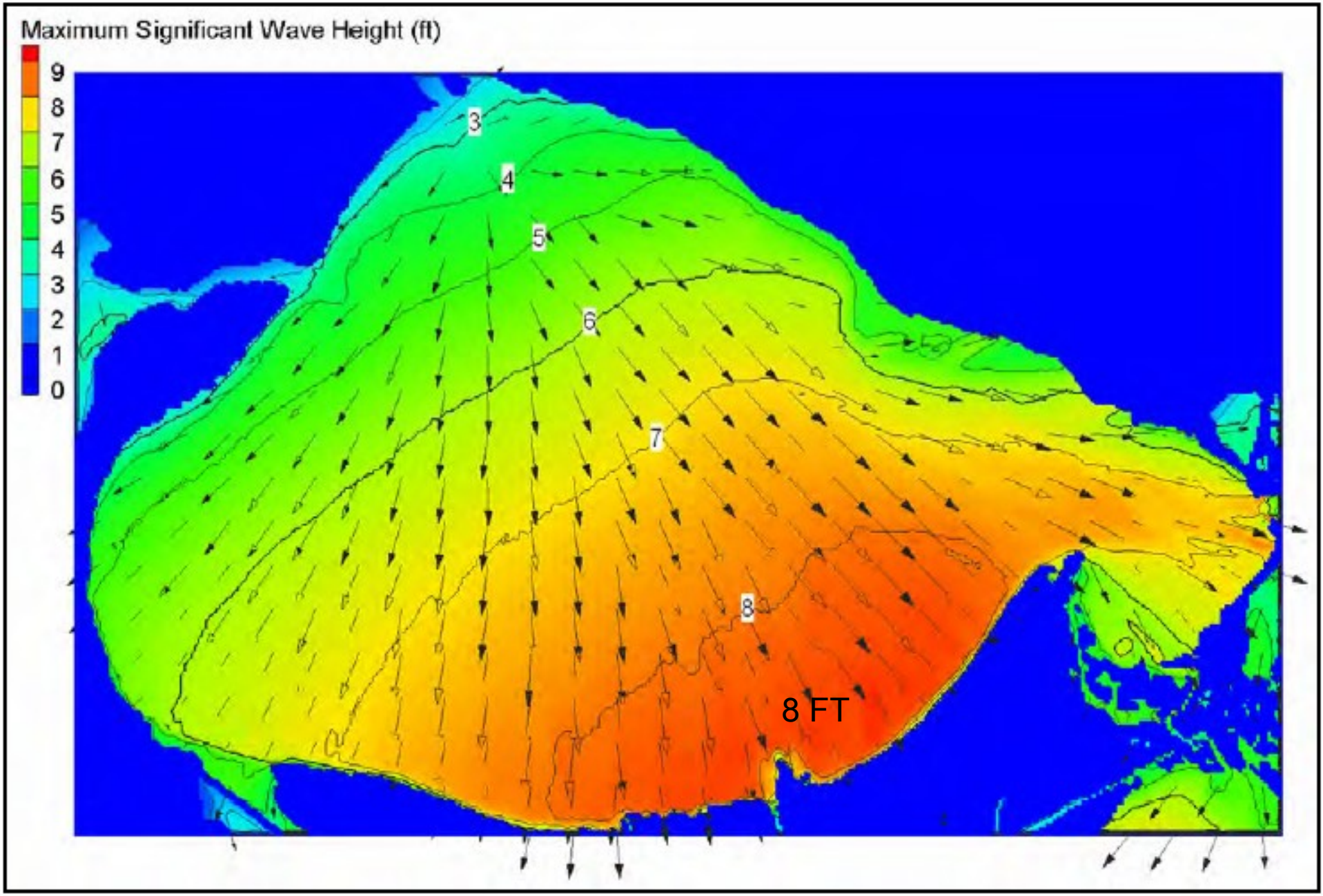


Figure 4-7. Lake Pontchartrain maximum modeled significant wave height and corresponding mean direction for 0030 UTC on 28 August to 0000 UTC on 30 August 2005 (wave heights in feet).

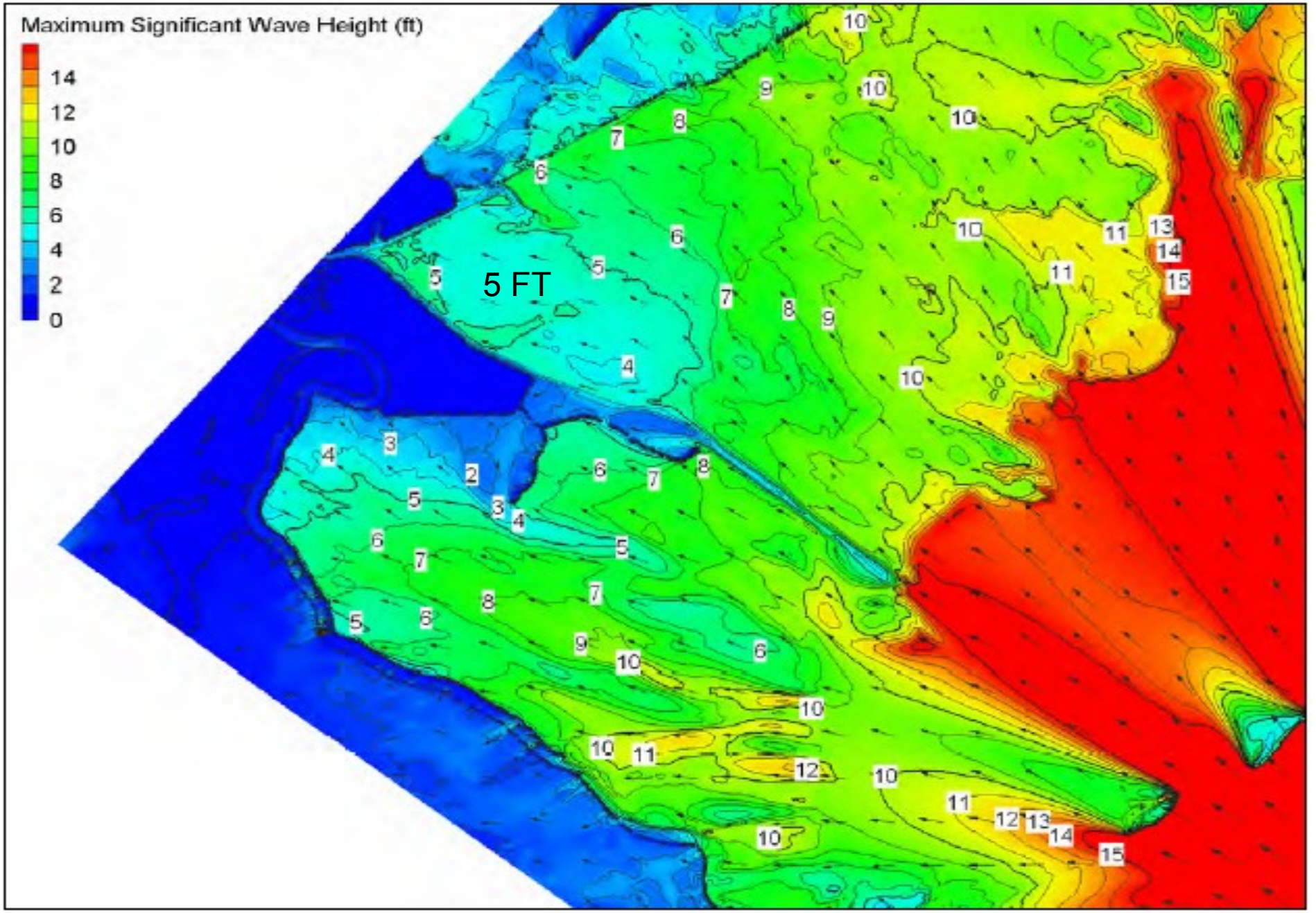
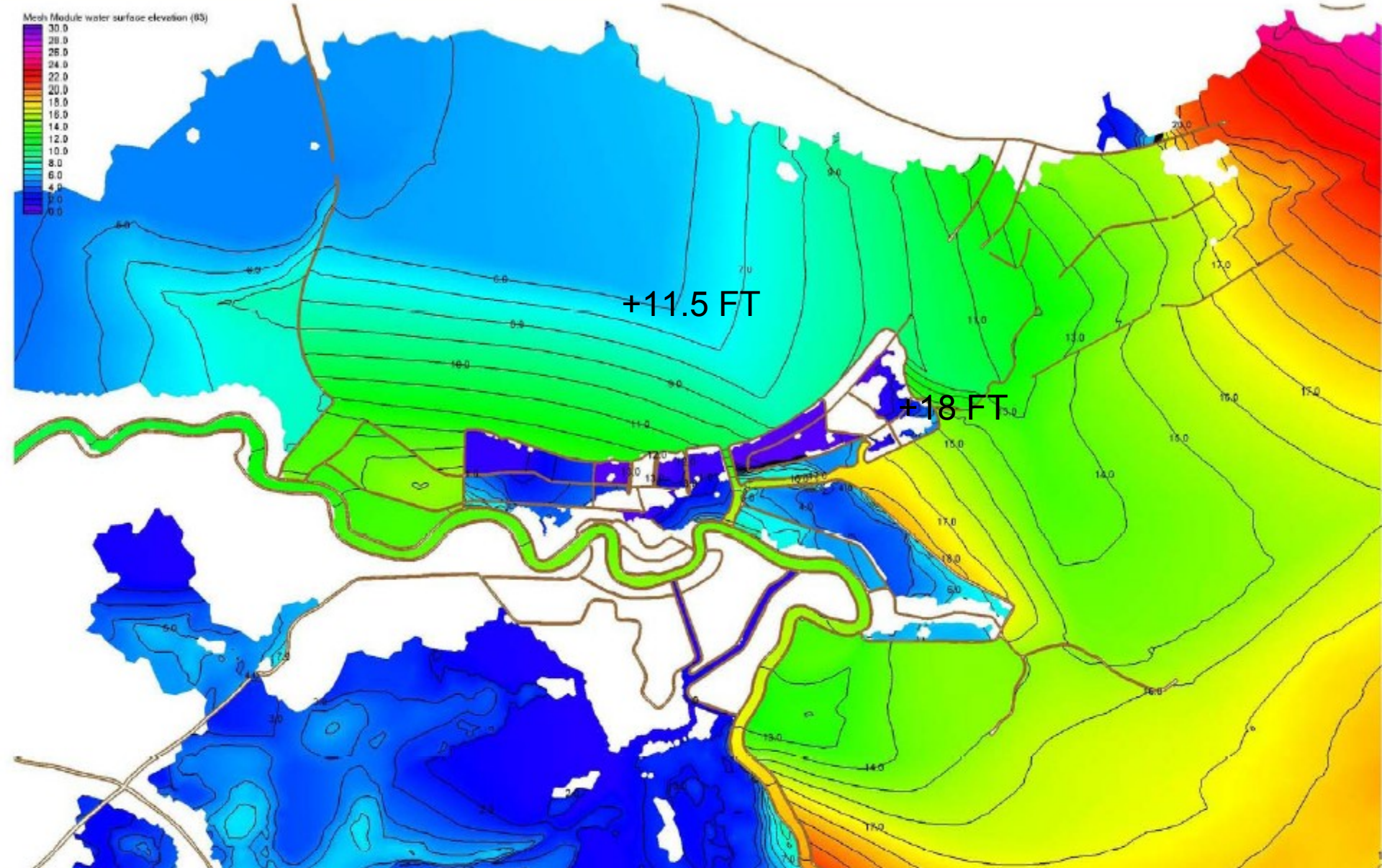


Figure 4-28. Southeast Louisiana modeled wave height and direction for 1200 UTC on 29 August 2005 (wave heights in feet); expanded view for St. Bernards and upper Plaquemines Parishes.

Zoom sur le lac Pontchartrain et le Mississippi

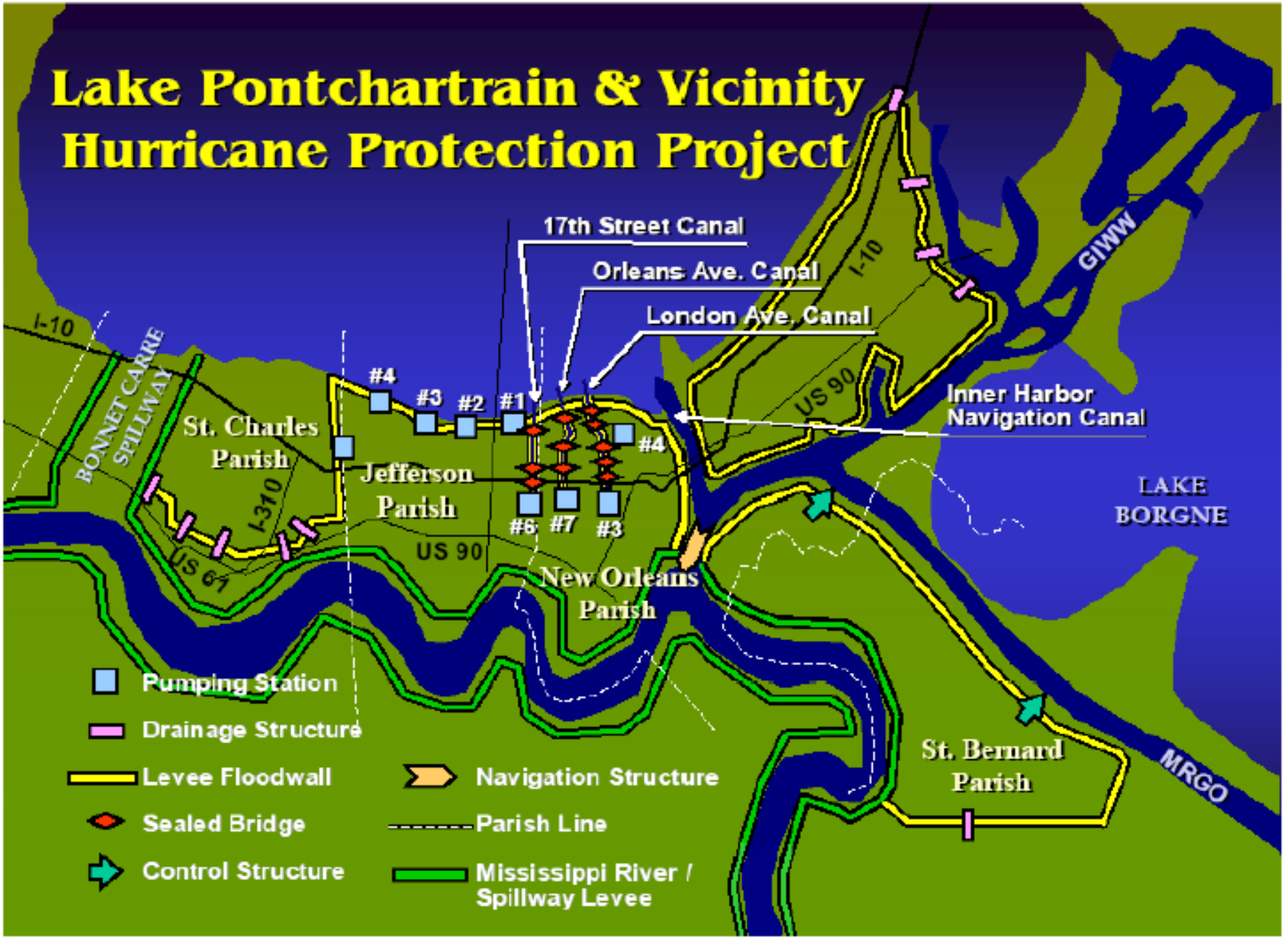


2- Consistance du système de protection avant le cyclone Katrina

1-Un système composé de levées , de murs anti-tempête et de stations de pompage, destiné à éviter les submersions et les inondations liées aux précipitations

2- Un système édifié au fil du temps sur plusieurs décennies, de part et d'autre du Mississippi et au sud du lac Pontchartain

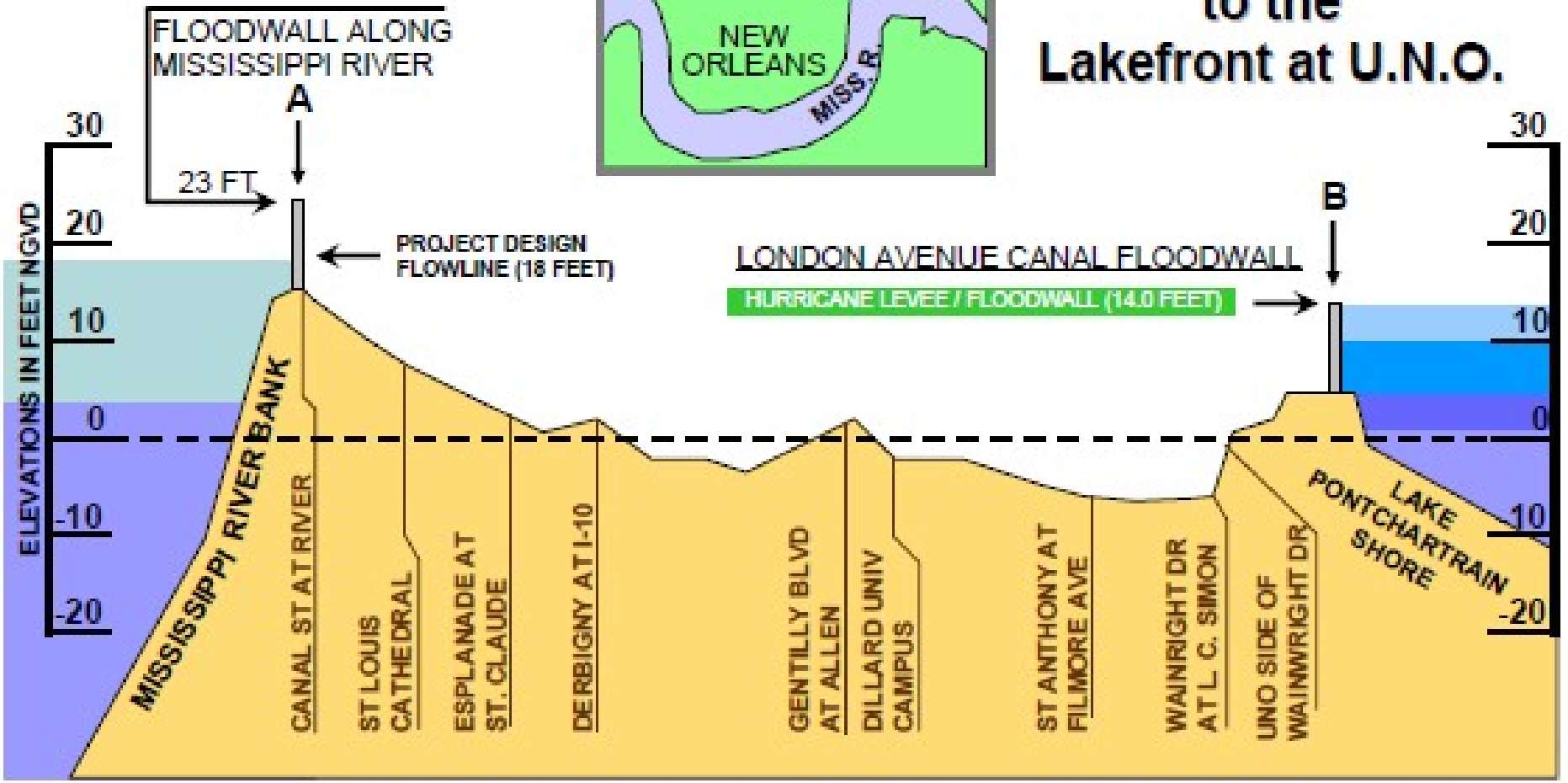
3- Des demandes antérieures auprès du Gouvernement Fédéral non satisfaites, notamment pour compléter le système en évitant les remontées par le MRGO

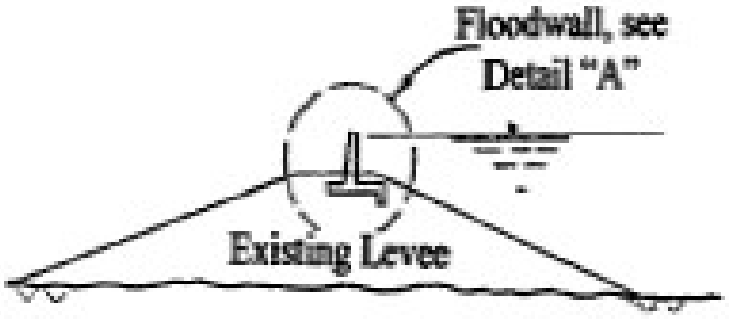

Lake Pontchartrain & Vicinity
Hurricane Protection Project
17th Street Canal
Orleans Ave. Canal
London Ave. Canal
Inner Harbor
Navigation Canal
GIWW
I-10
I-10
BONNET CARRE
SPILLWAY
St. Charles
Parish
Jefferson
Parish
New Orleans
Parish
St. Bernard
Parish
LAKE
BORGNE
MRGO
I-310
US 61
US 90
US 90
#4
#3
#2
#1
#4
#6
#7
#3
Pumping Station
Drainage Structure
Levee Floodwall
Sealed Bridge
Control Structure
Navigation Structure
Parish Line
Mississippi River /
Spillway Levee

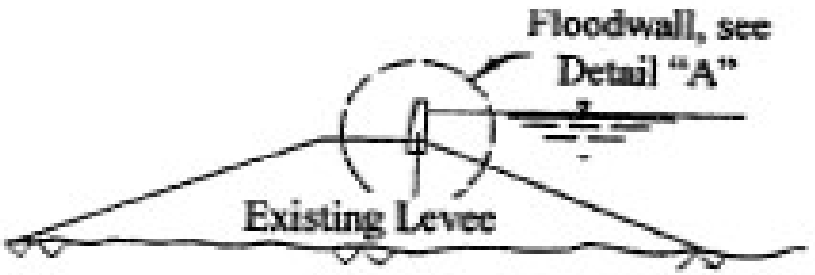

New Orleans to Venice
Hurricane Protection Project
Phoenix
Davant
Reach C
Pointe a la Hache
MISSISSIPPI RIVER
St. Jude
Bohemia
West Bank
River Levee
City Price
Port Sulphur
Reach A
Tropical Bend
Empire
Fort Jackson
Reach B-1
Venice
Reach B-2

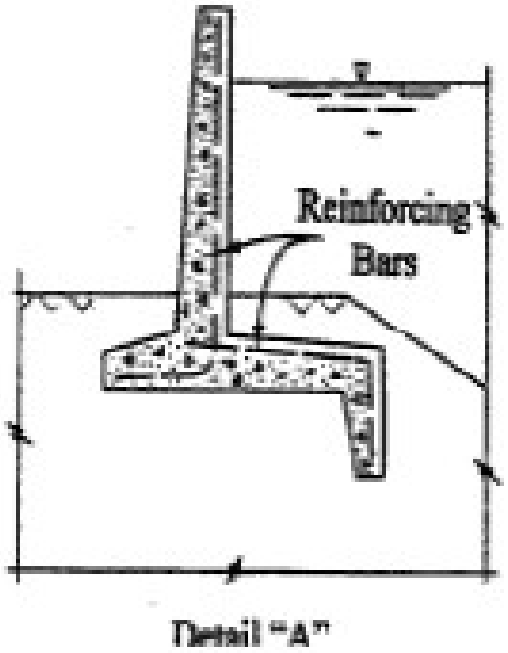
City of New Orleans Ground Elevations and Topography

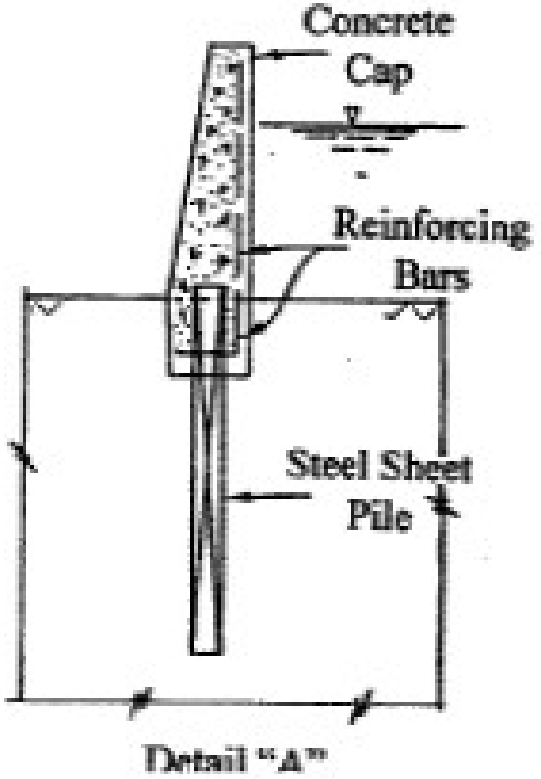
From Canal St. at Mississippi River to the Lakefront at U.N.O.




Floodwall, see
Detail "A"
Existing Levee


Floodwall, see
Detail "A"
Existing Levee

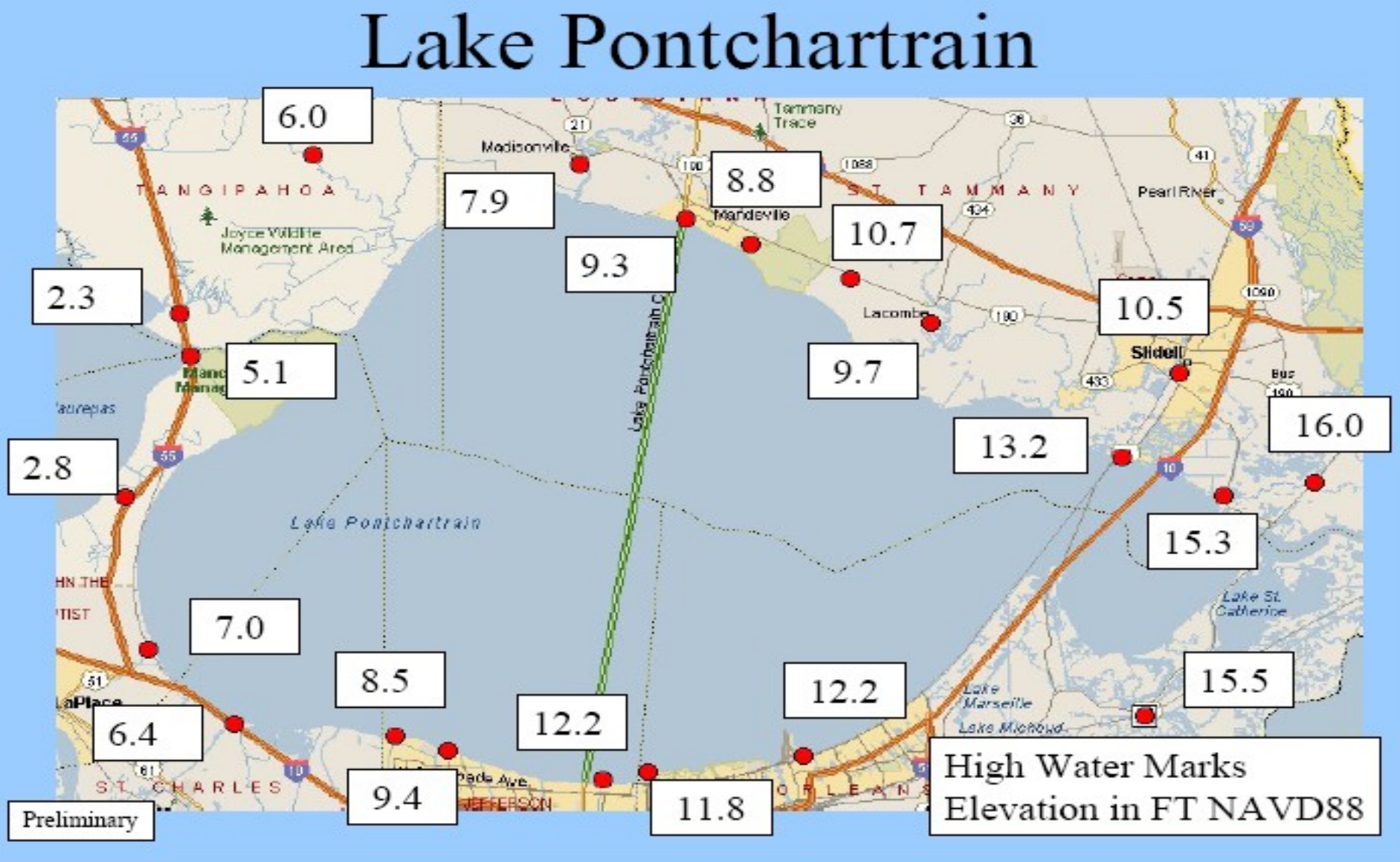

Reinforcing
Bars
Detail "A"

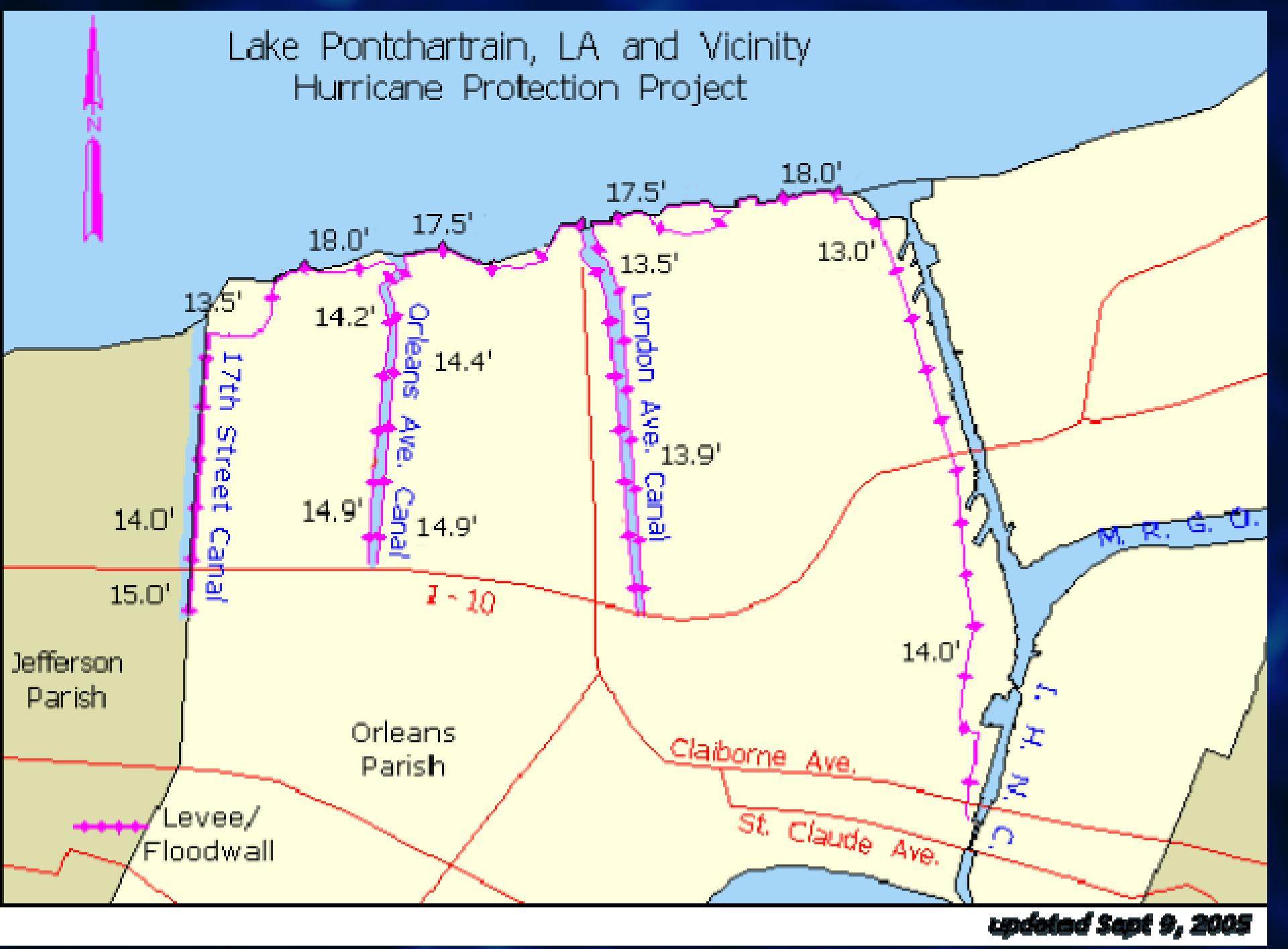

Concrete
Cap
Reinforcing
Bars
Steel Sheet
Pile
Detail "A"

T-Wall

I-Wall

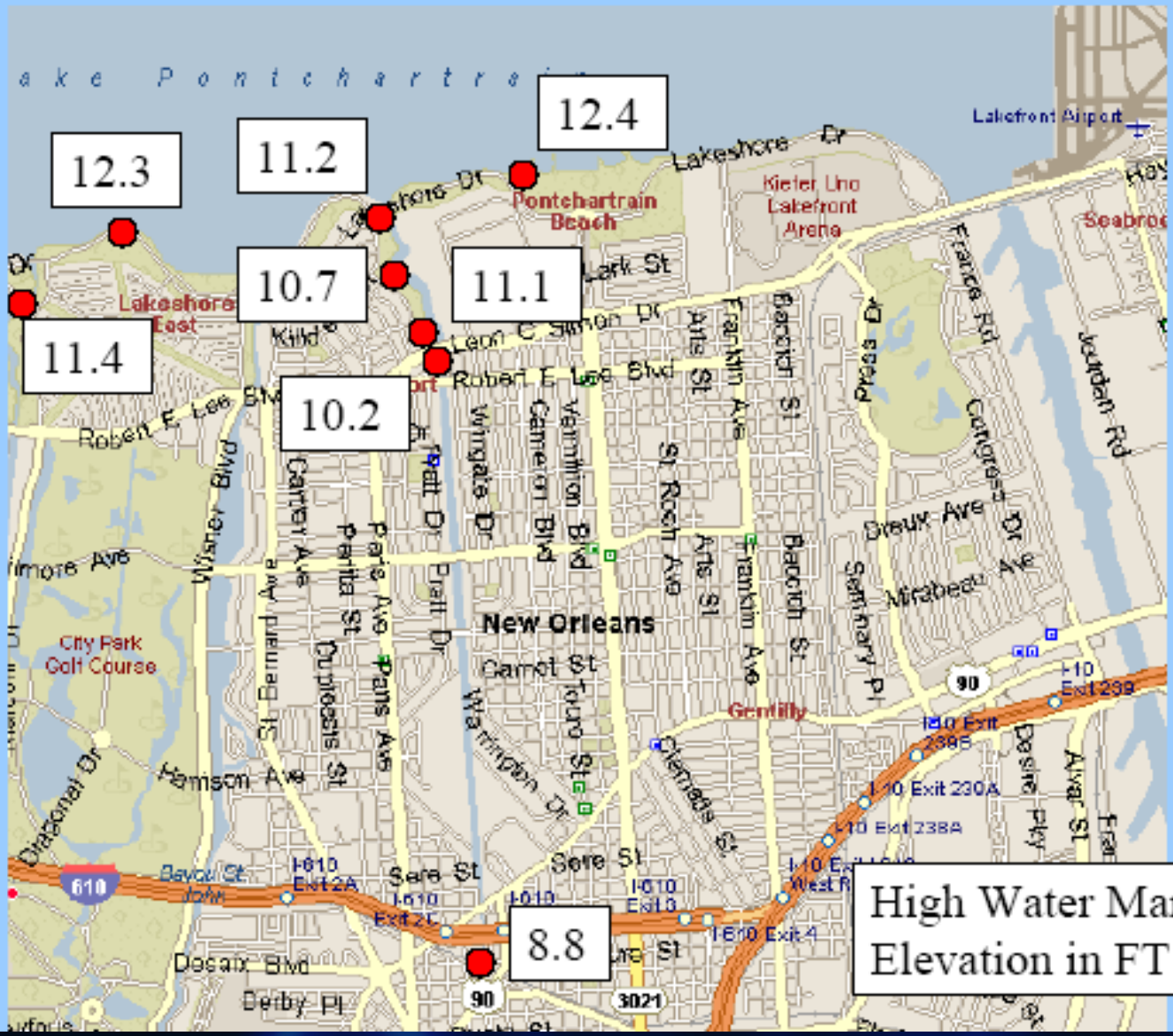
3-1 Les effets du cyclone




Lake Pontchartrain, LA and Vicinity
Hurricane Protection Project
N
18.0'
17.5'
18.0'
17.5'
13.5'
13.0'
13.5'
14.2'
14.4'
17th Street Canal
Orleans Ave. Canal
London Ave. Canal
13.9'
14.0'
14.9'
14.9'
15.0'
I - 10
M. R. G. O.
14.0'
Jefferson Parish
Orleans Parish
Claiborne Ave.
St. Claude Ave.
Levee/ Floodwall
updated Sept 9, 2005

17th St Canal

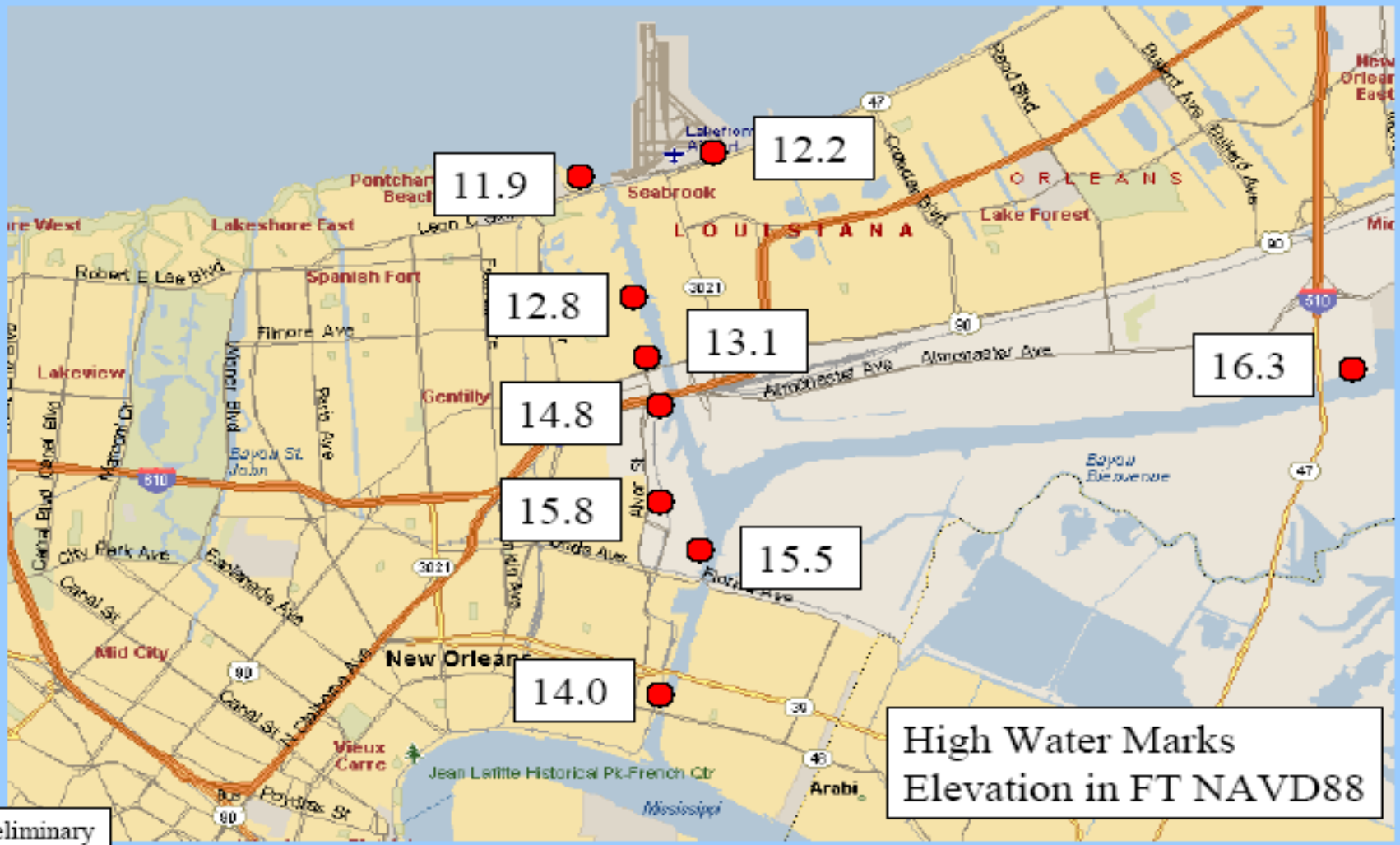
London Ave Canal



Preliminary

Inner Harbour Navigation canal

IHNC



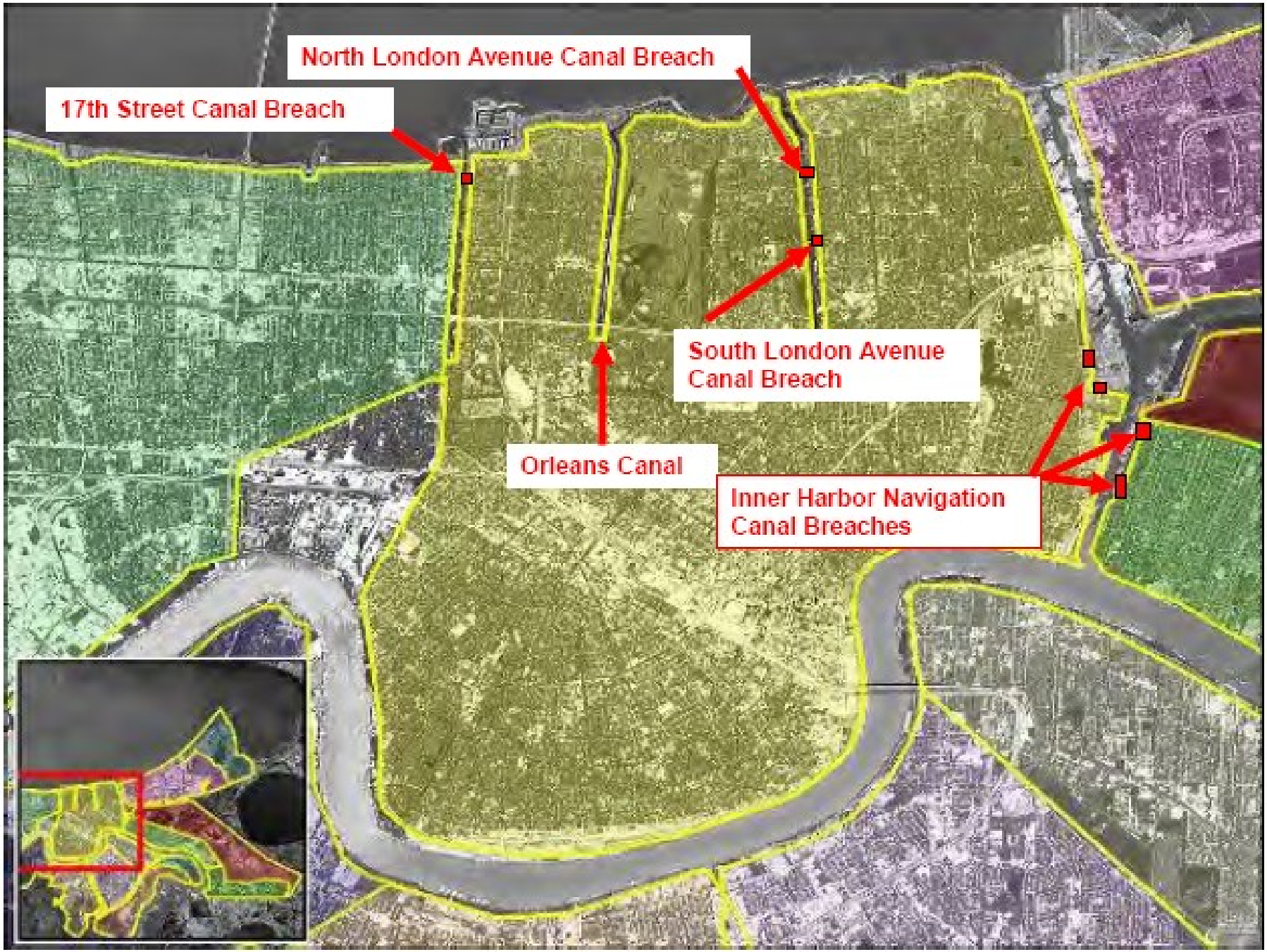
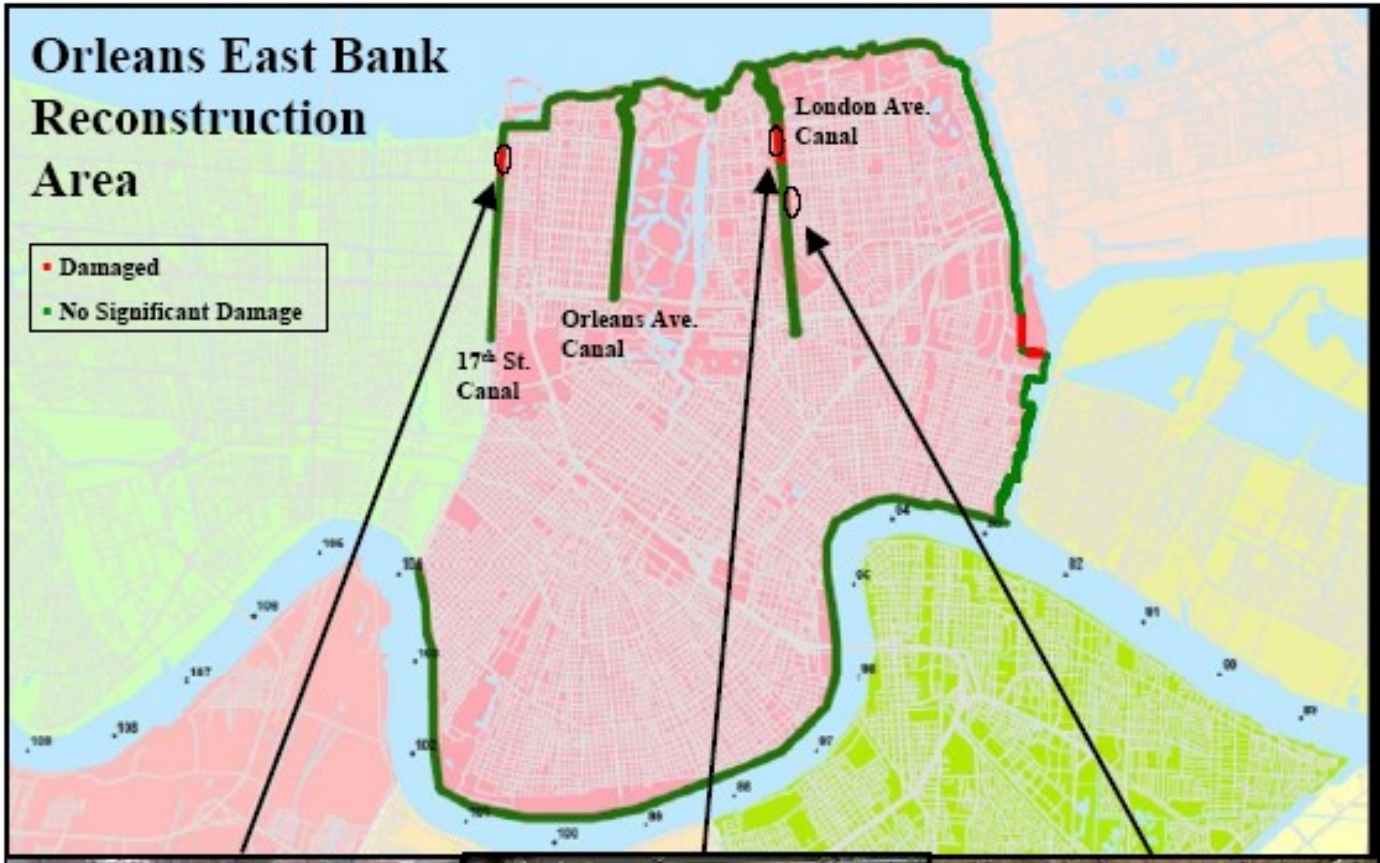


Figure 2. Location of Breaches in Orleans Parish, East Bank

Orleans East Bank Reconstruction Area



Local Authorities

- Orleans Levee District
- Orleans Parish Government
- N.O. Sewerage and Water Board
- Louisiana DOTD

Hurricane Protection System

- 19.2 miles of levee and floodwall
- 13 pump stations
- 15 roadway floodgates

Damage

- 1.1 miles of levee and floodwall
- 13 pump stations

17th St. Canal I-wall Breach

London Ave. Canal Breach

Canal Breach at Mirabeau

US Army Corps of Engineers

As of 24 2200 OCT 05

Flooding of Container Storage Yard

Northern 9th Ward Breach

Sheetpile Floodwall Collapse

Local Authorities

- Orleans Levee District
- Port of New Orleans
- Louisiana DOTD

Hurricane Protection System

- 12.3 miles of floodwall and levee

Damage

- 5 miles of floodwall and levee

US Army Corps of Engineers

As of 24 2200 OCT 05

17th Street Canal Breach

Figure 3. Aerial Photograph of the 17th Street Canal Breach Looking South From the Old Hammond

London Avenue Canal Breach

Figure 28. South Breach, London Avenue Canal

London Avenue Canal N. Breach

Figure 29. North Breach, London Avenue Canal

gure 12-6. NOE6_B. Scoured Section on Protected Side at Lakefront Airport Floodwall

gure 12-10. NOE7_B Typical Crown and Landside Scouring

Figure 11-4. Scour and Erosion on the Protected Side of the IHNC Adjacent to the Ninth Ward in the Vicinity of the South Breach

Figure 13-5. Scour Pattern "A" on East Side IHNC near N. Claiborne Ave. Bridge

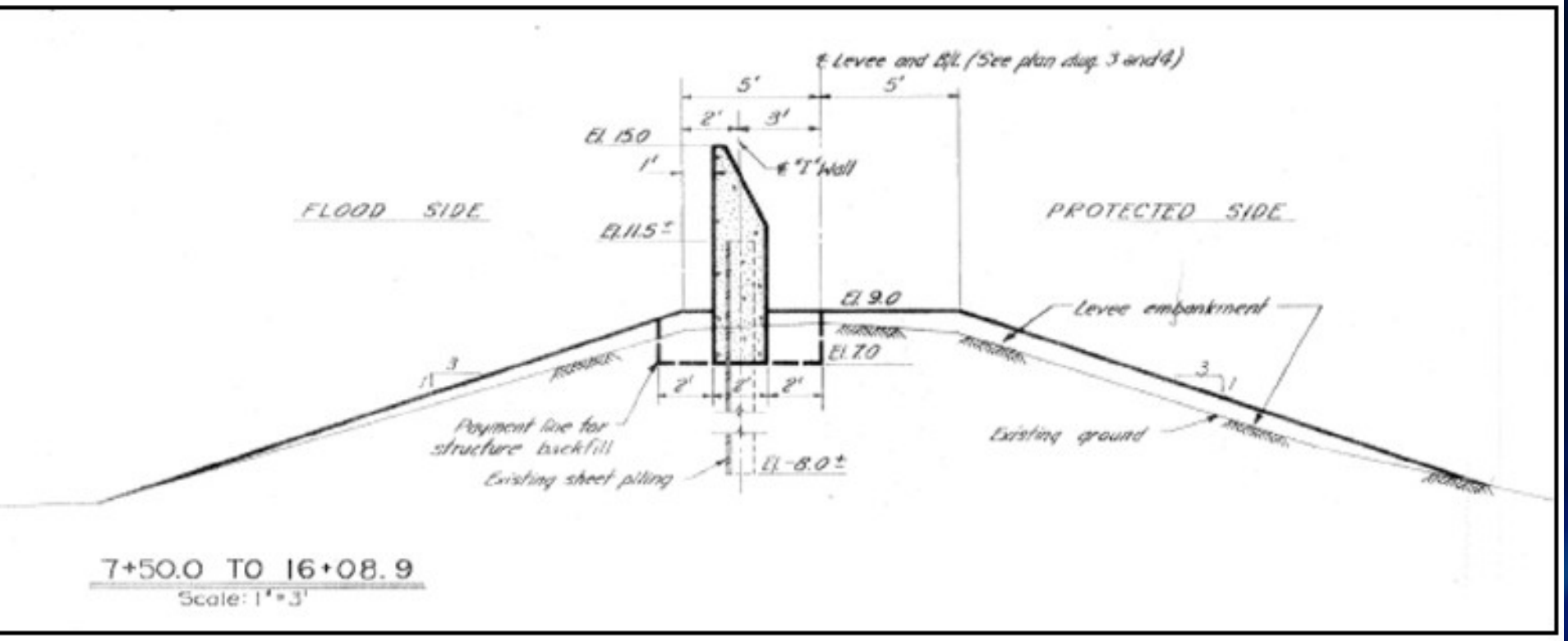


Figure 13-6. Existing Levee and I-Wall Drawing for IHNC East. Note that scoured soil included the "structure backfill" zone (from drawing file H-4-25157, IHNC East Levee from Lock to Florida Ave. Floodwall, sheet 12 of 15)

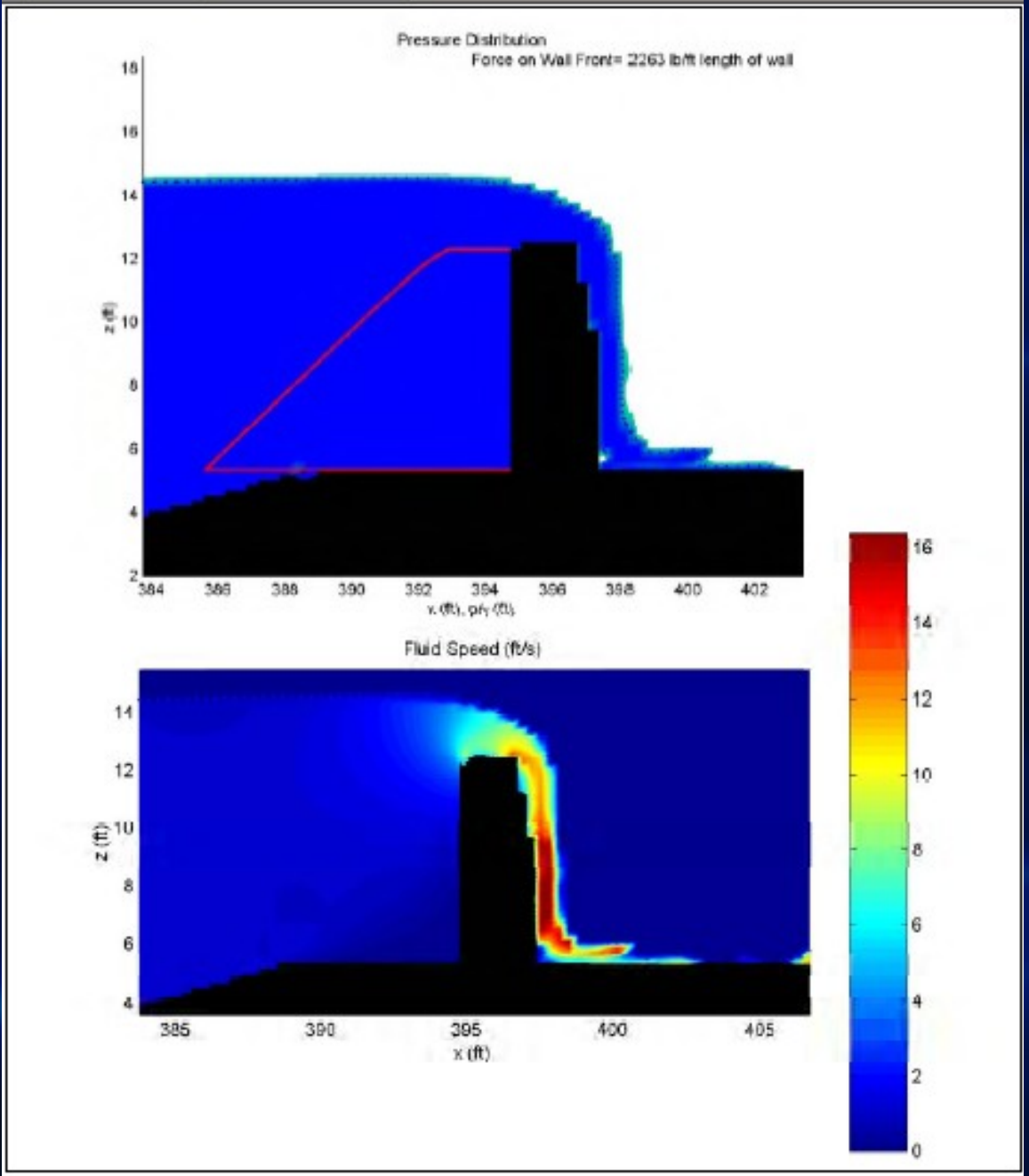


Figure 15-30. Surge overtopping an IHNC wall with 1 foot, 5 second waves. The wall elevation is specified as 1ft below the surge. The top plot gives the water surface and pressure distribution, the lower plot gives the fluid speed field.

Figure 11-5. Scour and Erosion Leading to the Failure of the I-Wall on the IHNC Adjacent the South Breach (9th Ward)

New Orleans East

Reconstruction Area

- Damaged
- No Significant Damage
- Non-Federal Levee

Maxent Levee

Citrus Back Levee

Air Products Breach

Intracoastal Waterway Breach

Local Authorities

- Orleans Levee District
- Orleans Parish Government
- N.O. Sewerage and Water Board
- Louisiana DOTD

Hurricane Protection System

- 39 miles of exterior levee and floodwall (I-wall)
- 8 miles of interior levee
- 8 pump stations
- 2 highway floodgates
- 1 railroad floodgate

Damage

- 4.6 miles of exterior levee and floodwall
- 8 pump stations

US Army Corps of Engineers

As of 24 2200 OCT 05

New Orleans East

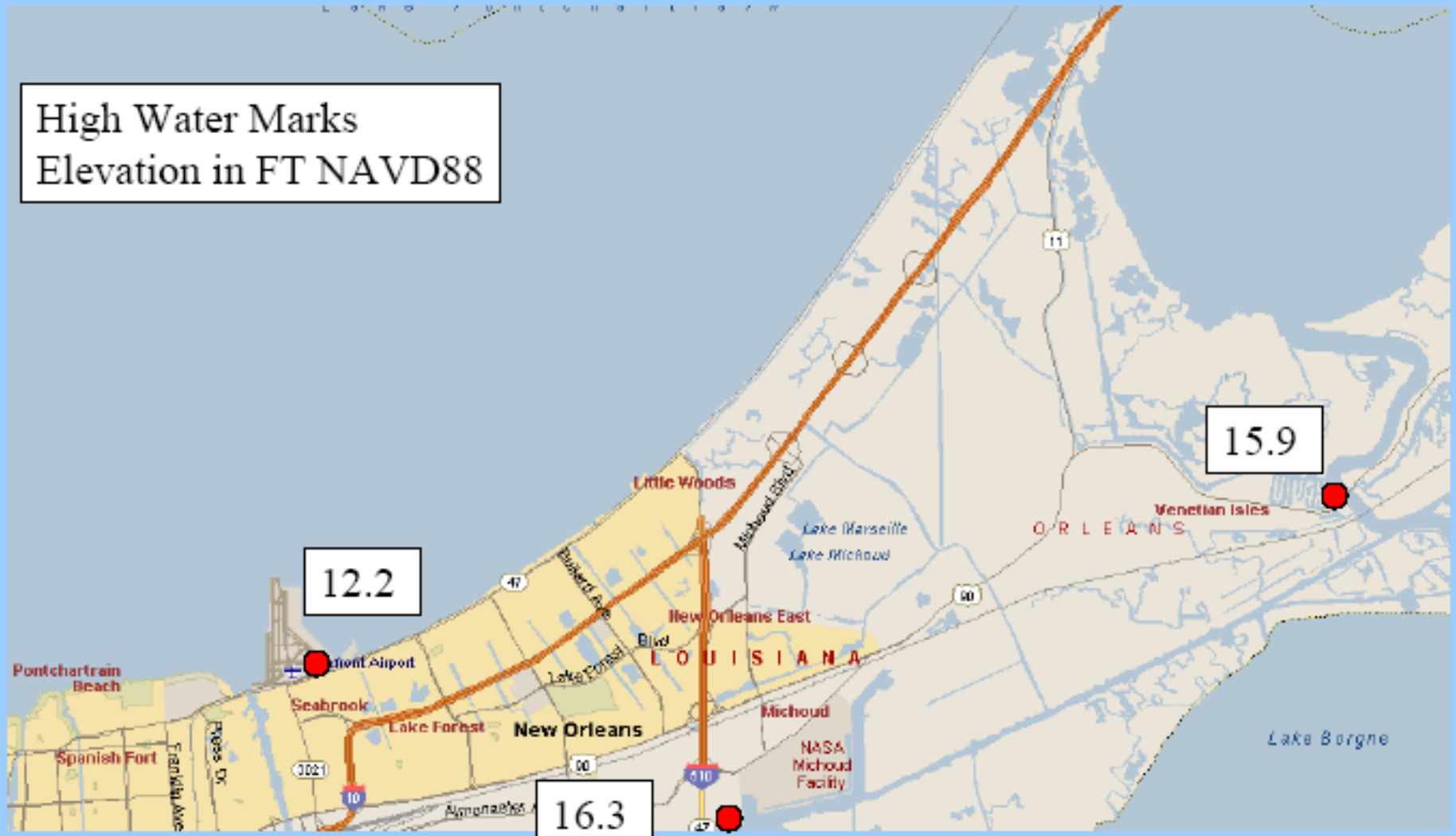
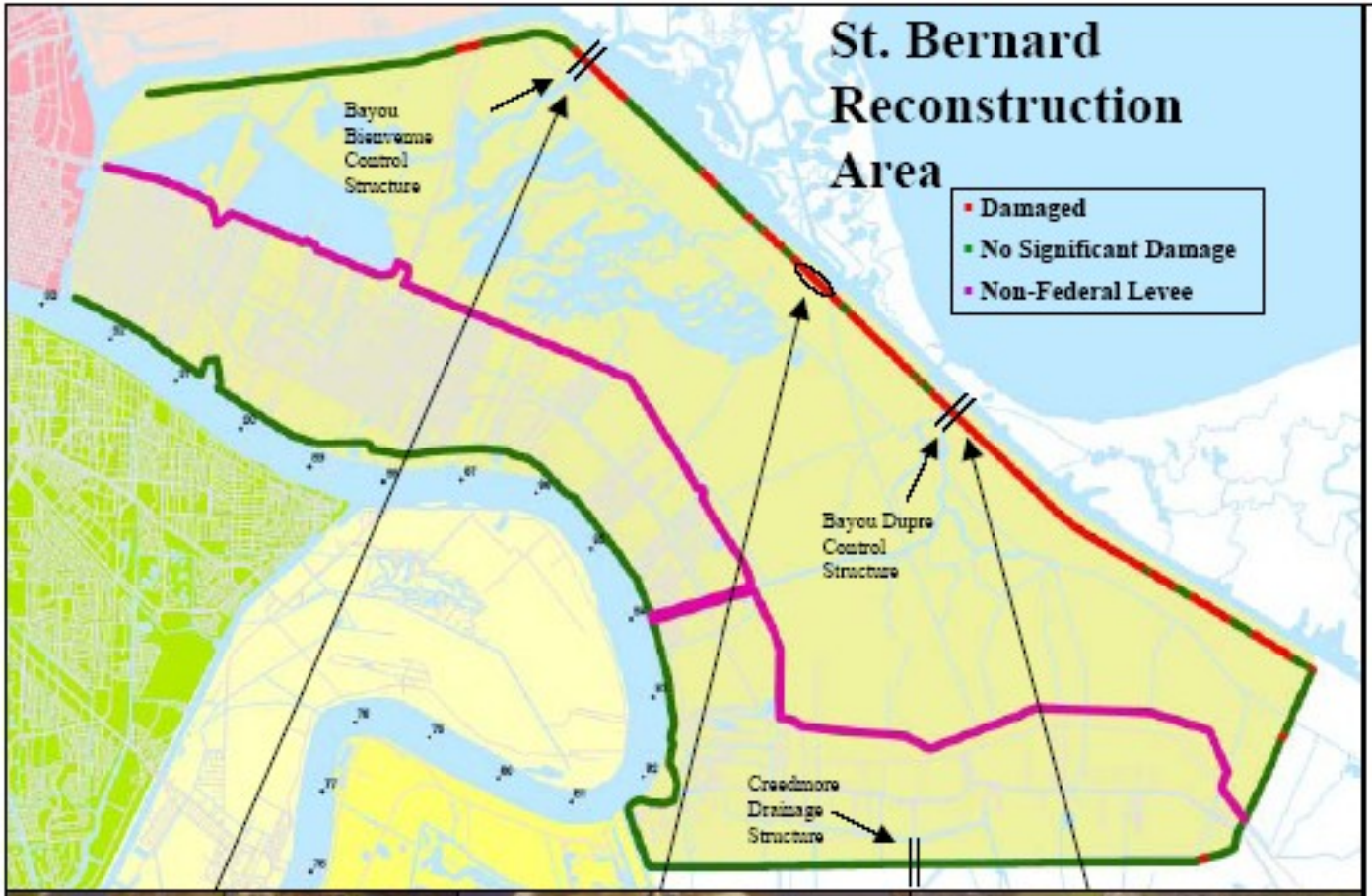


Figure 12-44. NOE3_D Sheetpile Wall Failure (near Sta 772+00 B/L New Orleans East Back Levee)
(Coordinates 30 deg 01 min 04.30 sec N, 89 deg 53 min 49.36 sec W)

St. Bernard Reconstruction Area



Local Authorities

- Lake Borgne Basin Levee District / Orleans Levee District
- St. Bernard Parish Government
- Louisiana DOTD

Hurricane Protection System

- 30 miles of exterior levee and floodwall
- 22 miles of non-federal interior levee
- 8 pump stations
- 2 control structures
- 6 floodgates

Damage

- 8 miles of exterior levee and floodwall (I-wall)
- 1.4 miles of non-federal interior levee
- 8 pump stations
- 2 control structures
- 4 floodgates

Bayou Bienvenue Control Structure

Breach near Pipeline Canal

Bayou Dupre Control Structure

US Army Corps of Engineers

St Bernard and 9th Ward

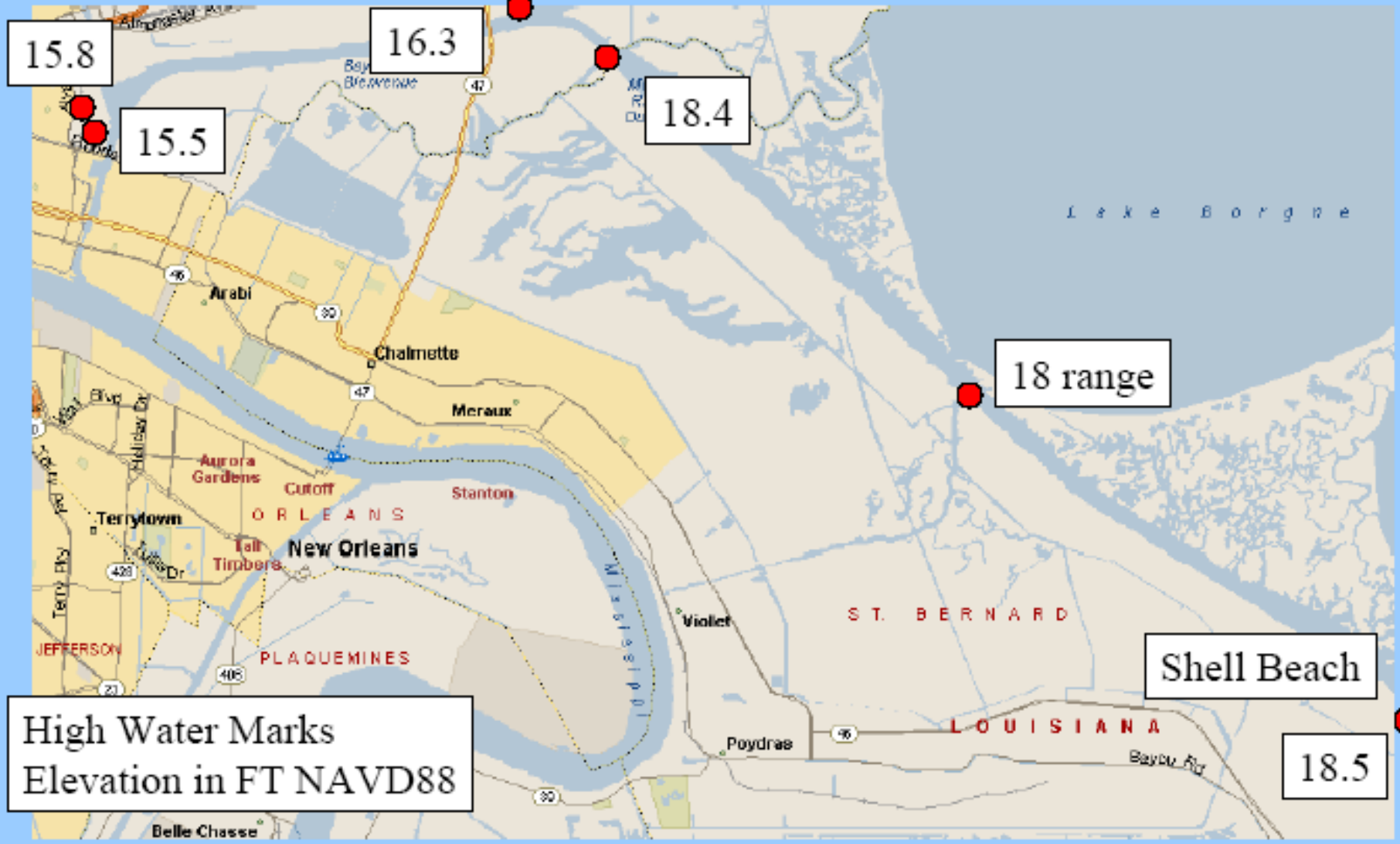


Figure 13-68. 2,500 ft. of Levee Along MRGO from Bayou Dupre to STA 1007+91 That Lost Approximately 8′ of Elevation

Figure 13-76. End of Sheetpile Wall at B/L Sta 980+58, Along the MRGO (St. Bernard Parish). Note that scour occurred along the sheetpile wall and minimally beyond the levee transition. Approximate sheetpile elevation was 17 ft and levee crown elevation was 13 ft. Beyond the transition, the levee crown elevation was approximately 17 ft. The approximate storm surge overtopping crest was 4 ft over the sheetpile and 1 ft over the transition levee

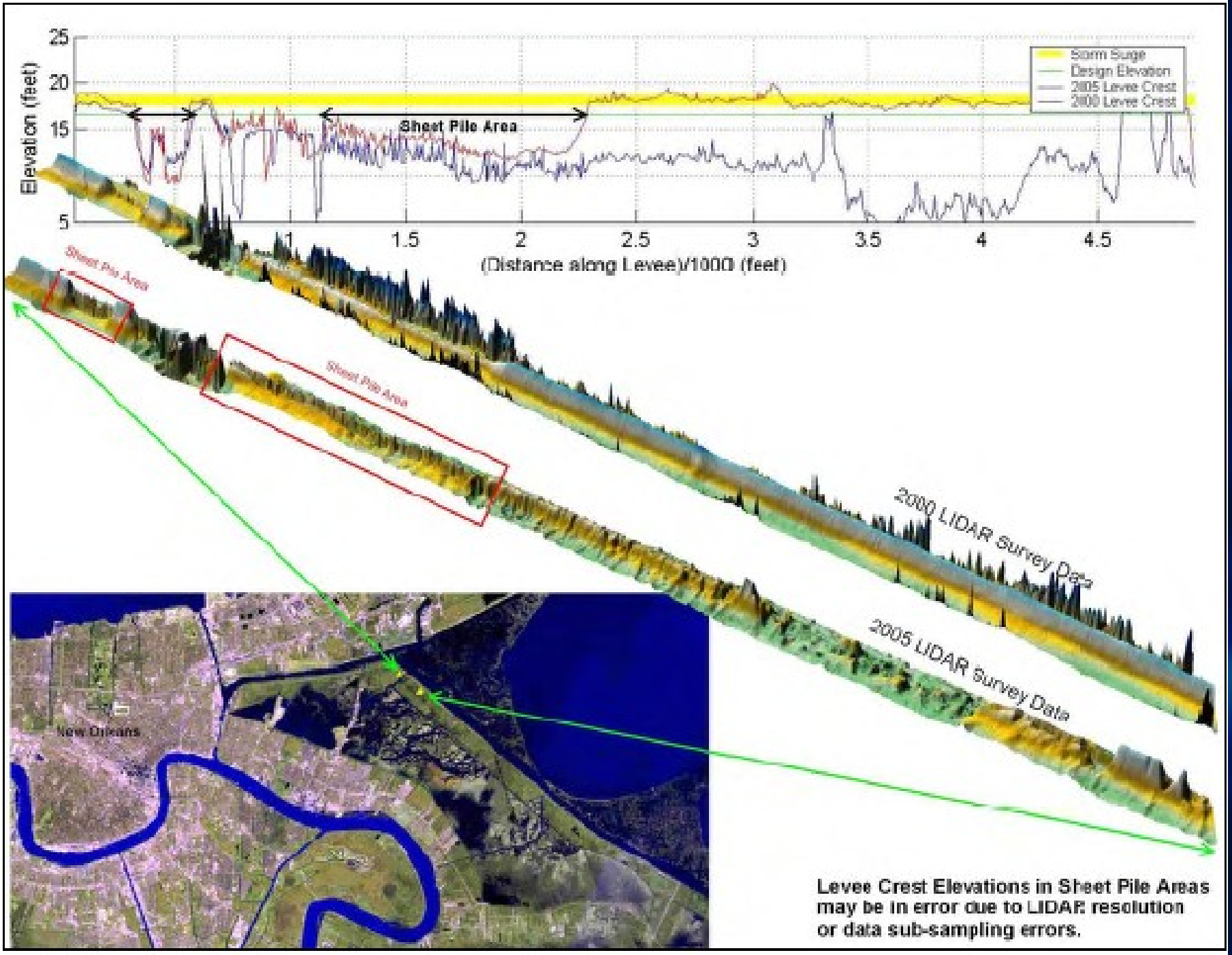
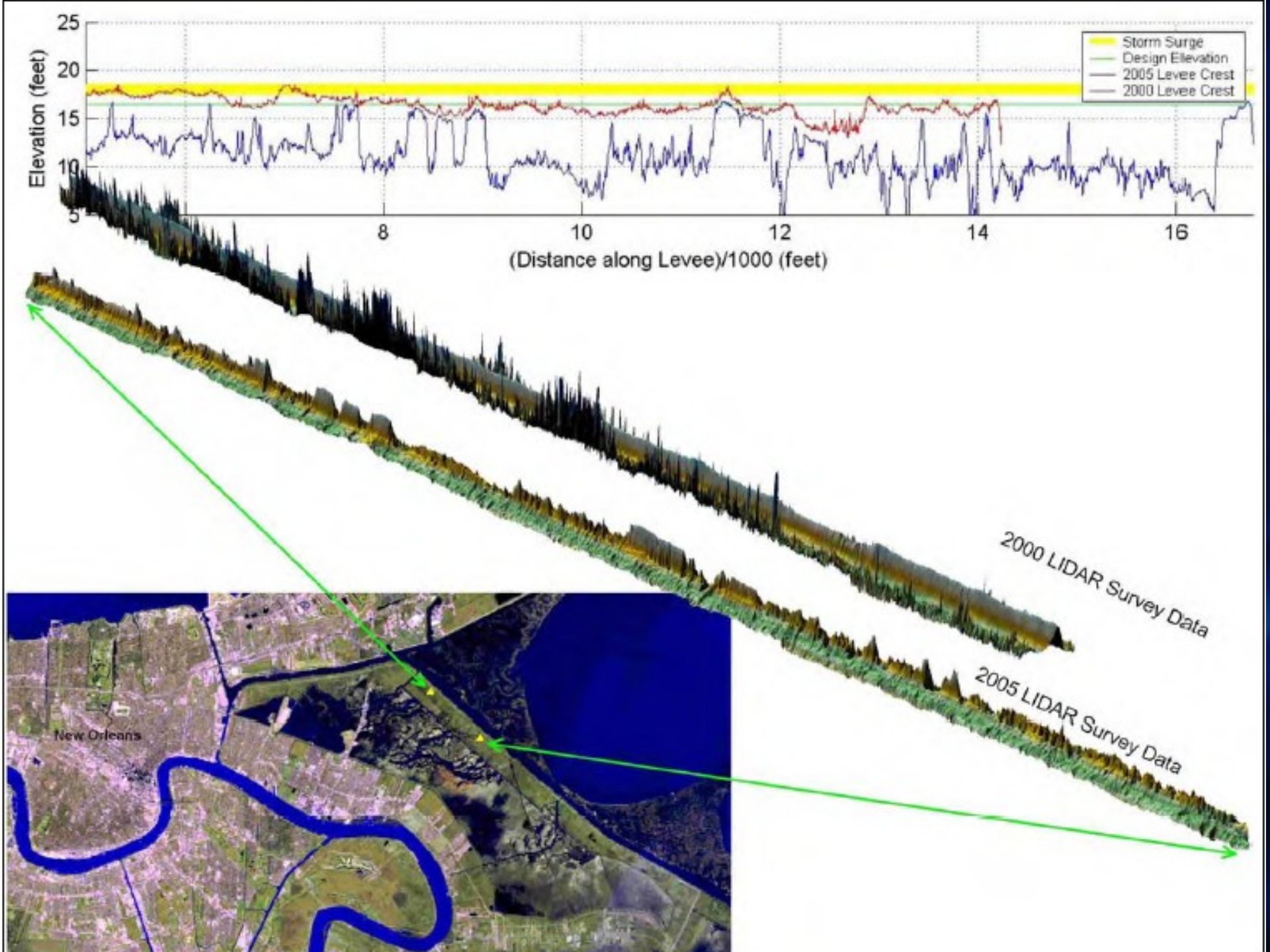


Figure 16-1. MRGO levee damage determined from LIDAR surveys: Station 0 to 4,500 ft


Storm Surge
Design Elevation
2005 Levee Crest
2000 Levee Crest
Elevation (feet)
25
20
15
10
5
8
10
12
14
16
(Distance along Levee)/1000 (feet)
2000 LIDAR Survey Data
2005 LIDAR Survey Data
New Orleans

3-2 Chronologie reconstituée de Katrina dans ses effets de submersion de la ville


The Times-Picayune | Interactive Graphics
FLASH FLOOD
Hurricane Katrina's Inundation of New Orleans, August 29, 2005
By Dan Swenson, staff artist
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
Lake Borgne
START
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
ALGIERS
CHALMETTE
MERAUX
Mississippi River
UPTOWN
GRETNA
TERRYTOWN
ENGLISH TURN
VIOLET
WESTWEGO
MARRERO
HARVEY
POYDRAS
1 mile
TIME
AM
PM
0:00
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
1

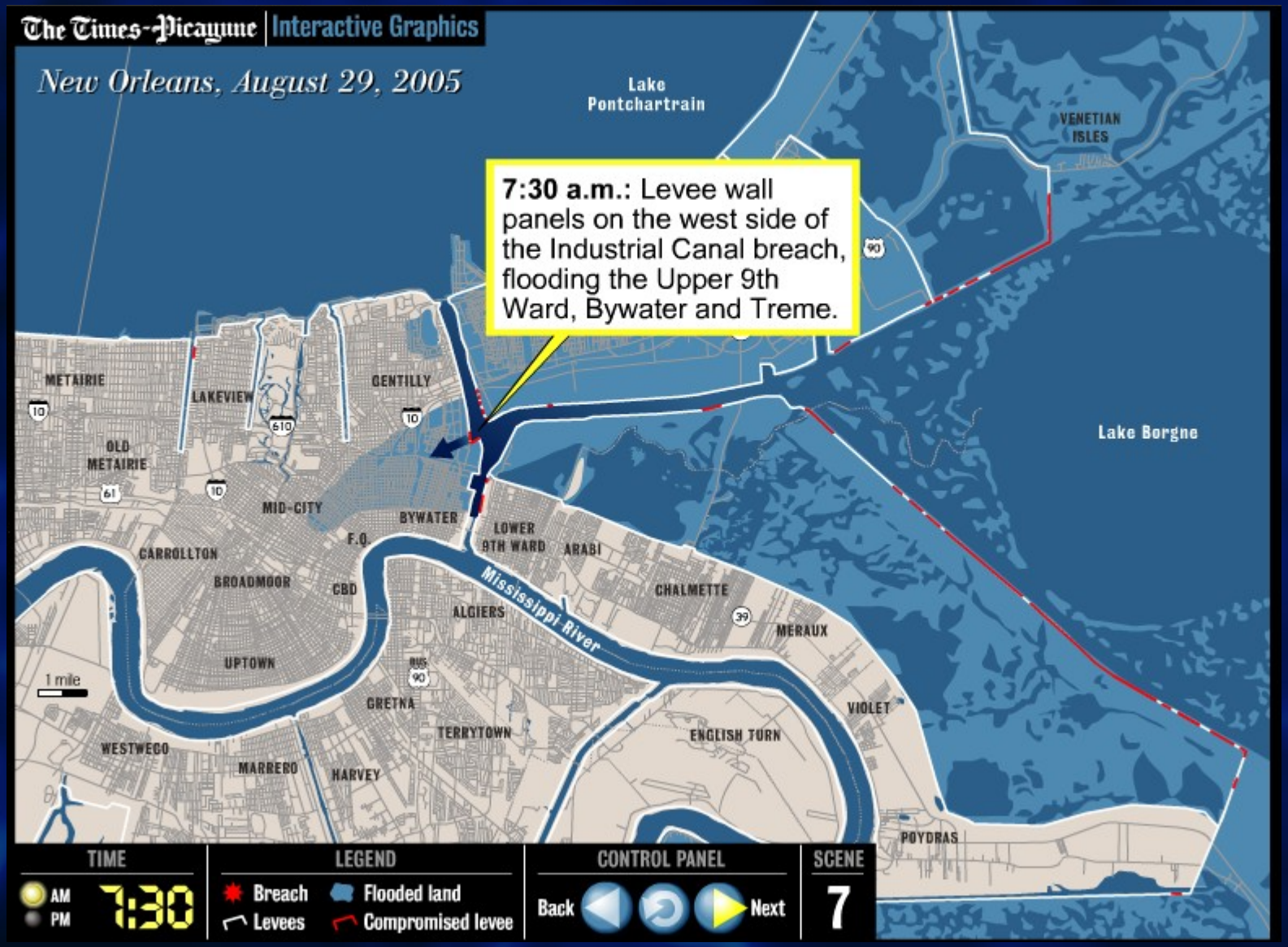

The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
Lake Borgne
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
F.Q.
CARROLLTON
BROADMOOR
CBD
ALGIERS
UPTOWN
GRETNA
TERRYTOWN
WESTWEGO
MARRERO
HARVEY
POYDRAS
1 mile
4:30 a.m.: Rising water in the Industrial Canal leaks through damaged gates into neighborhoods on both sides of the I-10 High Rise. The flow is minor compared to what is in store for these areas.
TIME
AM
PM
4:30
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
2


The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
5 a.m.: Katrina's storm surge begins pounding the MR-GO levee. By dawn, levee sections crumble and Lake Borgne advances into wetlands toward St. Bernard Parish.
EASTERN NEW ORLEANS
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
ALGIERS
CHALMETTE
MERAUX
Mississippi River
UPTOWN
GRETNA
TERRYTOWN
ENGLISH TURN
VIOLET
WESTWEGO
MARRERO
HARVEY
POYDRAS
Lake Borgne
1 mile
TIME
AM
PM
5:00
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
3

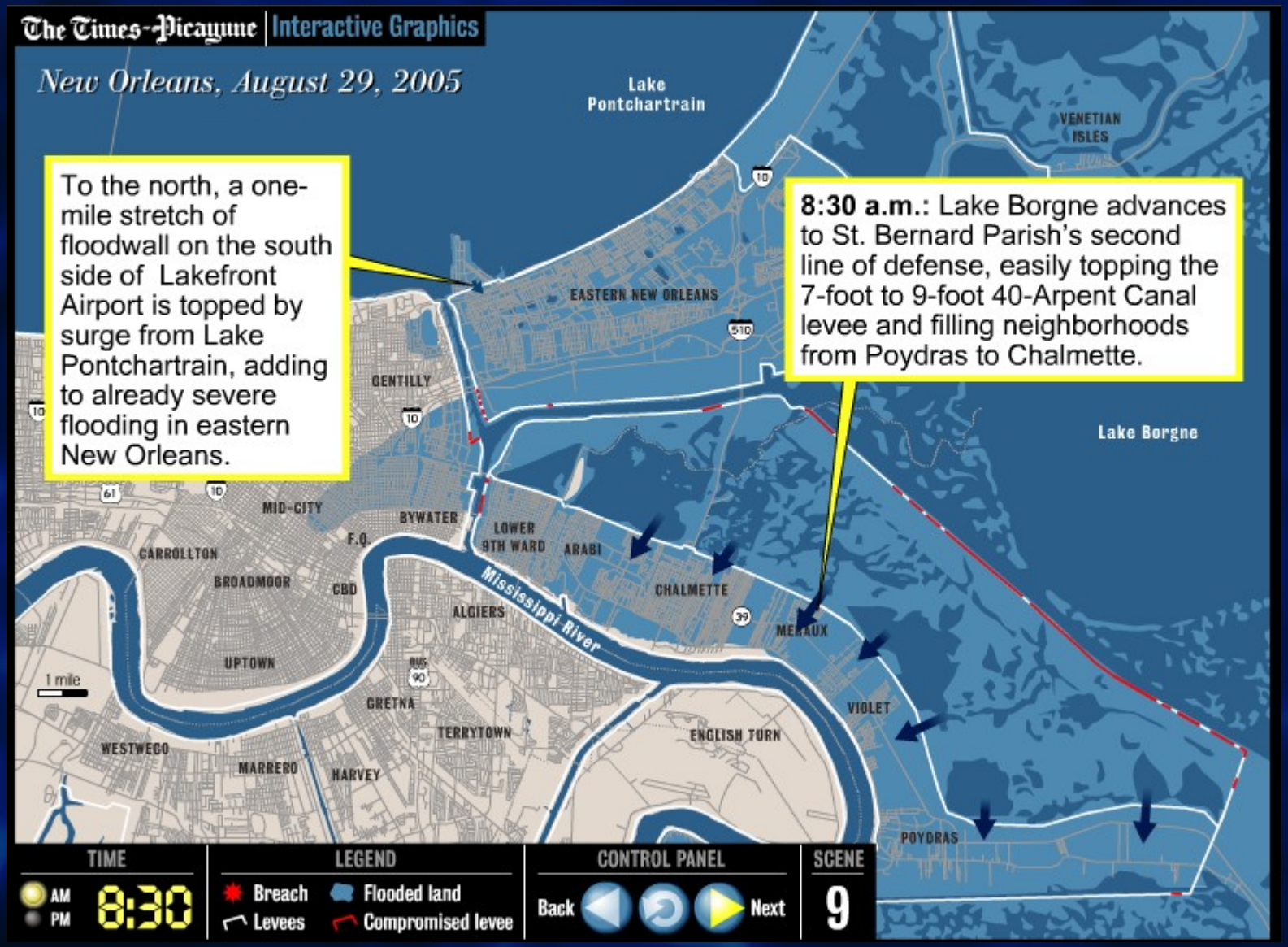

The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
CHALMETTE
ALGIERS
Mississippi River
UPTOWN
GRETNA
TERRYTOWN
WESTWEGO
MARRERO
HARVEY
1 mile
POYDRAS
6:10 a.m.: Katrina makes landfall at Buras. A wall of water 21 feet high crosses the Mississippi River and its levees, inundating most of Plaquemines Parish.
NEW ORLEANS
POINTE A LA HACHE
Breton Sound
PORT SULPHUR
Miss. River
BURAS
VENICE
Gulf of Mexico
TIME
AM
PM
6:10
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
4

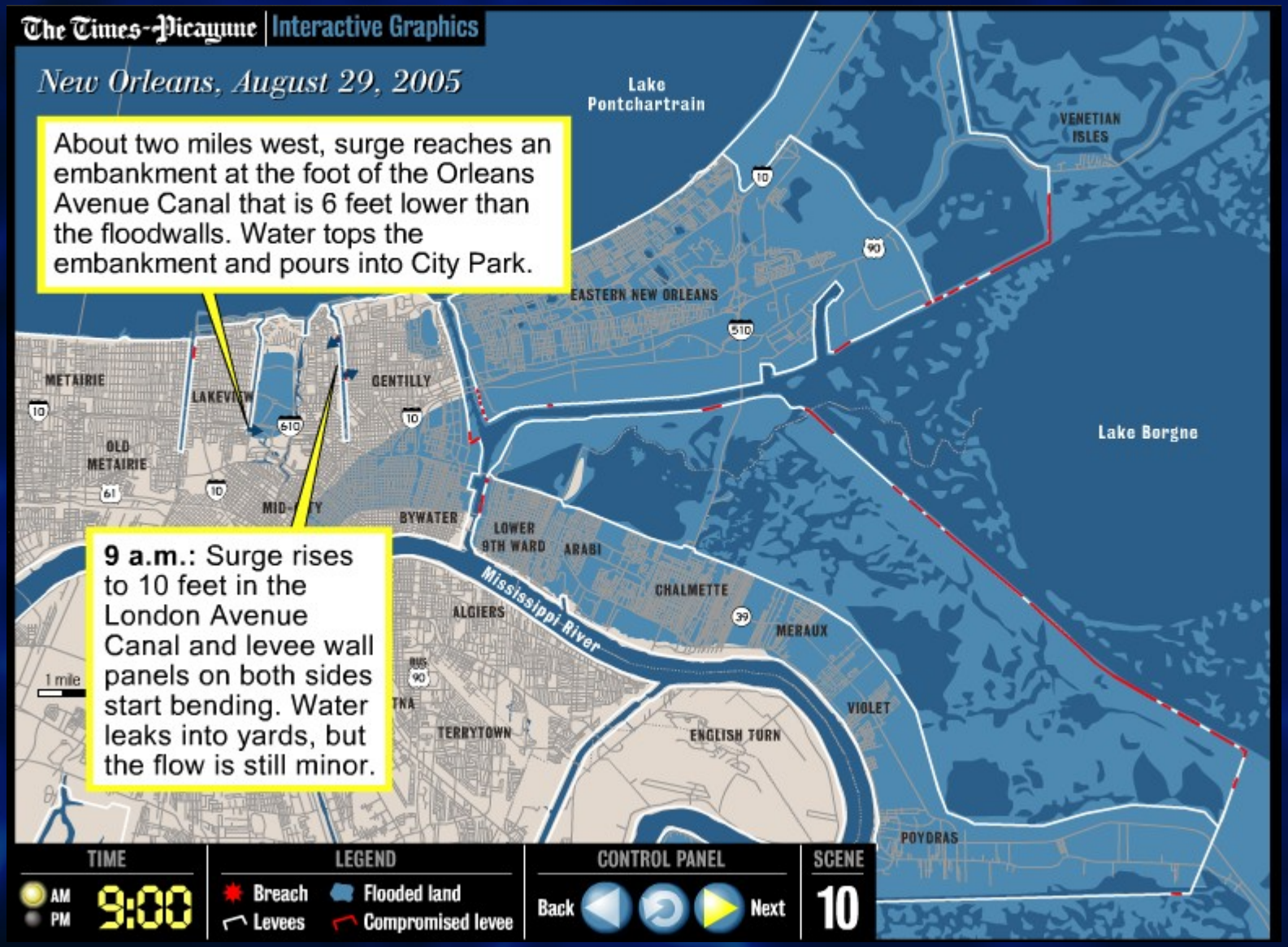

The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
Lake Borgne
To the west, witnesses report sections of the 17th Street Canal levee wall are leaning toward Lakeview. Water leaks through cracks in the wall into the neighborhood.
6:30 a.m.: Surge builds in the Intracoastal Waterway's "funnel," and levees protecting eastern New Orleans are overtopped and breached. Soon, the area is under water.
WESTWEGO
MARRERO
HARVEY
POYDRAS
TIME
AM
PM
6:30
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
5


The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
6:50 a.m.: Storm surge from the "funnel" reaches the Industrial Canal. Water overtops floodwalls and levees on both sides, but the worst is still ahead.
Lake Pontchartrain
VENETIAN ISLES
Lake Borgne
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
CHALMETTE
ALGIERS
MERAUX
Mississippi River
UPTOWN
GRETNA
TERRYTOWN
ENGLISH TURN
VIOLET
WESTWEGO
MARRERO
HARVEY
POYDRAS
1 mile
TIME
AM
PM
6:50
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
6

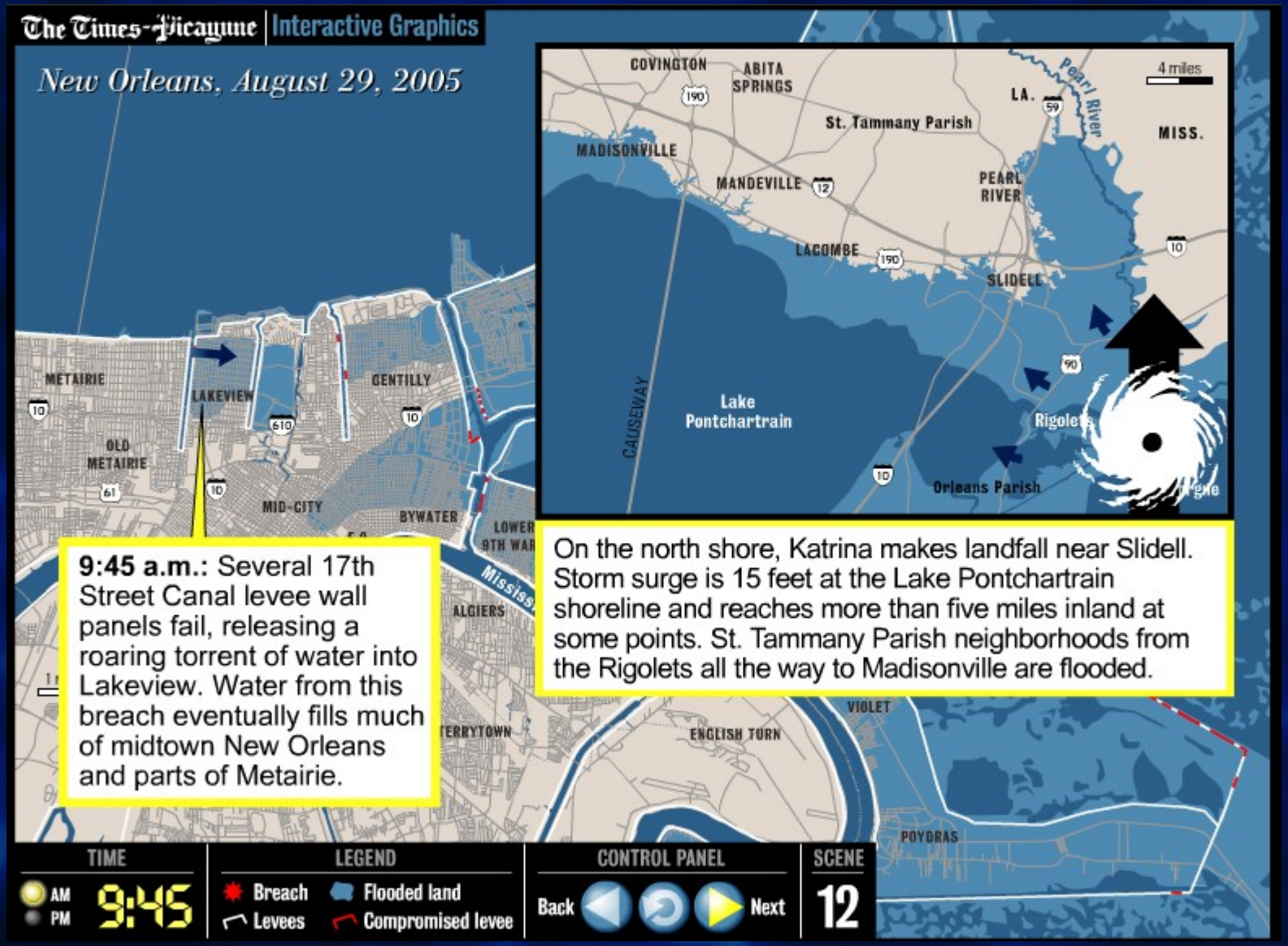

The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
7:30 a.m.: Levee wall panels on the west side of the Industrial Canal breach, flooding the Upper 9th Ward, Bywater and Treme.
Lake Borgne
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
CHALMETTE
ALGIERS
Mississippi River
MERAUX
UPTOWN
1 mile
GRETNA
VIOLET
TERRYTOWN
ENGLISH TURN
WESTWEGO
MARRERO
HARVEY
POYDRAS
TIME
AM
PM
7:30
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
7


The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
CHALMETTE
MERAUX
Mississippi River
VIOLET
ENGLISH TURN
POYDRAS
Lake Borgne
7:45 a.m.: Two floodwall sections on the east side of the Industrial Canal fall, releasing a wall of water into the Lower 9th Ward, tossing homes and cars around like toys. The water also pours into Arabi and Chalmette.
TIME
AM
PM
7:45
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
8

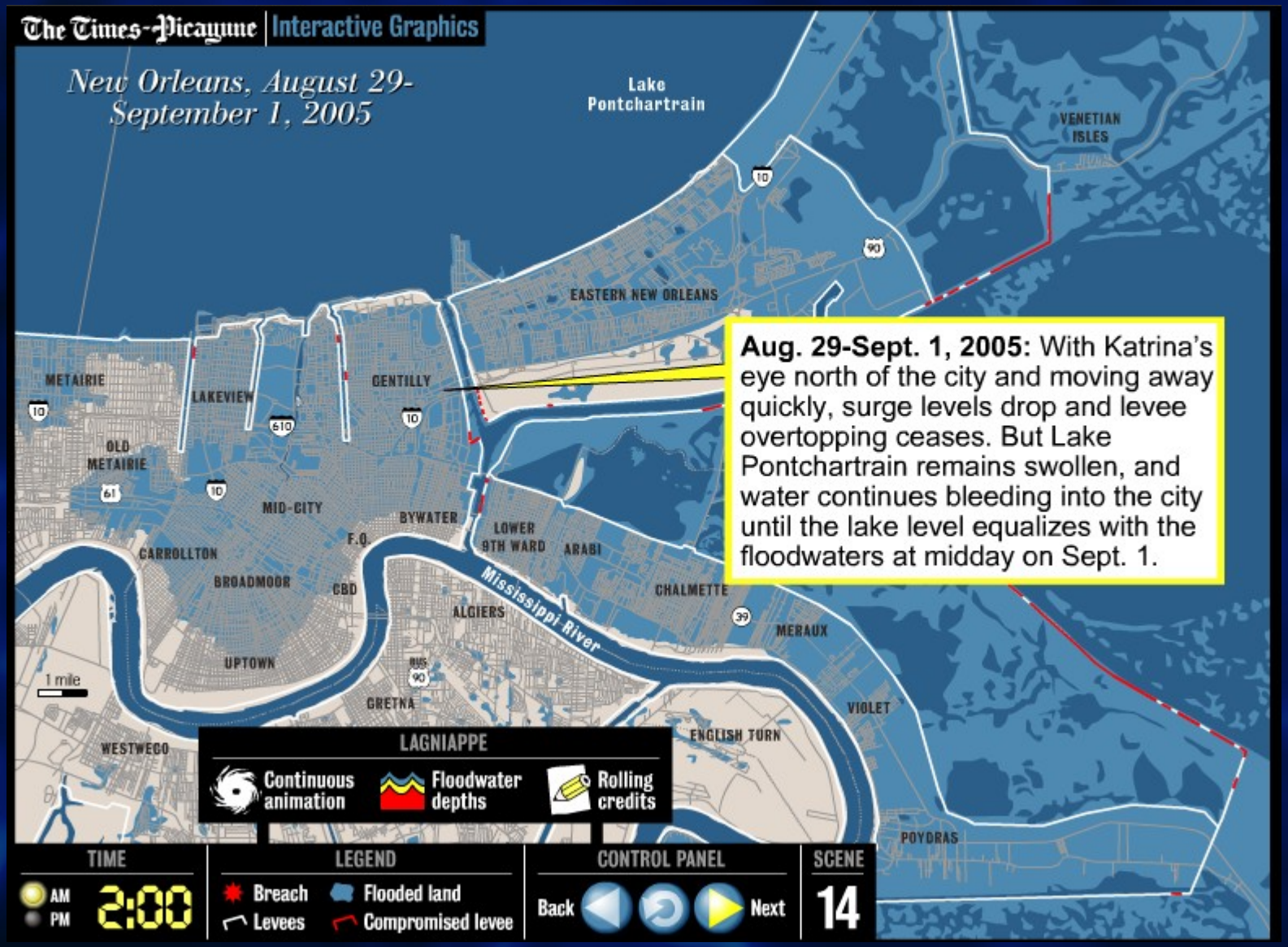

The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
To the north, a one-mile stretch of floodwall on the south side of Lakefront Airport is topped by surge from Lake Pontchartrain, adding to already severe flooding in eastern New Orleans.
8:30 a.m.: Lake Borgne advances to St. Bernard Parish's second line of defense, easily topping the 7-foot to 9-foot 40-Arpent Canal levee and filling neighborhoods from Poydras to Chalmette.
EASTERN NEW ORLEANS
GENTILLY
Lake Borgne
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
CHALMETTE
ALGIERS
Mississippi River
MEraux
UPTOWN
1 mile
GRETNA
VIOLET
TERRYTOWN
ENGLISH TURN
WESTWEGO
MARRERO
HARVEY
POYDRAS
TIME
AM
PM
8:30
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
9

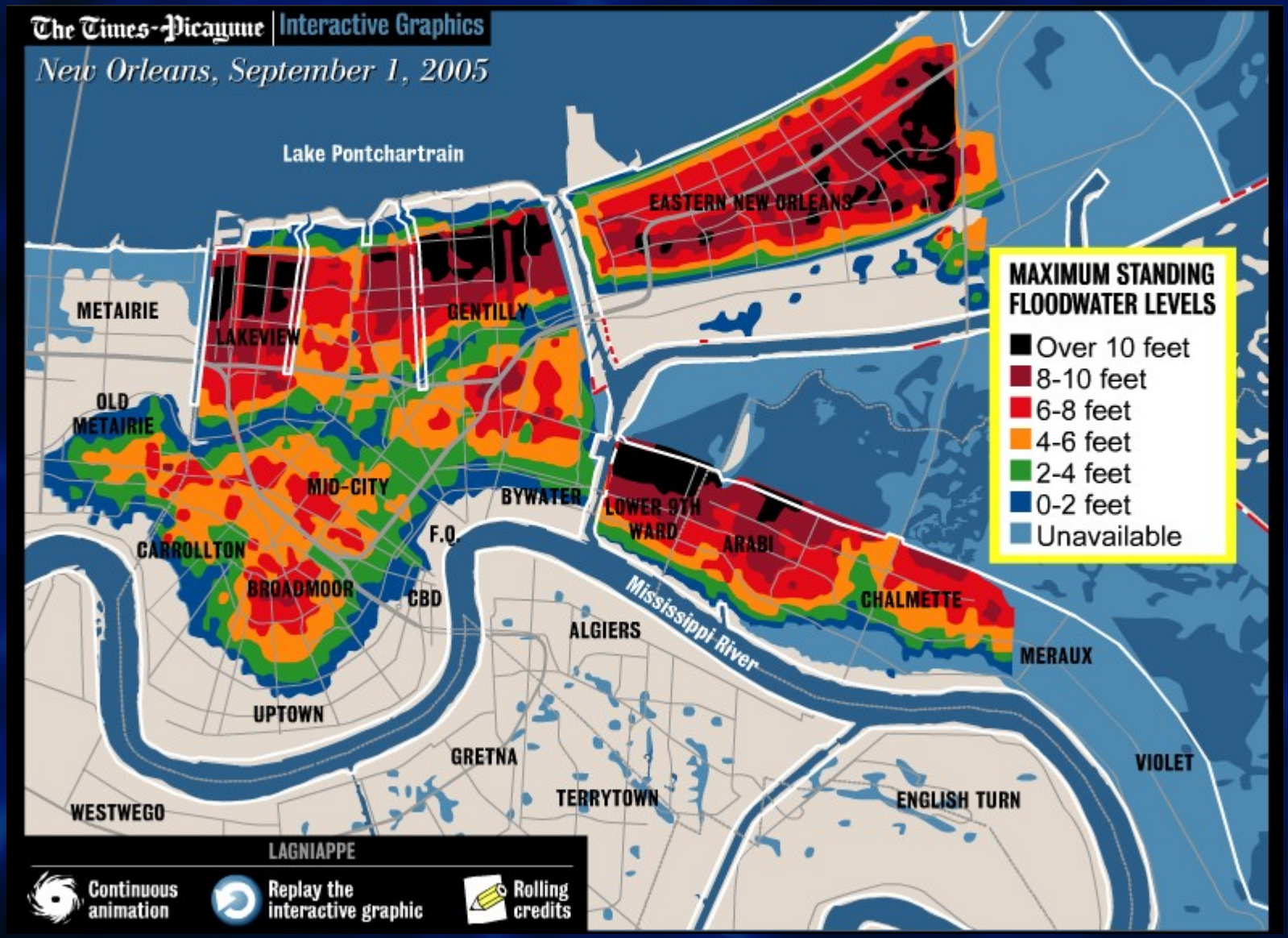

The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
About two miles west, surge reaches an embankment at the foot of the Orleans Avenue Canal that is 6 feet lower than the floodwalls. Water tops the embankment and pours into City Park.
9 a.m.: Surge rises to 10 feet in the London Avenue Canal and levee wall panels on both sides start bending. Water leaks into yards, but the flow is still minor.
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
Lake Borgne
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
CHALMETTE
ALGIERS
MERAUX
Mississippi River
TERRYTOWN
ENGLISH TURN
VIOLET
POYDRAS
1 mile
TIME
AM
PM
9:00
LEGEND
Breach
Levees
Flooded land
Compromised levee
CONTROL PANEL
Back
Next
SCENE
10

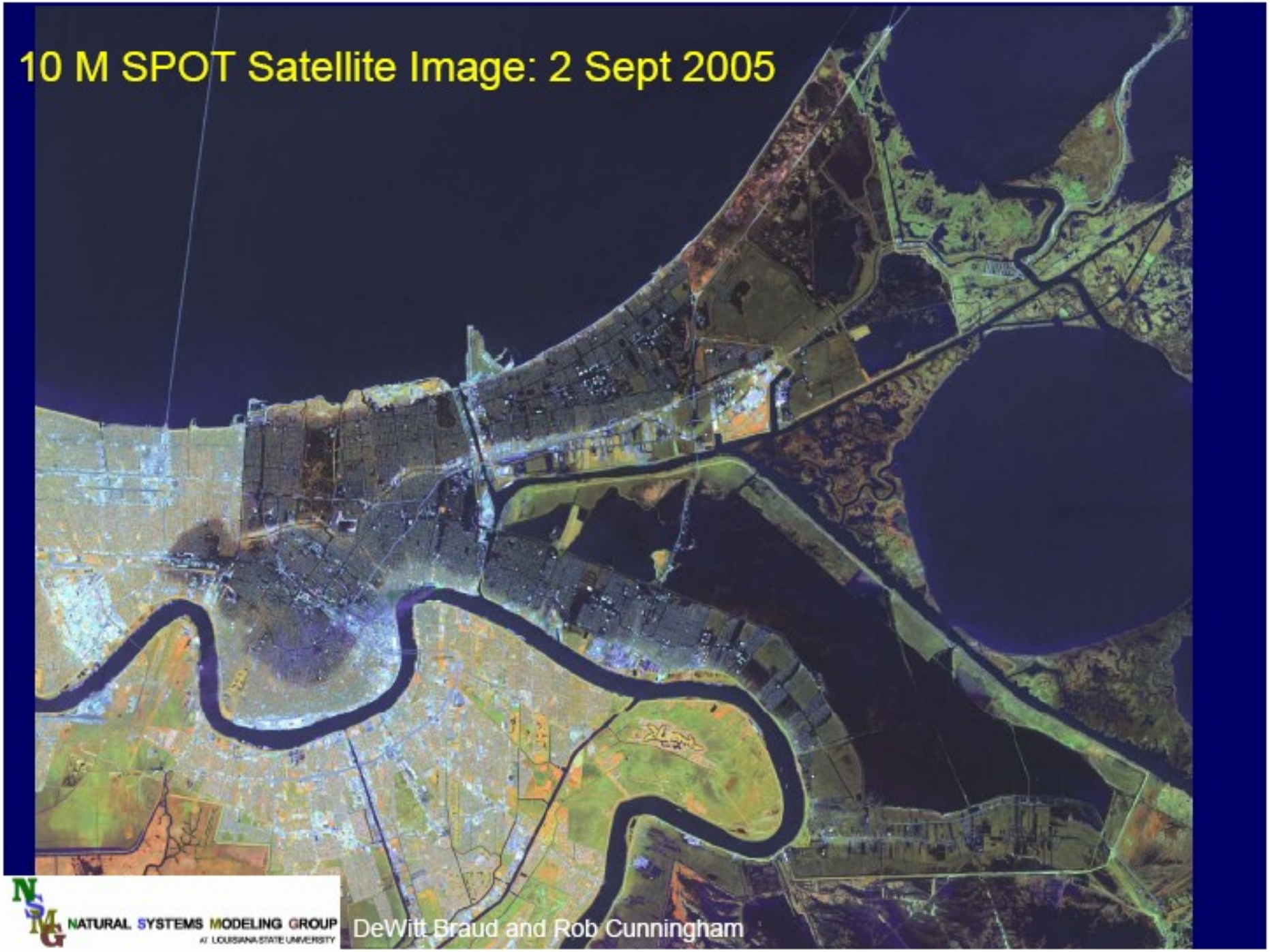

The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
Lake Borgne
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
F.Q.
LOWER 9TH WARD
ARABI
CBD
ALGIERS
CHALMETTE
MERAUX
Mississippi River
GRETNA
TERRYTOWN
HARVEY
ENGLISH TURN
VIOLET
POYDRAS
9:30 a.m.: I-wall panels on the east side of the London Avenue Canal fail, releasing a wall of water and sand into homes and expanding the flooding of Gentilly.
TIME
AM
PM
9:30
LEGEND
Breach
Levees
Flooded land
Compromised levee
CONTROL PANEL
Back
Next
SCENE
11


The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
COVINGTON
ABITA SPRINGS
Pearl River
4 miles
LA.
MISS.
St. Tammany Parish
MADISONVILLE
MANDEVILLE
PEARL RIVER
LACOMBE
SLIDELL
CAUSEWAY
Lake Pontchartrain
Rigolets
Orleans Parish
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
ALGIERS
ENGLISH TURN
VIOLET
POYDRAS
9:45 a.m.: Several 17th Street Canal levee wall panels fail, releasing a roaring torrent of water into Lakeview. Water from this breach eventually fills much of midtown New Orleans and parts of Metairie.
On the north shore, Katrina makes landfall near Slidell. Storm surge is 15 feet at the Lake Pontchartrain shoreline and reaches more than five miles inland at some points. St. Tammany Parish neighborhoods from the Rigolets all the way to Madisonville are flooded.
TIME
AM
PM
9:45
LEGEND
Breach
Levees
Flooded land
Compromised levee
CONTROL PANEL
Back
Next
SCENE
12


The Times-Picayune | Interactive Graphics
New Orleans, August 29, 2005
Lake Pontchartrain
VENETIAN ISLES
10:30 a.m.: I-wall panels on the west side of the London Avenue Canal are pushed over, adding 8 feet of water to flooded Gentilly and contributing to rising water across the city.
Lake Borgne
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
F.Q.
LOWER 9TH WARD
ARABI
CBD
CHALMETTE
ALGIERS
Mississippi River
MERAUX
GRETNA
TERRYTOWN
ENGLISH TURN
VIOLET
HARVEY
POYDRAS
Parts of Jefferson Parish also flood as rainwater leaks through an unstaffed pumping system.
TIME
AM PM 10:30
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
13


The Times-Picayune | Interactive Graphics
New Orleans, August 29-September 1, 2005
Lake Pontchartrain
VENETIAN ISLES
EASTERN NEW ORLEANS
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
F.Q.
CARROLLTON
BROADMOOR
CBD
ALGIERS
CHALMETTE
MERAUX
Mississippi River
UPTOWN
GRETNA
WESTWEGO
ENGLISH TURN
VIOLET
POYDRAS
1 mile
Aug. 29-Sept. 1, 2005: With Katrina's eye north of the city and moving away quickly, surge levels drop and levee overtopping ceases. But Lake Pontchartrain remains swollen, and water continues bleeding into the city until the lake level equalizes with the floodwaters at midday on Sept. 1.
LAGNIAPPE
Continuous animation
Floodwater depths
Rolling credits
TIME
AM
PM
2:00
LEGEND
Breach
Flooded land
Levees
Compromised levee
CONTROL PANEL
Back
Next
SCENE
14

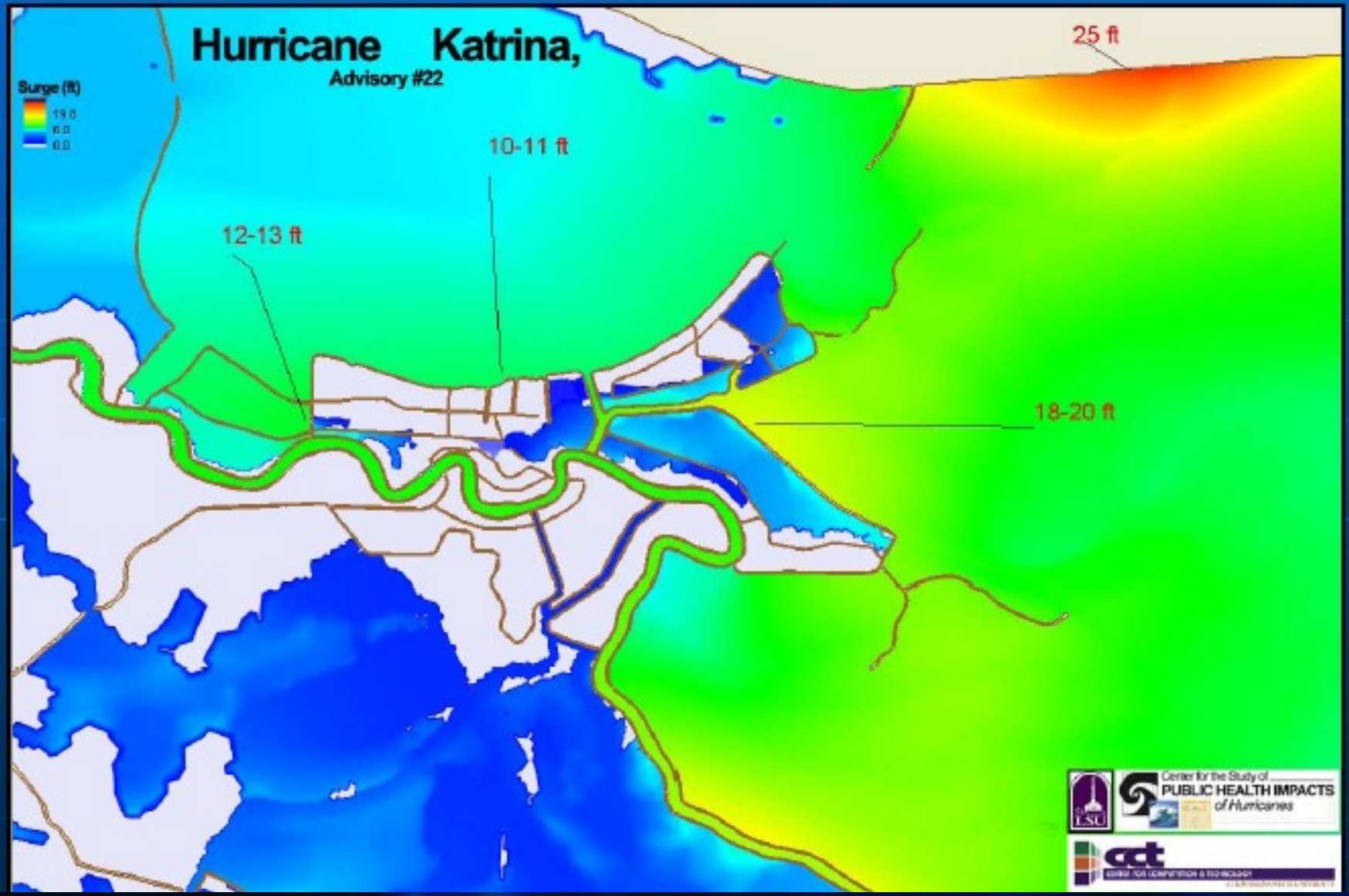

The Times-Picayune | Interactive Graphics
New Orleans, September 1, 2005
Lake Pontchartrain
EASTERN NEW ORLEANS
METAIRIE
LAKEVIEW
GENTILLY
OLD METAIRIE
MID-CITY
BYWATER
LOWER 9TH WARD
ARABI
CHALMETTE
CARROLLTON
F.Q.
BROADMOOR
CBD
ALGIERS
Mississippi River
MERAUX
UPTOWN
GRETNA
VIOLET
TERRYTOWN
ENGLISH TURN
WESTWEGO
LAGNIAPPE
MAXIMUM STANDING FLOODWATER LEVELS
Over 10 feet
8-10 feet
6-8 feet
4-6 feet
2-4 feet
0-2 feet
Unavailable
Continuous animation
Replay the interactive graphic
Rolling credits



NATURAL SYSTEMS MODELING GROUP
AT LOUISIANA STATE UNIVERSITY

DeWitt Braud and Rob Cunningham

If Levees Had Held



4-1 Quel diagnostic pour des pistes de solution ?

1- Un cyclone de niveau supérieur au système de protection en place et la localisation côtière la plus défavorable

2- Une résilience partielle du système antérieur aux submersions(sauf localement) mais pas du tout aux brèches

3- Des stations de pompage non résilientes

4- Une possible remontée des surcotes par le Mississippi River Gulf Outlet Canal

5- Une érosion côtière controversée limitant les zones tampons de stockage des volumes de surcote

Hurricane Katrina

Aug 29, 2005

- One of America's largest natural disasters
- Cat 5 less than 12 hrs before landfall
- 127 MPH wind at Louisiana landfall
- Maximum surge of 28 to 30 feet (8.5 to 9+ meters) along Mississippi coast

Hurricane Rita

Sep 24, 2005

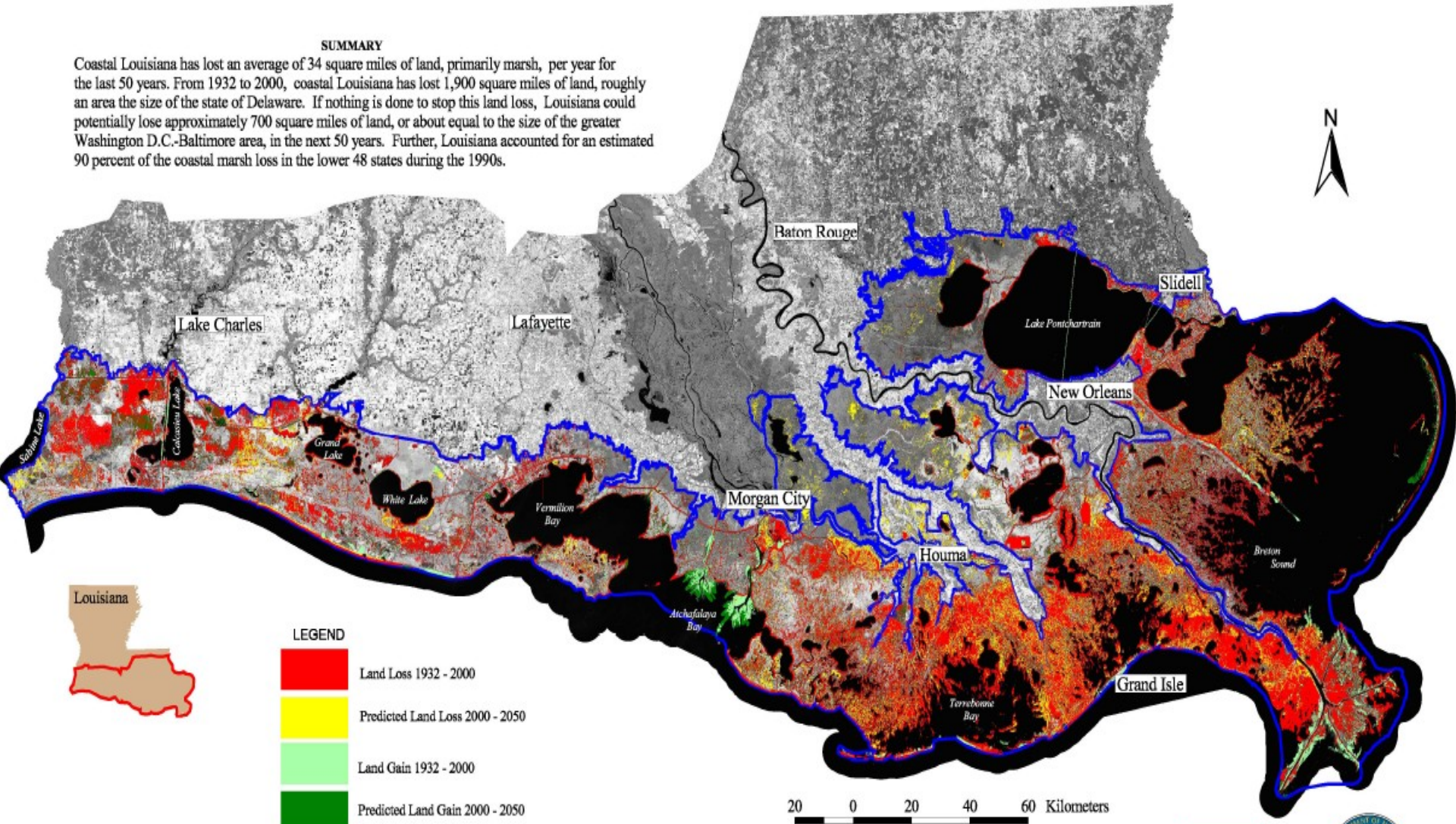
- Cat 4 less than 12 hrs before landfall
- 175 MPH (281 KM) max sustained winds in Gulf of Mexico
- 120 MPH (193 KM) max sustained winds at landfall
- Cat 3 strength at landfall

100+ Years of Land Change for Coastal Louisiana

USGS
science for a changing world

SUMMARY

Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2000, coastal Louisiana has lost 1,900 square miles of land, roughly an area the size of the state of Delaware. If nothing is done to stop this land loss, Louisiana could potentially lose approximately 700 square miles of land, or about equal to the size of the greater Washington D.C.-Baltimore area, in the next 50 years. Further, Louisiana accounted for an estimated 90 percent of the coastal marsh loss in the lower 48 states during the 1990s.



Background is 2000 Thematic Mapper panchromatic band.

Prepared by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

US Army Corps of Engineers

Map ID: USGS-NWRC 2003-0

4-2 La maturation du projet : bref panorama des pistes de solution imaginées en 2006

1- Un nouveau système d'ouvrages de défense

2- Une conception rénovée des levées et des murs

3- Des barrages bloquant la remontée des eaux du MRGO et

vers le canal Pontchartrain(IHNC)

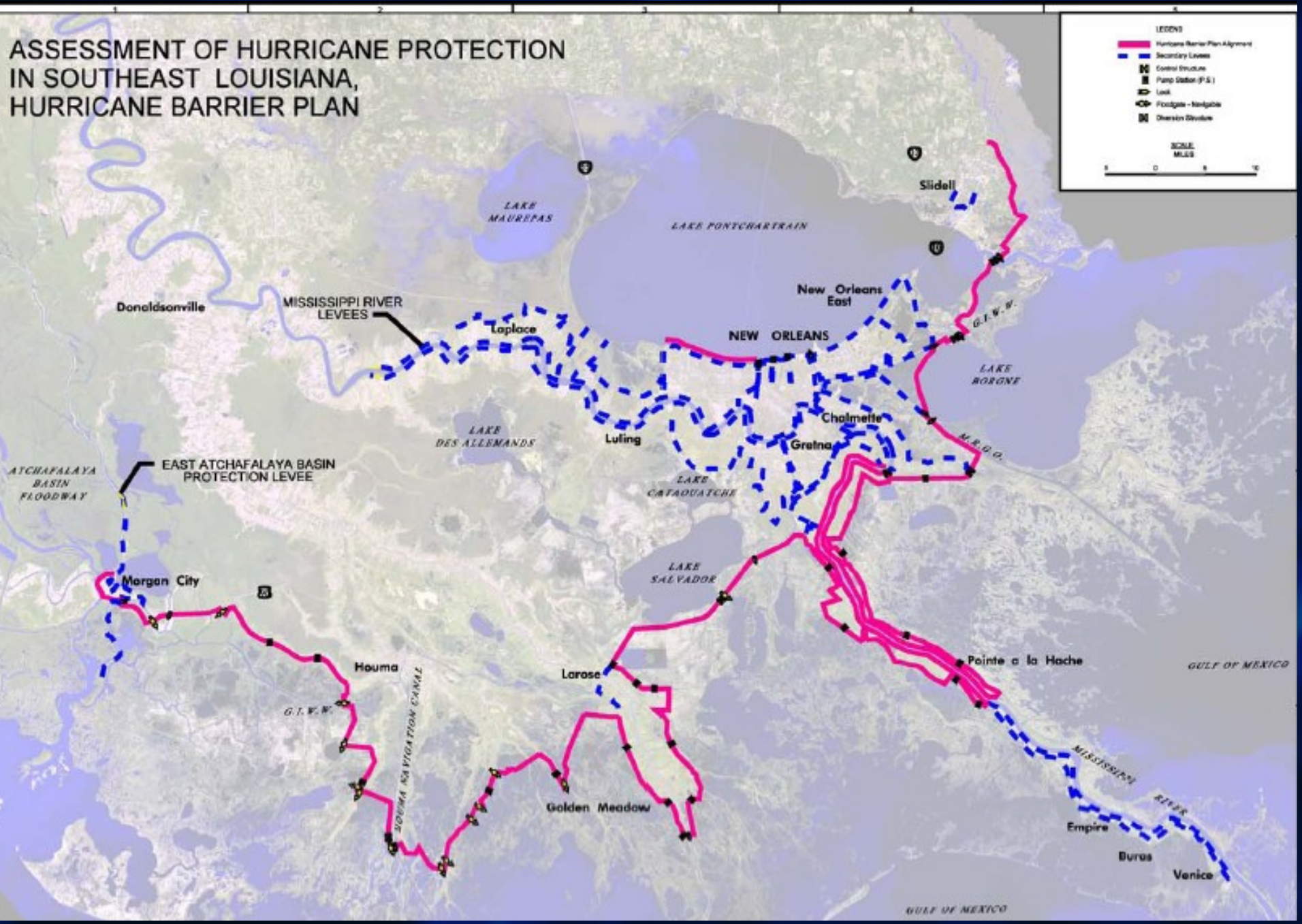
Multiple Lines of Defense

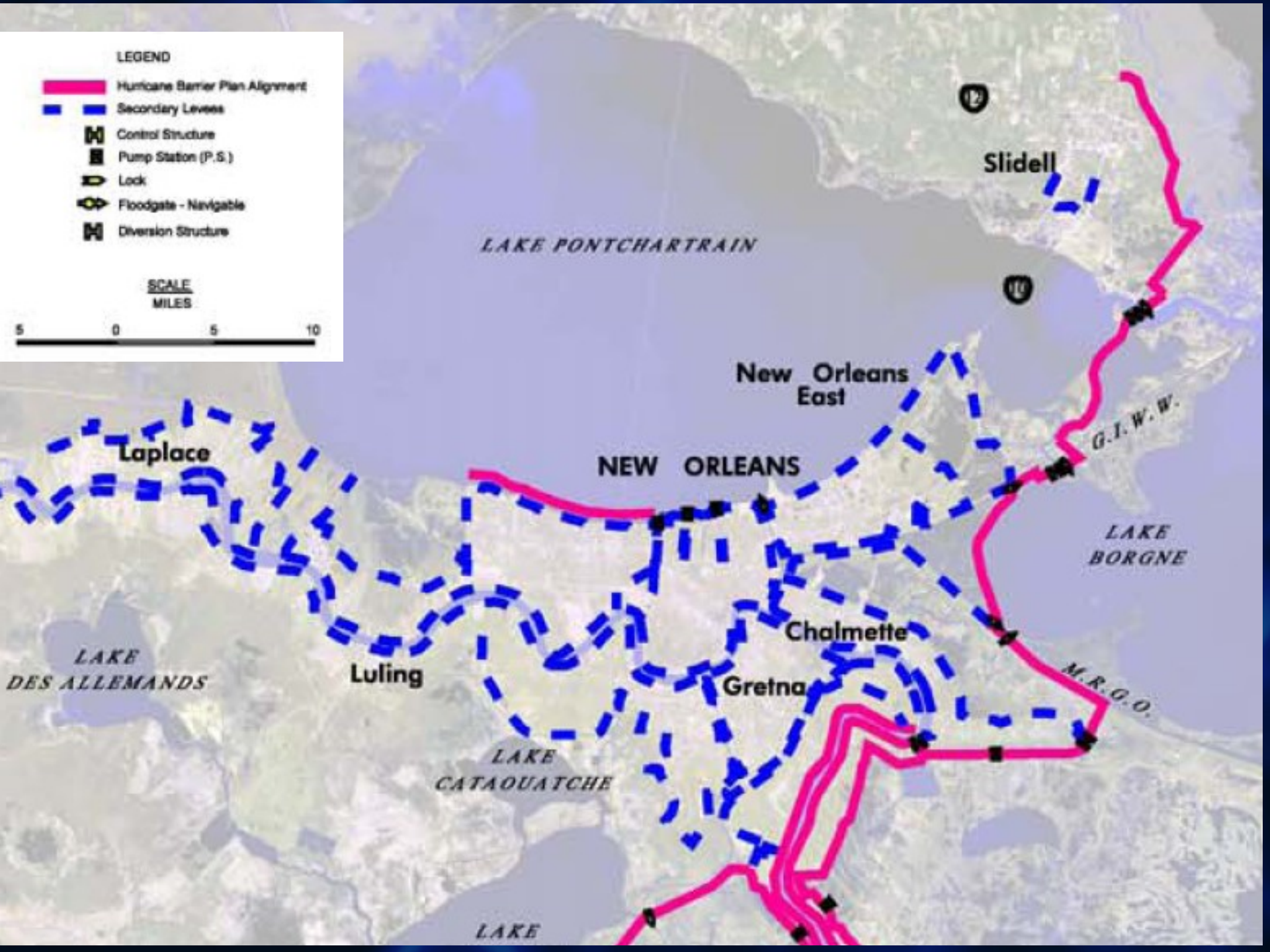
Elements include:

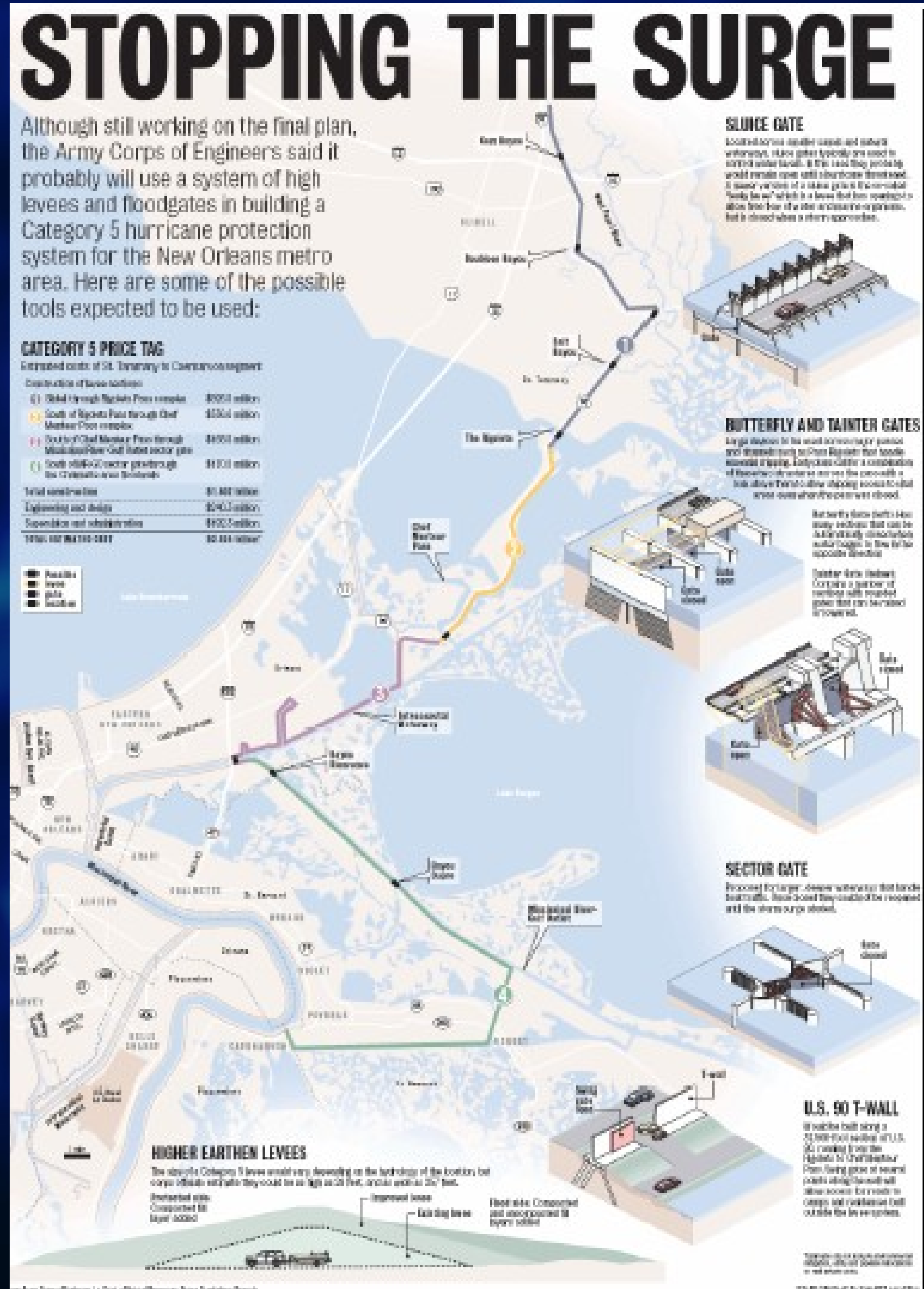
Coastal restoration/protection

Structural measures

Non-structural features

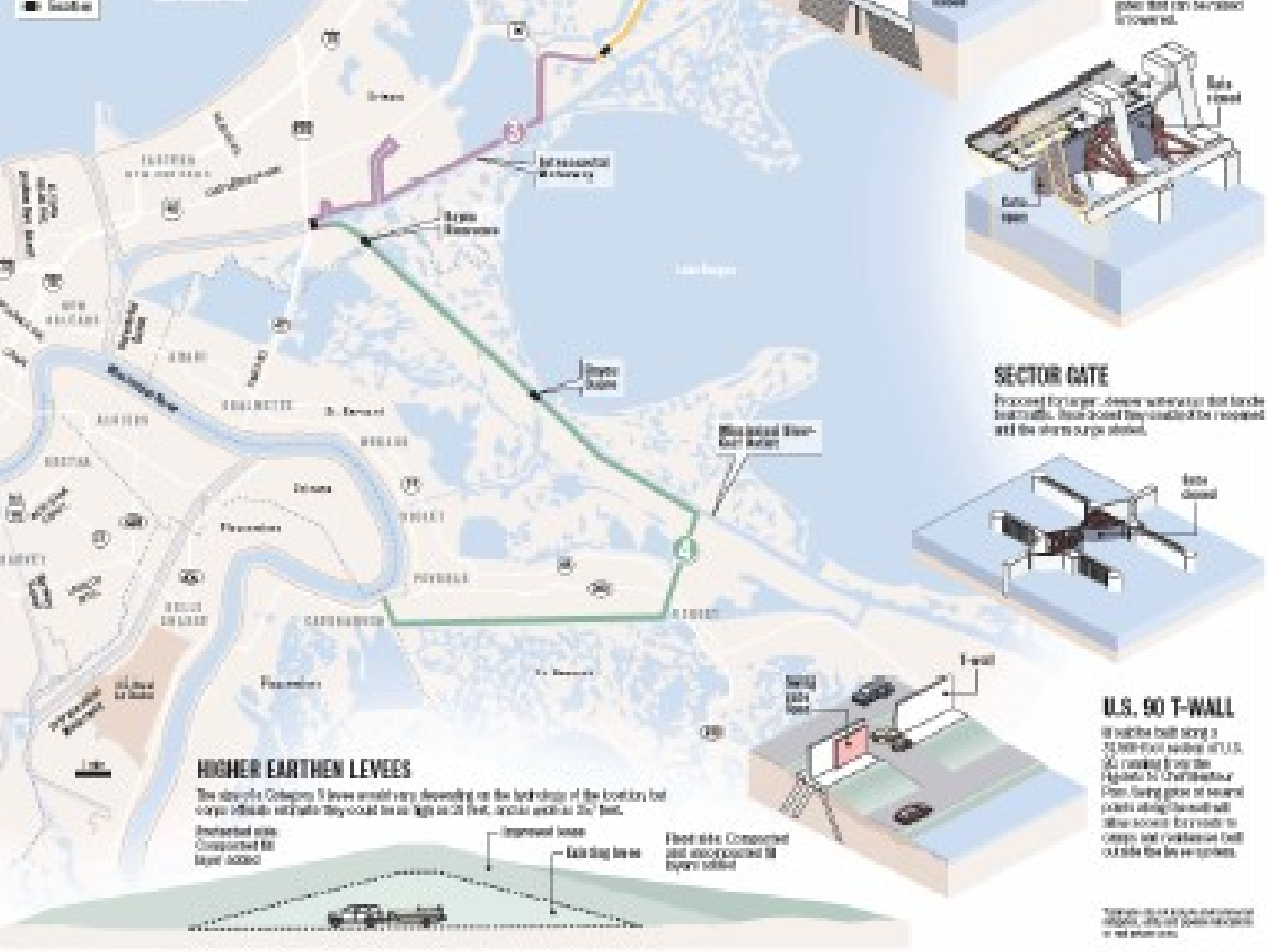

ASSESSMENT OF HURRICANE PROTECTION
IN SOUTHEAST LOUISIANA,
HURRICANE BARRIER PLAN
LEGEND
Hurricane Barrier Plan Alignment
Secondary Levees
Control Structure
Pump Station (P.S.)
Lock
Floodgate - Navigable
Diversion Structure
SCALE
MILES
0
5
10
Slidell
LAKE MAUREPAS
LAKE PONTCHARTRAIN
Donaldsonville
MISSISSIPPI RIVER
LEVEES
Laplace
New Orleans
East
NEW ORLEANS
G.I.W.W.
LAKE
BORGNE
Chalmette
Gretna
Luling
LAKE
DES ALLEMANDS
M.R.G.O.
LAKE
CATAOUATCHE
ATCHAFALAYA
BASIN
FLOODWAY
EAST ATCHAFALAYA BASIN
PROTECTION LEVEE
LAKE
SALVADOR
Morgan City
Houma
Larose
Pointe a la Hache
GULF OF MEXICO
G.I.W.W.
SOUTHERN NAVIGATION CANAL
Golden Meadow
MISSISSIPPI
RIVER
Empire
Buras
Venice
GULF OF MEXICO


LEGEND
Hurricane Barrier Plan Alignment
Secondary Levees
Control Structure
Pump Station (P.S.)
Lock
Floodgate - Navigable
Diversion Structure
SCALE
MILES
5
0
5
10
Slidell
LAKE PONTCHARTRAIN
New Orleans East
Laplace
NEW ORLEANS
G.I.W.W.
LAKE BORGNE
Chalmette
Luling
Gretna
M.R.G.O.
LAKE DES ALLEMANDS
LAKE CATAOUATCHE
LAKE



STOPPING THE SURGE
Although still working on the final plan, the Army Corps of Engineers said it probably will use a system of high levees and floodgates in building a Category 5 hurricane protection system for the New Orleans metro area. Here are some of the possible tools expected to be used:
CATEGORY 5 PRICE TAG
SLUICE GATE
BUTTERFLY AND TAINTER GATES
SECTOR GATE
U.S. 90 T-WALL
HIGHER EARTHEN LEVEES


Category 5 hurricane protection system for the New Orleans metro area. Here are some of the possible tools expected to be used:
CATEGORY 5 PRICE TAG
BUTTERFLY AND TAINTER GATES
SECTOR GATE


SECTOR GATE
U.S. 90 T-WALL
HIGHER EARTHEN LEVEES

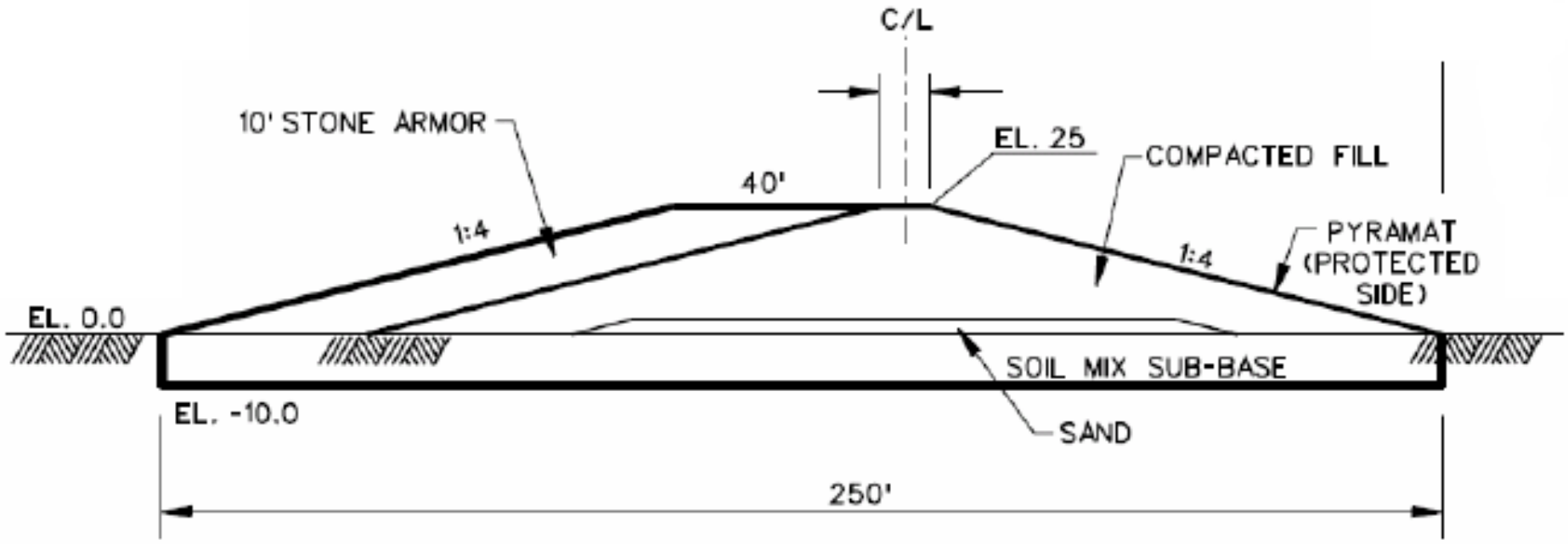


FIGURE L-24 Typical Soil-Cement Section

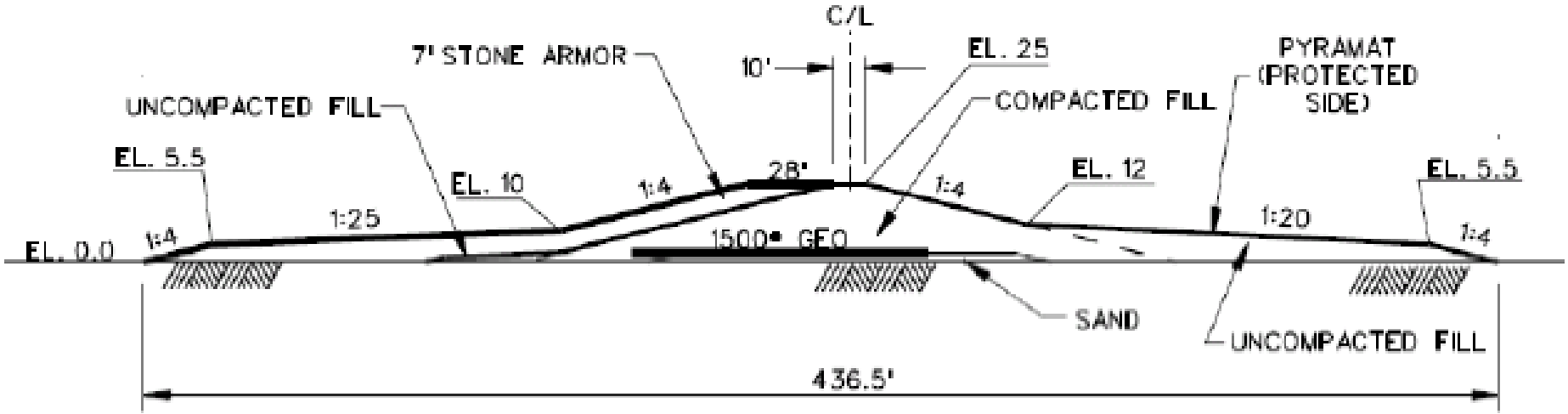
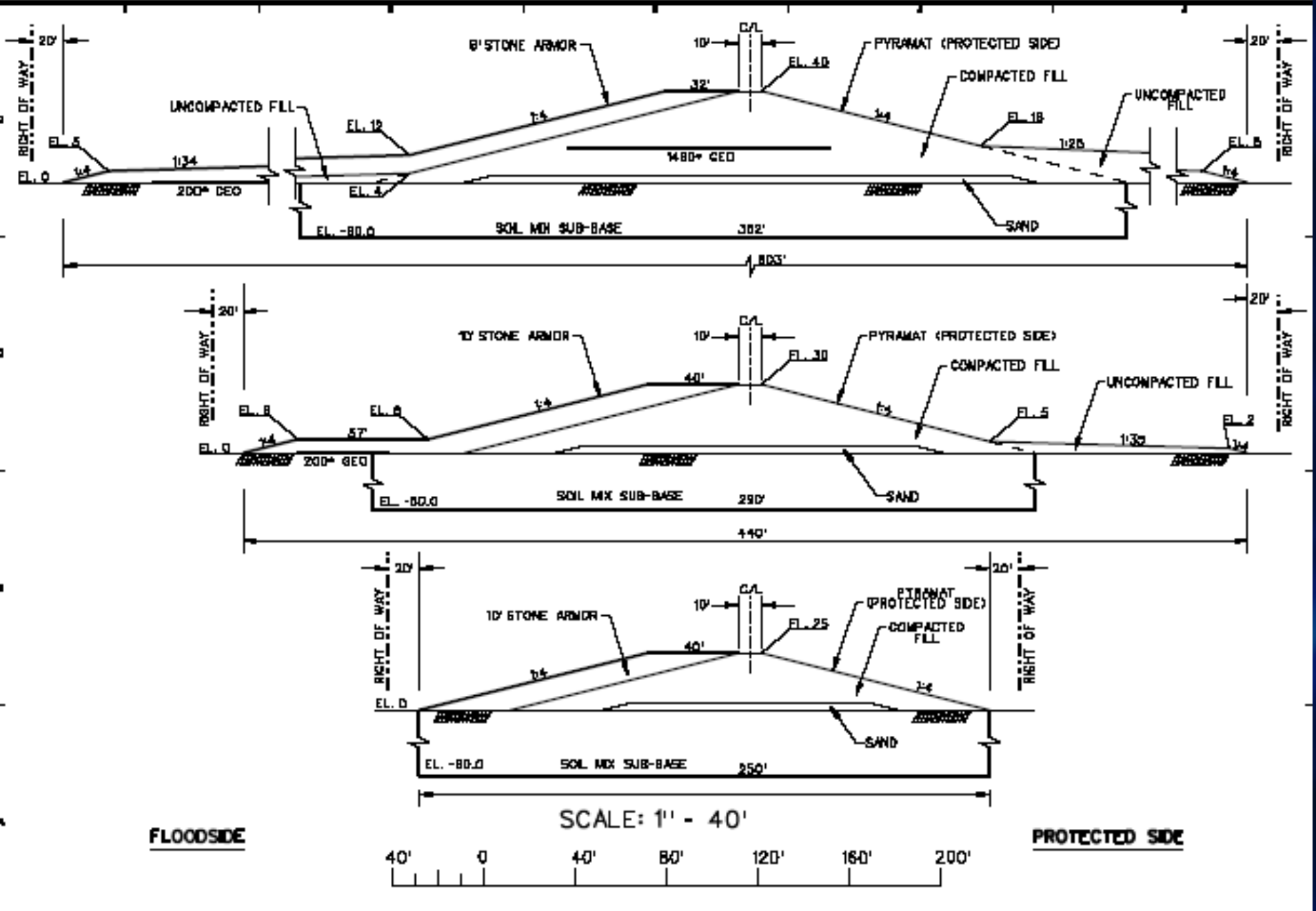


FIGURE L-25 Typical Geotextile-Reinforced Embankment Section


20'
RIGHT OF WAY
8' STONE ARMOR
10'
C/L
EL. 40
PYRAMAT (PROTECTED SIDE)
COMPACTED FILL
UNCOMPACTED FILL
32'
1:4
EL. 12
EL. 5
1:34
EL. 0
200# GEO
1480# GEO
EL. 18
1:25
EL. 4
EL. -80.0
SOIL MIX SUB-BASE
382'
SAND
805'
10' STONE ARMOR
EL. 30
40'
EL. 8
57'
1:35
EL. 2
290'
440'
PYRAMAT (PROTECTED SIDE)
EL. 25
EL. 0
250'
SCALE: 1" - 40'
FLOODSIDE
PROTECTED SIDE
40'
0
40'
80'
120'
160'
200'

5-1 Les conditions clef du succès du nouveau système

1- Une loi programme évitant l'annualité budgétaire avec une continuité politique des deux présidents Bush et Obama

2- Un travail à marches forcées (quatre ans)

3- Une disposition foncière permettant à l'US Corps of Engineers d'imposer des ouvrages chez des particuliers

4- Une mobilisation d'ingénierie, d'expertise et de contre-expertise sans précédent

5- Un projet global incluant la reconstitution de zones humides tampon

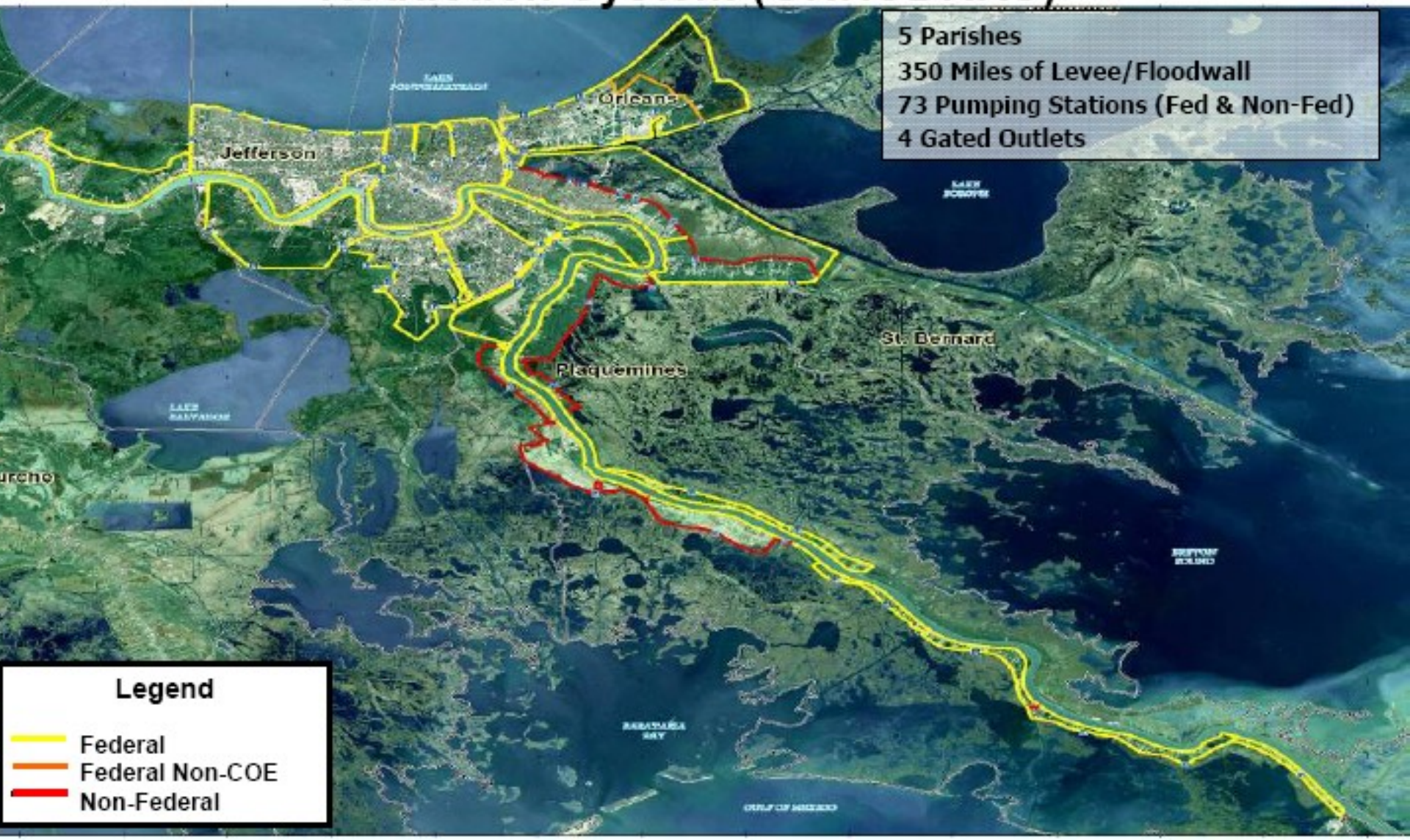
6- Un large dispositif de concertation national et local

Greater New Orleans Hurricane & Storm Damage Risk Reduction System:

Our Mission and Commitment

- Repair the damages, making what was there before whole again.
- Strengthen and improve the system and provide 100-year level of protection capable of withstanding the effects of a storm having a 1% chance of occurring each year.
- Current funding level $14.6 B (fully funded).
- Study and recommend solutions to provide higher levels of protection; restore and protect coastal wetlands (LaCPR).

Greater New Orleans Hurricane and Storm Damage Risk Reduction System (GNHSDRRS)

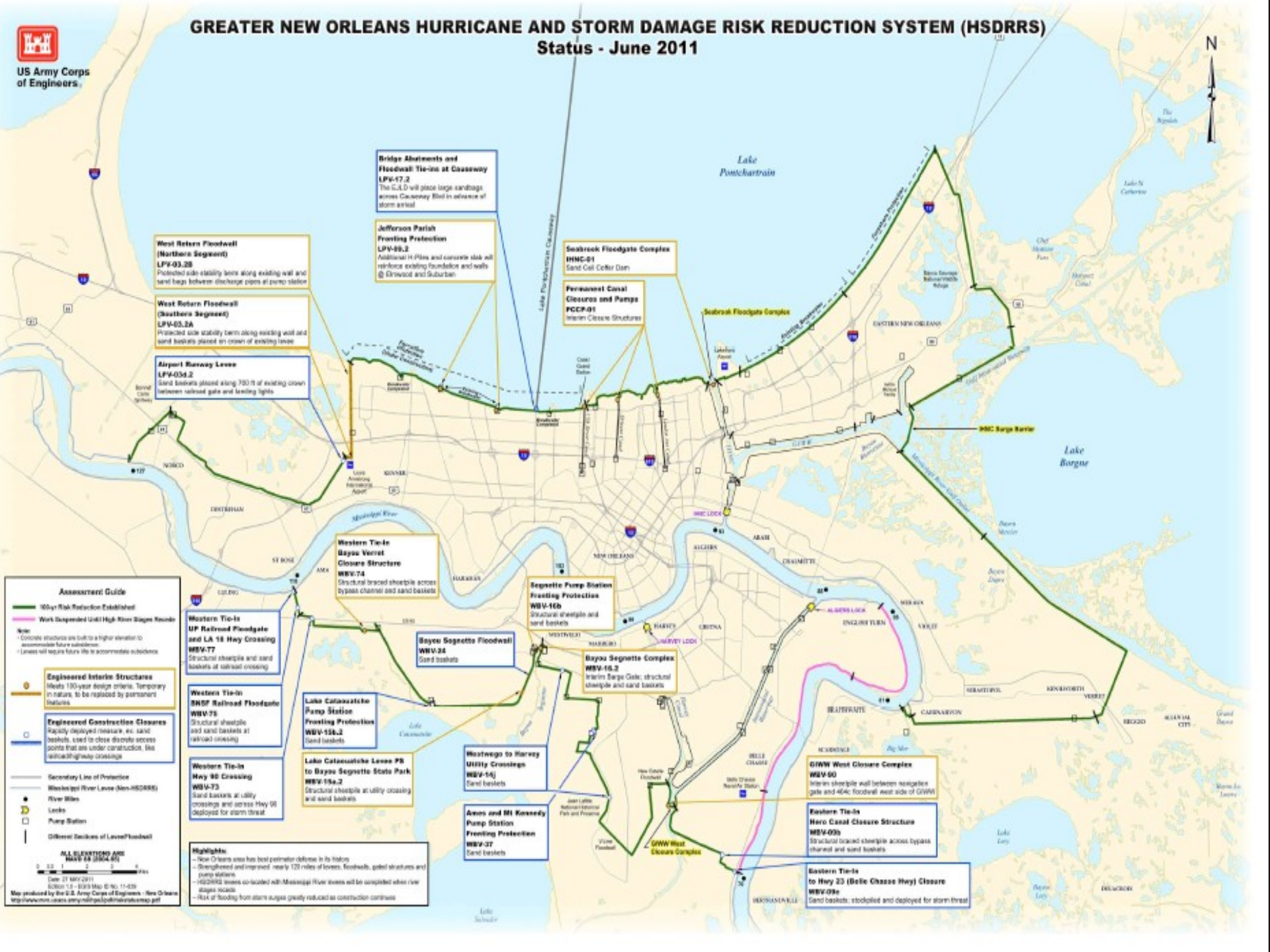


US Army Corps of Engineers

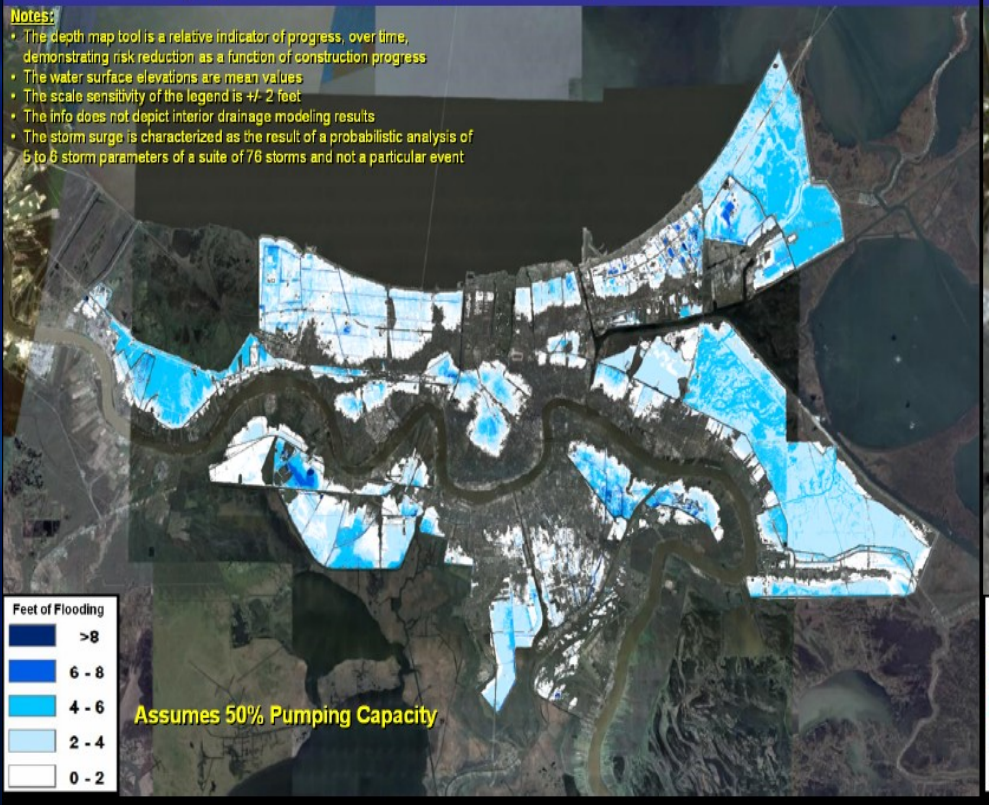
Southwest Coastal Study

GREATER NEW ORLEANS HURRICANE AND STORM DAMAGE RISK REDUCTION SYSTEM (HSDRRS)
Status - June 2011

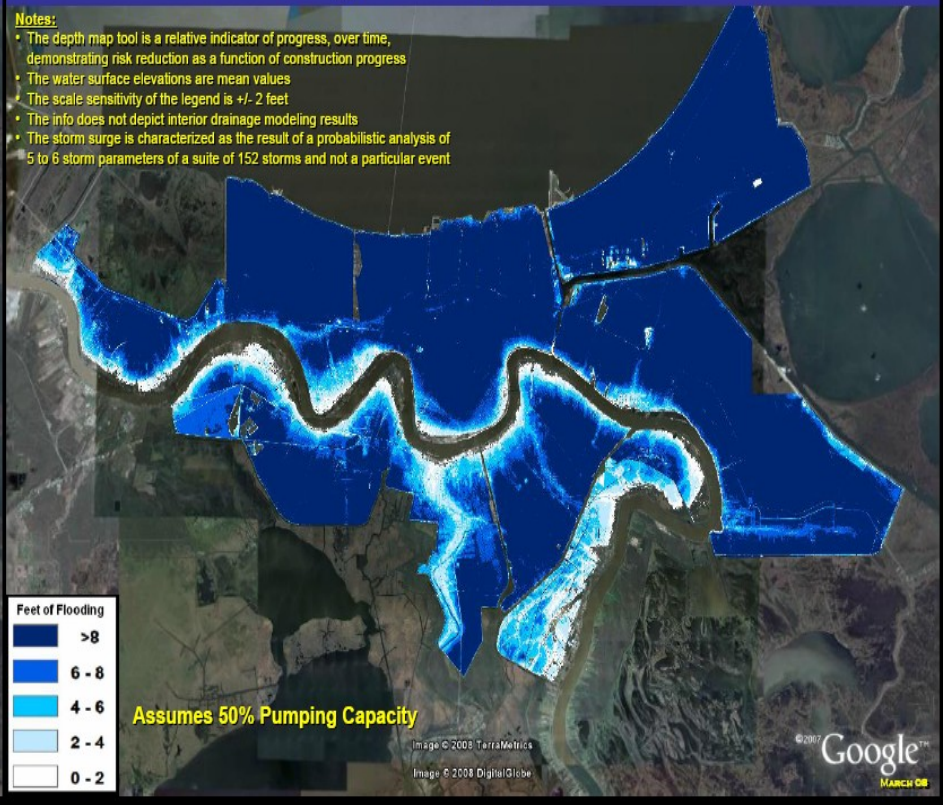
US Army Corps of Engineers

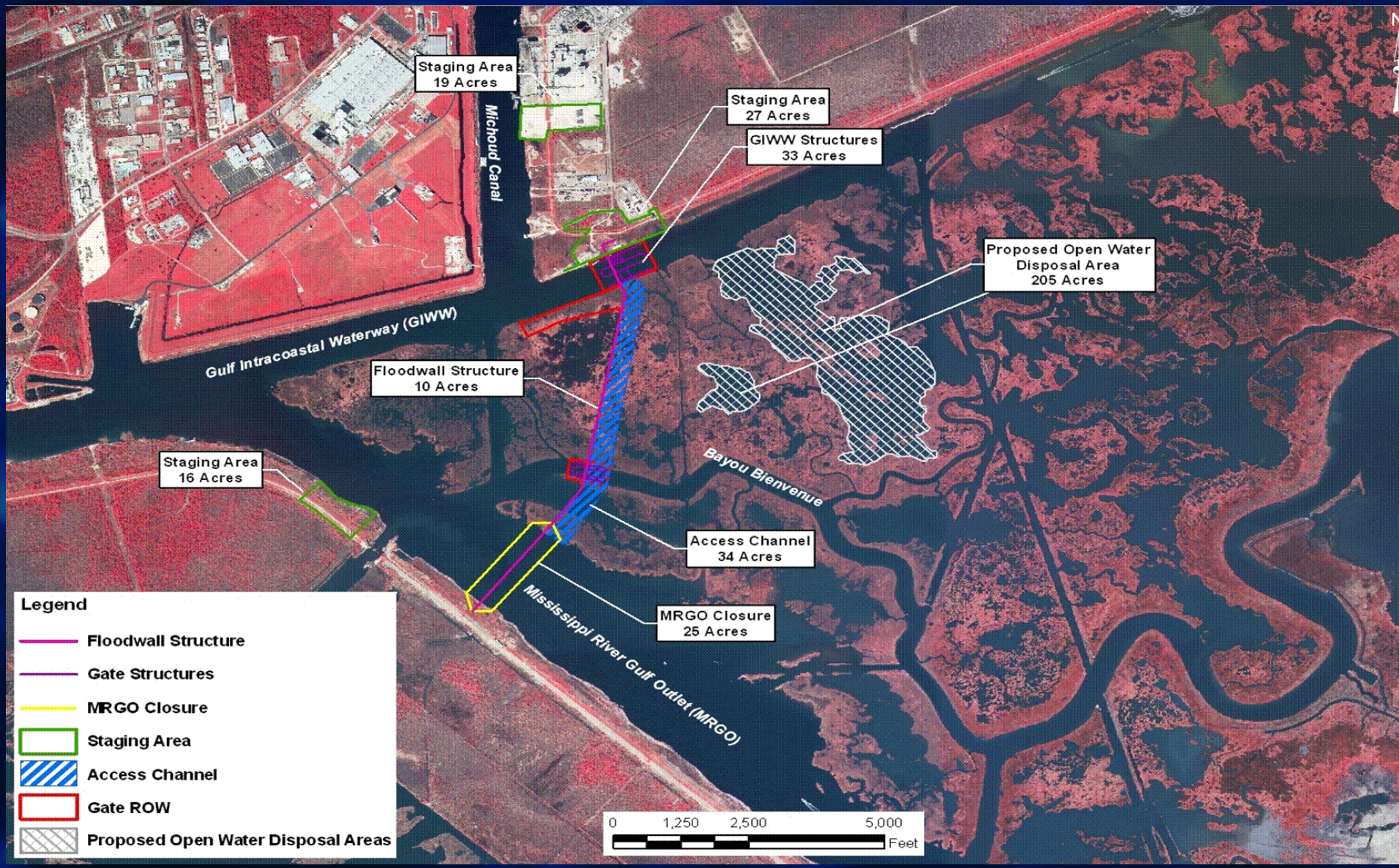


With the 100-year level of protection, you have a 0.2% chance every year of flooding this deep from Hurricanes



Before Katrina, you had a 0.2% chance every year of flooding this deep from Hurricanes




Staging Area
19 Acres
Michoud Canal
Staging Area
27 Acres
GIWW Structures
33 Acres
Proposed Open Water
Disposal Area
205 Acres
Gulf Intracoastal Waterway (GIWW)
Floodwall Structure
10 Acres
Staging Area
16 Acres
Bayou Bienvenue
Access Channel
34 Acres
MRGO Closure
25 Acres
Mississippi River Gulf Outlet (MRGO)
Legend
Floodwall Structure
Gate Structures
MRGO Closure
Staging Area
Access Channel
Gate ROW
Proposed Open Water Disposal Areas
0
1,250
2,500
5,000
Feet


1949


2001


2007

5-2 La réalisation des travaux présentée par l'US Corps et les entreprises de travaux lors de la conférence Smart Rivers en septembre 2012

Greater New Orleans Area Hurricane & Storm Damage Risk Reduction System

Smart Rivers Conference, Opening Plenary Session

Col. Edward Fleming
Commander, New Orleans District, U.S. Army Corps of Engineers

Angela DeSoto-Duncan
Director of Civil Works, Tetra Tech - INCA

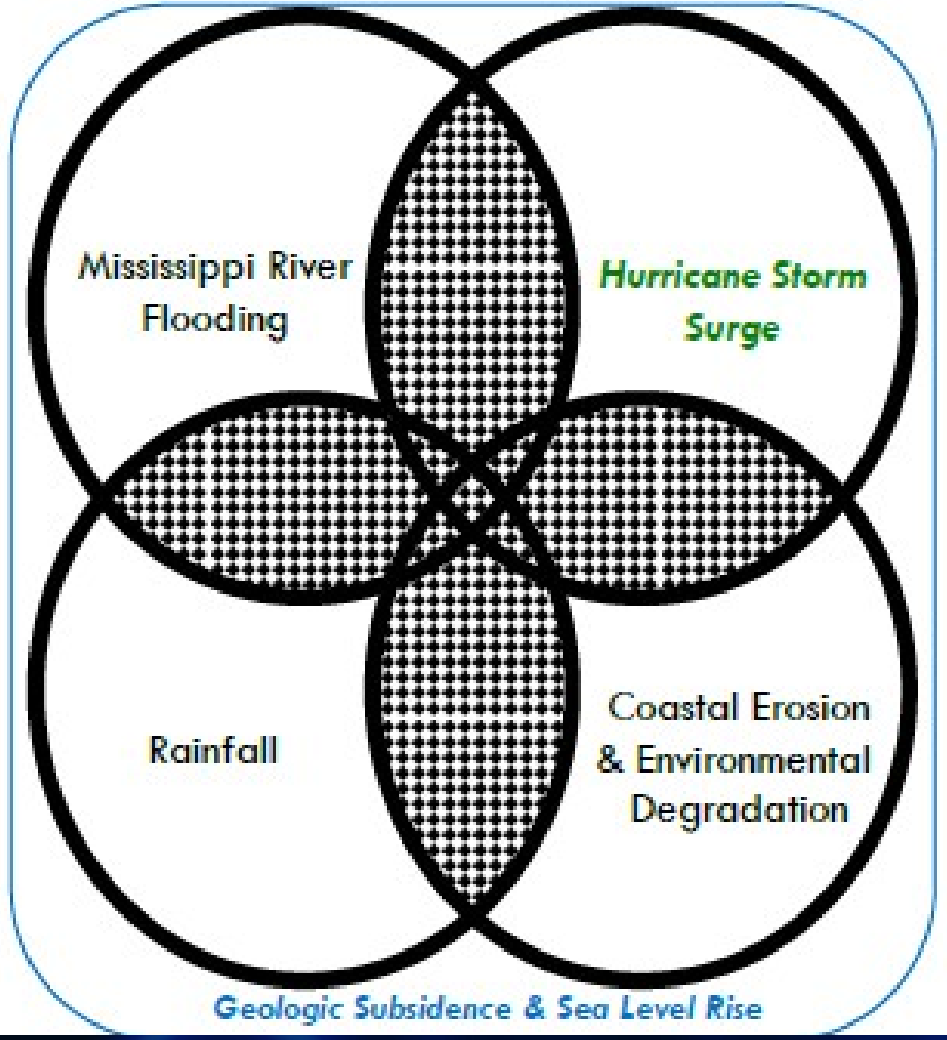
Dale Miller
Regional Vice-President, Tetra Tech - INCA

Lt Col (Ret) Vic Zillmer
Resident Manager, IHNC Lake Borgne Surge Barrier, U.S. Army Corps of Engineers

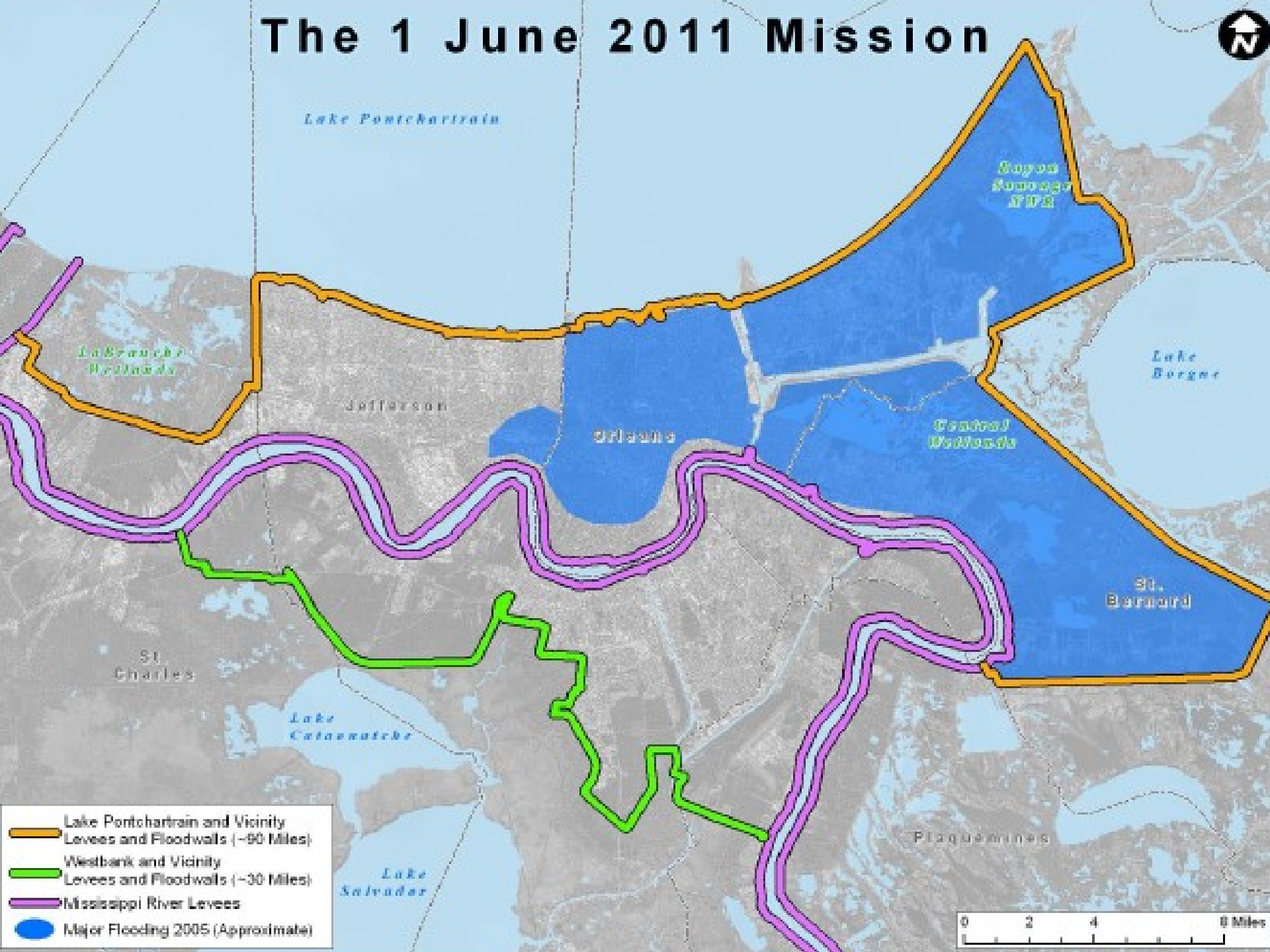
September 14, 2011

The Four Major New Orleans Flood Risks

Separate, but overlapping or related interagency systems or programs to address each!



The 1 June 2011 Mission



3 Glass Balls that Cannot Be Dropped

PUBLIC SAFETY DEPENDS ON ALL 3...

Three Strategic Improvements of the Hurricane and Storm Damage Risk Reduction System (HSDRRS)

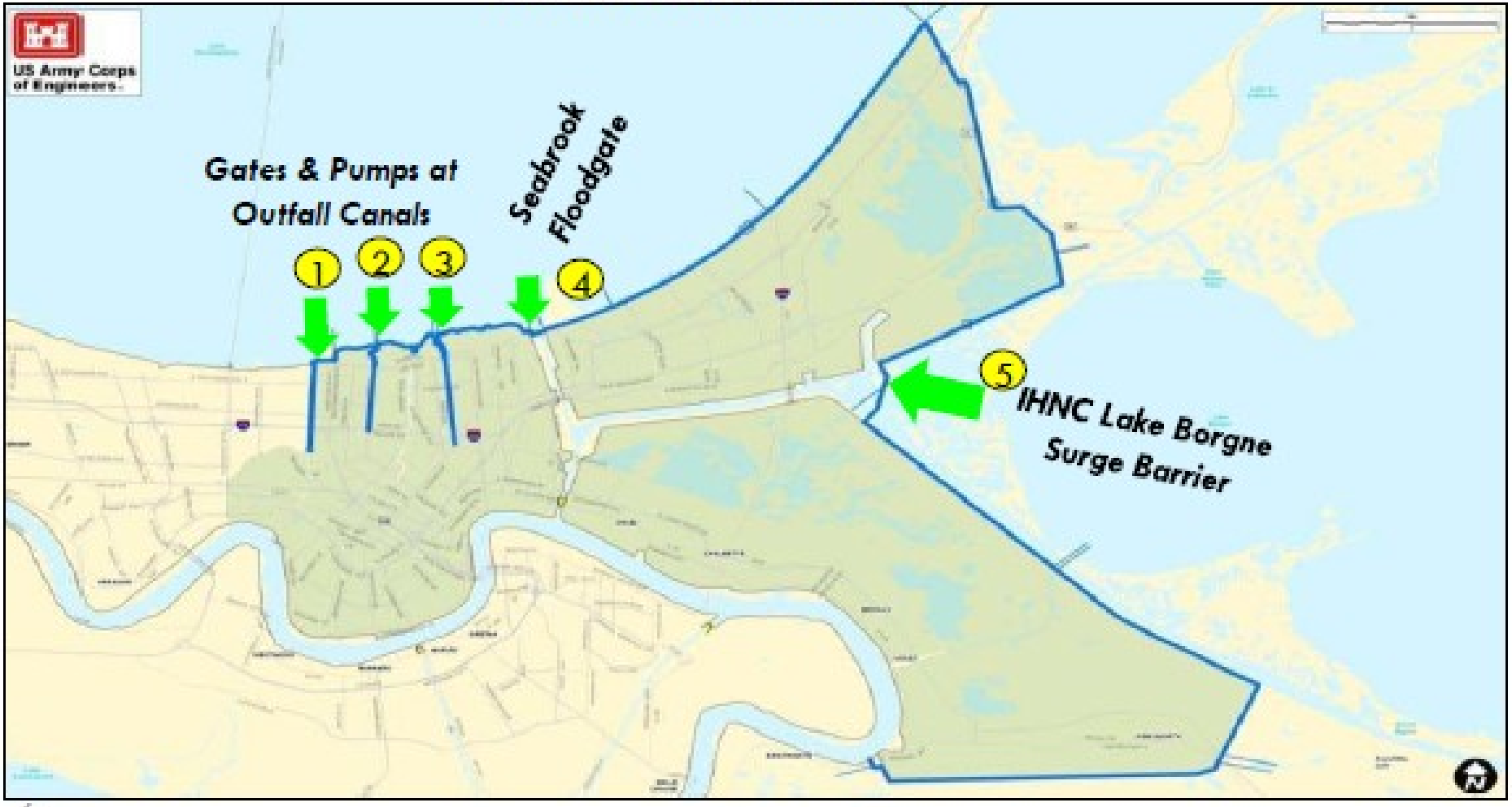
1. **Block five storm surge avenues** from a 100-year storm surge.

2. Raise and strengthen levees and floodwalls to the **same design guidelines.**

3. **Storm proof key pump stations** so they can function when there is flooding in the city.

Block The Five Storm Surge Avenues

(From a 100-year storm surge)



Raise and Strengthen Levees / Floodwalls

Orleans Metro

St. Bernard Parish

New Orleans East

Storm Proof Key Pump Stations

Repair 61 pump stations ($103 Mil)

Storm proof 49 pump stations ($322 Mil)

Construct 5 safe houses ($18 Mil)

A Priority of Two Administrations

"Now, even as we continue our recovery efforts, we're also focusing on preparing for future threats so that there is never another disaster like Katrina. ***The largest civil works project in American history*** *is underway to build a fortified levee system. And as I — just as I pledged as a candidate,* ***we're going to finish this system by next year so that this city is protected against a 100-year storm."***

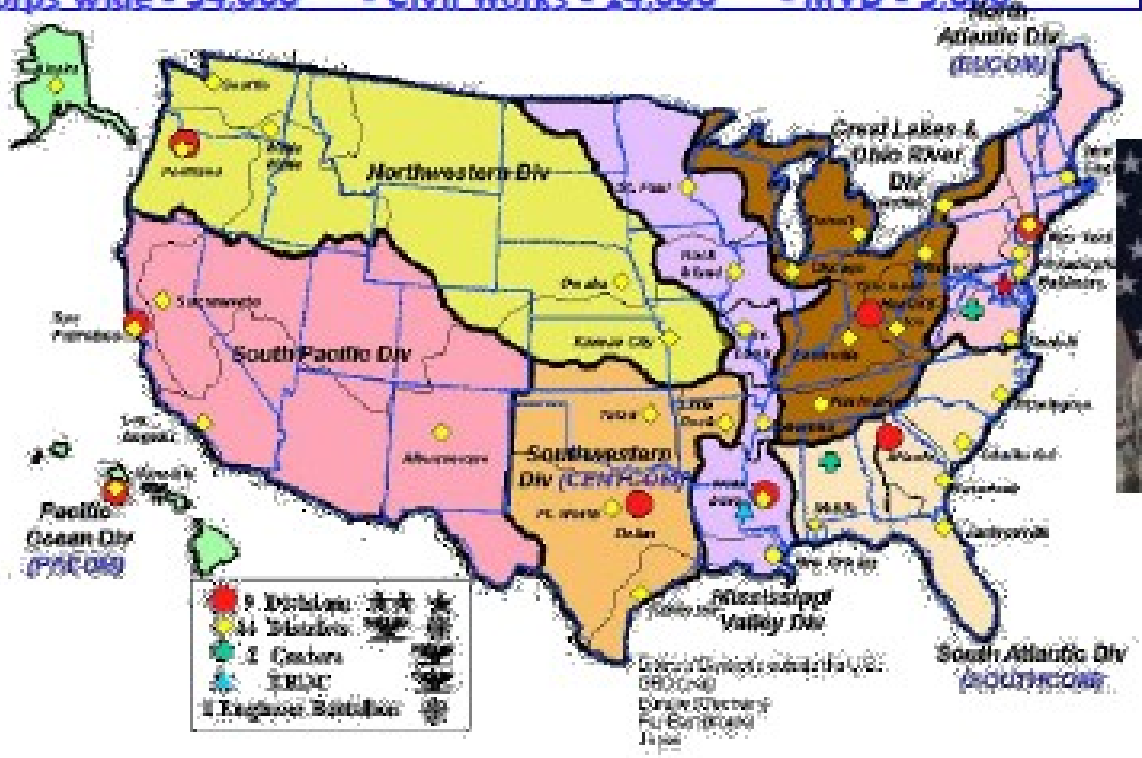
President Barack Obama

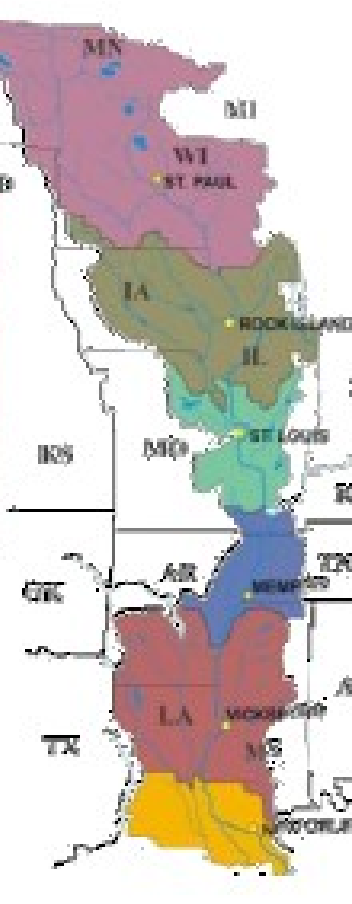
Xavier University, New Orleans

August 29, 2010

The U.S. Army Corps of Engineers Team

- **People:**
  - Corps wide - 34,000
  - Civil Works - 24,000
  - MVD - 5,000





The Delivery Team Includes:

Committed to ensuring that New Orleans can handle a 100-year storm surge by 1 June 2011.

Our Teammates Include:

Working together to ensure that New Orleans can handle a 100-year sto

A few of our key stakeholders include...

Garret Graves
Chairman, OCPR

Tim Doody
President, SLFPA-East

Mitch Landrieu
Mayor, City of New Orleans

Craig Taffaro
President, St. Bernard Parish

John Young
President, Jefferson Parish

Marcia St. Martin
Executive Director,
Sewerage and Water Board of New Orleans

Gary LaGrange
President & CEO, Port of New Orleans

Inner Harbor Navigation Canal

Lake Borgne Surge Barrier

Lake Borgne Surge Barrier

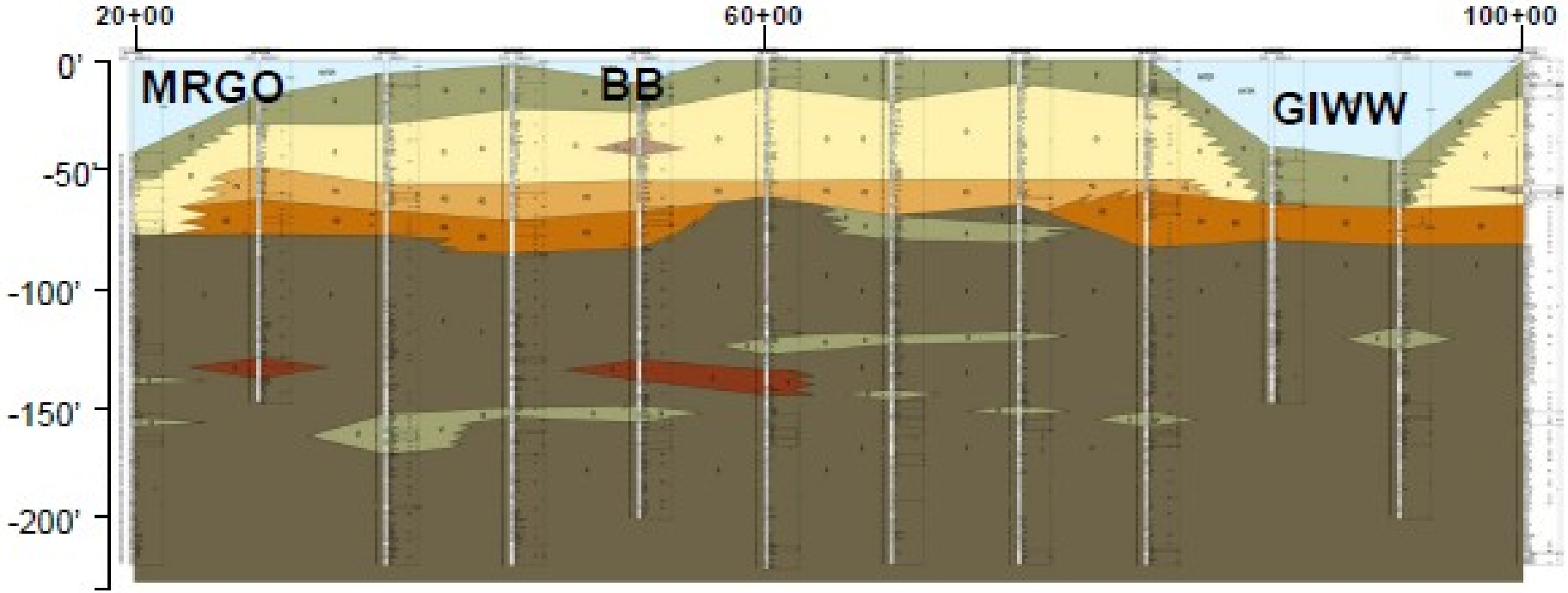
Lake Borgne Surge Barrier

Largest Design-Build Civil Works Project in the History of the Corps

IHNC-Lake Borgne Surge Barrier

IHNC-Lake Borgne Surge Barrier

Geologic Profile



M	MARSH
ID	INTERDISTRIBUTARY
IDE	INTRADELTA
PD	PRODELTA
B	BEACH
R	REEF
P	PLEISTOCENE

IHNC Storage Capacity

For a 100-yr Storm Surge:

Closure elevation: +3 *feet*
Rainfall (10-year, 24 hour event): +0.8 *feet*
Pumping into the basin: +2 *feet*
Overtopping: +1.5 *feet*
Wind setup: +0.5 *feet*
Water elevation of **less than 8 feet**

For a **500-yr storm surge**, the IHNC Basin will rise to an elevation of **less than 10 feet.**

The IHNC Basin will be able to safely hold water to the top of the wall, which is at elevation +12 feet at its lowest point.

(Hurricane Gustav Elevation)

Overtopping Analysis: Franco & Franco Method

Calculates overtopping

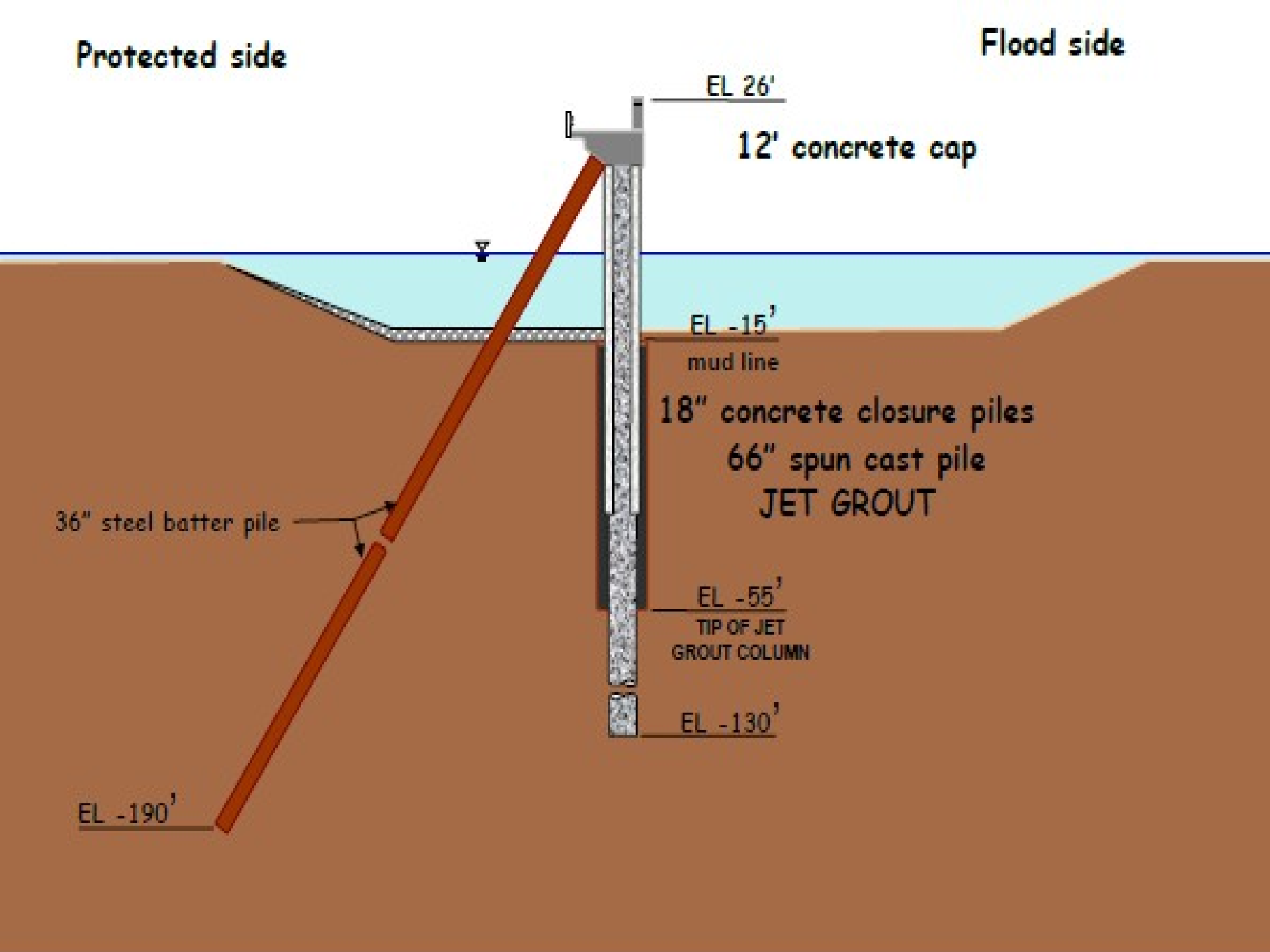
Maximum allowable storage capacity ehind IHNC HPP is equal to a 1.5 ft rise in ater level of 226.5 million ft^3 on the rotected side of the barrier.

Input: 1% Chance of exceedance values f H_s, T_p, Still Water Level (SWL), wall eight, wall length, and wall type oefficient.

Output: Run through Monte Carlo analysis o produce 50% and 90% Monte Carlo onfidence intervals.

GIWW Gate System Rendering

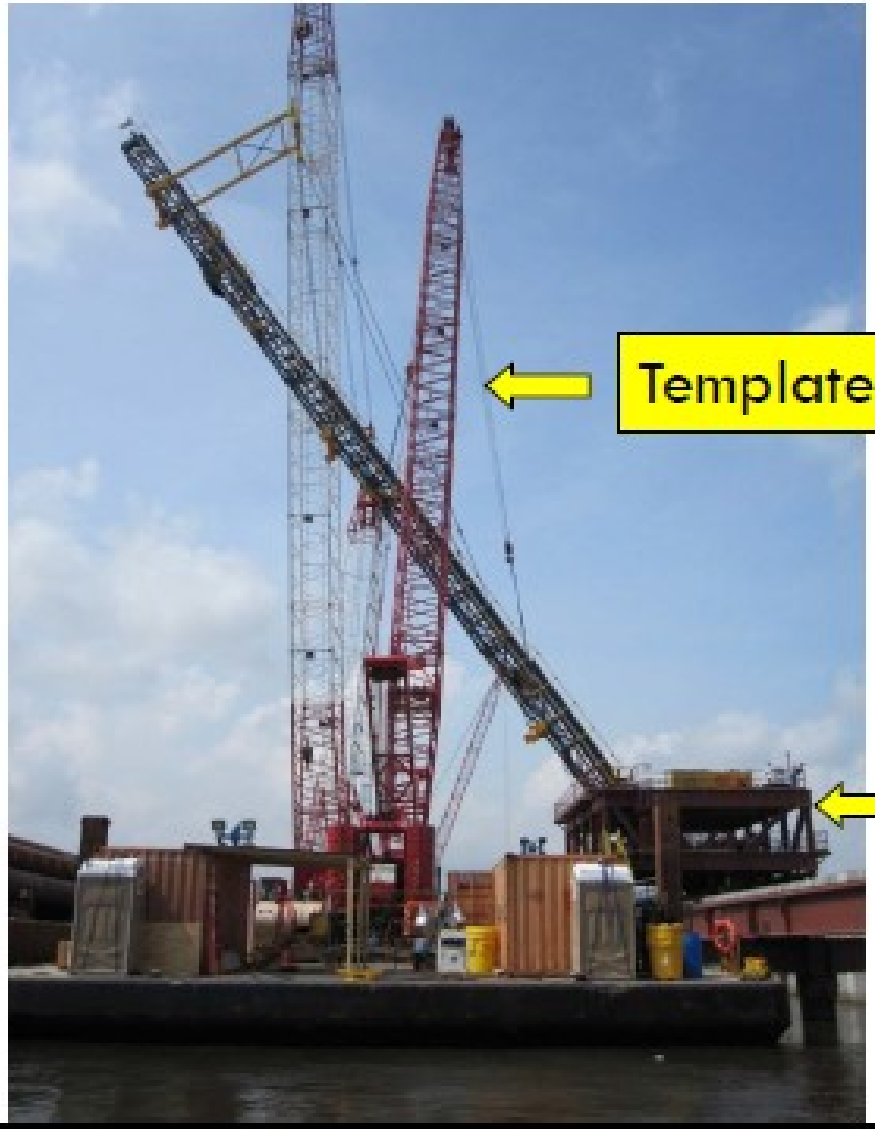
Bayou Bienvenue Vertical Lift Gate Rendering


Protected side
Flood side
EL 26'
12' concrete cap
EL -15'
mud line
18" concrete closure piles
66" spun cast pile
JET GROUT
36" steel batter pile
EL -55'
TIP OF JET
GROUT COLUMN
EL -130'
EL -190'

Soldier Piles

First Pile Driven May 9, 2009

Last Pile Driven Oct 23, 2009


Template
Mobile Platform

Soldier, Closure, Batter Piles

Grout Bag Placement

Trestle Construction

66" Concrete Pile Infill Reinforcement

Precast Caps

Cast in Place Concrete Section

6 Feet
Wide

Expansion Joints

Parapet Wall

Cast in Place
Complete!

Lake Borgne Surge Barrier – GIWW Gates

Barge Gate
Delivered: Feb 2011

Sector Gate
Installed: May 2011

Bayou Bienvenue Vertical Lift Gate

Bayou Bienvenue Gate Installation

Installed Gate

Bayou Bienvenue Vertical Lift Gate
Installed: March 2011

Surge Barrier Facts and Figures

- 1,271 spun-cast 66-inch-diameter concrete soldier piles
- 2,514 closure piles
- 647 steel batter piles
- 673 pre-cast and cast-in-place concrete caps
- 7,490 linear feet of parapet wall
- Two 150-foot-wide gates (sector gate and barge gate) at the GIWW and one 56-foot-wide vertical lift gate at Bayou Bienvenue
- Enough steel to construct 8 Eiffel Towers
- Enough concrete to fill one football field, 94 feet deep
- The project involves 160 miles of piles - approximately 20 miles more than the distance between New Orleans and Lafayette.

Project Status

- The design of the Lake Borgne Surge Barrier is approximately 99% complete.
- Overall project is approximately 91% complete.
- The three gates are approximately 60% complete.
- Construction is scheduled to be complete in October 2012.

6- Questions à approfondir

1- Le processus d'approbation technique de 2007 (peer review)

2- Le choix du niveau de protection retenu

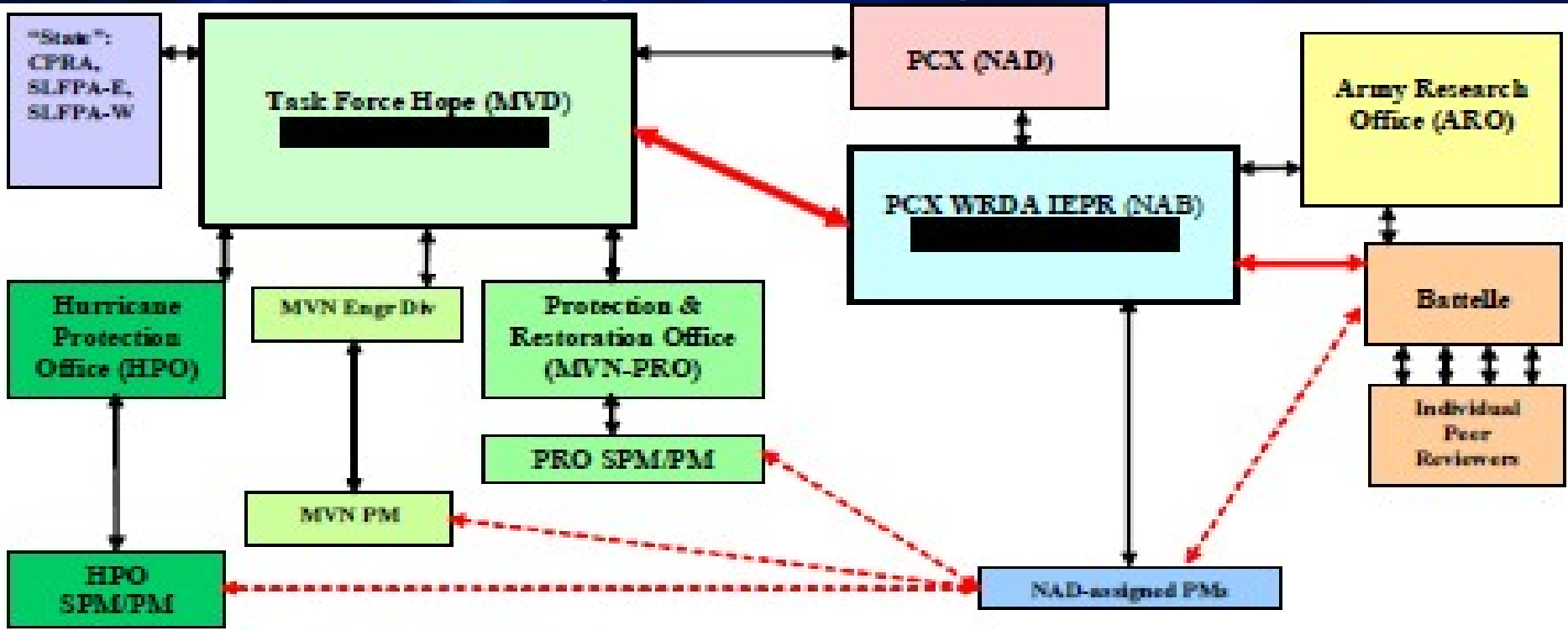
3- Le mode de communication adopté pour assurer l'acceptabilité du projet

4- L'imbrication des niveaux de décision

5- Les raisons de l'absence de communication technique sur un projet de cette ampleur

6- Le degré d'implication des experts hollandais

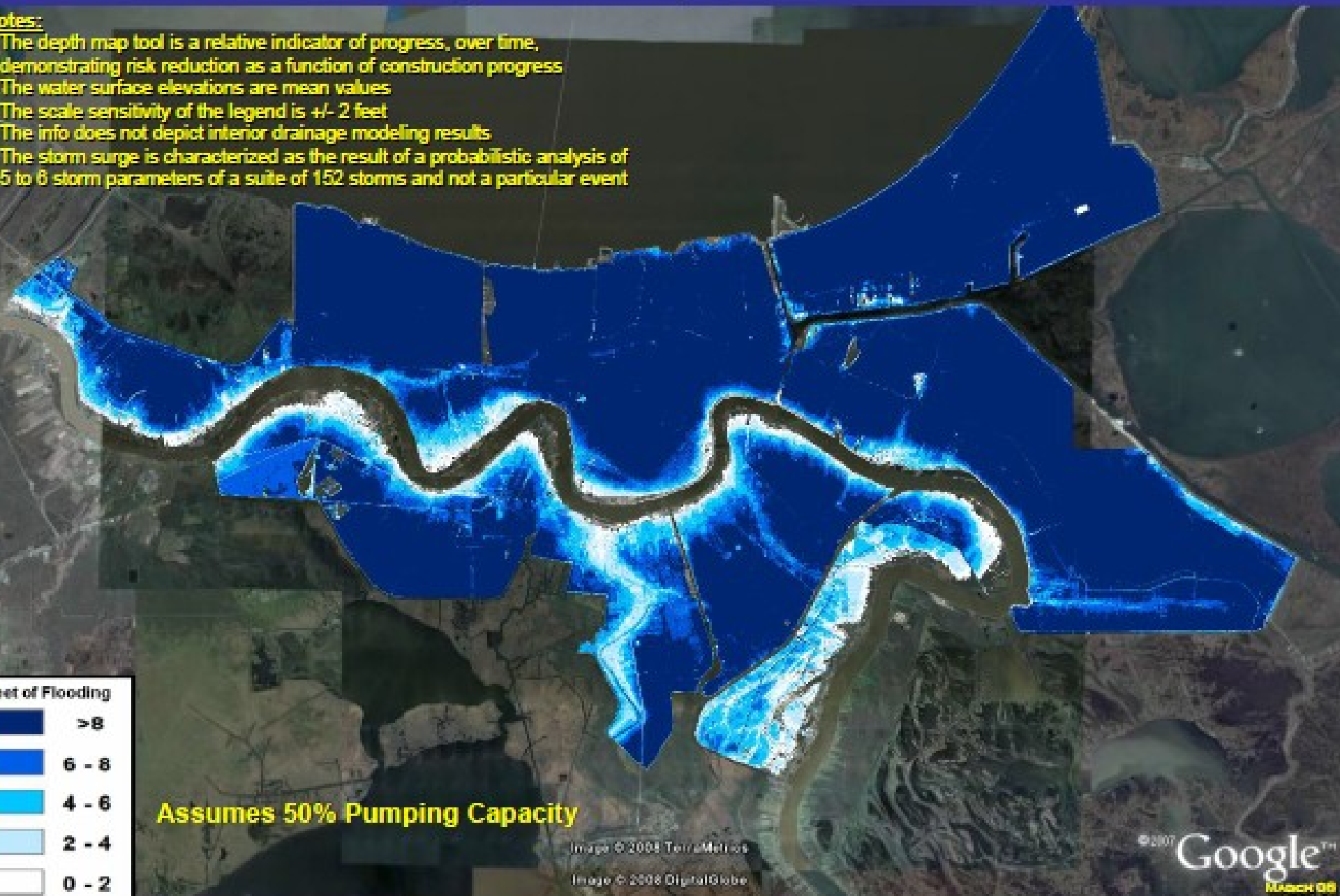
6-1 schématisation de la revue des pairs (peer-review)



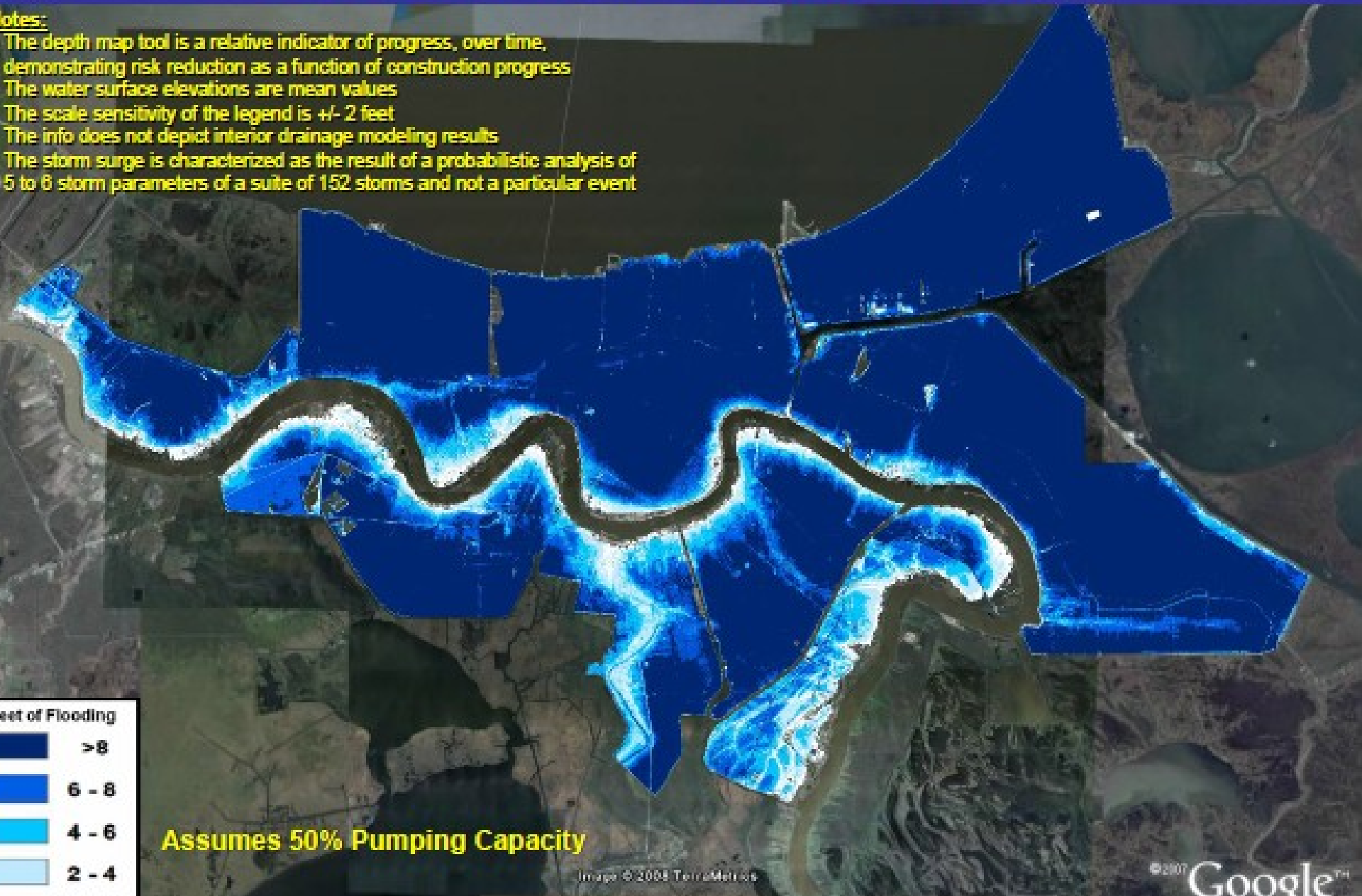
Acronyms not defined above:
CPRA = Coastal Protection and Restoration Authority
IEPR = Independent External Peer Review
MVD = Mississippi Valley Division
MVN = Mississippi Valley, New Orleans District
NAB = North Atlantic, Baltimore District
NAD = North Atlantic Division
PCX = Planning Center of Expertise
PM = Project Manager
PRO = Protection and Restoration Office
SLFPA-E = Southeast LA Flood Protection Authority - East
SLFPA-W = Southeast LA Flood Protection Authority - West
SPM = Senior Project Manager
WRDA 07 = Water Resources Development Act 2007

Figure 1. TFH/PCX WRDA 07 IEPR Organization

Before Katrina, you had a 0.2% chance every year of flooding this deep from Hurricanes



Currently, you have a 0.2% chance every year of flooding this deep from Hurricanes



With the 100-year level of protection, you have a 0.2% chance every year of flooding this deep from Hurricanes