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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

NOAA

Performance Evaluation of New Orleans and Southeast Louisiana Hurricane Protection System

Floodwall and Levee Performance Analysis

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Interagency Performance Evaluation Task Force (IPET)

Harris County
Flood Control District

ERS
ECONOMIC RESEARCH SERVICE
United States Department of Agriculture

National Geodetic Survey

NOAA/NOS CO-OPS

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Floodwall and Levee Performance Analysis Team

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- **Benita Abraham** – ERDC/GSL, Data Support
- **Tony Young** – MVD
- **Ken Klaus** – MVD
- **Richard Pinner** – MVN
- **Pete Cali** – MVN
- **Tom Brandon** – Virginia Tech - Geotechnical
- **Dave Bentler** – STAGE Analysis
- **C.Y. Chen** – Geomatrix – FLAC Analysis
- **Steve Wright** – UT – Slope Stability
- **Allen Marr** – GeoComp- PLAXIS Analysis
- Others TBD

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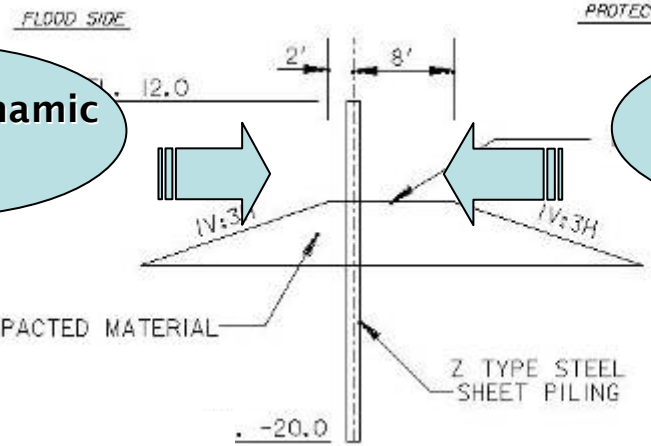
Physical Performance Analysis

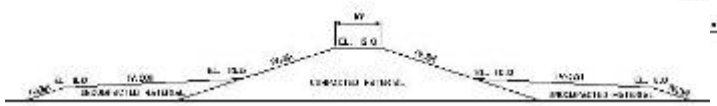
Surge and Waves

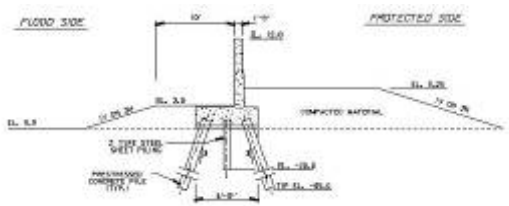
Design & Intent

Static & Dynamic Forces

As-built and Condition







Observed Performance

Expected Performance

Behavior Insights

Flooding

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Floodwall and Levee Performance Analysis

Objective

- **Analyze the levees and floodwalls performance during Hurricane Katrina**
- **Investigate the most likely causes of the damage and failure of the levees and floodwalls in the system**
- **Compare them with similar sections or reaches where the performance was satisfactory**
- **Understand mechanisms that led to the breaches along a reaches in order evaluate the potential performance of the similar un-breached reaches of the protective system**

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Floodwall and Levee Performance Analysis

Approach

- **Conduct a comprehensive assessment of the background information**
  - **Geology of the area**
  - **Geological conditions along the system**
  - **History of the construction**
  - **Design criteria and approach**
  - **Actual design documents, the as-built drawings and inspection and maintenance records.**

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Floodwall and Levee Performance Analysis

Approach (continued)

- **Examine entire levee system to identify areas or reaches that have performed satisfactory and those that have suffered damage**

- **Characterize damage areas or reaches based on the type of damage, the surge height and the wave action**

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Floodwall and Levee Performance Analysis

Approach (continued)

- **Select breaches will be analyzed separately in detail to ensure that no important site conditions or breach mechanisms are overlooked**

- **All potential failure possibilities and mechanisms will be considered and evaluated**

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Floodwall and Levee Performance Analysis

Work Plan

- Data Collection and Assessment
- Assessment of Field Evidence
- Define Soil Profile
- Material Characterization
- Conventional Analyses
- Numerical Modeling
- Comparison to Physical Model
- Comparison to Failure Evidence

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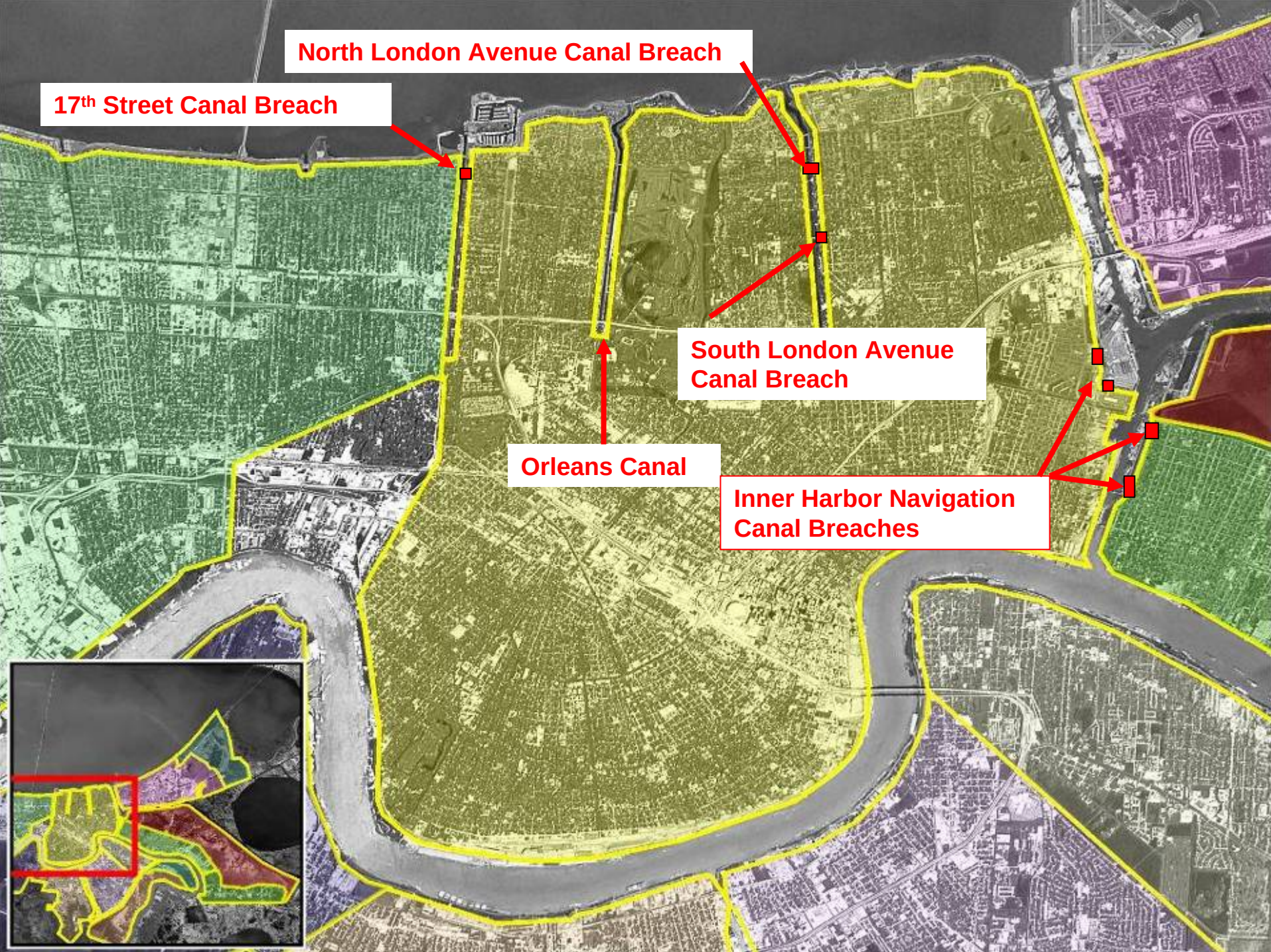
Status

Floodwall and Levee Performance Analysis


North London Avenue Canal Breach
17th Street Canal Breach
South London Avenue Canal Breach
Orleans Canal
Inner Harbor Navigation Canal Breaches

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17th Street Canal Breach

17th Street Canal Breach

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17th Street Canal Breach

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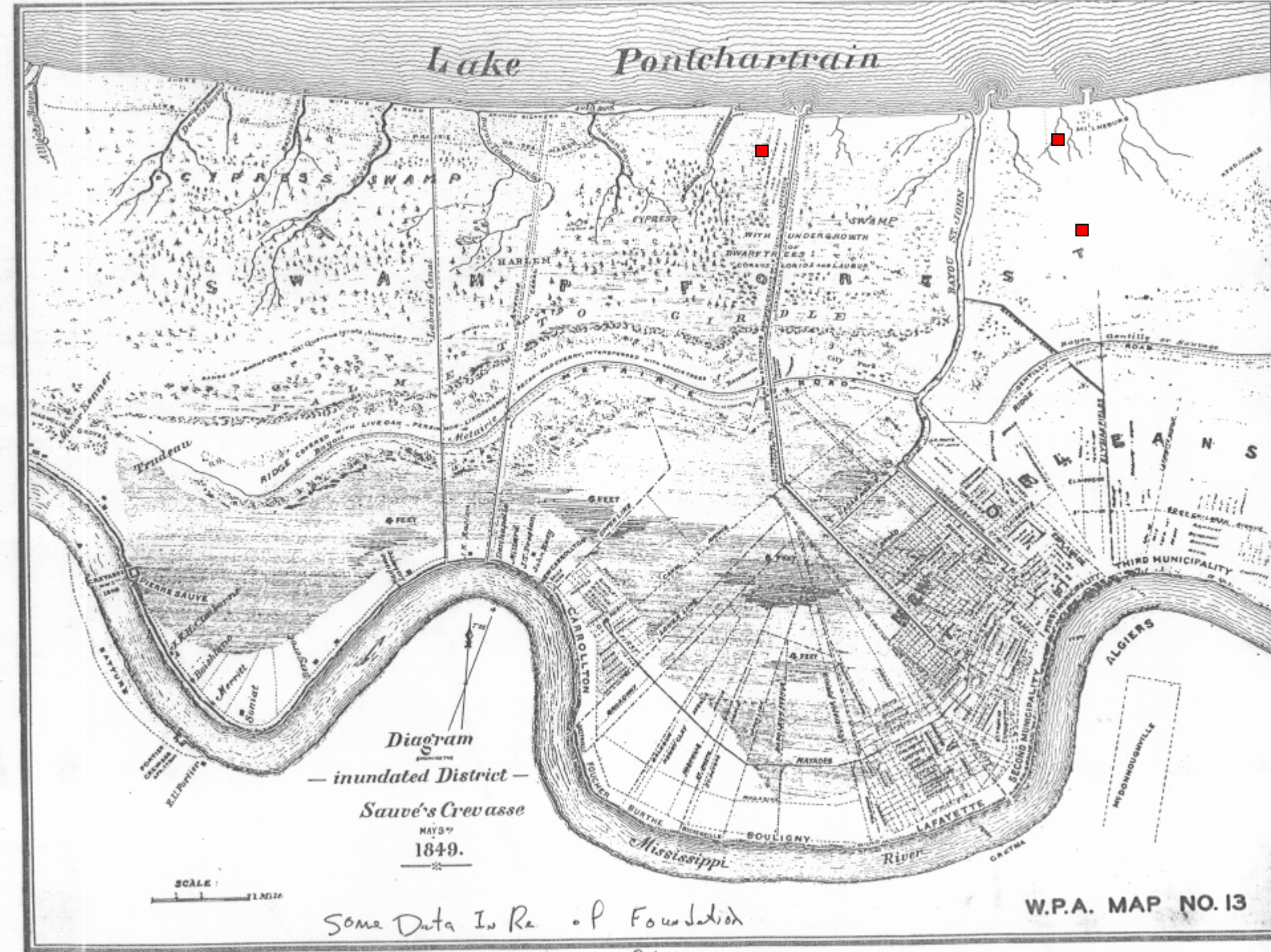
Cross-Sections & Soil Profiles for Use in Analysis



Some Data In Re . P Foundation

W.P.A. MAP NO. 13

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New Orleans Area

LEGEND

Point bar

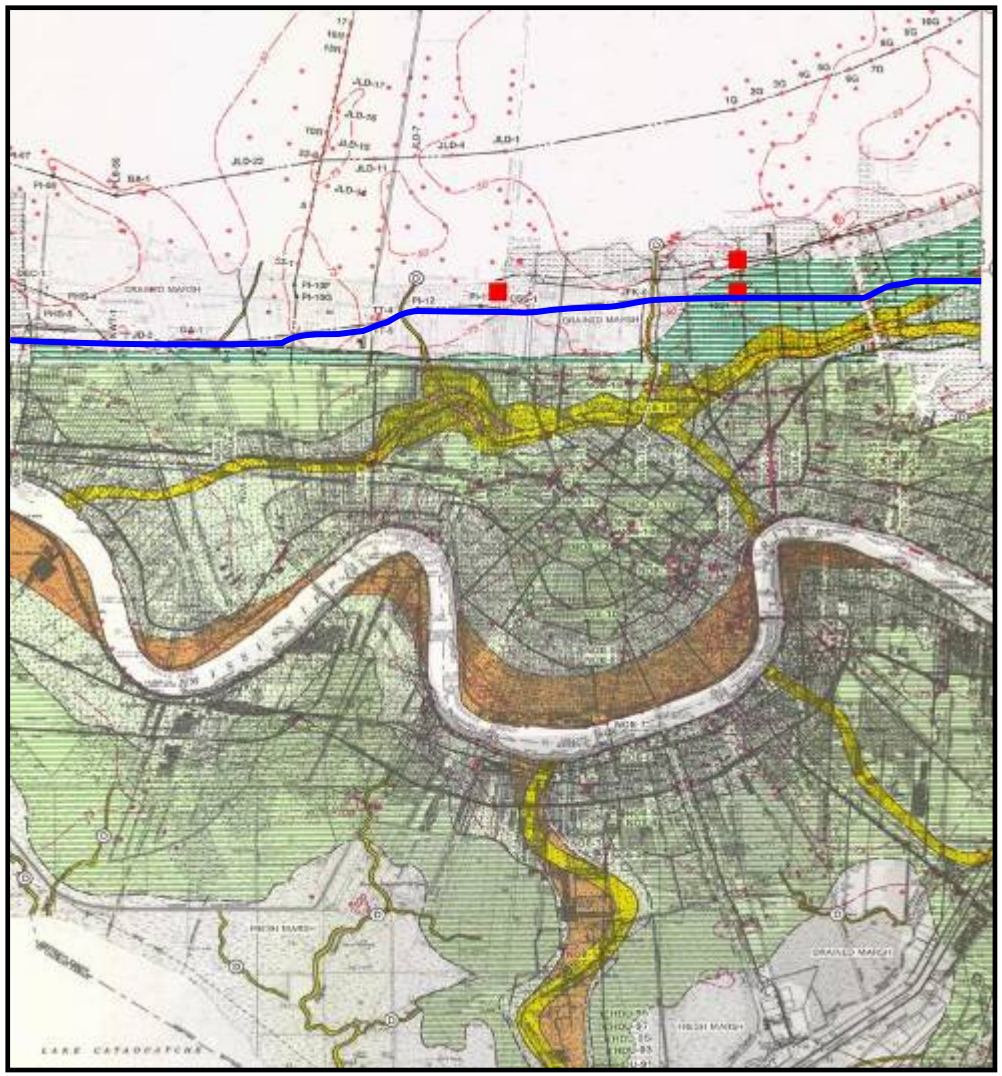
Distributary channel

Inland swamp

-40

Top of Pleistocene-ft msl

Spoil



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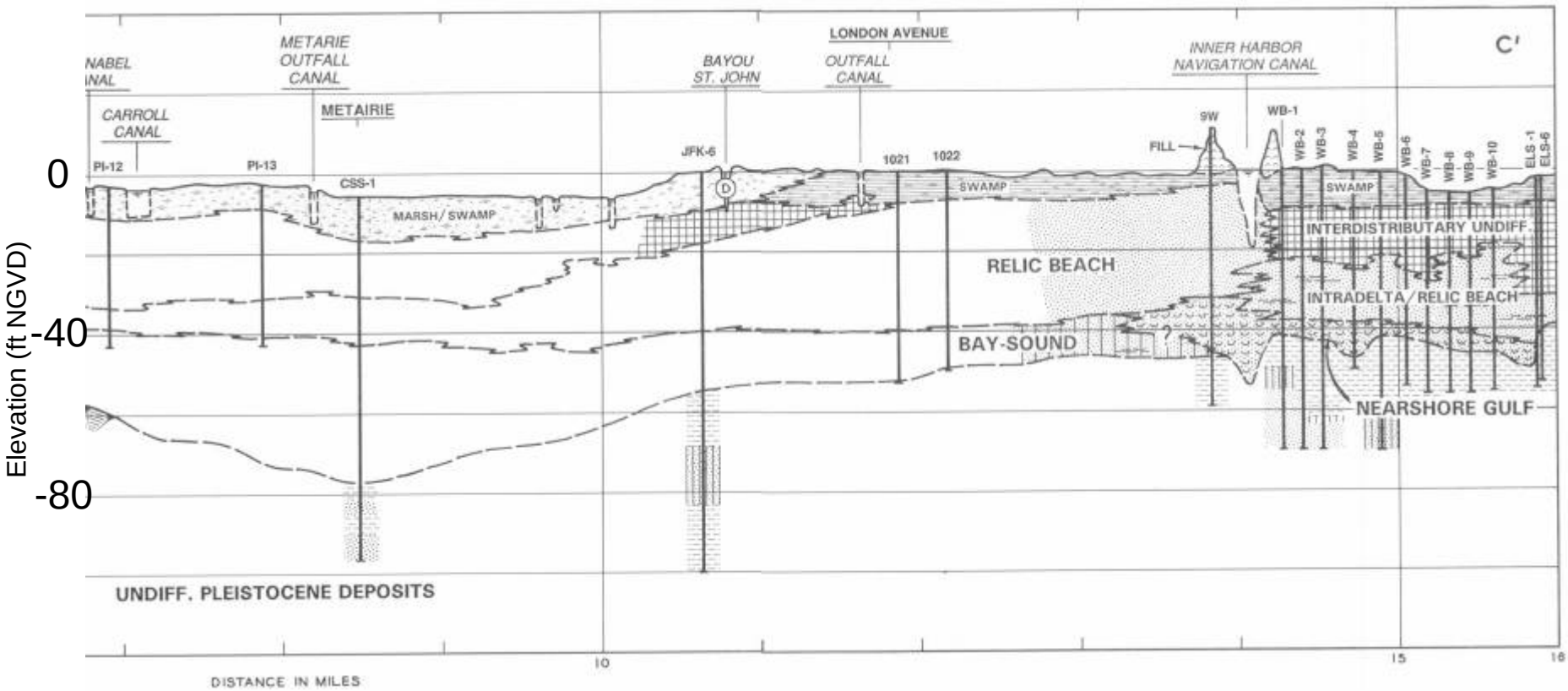
Spanish Fort: X-Section C-C'



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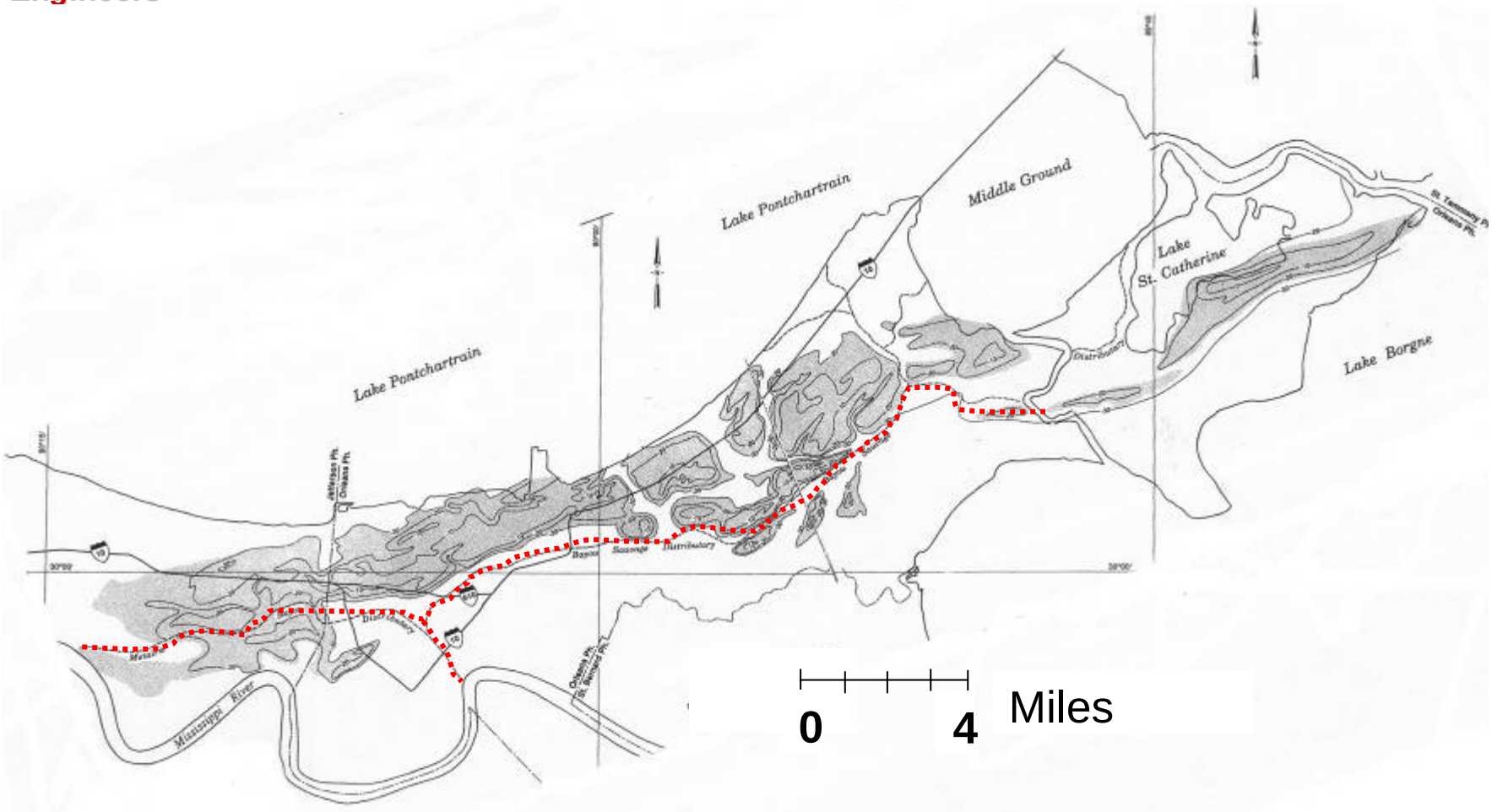
Pine Is. Beach Ridge



Saucier, 1964 and 1994

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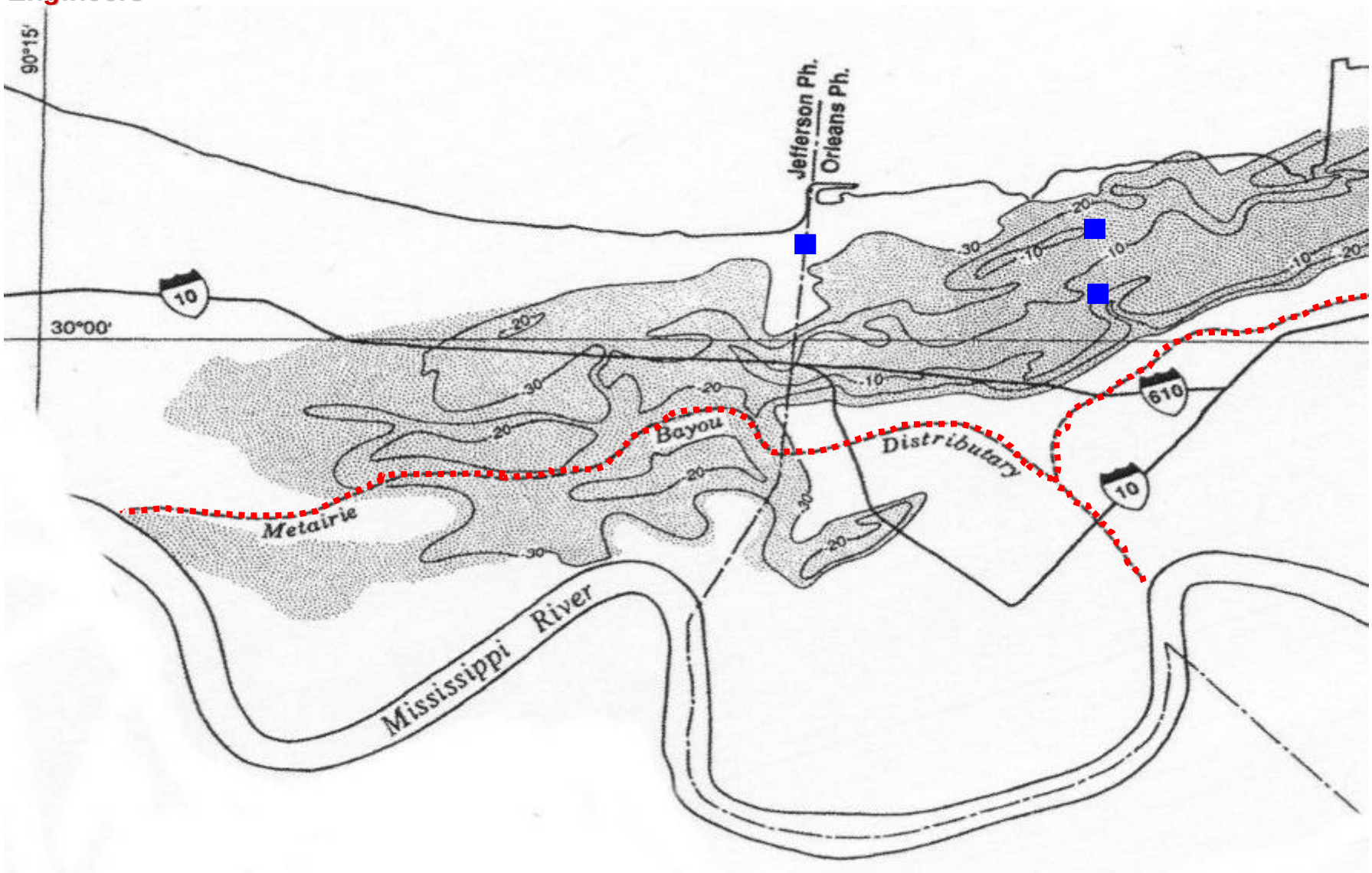
Pine Is Beach Ridge



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17th Street Canal Breach

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17th Street Canal Breach

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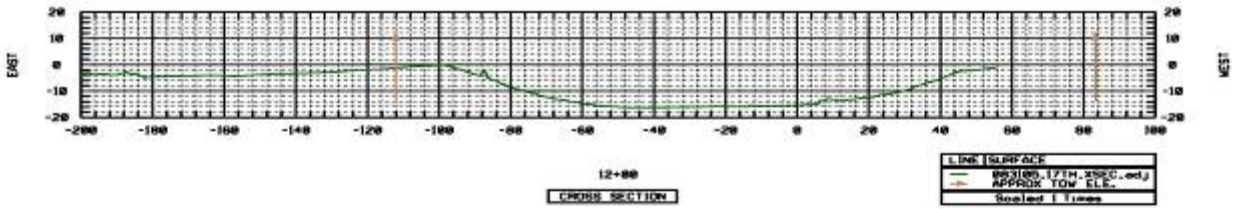

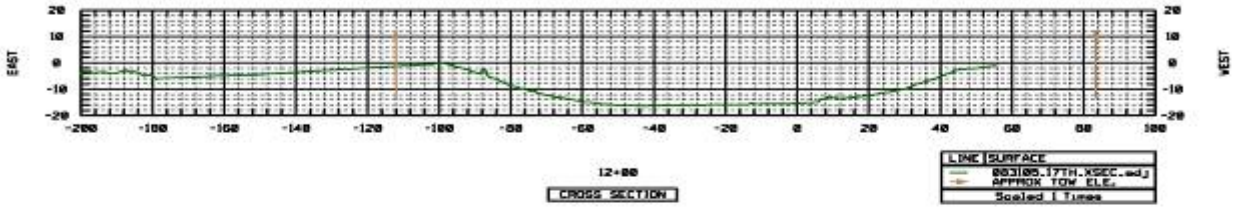

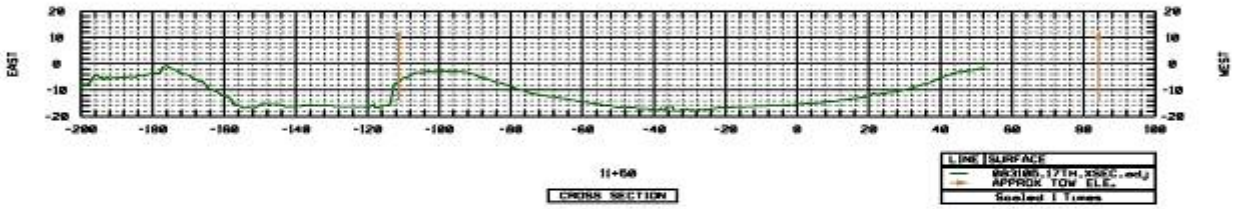

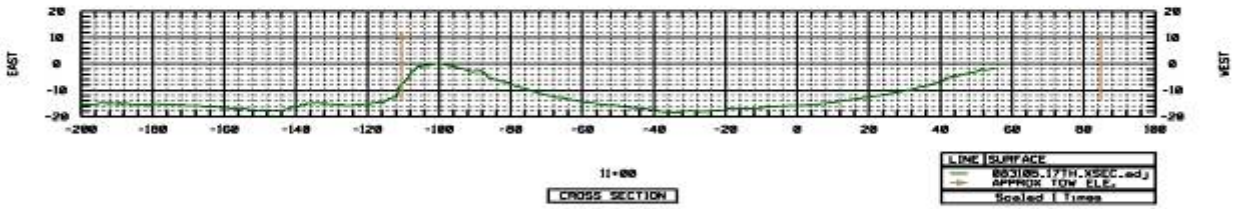

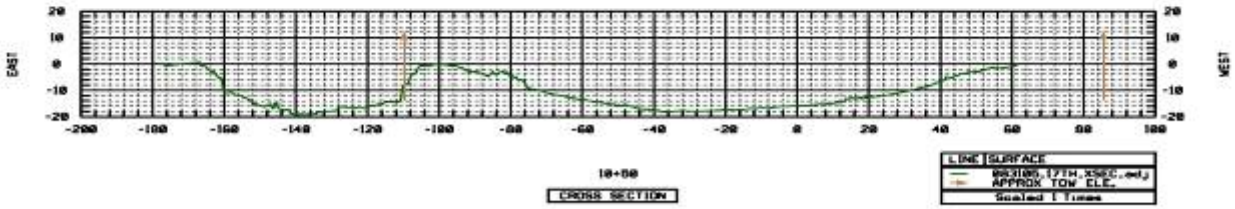

LINE	SURFACE
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→	APPROX TOW ELE.
Scaled 1 Times	

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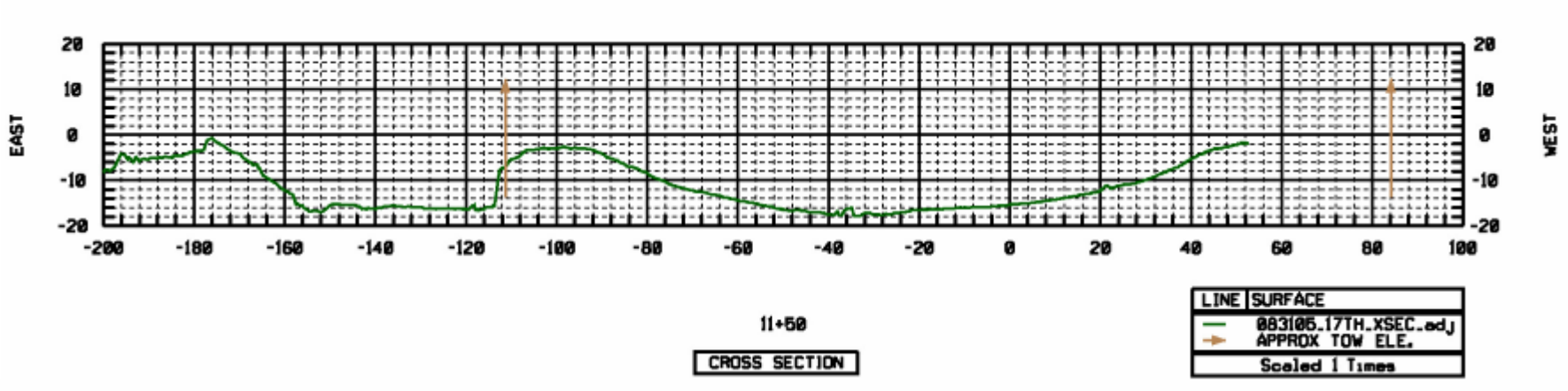
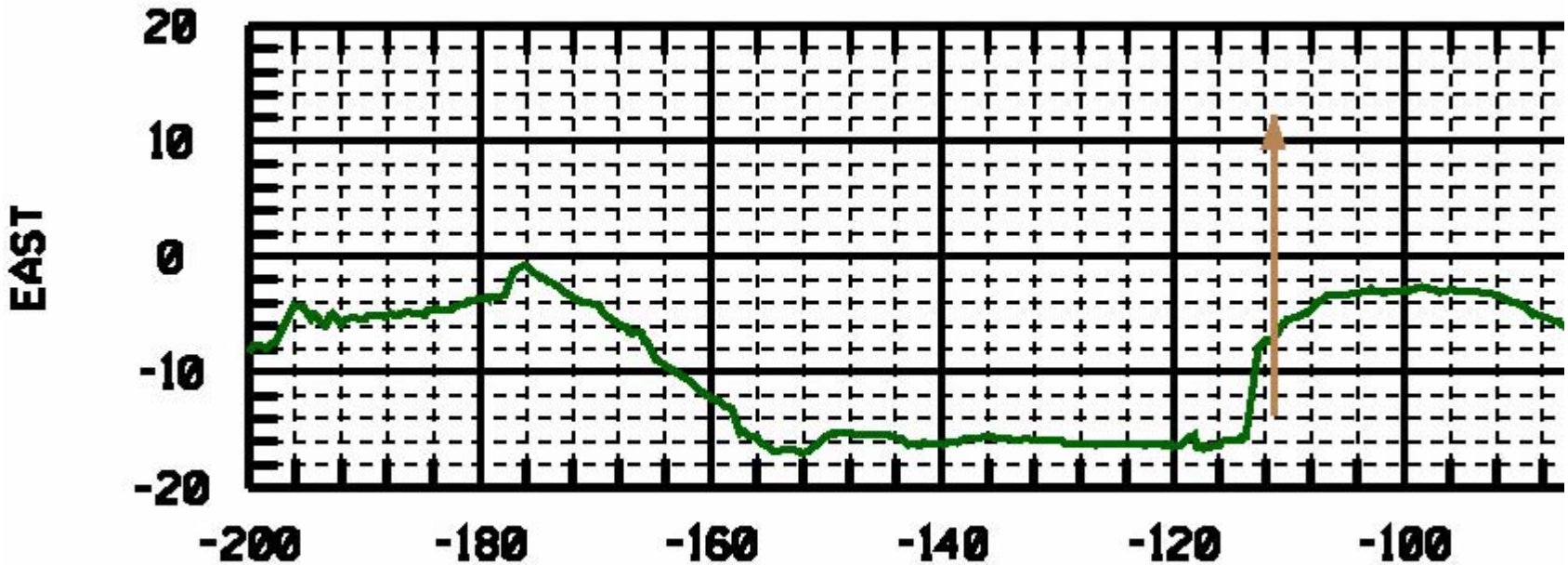
17th Street Canal Breach





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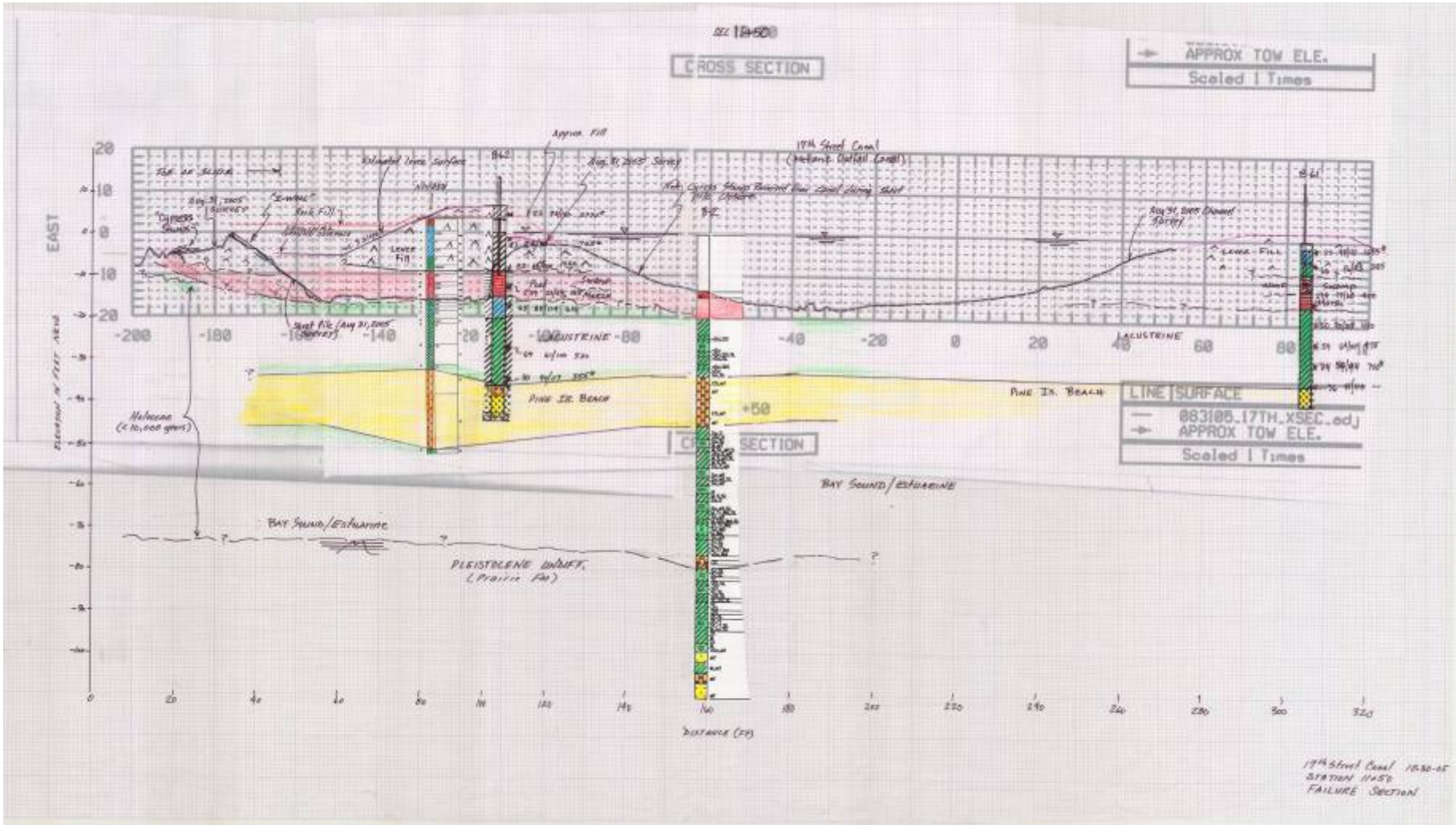
17th Street Canal Breach



17th Street Canal C/L Failure Section

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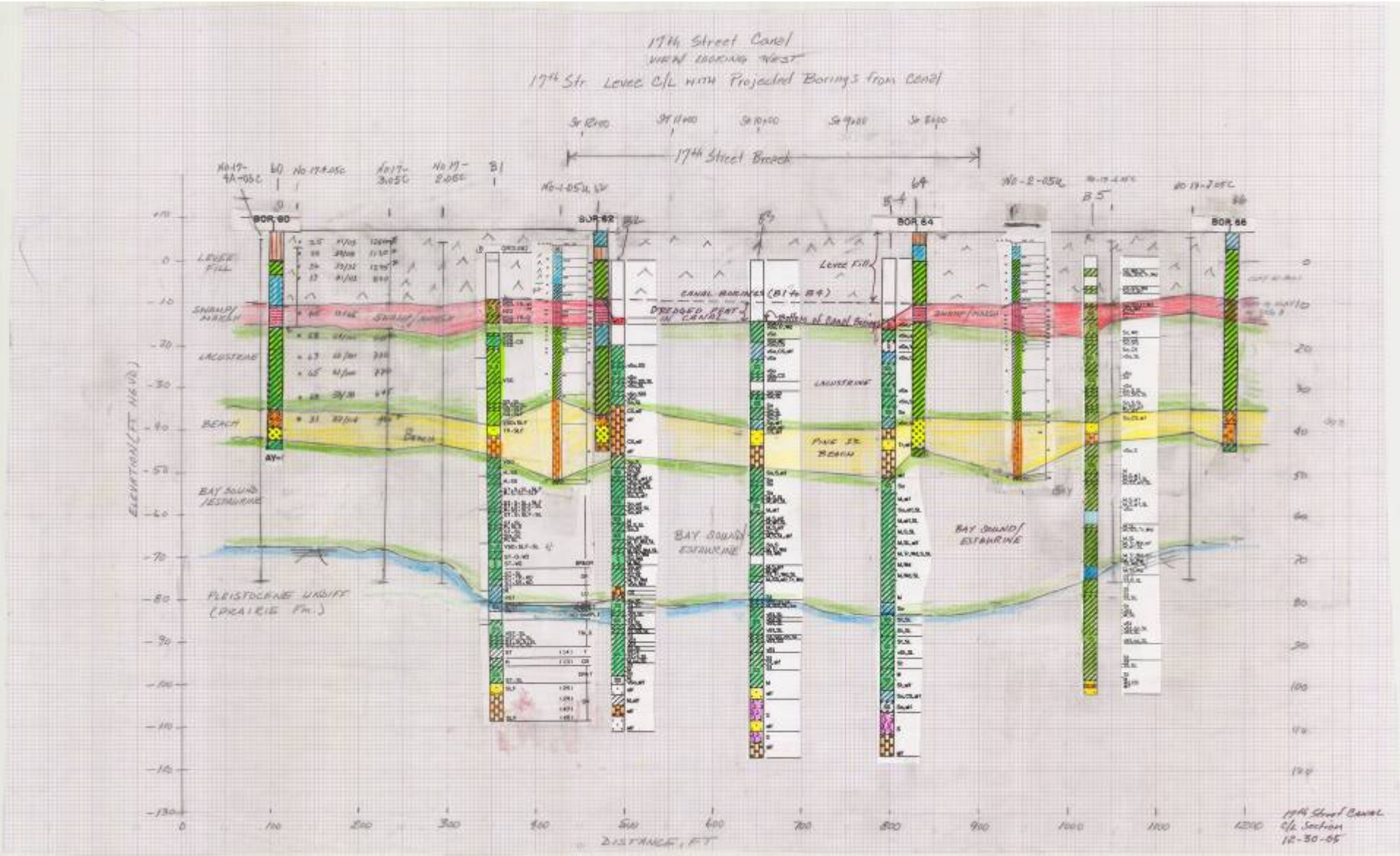

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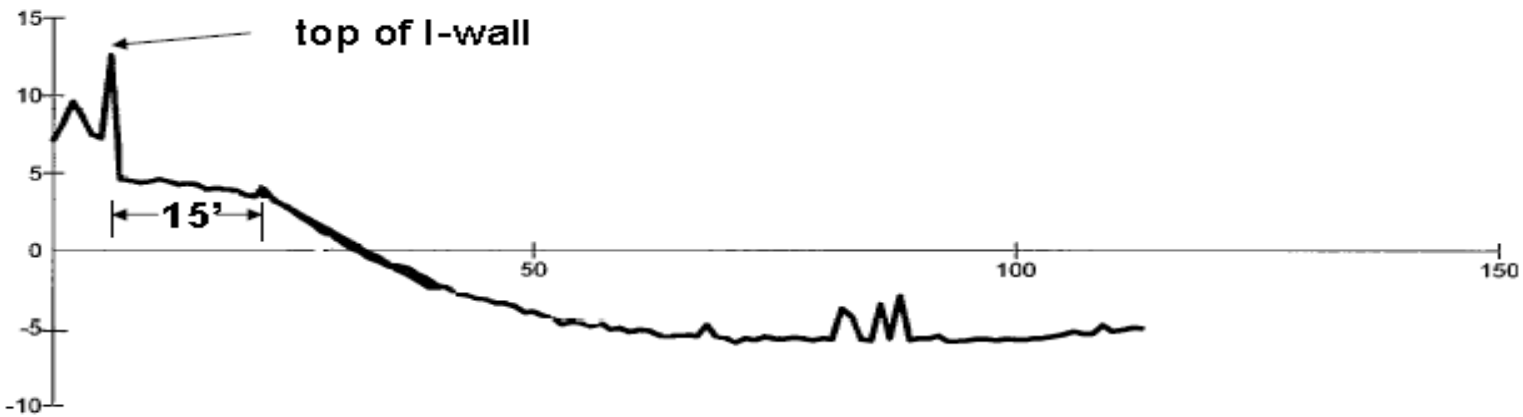
Verification of As-Built Conditions

Pre-Katrina Cross-Section Through Breach Area of 17th Street Canal (From LIDAR Survey)



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17th Street Canal Breach

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17 Street Canal Swamp

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Slide Surface?

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17th Street Slide Block

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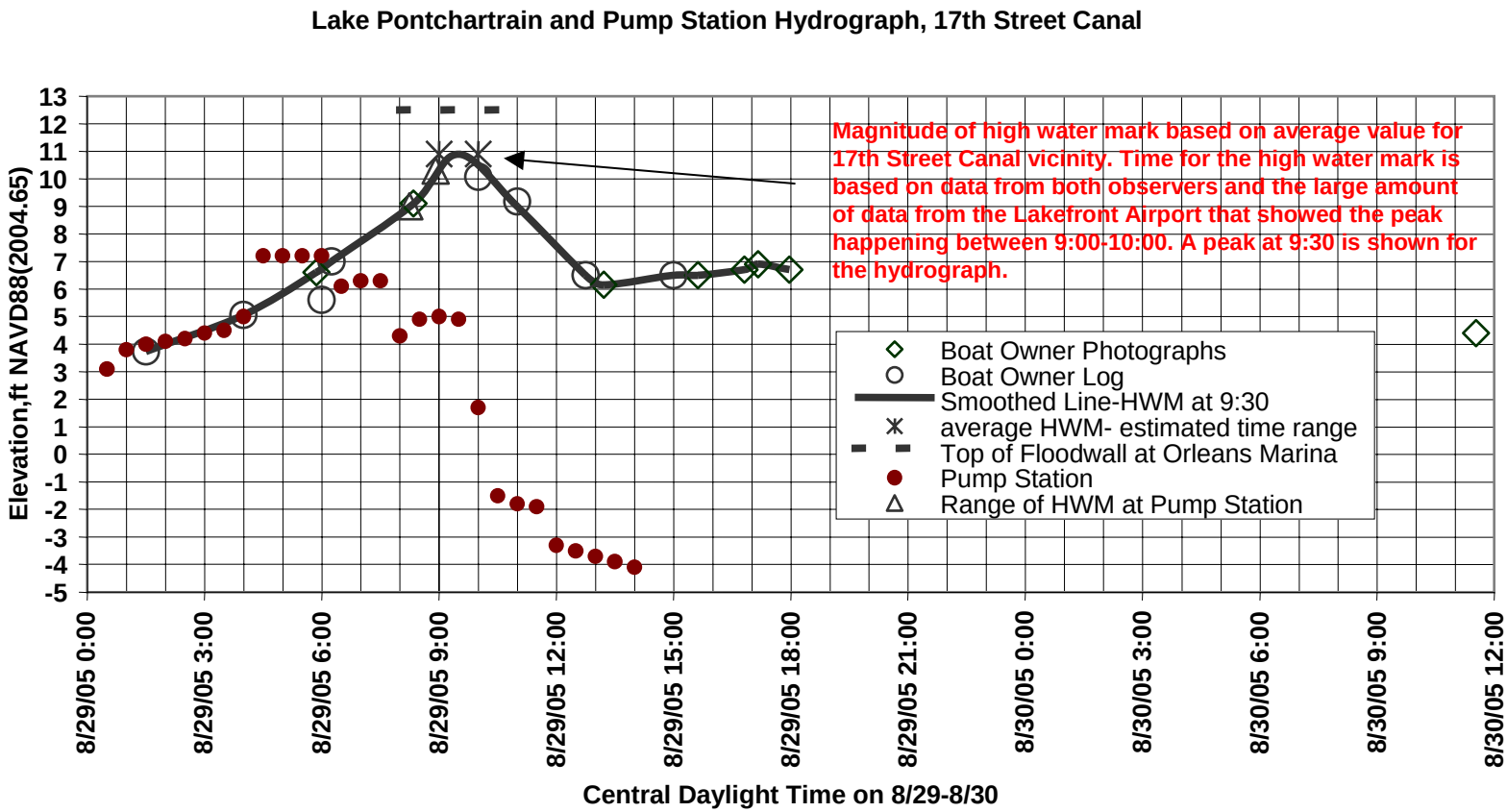
17th Street Canal Hydrograph



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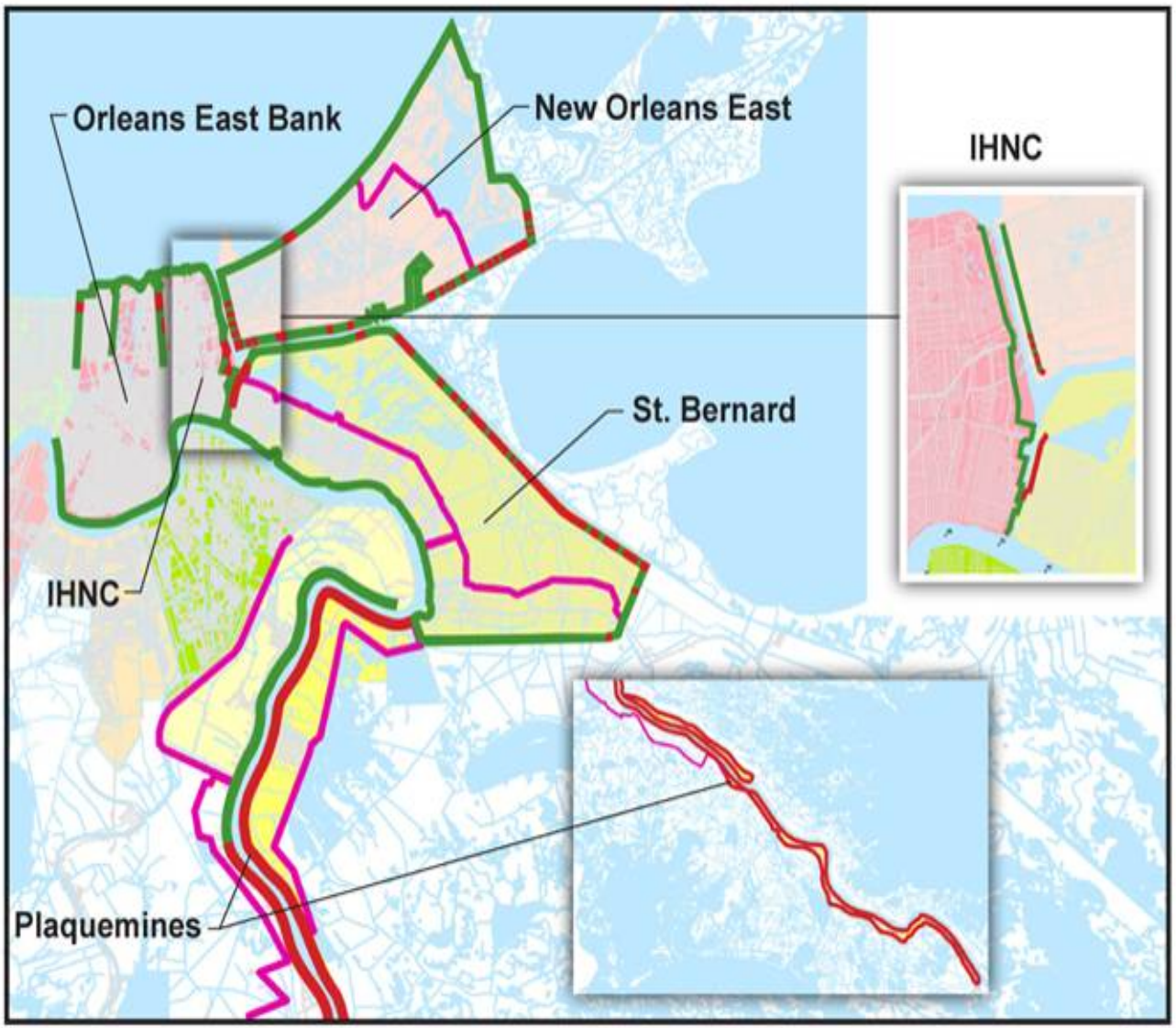
System-Wide Assessment

Impacted Area



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New Orleans District

Local Authorities
- Louisiana DOTD
- Port of New Orleans
- Lake Borgne Basin Levee District
- N.O. Sewerage and Water Board
- Orleans Levee District
- Plaquemines Parish Government
- St. Bernard Parish Government

Hurricane Protection System
- 284 miles: Federal levees/floodwalls
- 71 pump stations

Damage
- 169 miles: Federal levees/floodwalls
- 34 pump stations

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Floodwall and Levee Performance Analysis

Types of Damage

- **Overtopping of Floodwalls**
- **Overtopping of Levees**
- **Non-Overtopping Breaches**
- **Transitions, Closures, Levee and Wall Penetrations**
- **Piping**

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Assessment of Entire System

Selection For Detailed Analysis

- Walls that failed (category WF)
- Walls that were close to failure, indicated by permanent deflection (WCF)
- Walls that are stable, with no permanent deflection (WS)
- Levees that overtopped and breached (LOB)
- Levees that overtopped and did not breach (LONB)
- Levee under seepage locations (LU)
- Failures at transitions between different types of flood protection structures (TF)

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New Orleans East Basin

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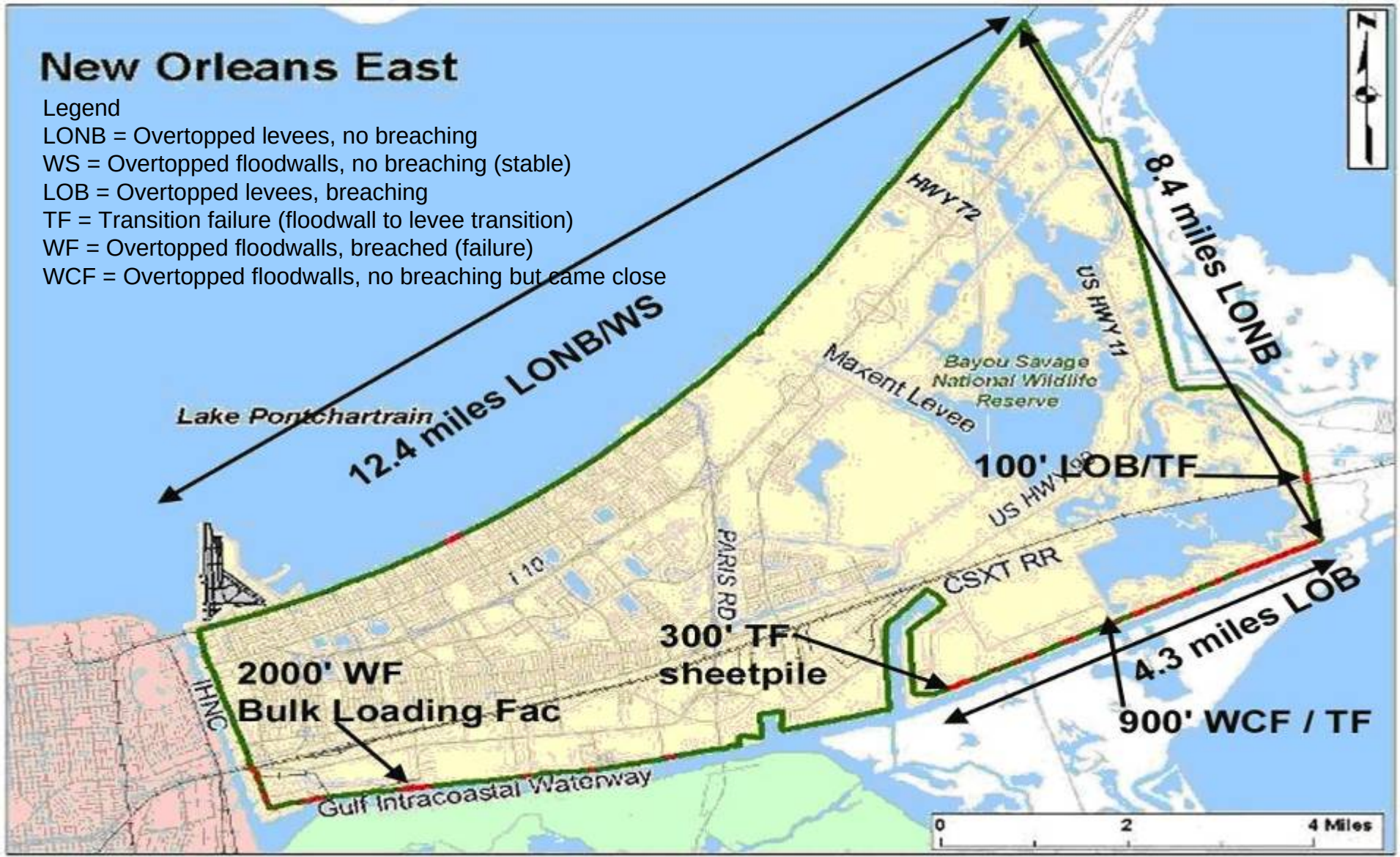
New Orleans East Basin



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Erosion Assessment

- **Pre-Katrina and post-Katrina LIDAR surveys**
  - Determine depth and surface area of erosion
  - Categorize the severity of the erosion
- **Storm surge height and duration**
- **Wave height and duration**
- **Levee surface soil type**
- **Elevation of the levee crest**

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Remaining Effort

- London Avenue Canal
- Orleans Canal
- Inner Harbor Navigation Canal
- St. Bernard Parish
  - Mississippi River Gulf Outlet
- Plaquemines Parish

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Way Ahead

- Additional CPTU, Shear Vane, DSS
- Soil-Structure Interaction Analysis
- Comparison Failed and Unfailed I-walls