CHALLENGES IN THE DESIGN OF OIL & GAS FACILITIES IN COASTAL WATERS

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New Orleans, LA

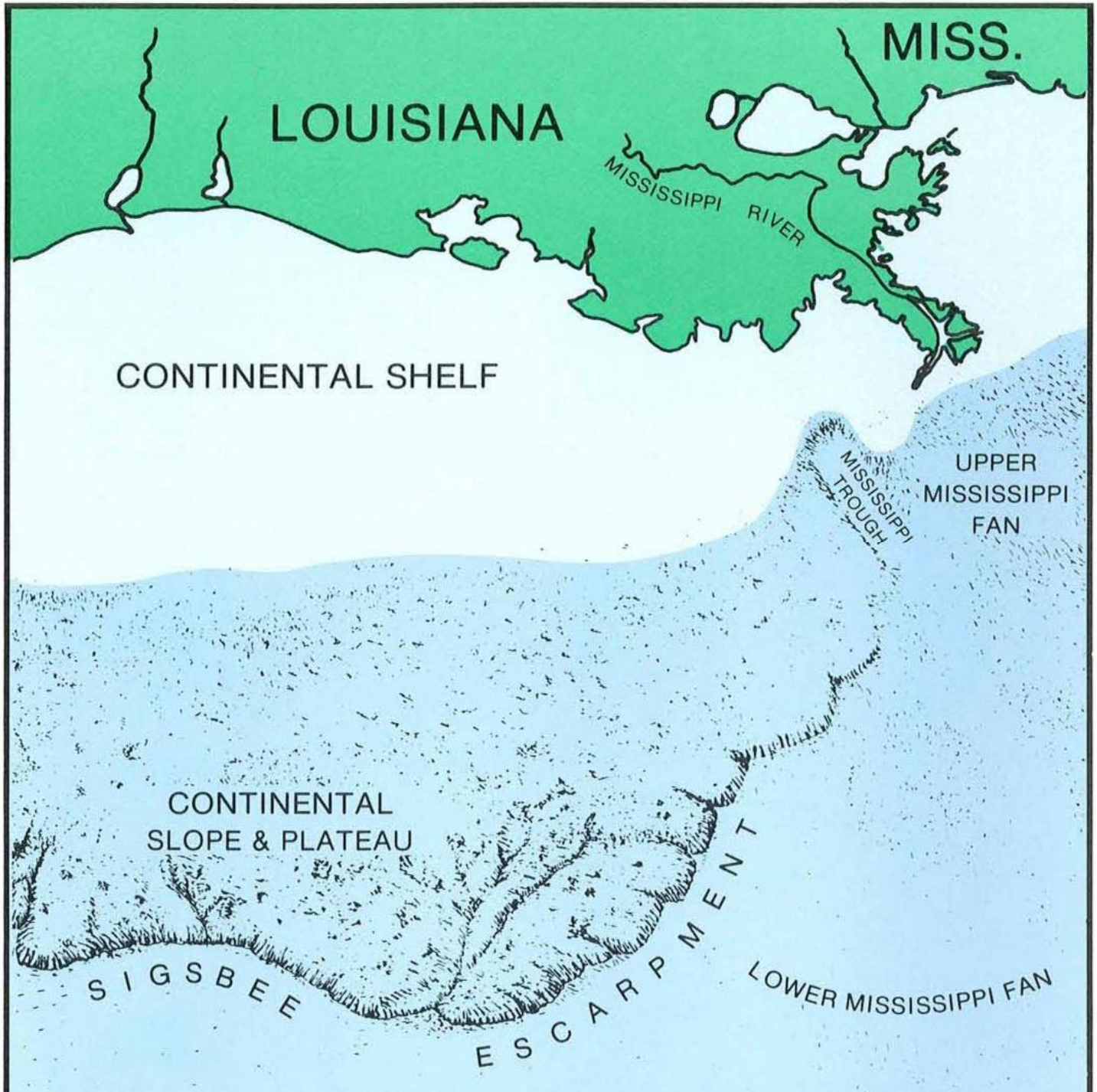
PETRONYX
consulting engineers
LLC

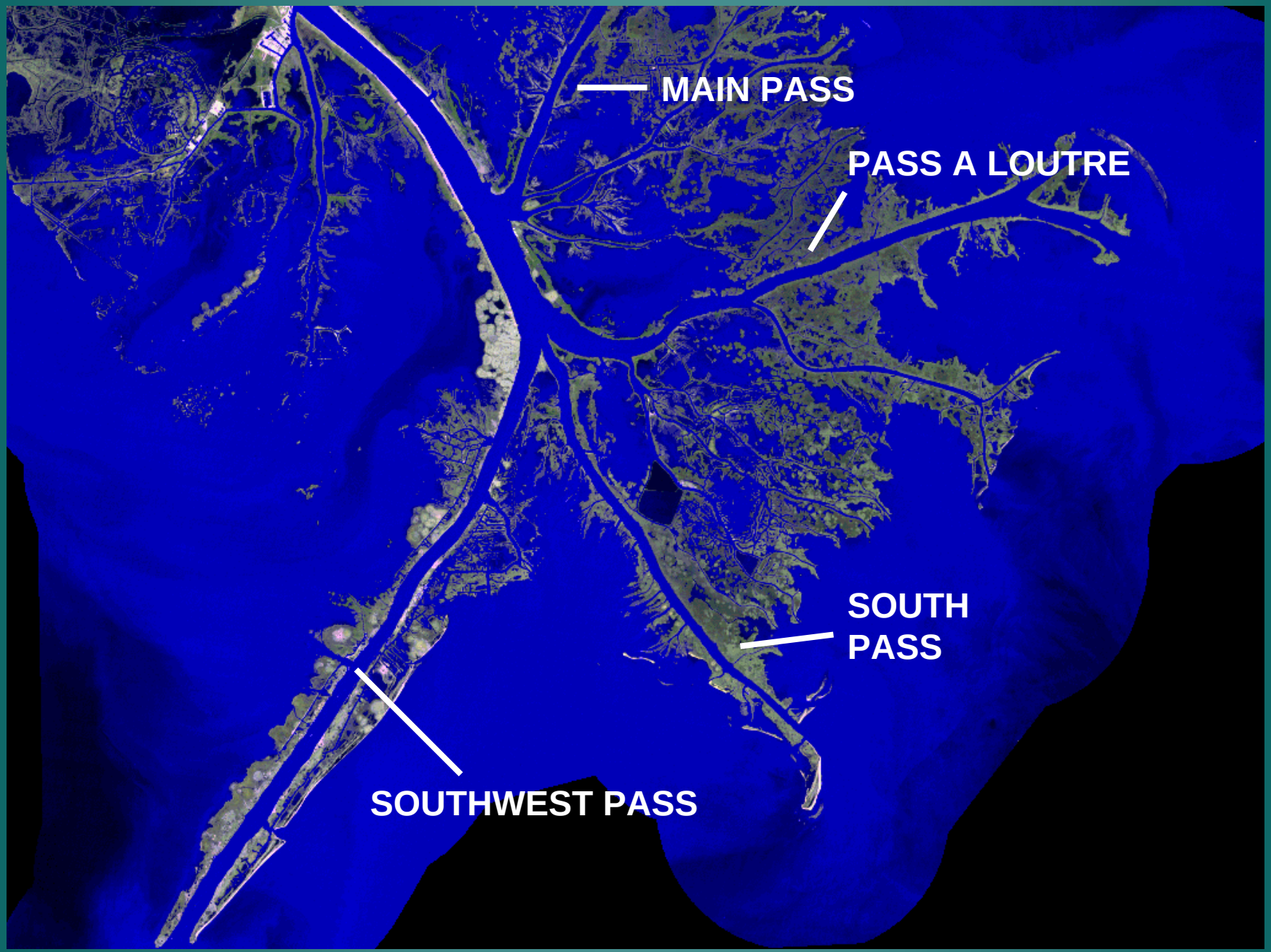
GULF OF MEXICO PRODUCTION
Domestic Consumption, Est'd

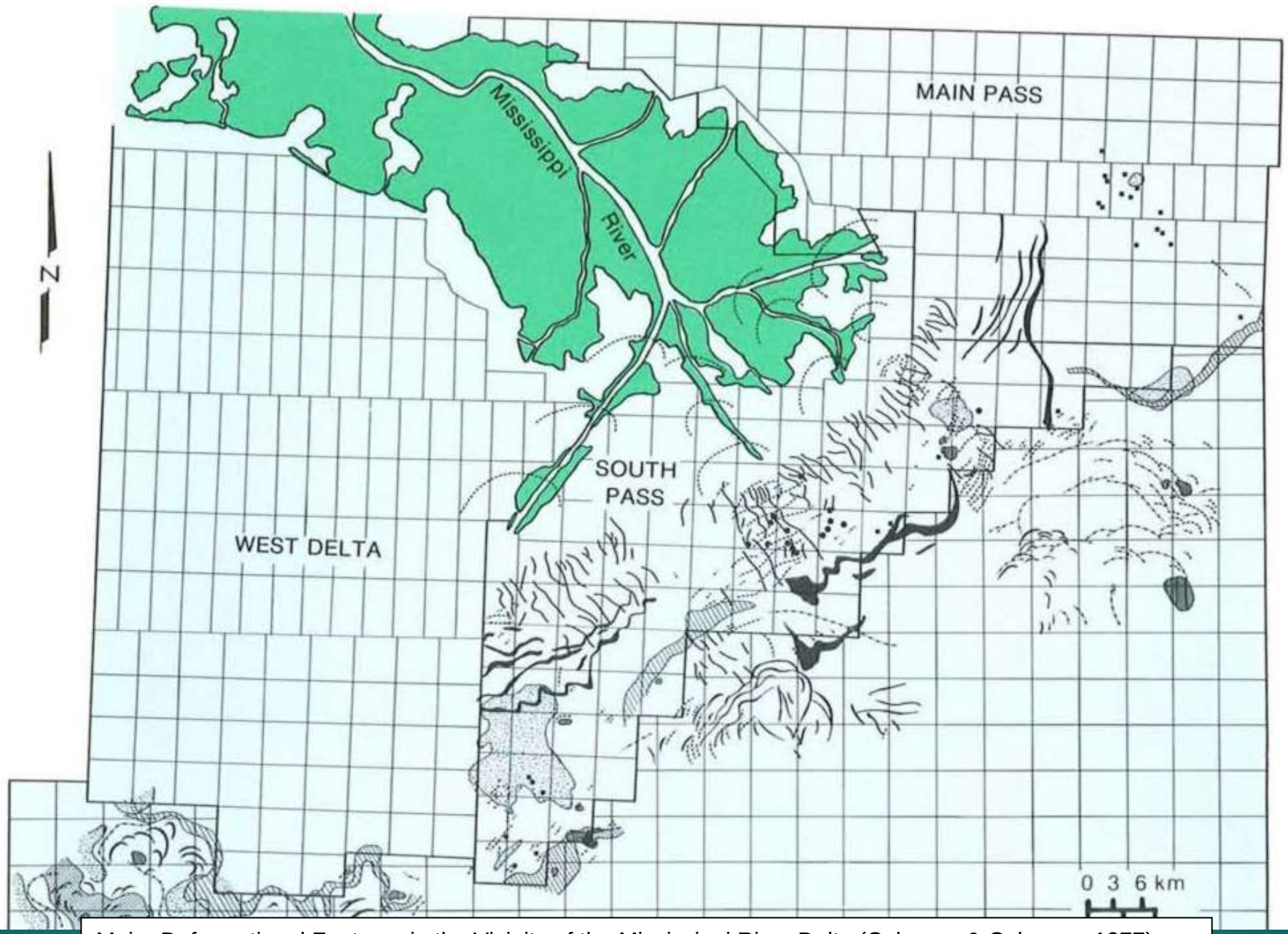
Gas: 20%
Oil: 30%

DESIGN CHALLENGES

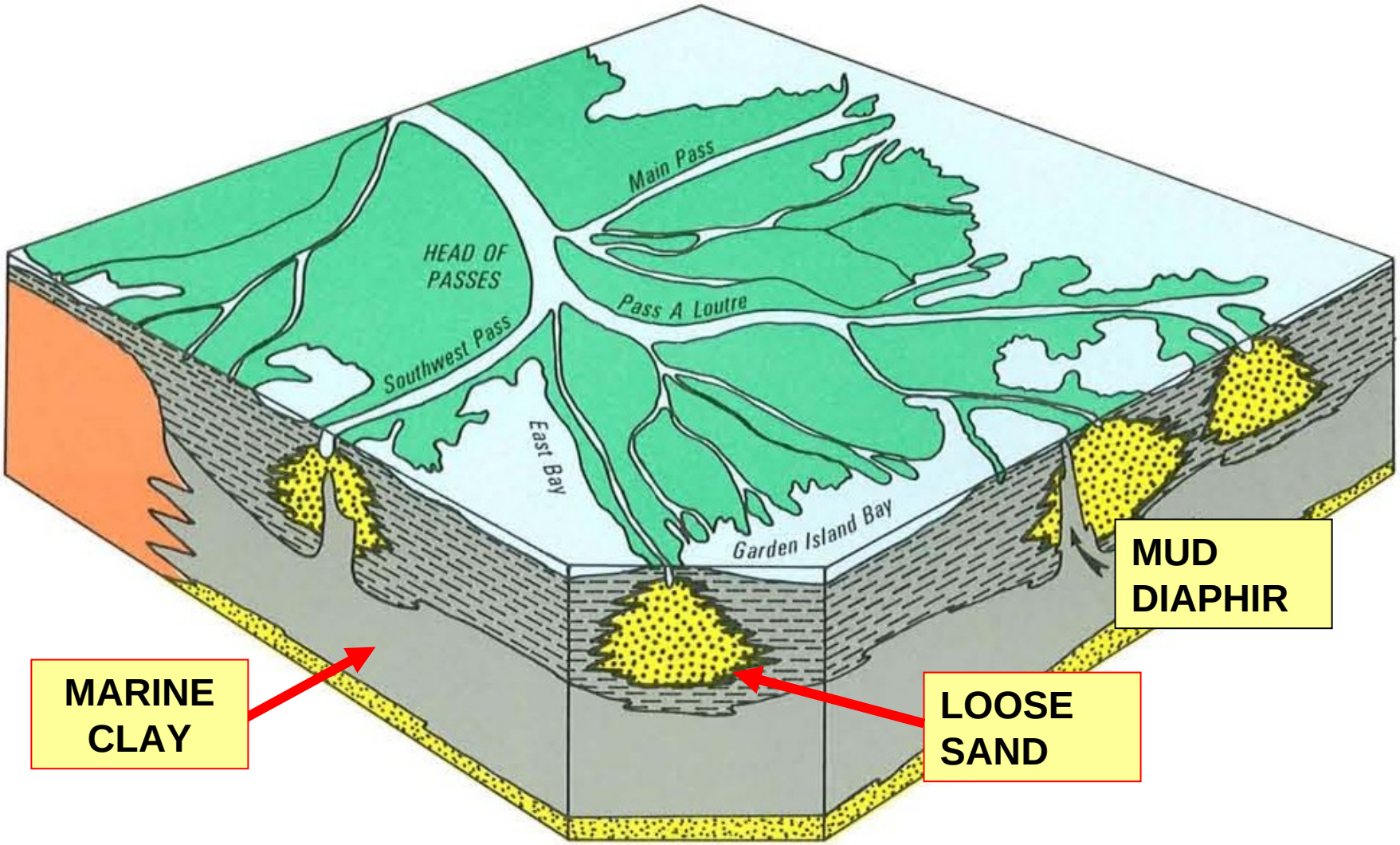
- **Hurricane Survivability**
- **Fabrication & Installation**


MISS.
LOUISIANA
MISSISSIPPI RIVER
CONTINENTAL SHELF
MISSISSIPPI TROUGH
UPPER MISSISSIPPI FAN
CONTINENTAL SLOPE & PLATEAU
SIGSBEE ESCARPMENT
LOWER MISSISSIPPI FAN

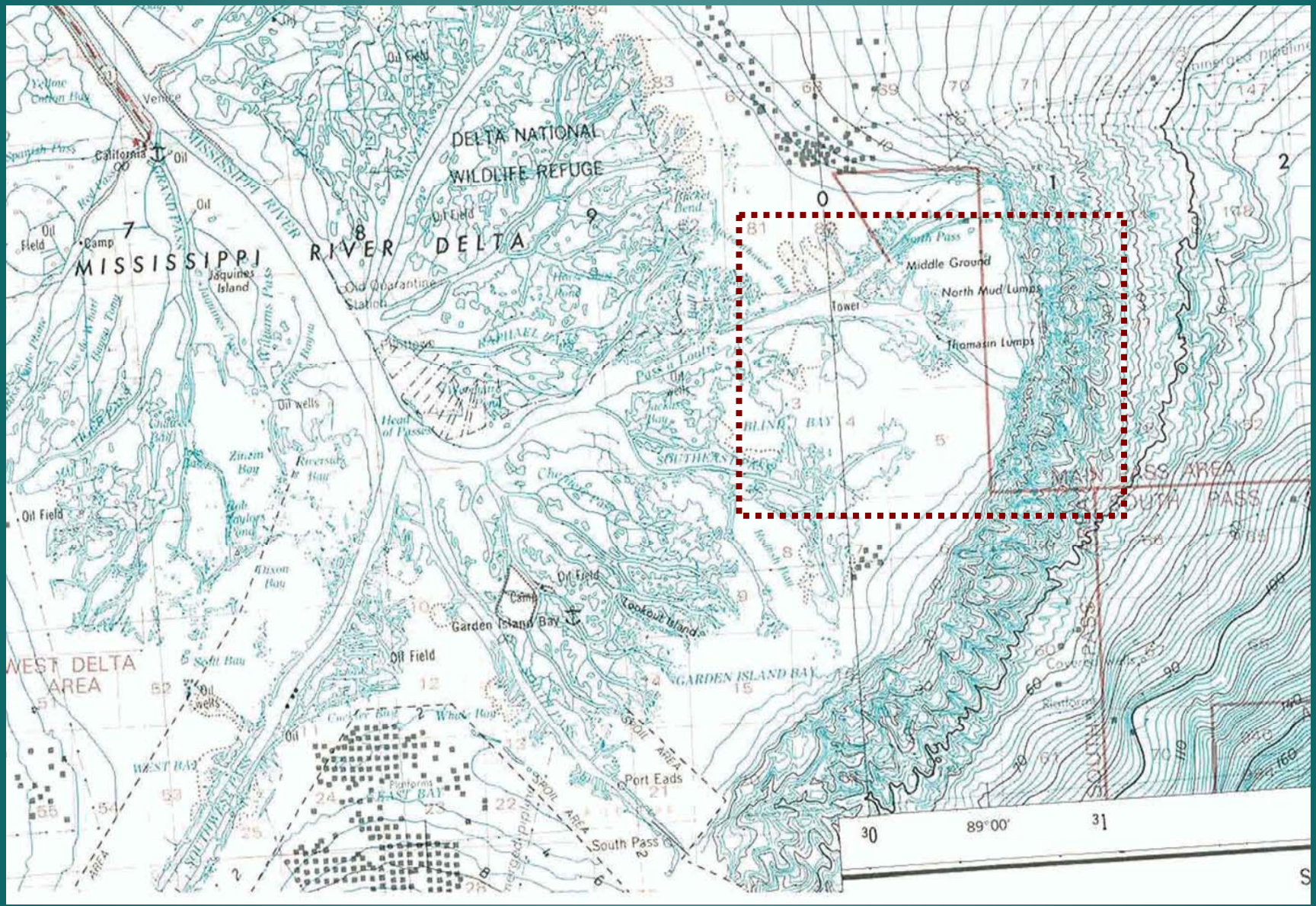

MAIN PASS
PASS A LOUTRE
SOUTH PASS
SOUTHWEST PASS

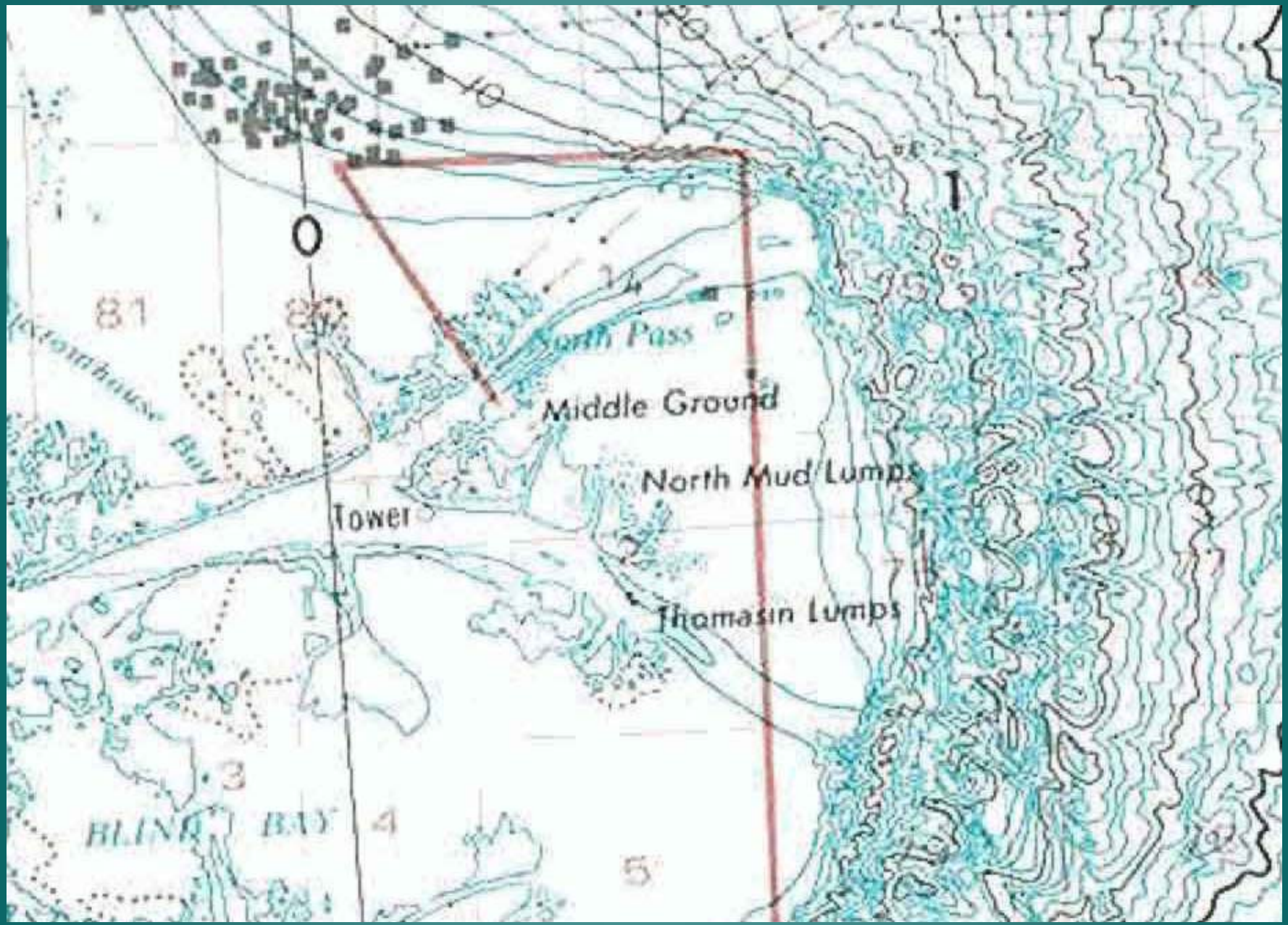


Major Deformational Features in the Vicinity of the Mississippi River Delta (Coleman & Coleman, 1977)

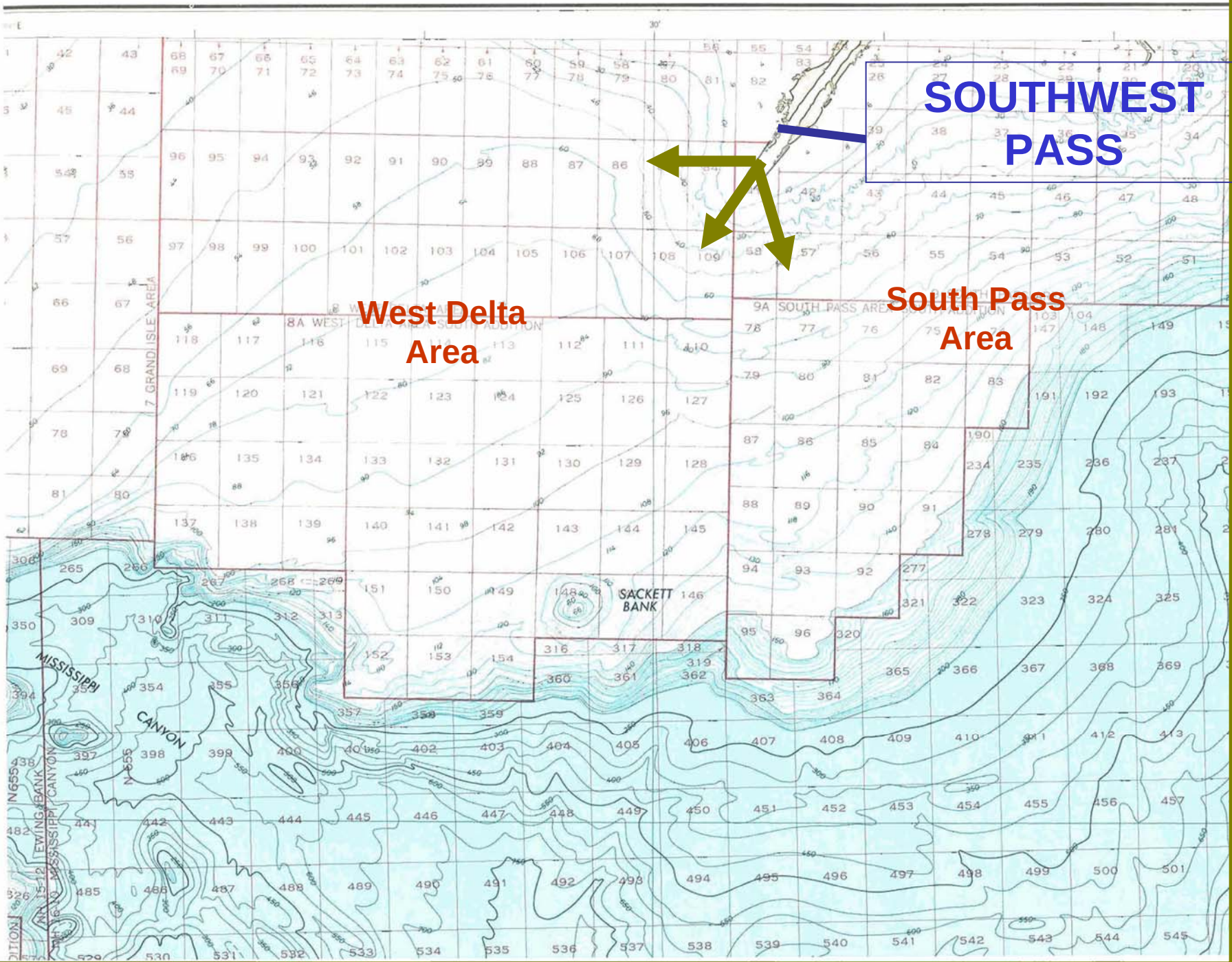


b. Birdfoot delta, Mississippi River (after Fisk et al, 1954)


DELTA NATIONAL
WILDLIFE REFUGE
MISSISSIPPI
RIVER DELTA
Venice
California
Oil
Oil Field
Camp
Jaquines Island
Old Quarantine Station
Middle Ground
North Mud Lumps
Tower
Thomasin Lumps
Garden Island Bay
Lookout Island
Port Eads
South Pass
WEST DELTA AREA
GARDEN ISLAND BAY
SOUTH PASS AREA
89°00'


0
1
81
South Pass
Middle Ground
North Mud Lumps
Tower
Thomasin Lumps
BLIND BAY
3
4
5

SONAR RECORD: MAIN PASS MUD AREA


SOUTHWEST PASS
West Delta Area
South Pass Area
SACKETT BANK
MISSISSIPPI CANYON

UNSTABLE DELTA SOIL

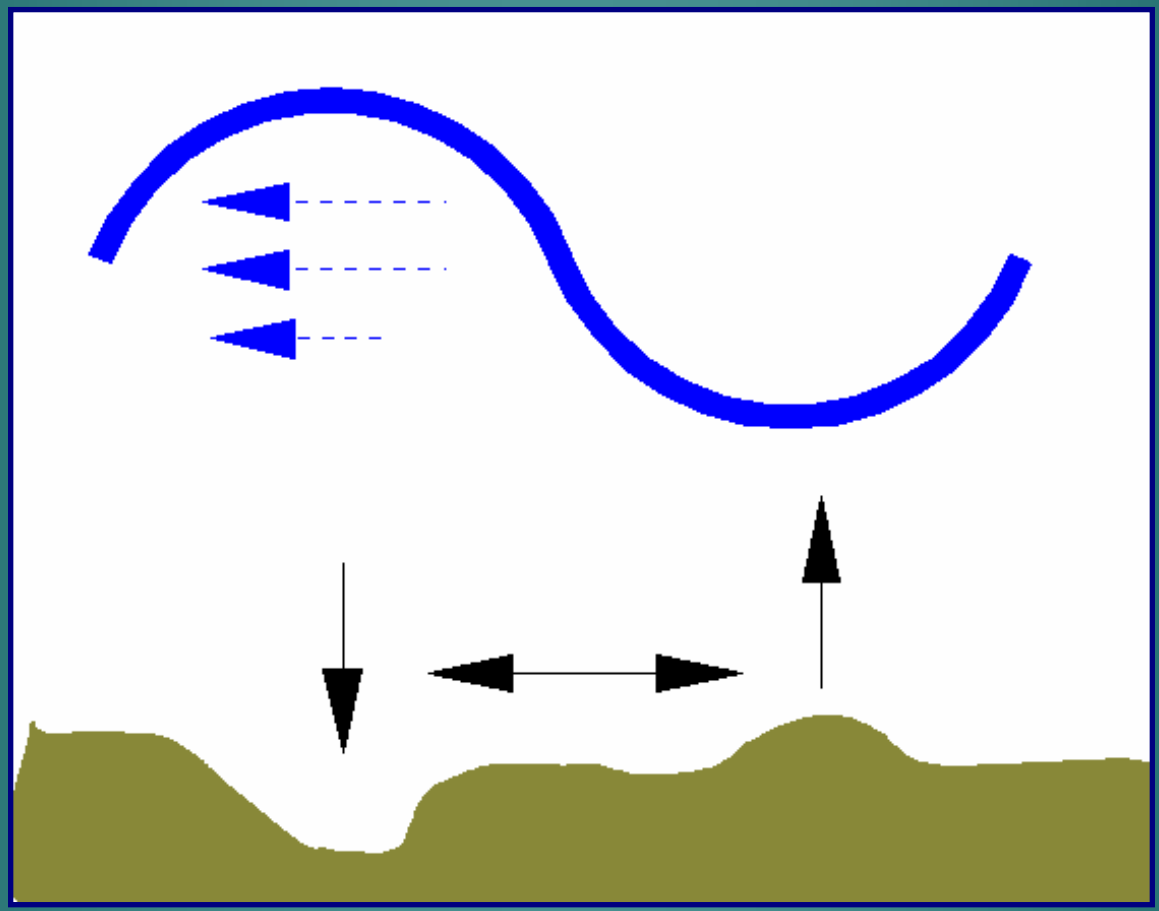
- Poor foundation for offshore structures.
- Susceptibility to displacement during hurricanes – risk to O&G infrastructure

MUDSLIDE RECOVERY

- Delta clays are thixotropic materials - regain strength with time (full recovery decades?)
- Multiple events extend the recovery period

MUDSLIDE INITIATORS

- **Storm Wave Effects on Soil**



- **Degradation of Shear Modulus**

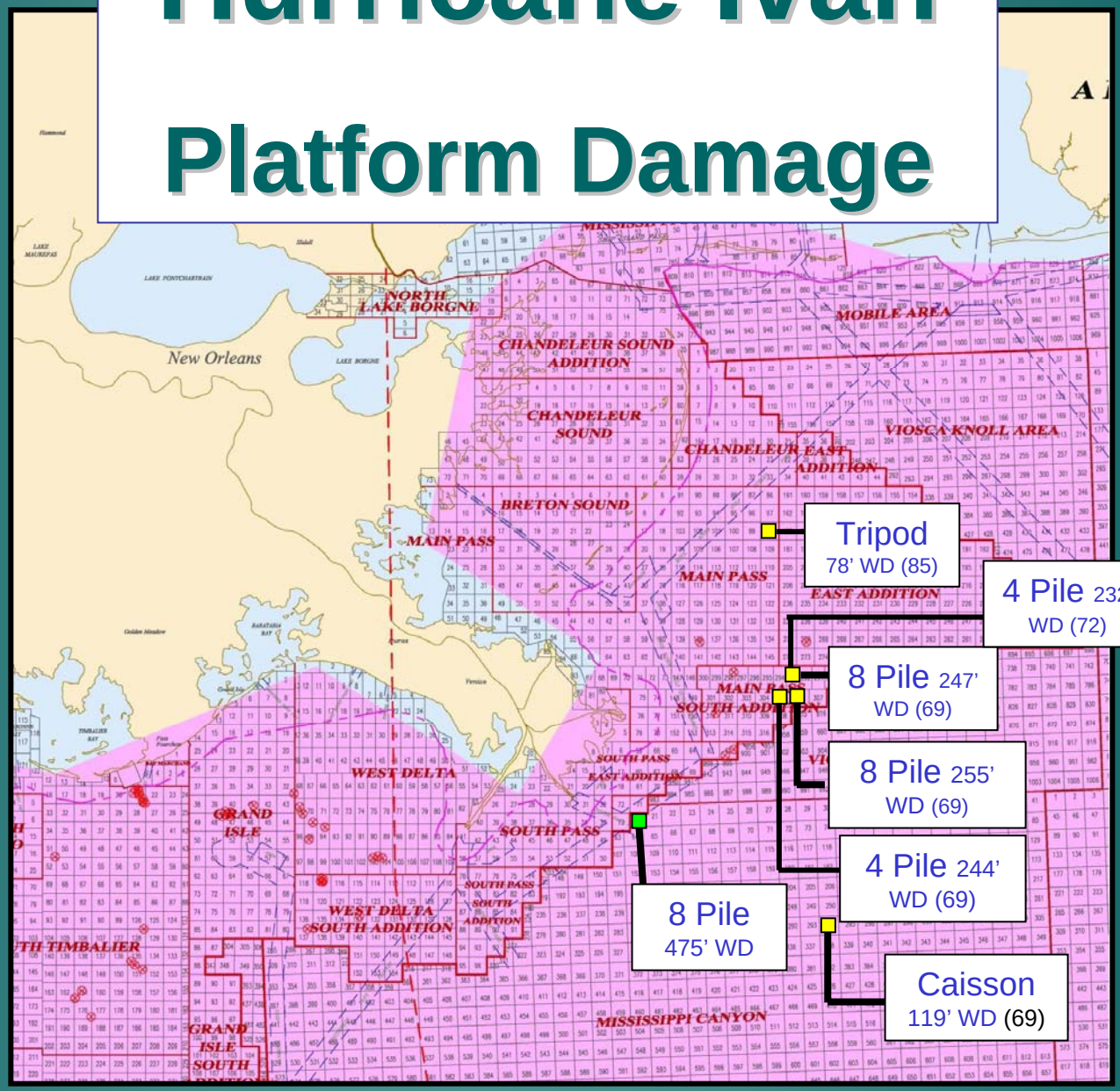
HURRICANE DAMAGE

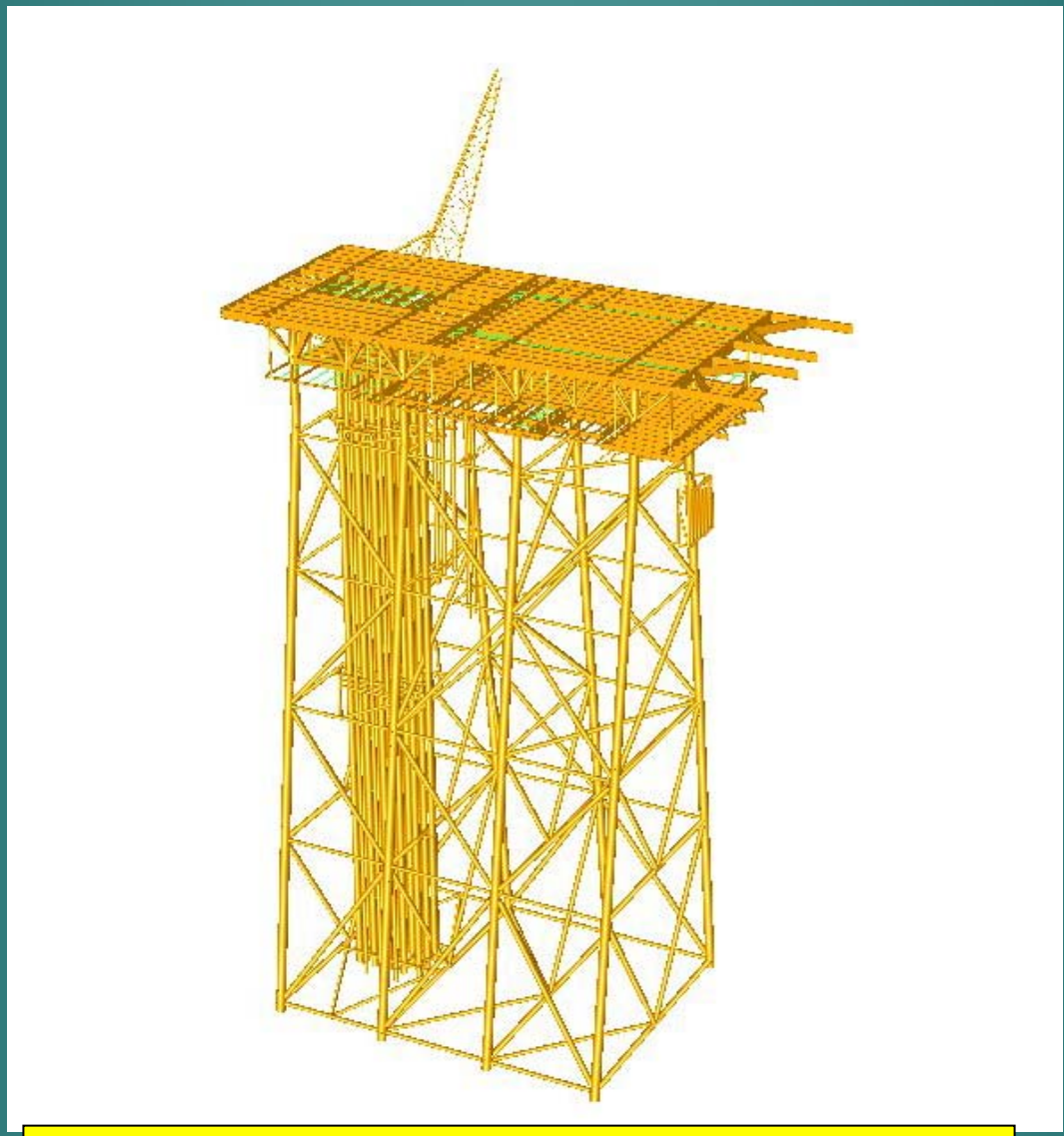
- Pipeline Damage
- Platform Damage
- Rig Damage

STORM	Platform Destroyed	Pipelines (>10”) Damaged	Rigs Destroyed (Damaged)
Ivan (2004)	7	20	ND
Katrina (2005)	44	61	4 (9)
Rita (2005)	69	40	1 (10)

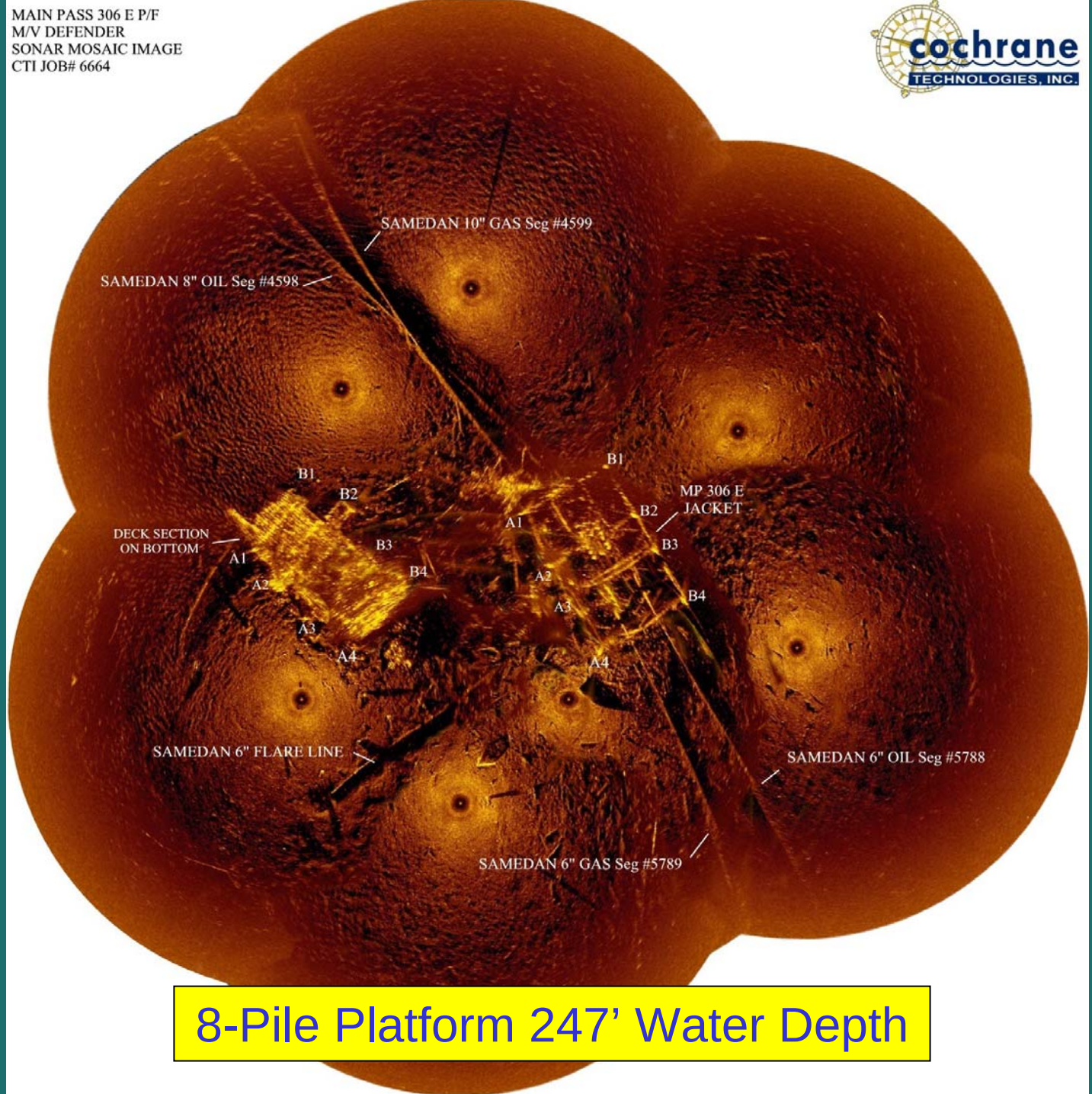
Hurricane Ivan

Platform Damage



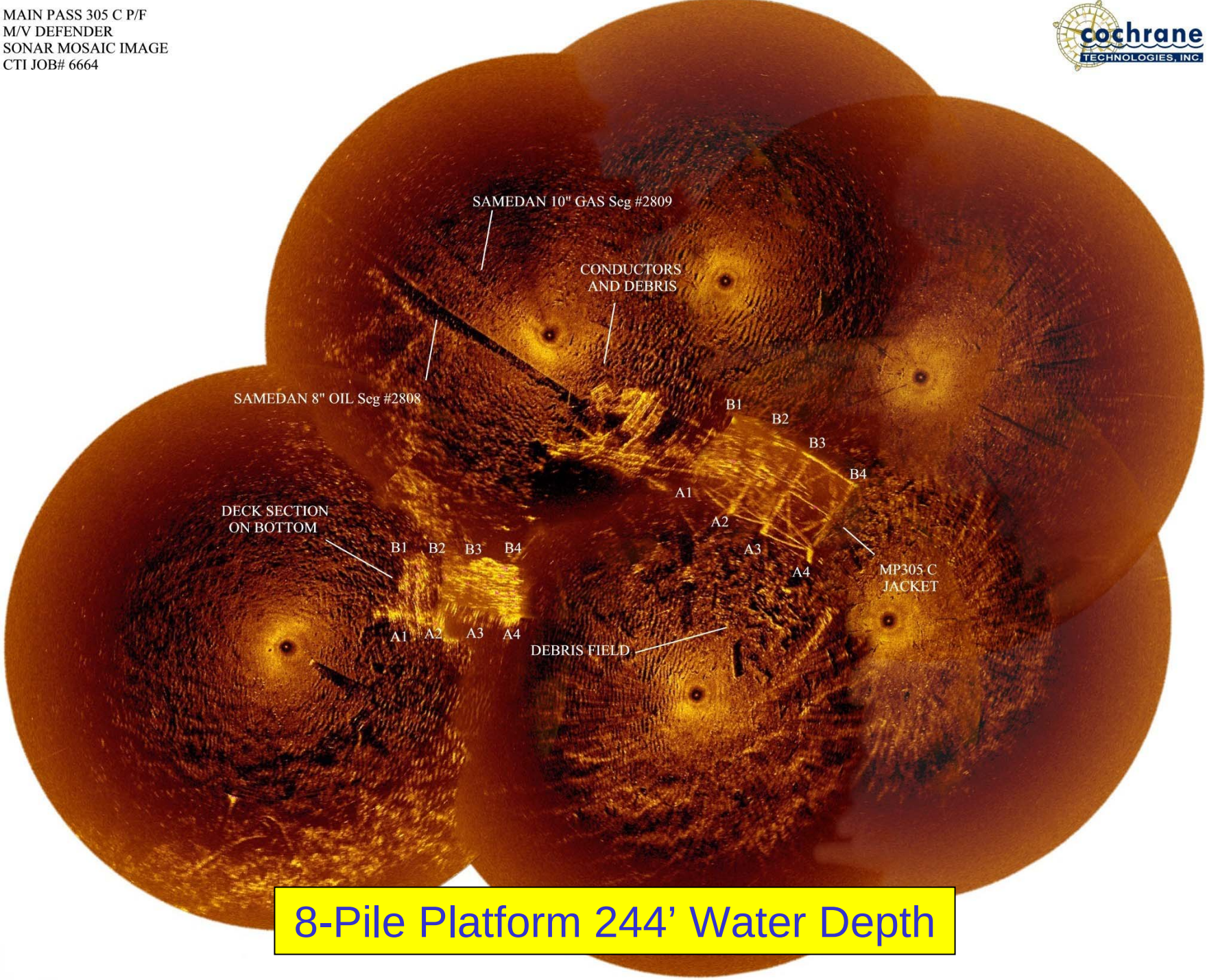


Typical 8-Pile Platform

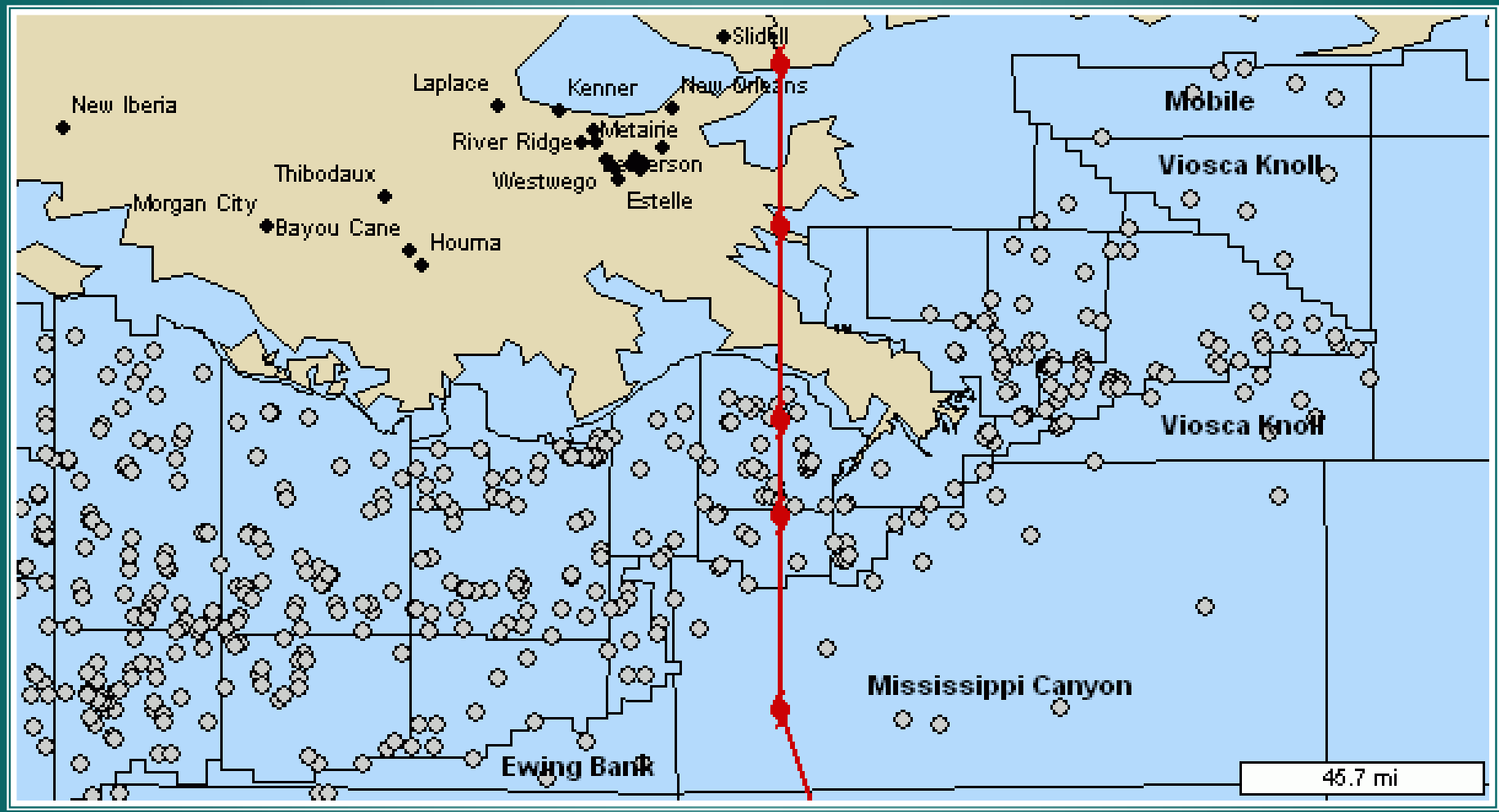


8-Pile Platform 247’ Water Depth

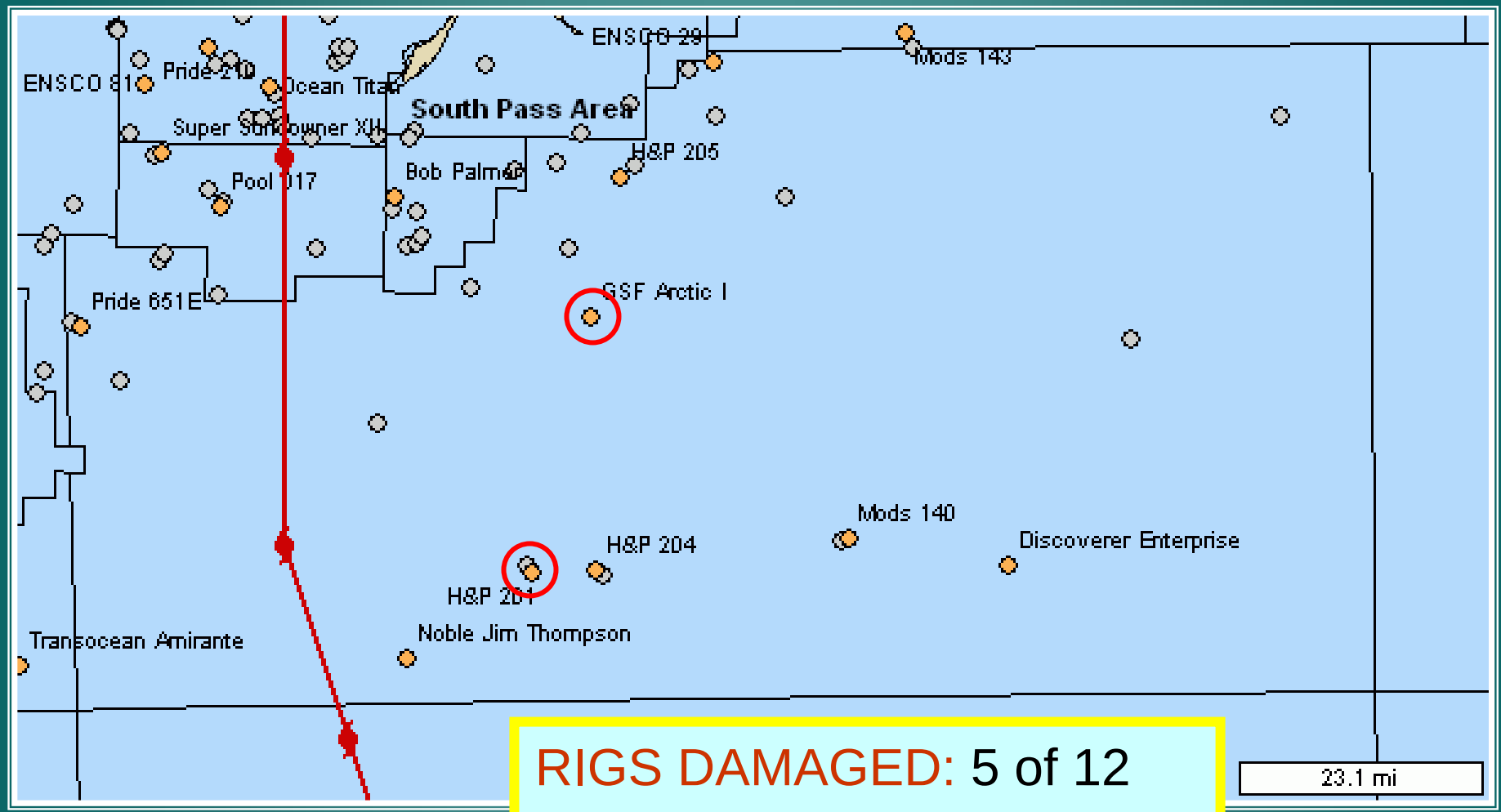
MAIN PASS 305 C P/F
M/V DEFENDER
SONAR MOSAIC IMAGE
CTI JOB# 6664



8-Pile Platform 244’ Water Depth


Slidell
Laplace
Kenner
New Orleans
New Iberia
Metairie
River Ridge
Thibodaux
Westwego
Morgan City
Estelle
Bayou Cane
Houma
Mobile
Viosca Knoll
Viosca Knoll
Mississippi Canyon
Ewing Bank
45.7 mi

MISSISSIPPI CANYON



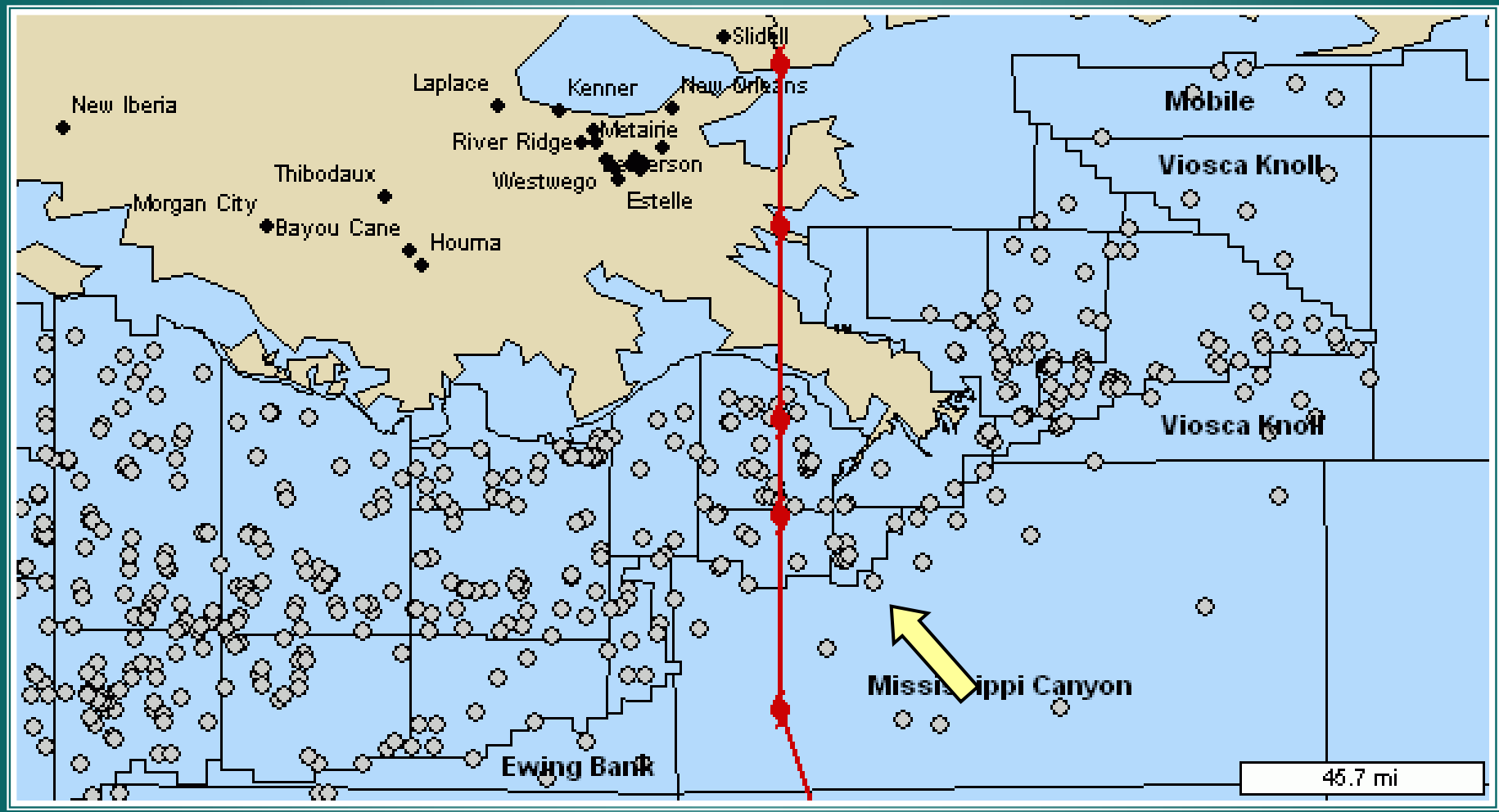
RIGS DAMAGED: 5 of 12

PLATFORMS DAMAGED: 3

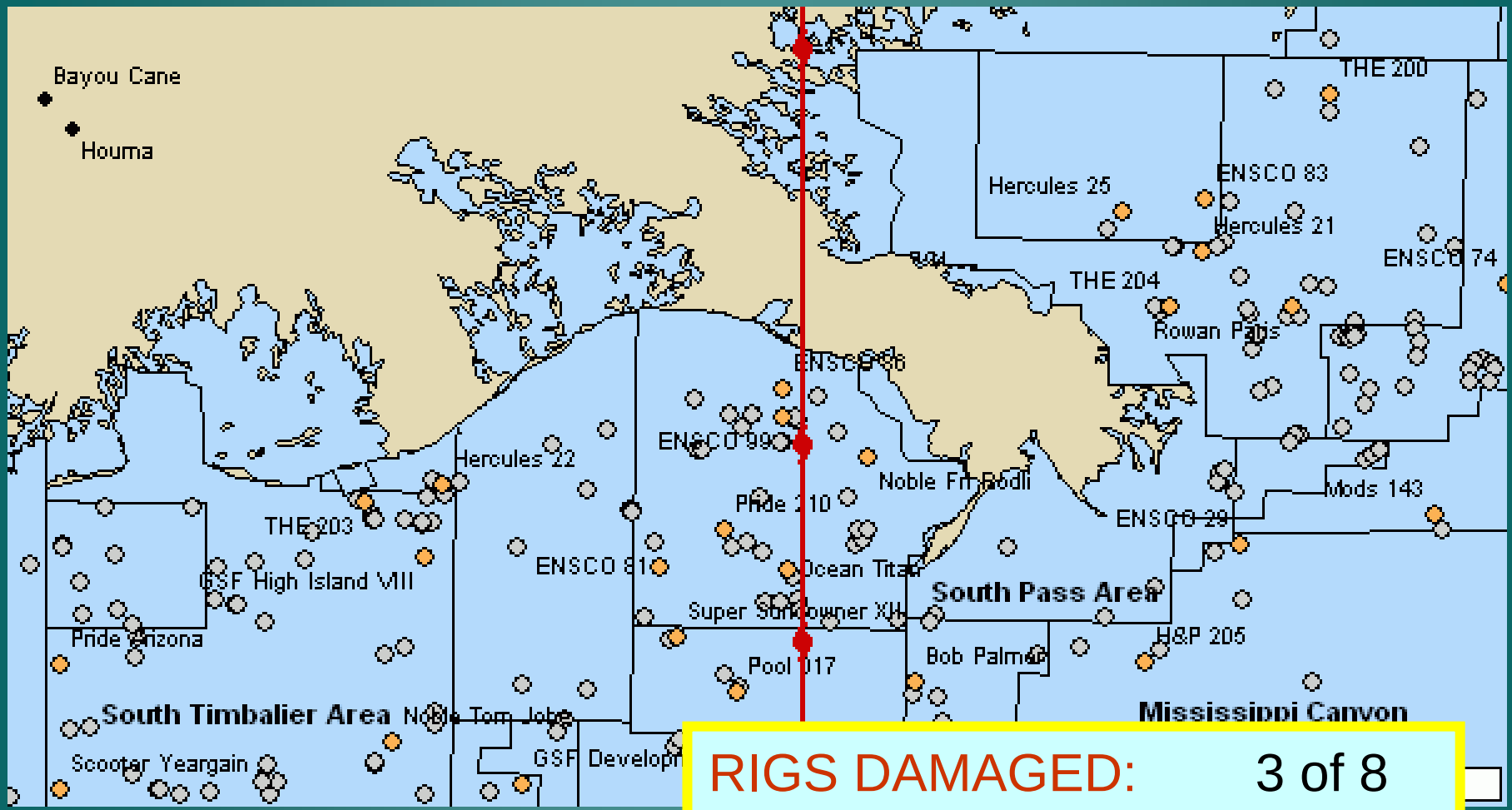
Spinnaker rig lost mooring & drifted

Shell's MARS TLP

Platform Rig Derrick Collapse – Hurricane Katrina


Slidell
Laplace
Kenner
New Orleans
New Iberia
Metairie
River Ridge
Thibodaux
Westwego
Morgan City
Estelle
Bayou Cane
Houma
Mobile
Viosca Knoll
Viosca Knoll
Mississippi Canyon
Ewing Bank
45.7 mi

WEST DELTA



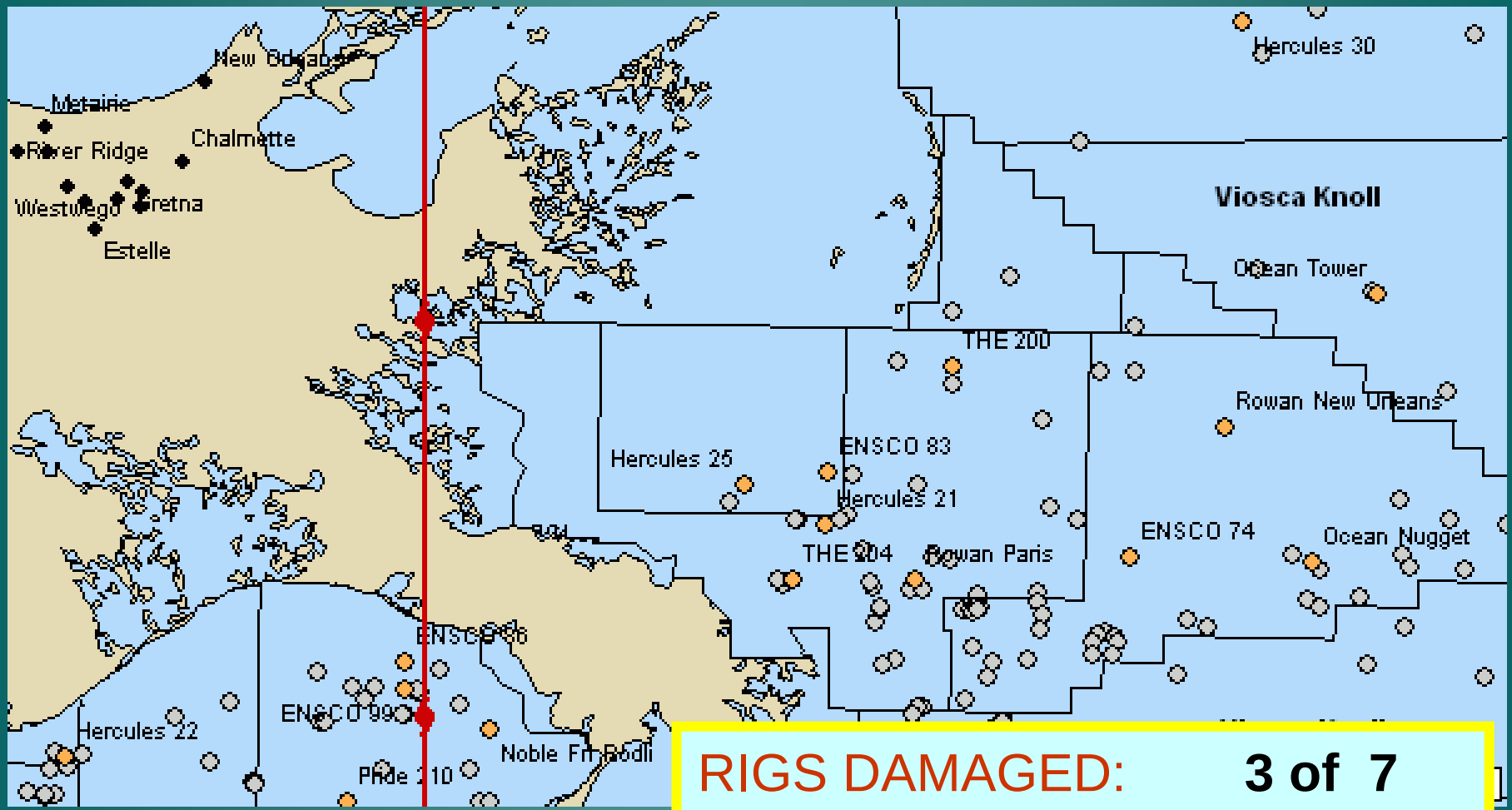
4 Chevron Platforms

RIGS DAMAGED: 3 of 8

PLATFORM DAMAGED: 1

PLATFORMS LOST: 4

MAIN PASS

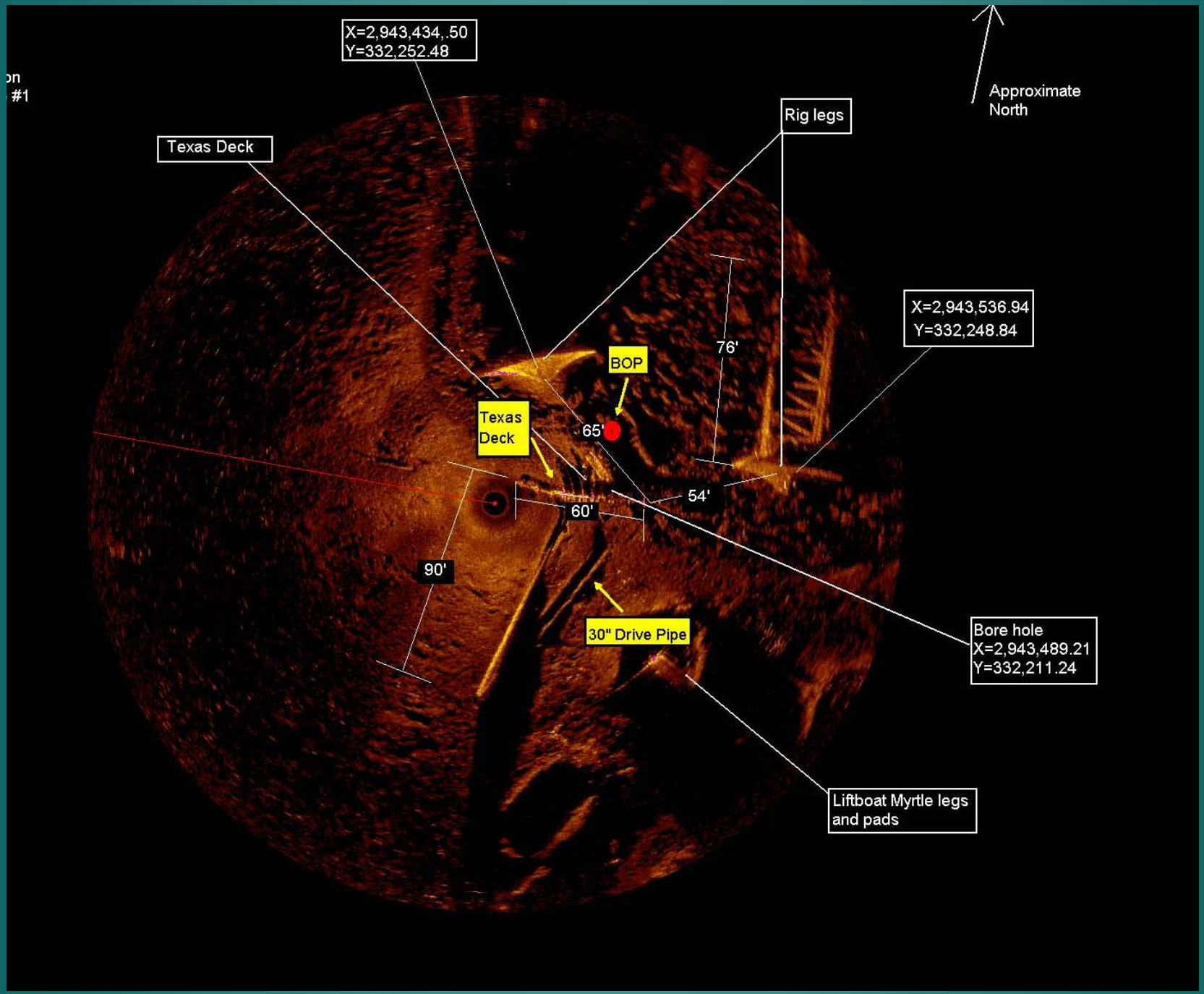


1 Newfield MP128
1 Noble Energy MP 306D
1 Chevron

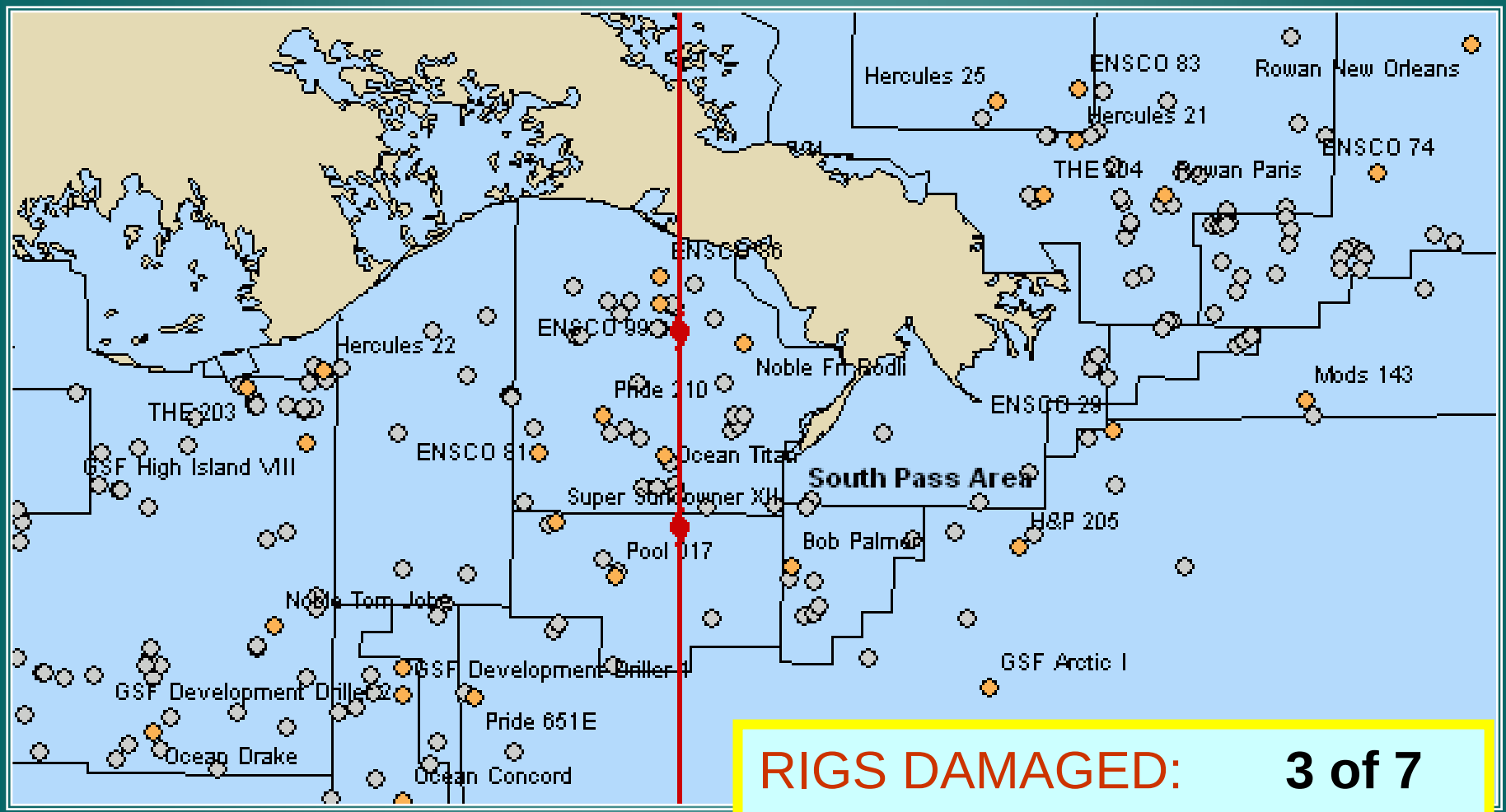
RIGS DAMAGED: **3 of 7**

PLATFORM DAMAGED: **1**

PLATFORMS LOST: **3**


X=2,943,434,.50
Y=332,252.48
Approximate
North
Rig legs
Texas Deck
X=2,943,536.94
Y=332,248.84
76'
BOP
Texas
Deck
65'
54'
60'
90'
30" Drive Pipe
Bore hole
X=2,943,489.21
Y=332,211.24
Liftboat Myrtle legs
and pads

SOUTH PASS



RIGS DAMAGED: **3 of 7**

PLATFORM DAMAGED: **6**

PLATFORMS LOST: **2**

2 Chevron

DESIGNING FOR FUTURE STORMS

ELEVATION OF DECK HEIGHTS

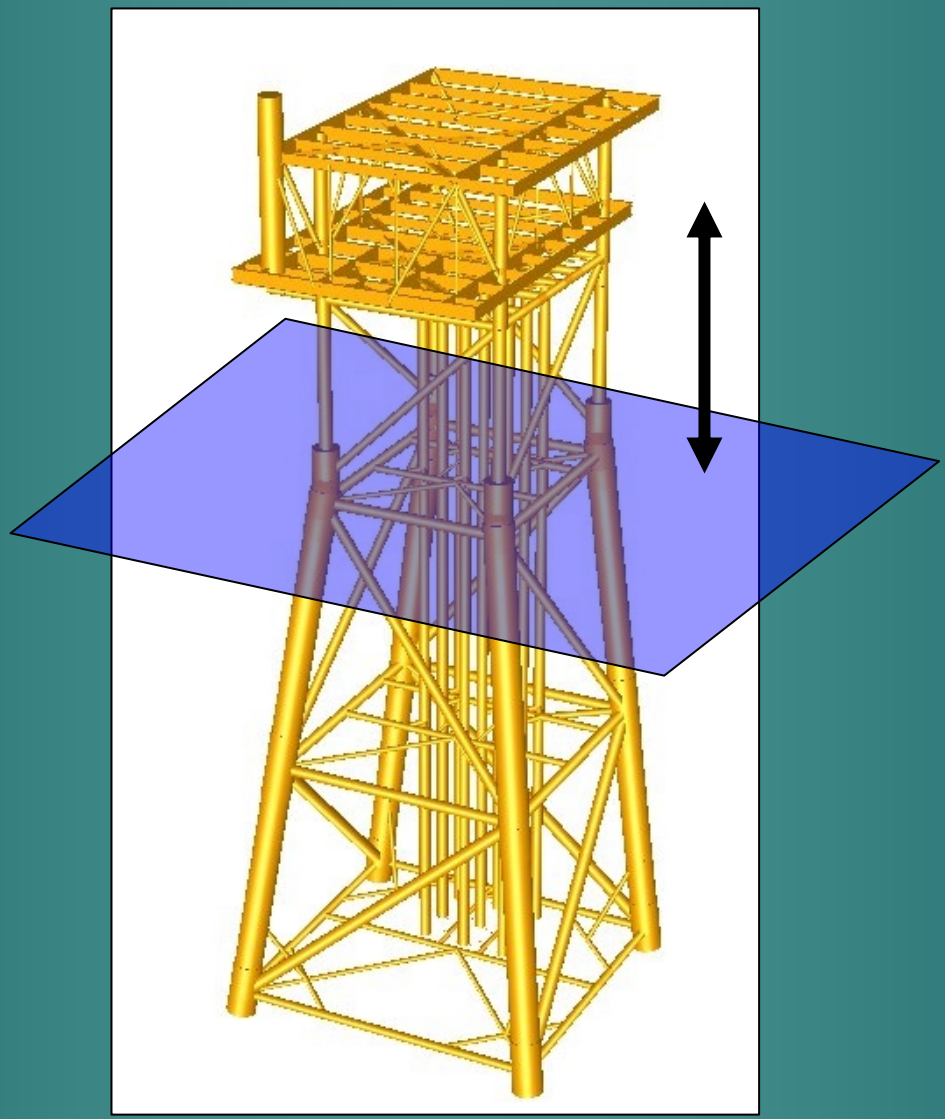
- Minimize Wave Innundation
- New Deck Heights Criteria

JACKET MODIFICATIONS

IMPROVEMENT OF SEA FASTENING OF RIGS

- Topside Fixation of Topside Drill Rigs
- Anchoring / Stabilization of Floating Rigs

PLATFORM DECK HEIGHT



DECK HEIGHT

CURRENT CRITERIA

(100-300 FT W.D.)

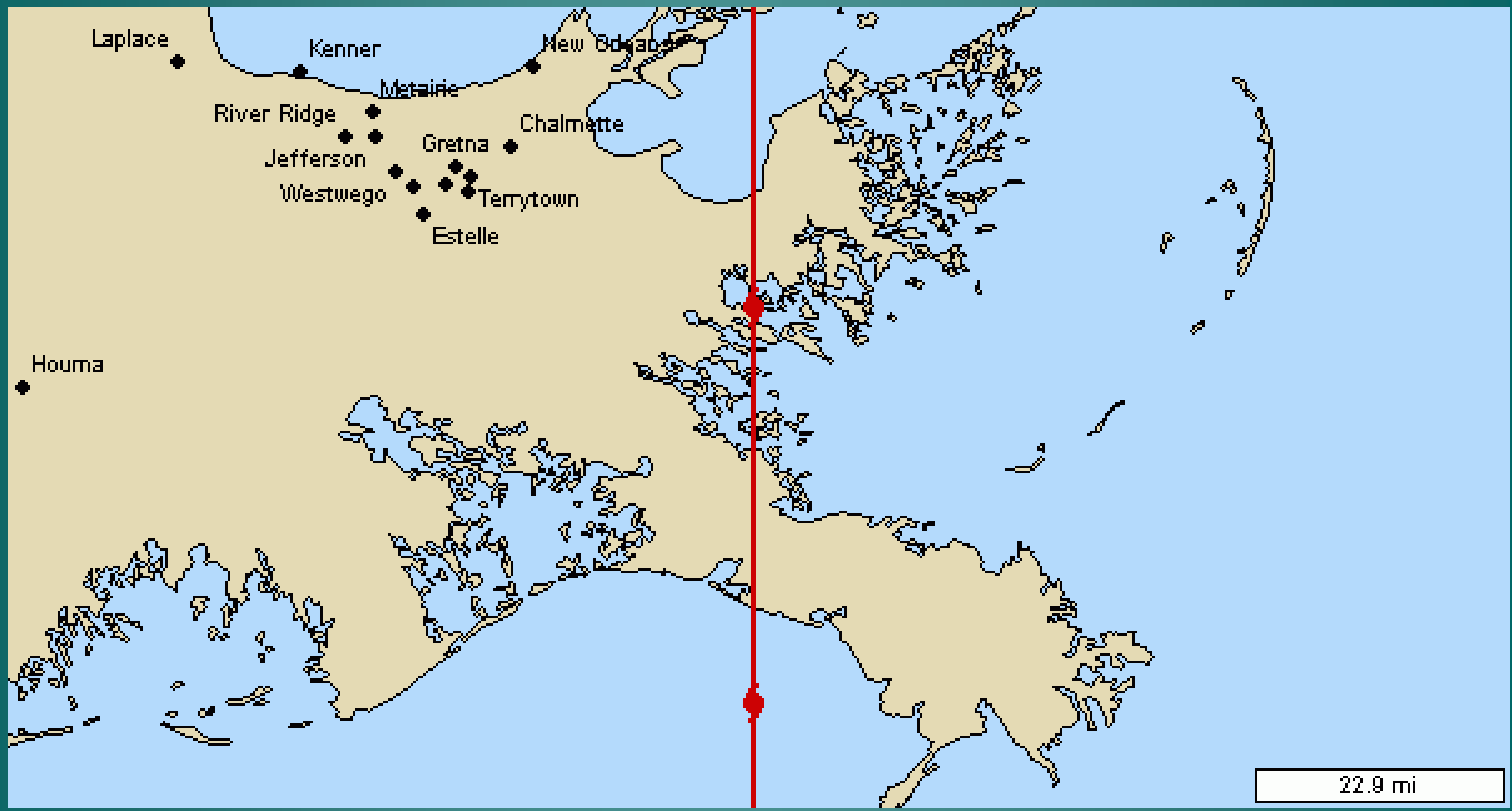
API RP2A, Sec2, L1	47-54 ft
API RP2A, Sec17, L1	45-47 ft
API RP2A, Sec17, L2	38-37 ft
API RP2A, Sec17, L3	30 ft

DATA POOL

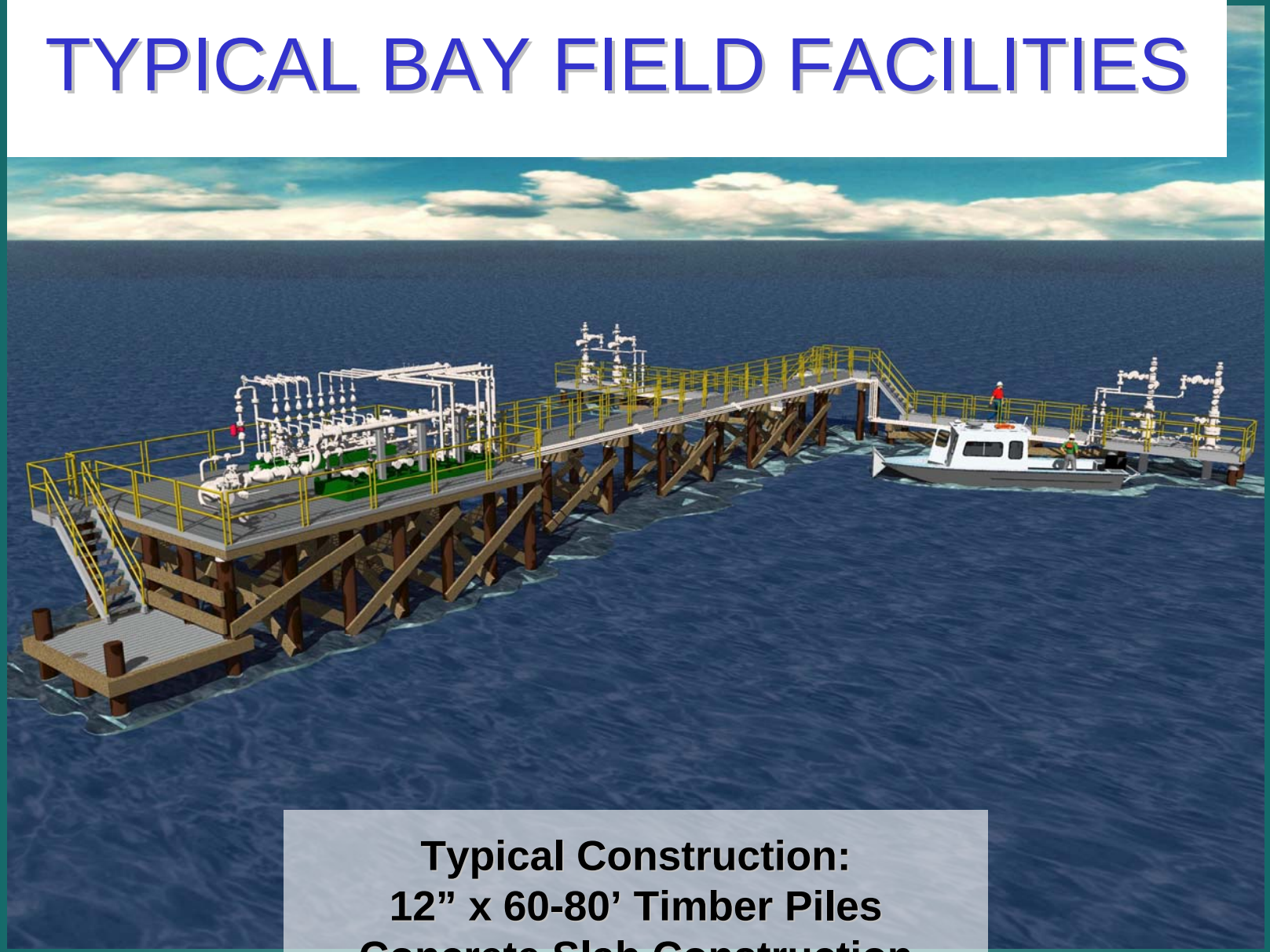
Lost Platforms

Hurricane Andrew: Deck Heights vs. API RP2A Minimum Deck Elevation Requirements

KATRINA TRAJECTORY
Through Inland Bay Fields



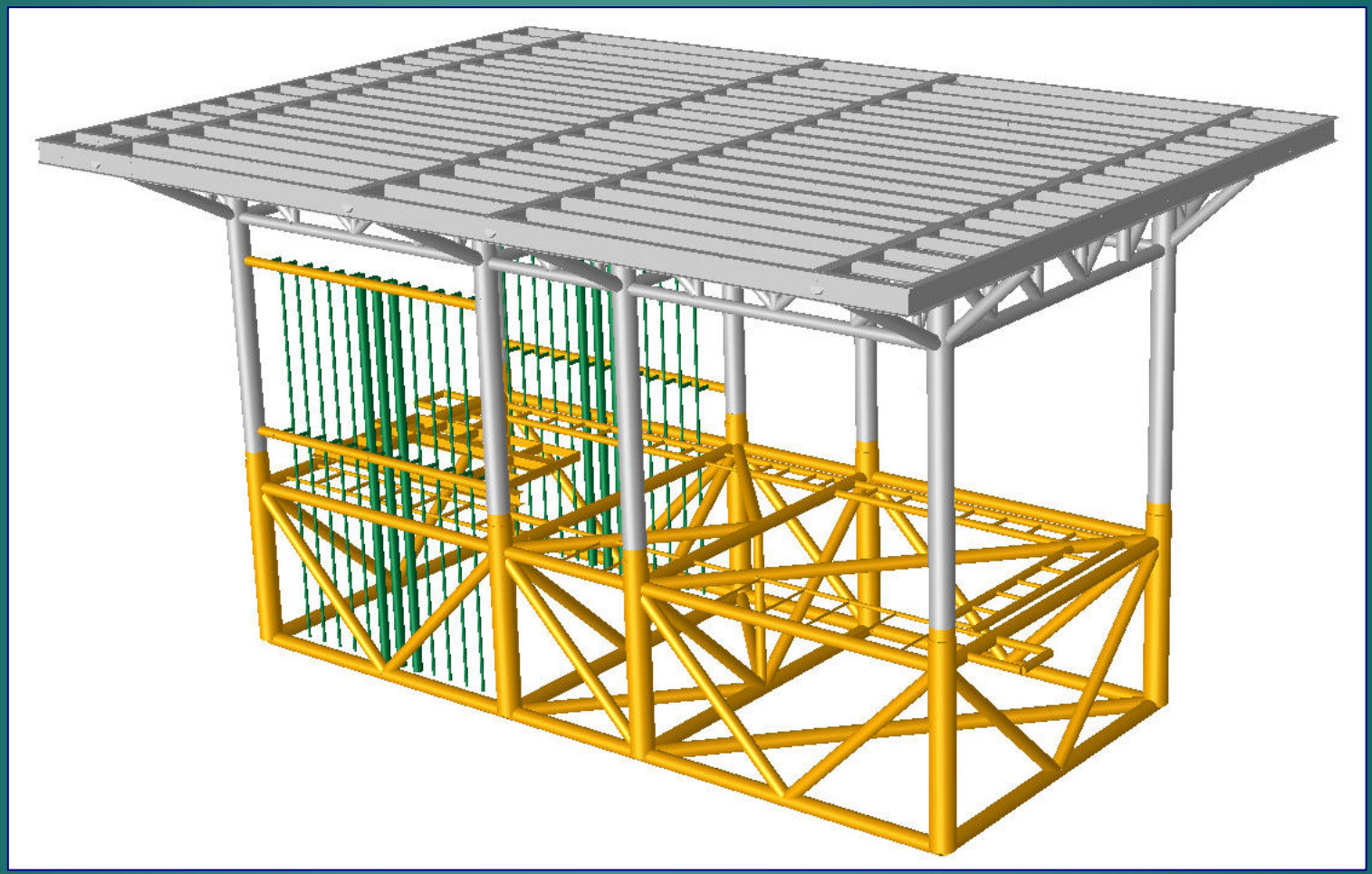
TYPICAL BAY FIELD FACILITIES



Typical Construction:
12” x 60-80’ Timber Piles
Concrete Slab Construction

Bay Field O&G Facility East of River

Steel Structure Alternatives



Hurricane Damage to Pipelines

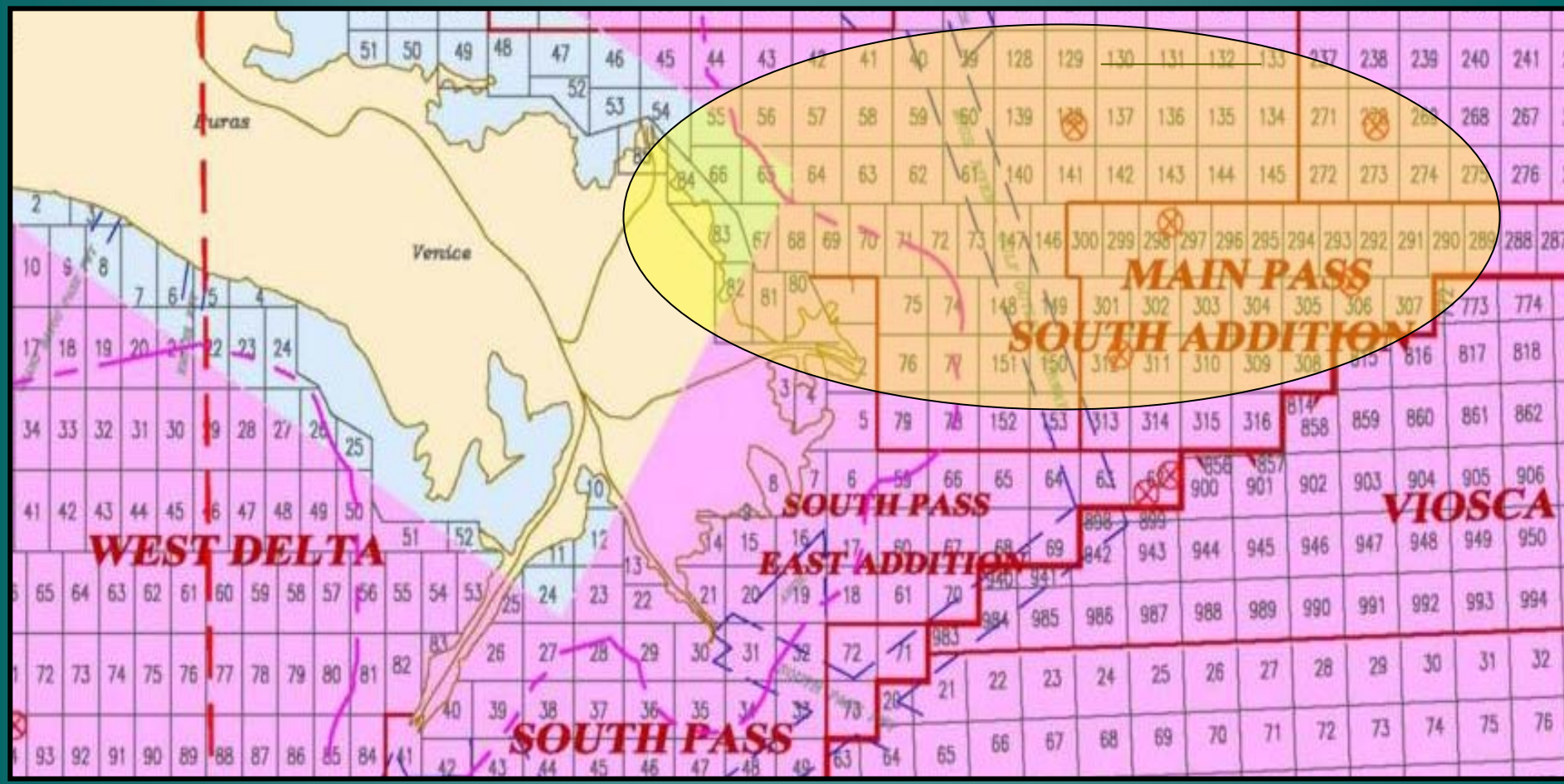
- Rig Anchor Damage
- Mudslide Displacement & Failure

Mudslide Damage

Failure Susceptibility

- **Larger Diameter Pipelines**
- **Pipeline Perpendicular to direction of mudslide**

Larger Diameter TRUNK LINE MOVEMENT



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