GOOSE ISLAND SHORELINE PROTECTION AND RESTORATION OF ADJACENT HABITATS

Feasibility Study/Alternatives Analysis

TEXAS PARKS & WILDLIFE

PBS&J

BELAIRE ENVIRONMENTAL INC.

Kay Jenkins

Yu-Chun Su
Paul Jensen
Martin Heaney
Bob Gearhart

Charlie Belaire

PROJECT PARTNERS

TEXAS PARKS & WILDLIFE

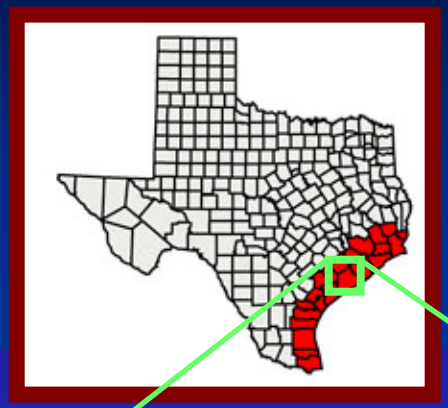
Coastal Erosion Prevention and Response Act (CEPRA)

PROJECT GOALS

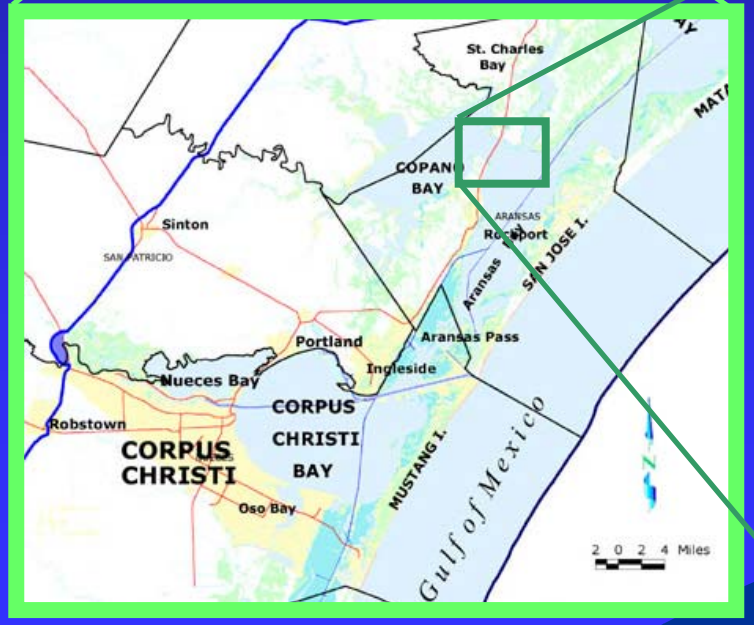
Protect and restore wetland habitats on GI at Goose Island State Park in Lamar, Aransas County

- **Protecting the 1 mile long eroding shoreline of Goose Island and**
- **Creating smooth cordgrass marsh**

PROJECT LOCATION



On southern tip of Lamar Peninsula, northern shore of Aransas Bay between St. Charles Bay and Copano Bay

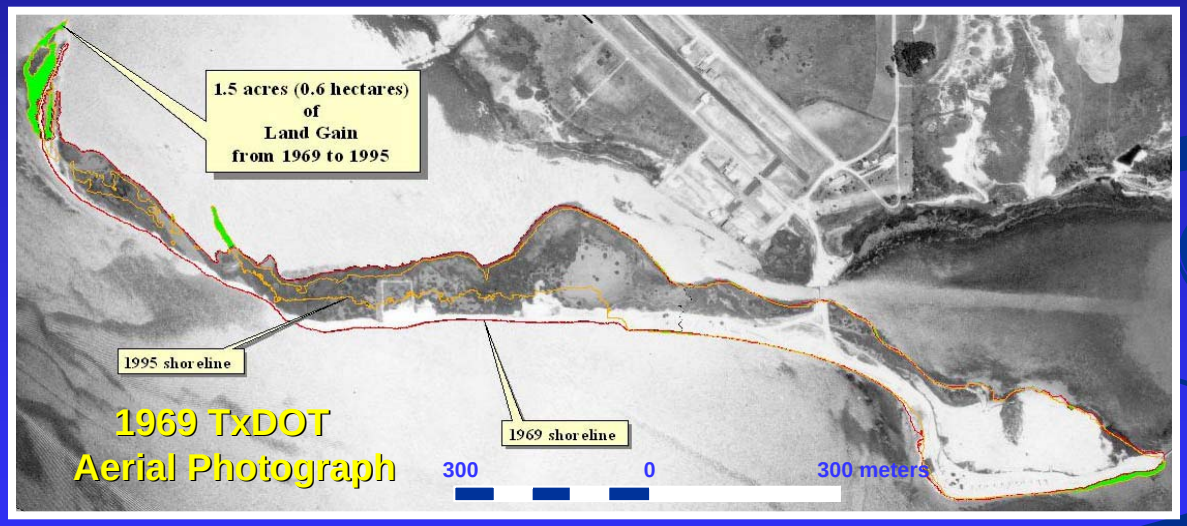


BACKGROUND

Eastern portion of Goose Island has been protected with a bulkhead since the 1970's which has been effective in protecting that part of the island.

EROSION ON GI SHORELINE

- **Significant erosion on the unprotected western section**
- **TPWD analysis of aerial photography:**
  - **Land eroded between 1969 and 1995: 17.1 acres**
  - **Average erosion rate: 0.66 acre/year**

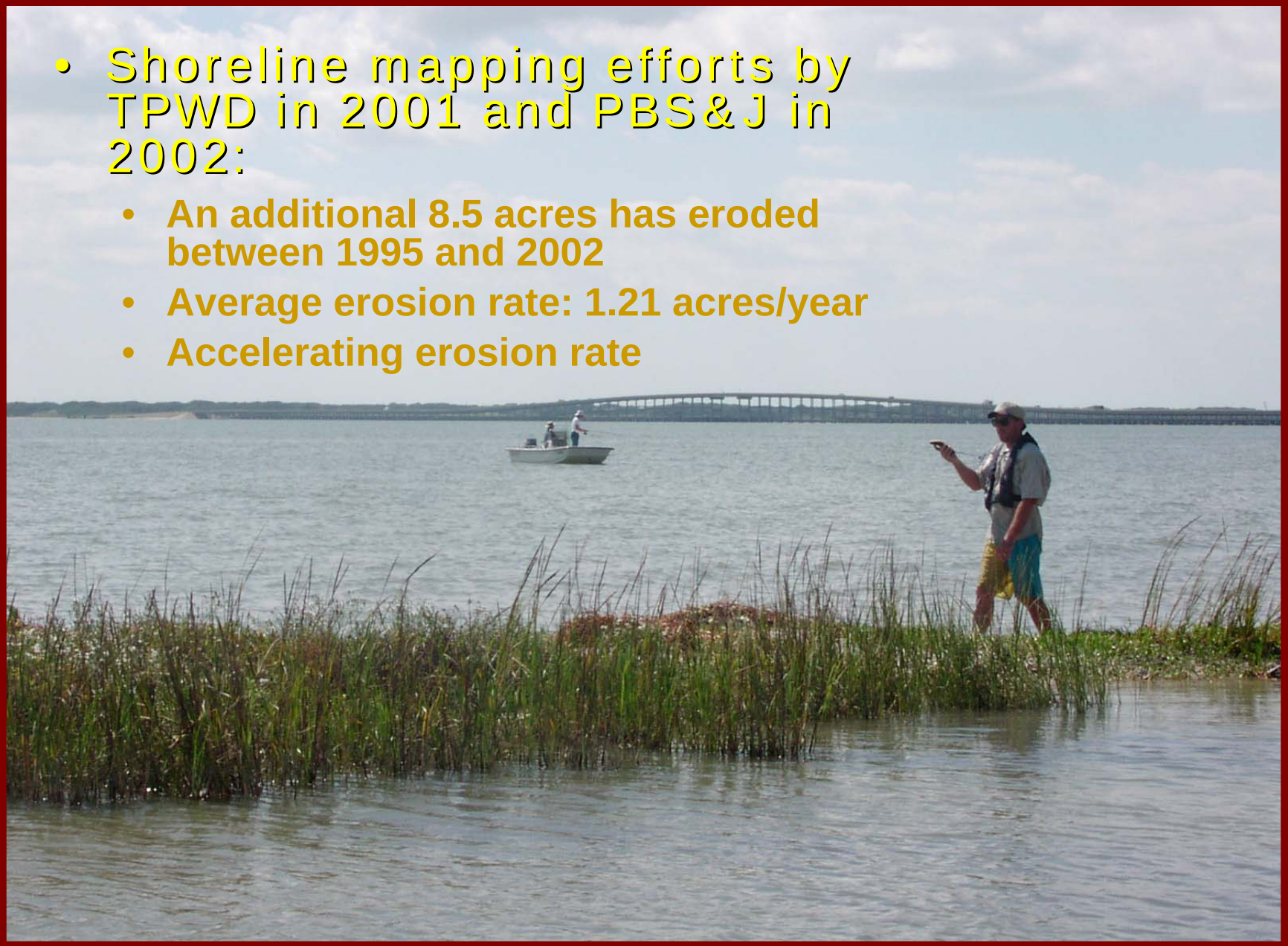


Land Loss

Land Gain

Comparison of aerial photography between 1969 and 1995 showing extent of habitat loss due to erosion.

- Shoreline mapping efforts by TPWD in 2001 and PBS&J in 2002:
  - **An additional 8.5 acres has eroded between 1995 and 2002**
  - **Average erosion rate: 1.21 acres/year**
  - **Accelerating erosion rate**



GI Shoreline Changes Between 1995 and 2002

WETLAND & AQUATIC HABITATS BEING LOST OR DEGRADED

- **Nursery habitat for important fisheries, providing both protection and food**
- **Source of nutrients for entire bay system**
- **Provides food, shelter, perching, and roosting areas for many birds**
- **Removes sediments and contaminants from runoff leaving adjacent uplands**

Smooth Cordgrass Marsh

OYSTER REEFS

- **Important economic activity in Aransas Bay**
- **Valuable habitat for aquatic plants and animals providing food, nutrients, hiding places and attachment sites for these organisms**

SEAGRASS BEDS

- Provide critical nursery habitat for many fisheries species
- Provide food for fish, sea turtles, and waterfowl
- Provide nutrients and organic matter for bay system
- Provide habitat for invertebrates, which are in turn fed upon by other organisms in the food web
- Stabilize the bay bottom with their root systems, dampening wave action, and reducing erosion

RECREATONAL IMPACTS

- Birding
  - Checklist of 315 species
- Park use
  - 307,657 people visited the park from September 1999 to August 2000
- Fishing
  - 12,700 vehicles used Goose Island public boat ramp from September 1999 to August 2000

SEEKING SOLUTIONS

- **TPWD sought partners to help address the shoreline erosion problems on Goose Island in 2001**
- **In spring of 2002 TPWD entered into a partnership with the Texas General Land Office (GLO) and the Coastal Bend Bays & Estuaries Program to**
  - **evaluate alternatives for avoiding, slowing, or remedying coastal erosion on Goose Island and to**
  - **assess the feasibility, cost and financing of the alternatives**
- **GLO selected *PBS&J* as the engineering contractor (with *Belaire Environmental, Inc.* as a sub) and charged them with developing shoreline erosion alternatives and marsh creation alternatives, preferably using dredge material from nearby boat channels**

PROJECT FEASIBILITY STUDIES

- **Bathymetry Survey**
- **Shoreline Mapping**
- **Seagrass And Oyster Survey**
- **Magnetometer Survey**
- **Geotechnical Survey**
- **Wind And Wave Analysis**
- **Alternatives Analysis**
- **Geotechnical Investigation Along Preferred Alignment**

PBS&J SURVEY BOAT

- A 20-foot (ft) aluminum workboat
- Hydropro 2.0 navigation software
- A Satloc SLX GPS with Omnistar differential correction receiver
- An EG&G Geometrics G 881 cesium magnetometer
- A CODA Technologies DA50 side-scan sonar data acquisition system
- An Edgetech TD272 sonar towfish

- An Odom Hydrotrac echo sounder with a narrow beam (4-degree), 200-kHz transducer

PBS&J SURVEY BOAT

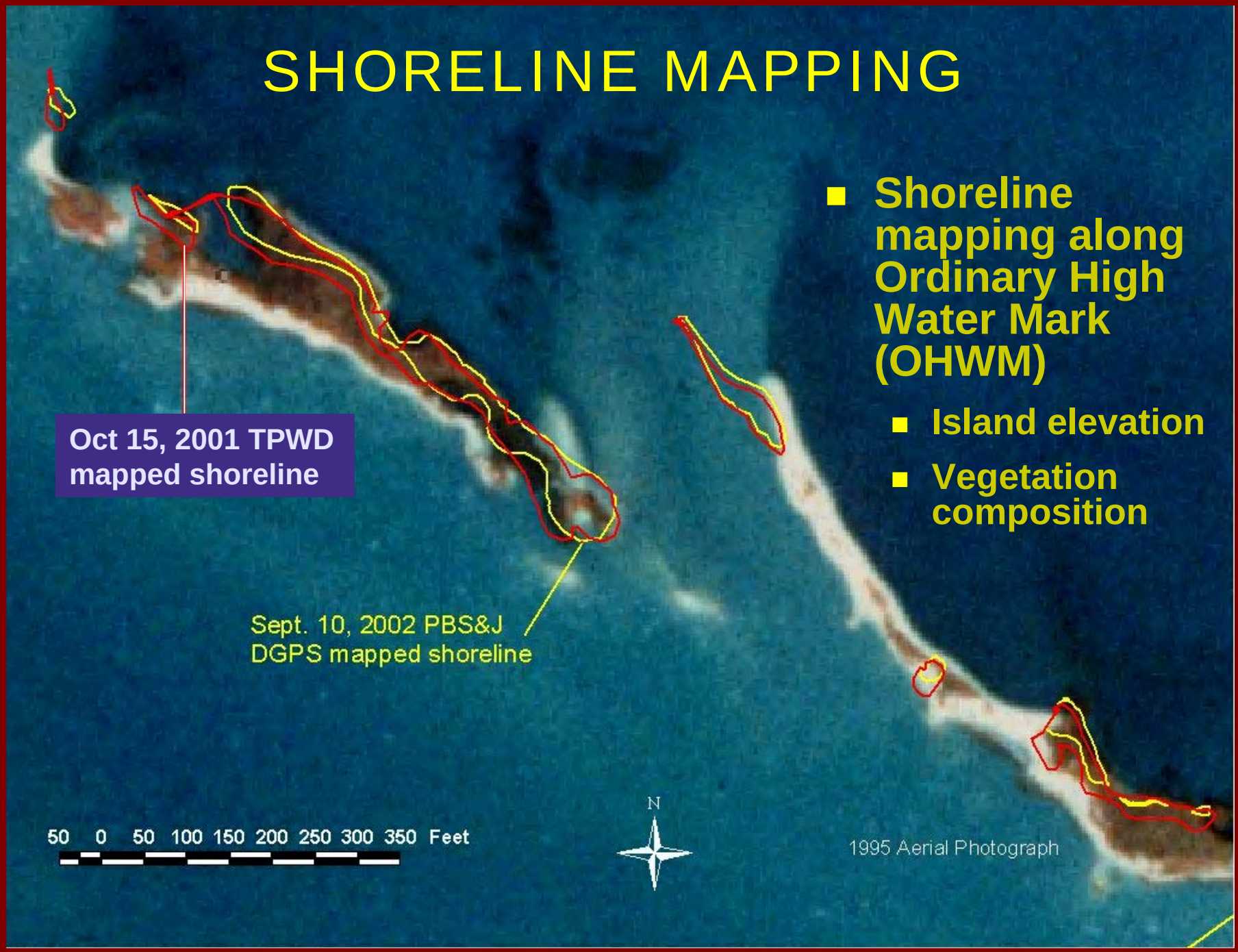
- A TSS DMS 05 heave compensator
- A Valeport VTM740 automatic tide recorder
- Sonar transducers at a depth of about 2 ft
- Echo sounder transducer at 1.1 ft beneath the surface
- Boat speeds at 2.5 to 4.5 knots (2.9 to 5.2 mph)
- Side-scan sonar range - 98 ft on each side of the towfish

- Magnetometer readings - once per second
- Water depths - four times per second

BATHYMETRY SURVEY

- Boat survey to as near shore as possible (~ 3 ft deep at high tide)
- Near shore survey along transects perpendicular to shoreline at 500-ft interval
- Tidal correction using TCOON gage data
- Data converted to NAVD88 via two bench marks
  - 036.001 4513 B 1989 located at Copano Bay State Fishing Pier Building
  - 036.002 4513 C 1989 located at Copano Bay State Fishing Pier

SHORELINE MAPPING



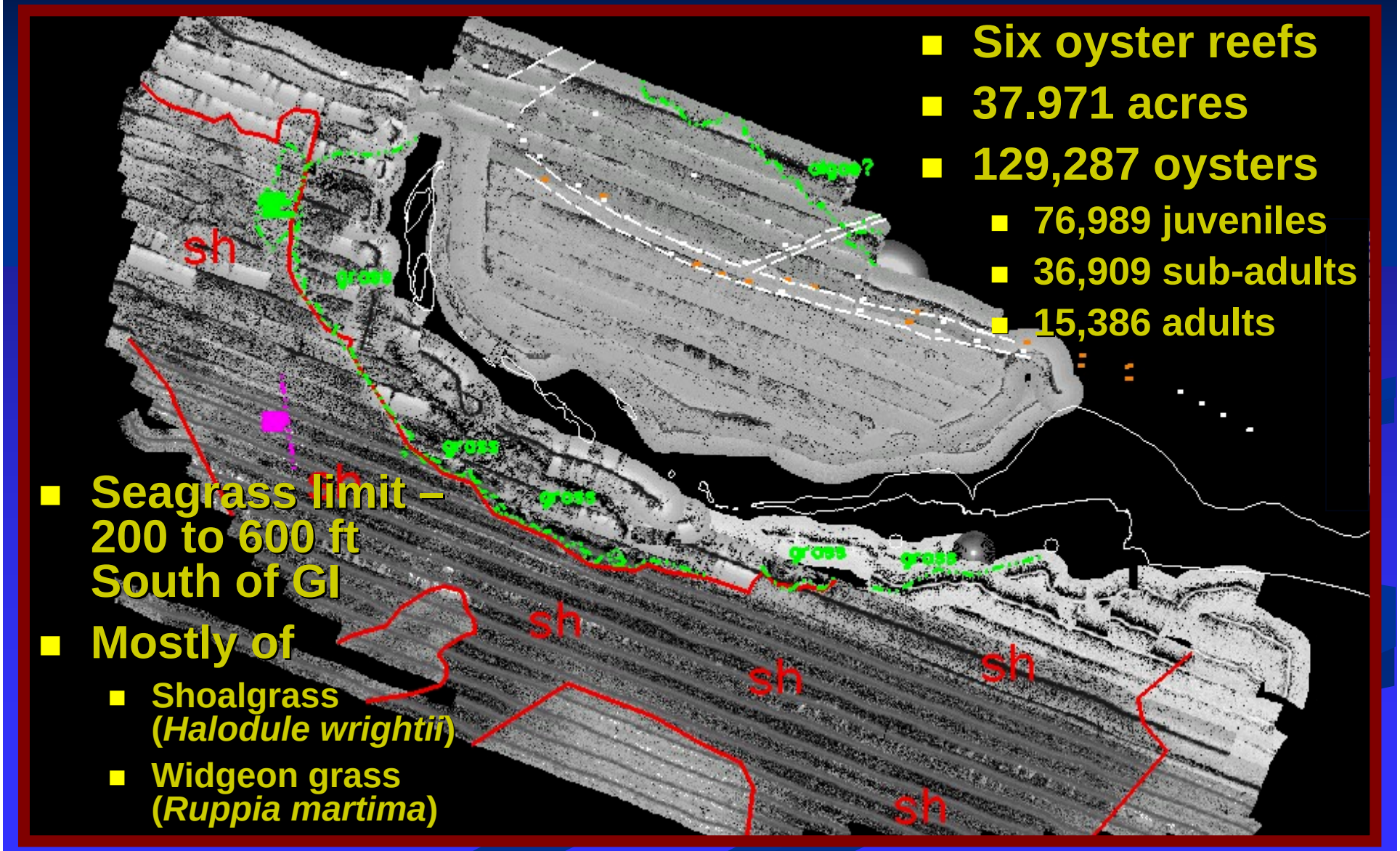
- **Shoreline mapping along Ordinary High Water Mark (OHWM)**
  - **Island elevation**
  - **Vegetation composition**

SEAGRASS AND OYSTER SURVEY

- **Side-scan sonar to map substrate anomalies that might represent oyster reefs or seagrass beds**

- **Physical survey**
  - **Verify all substrate anomalies identified**
  - **Areas not accessible by side-scan sonar**

SEAGRASS AND OYSTER SURVEY

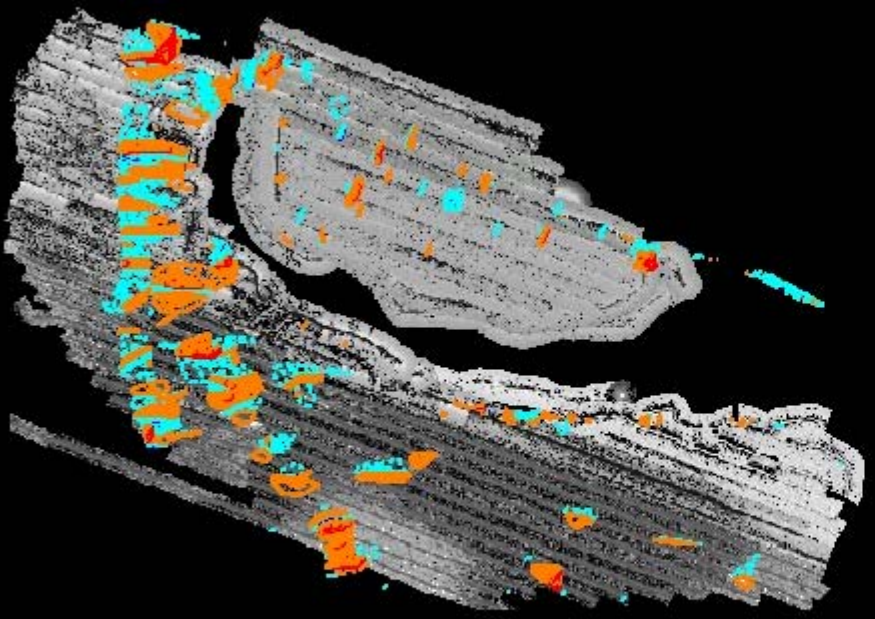


- Six oyster reefs
- 37.971 acres
- 129,287 oysters
  - 76,989 juveniles
  - 36,909 sub-adults
  - 15,386 adults

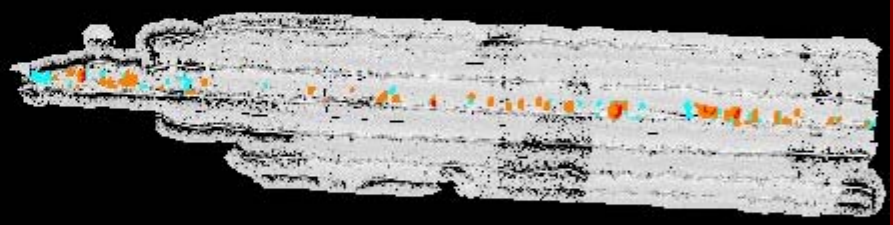
- Seagrass limit – 200 to 600 ft South of GI
- Mostly of
  - Shoalgrass (*Halodule wrightii*)
  - Widgeon grass (*Ruppia martima*)

MAGNETOMETER SURVEY

- **Detect magnetic anomaly**
  - **0.5 gamma difference**

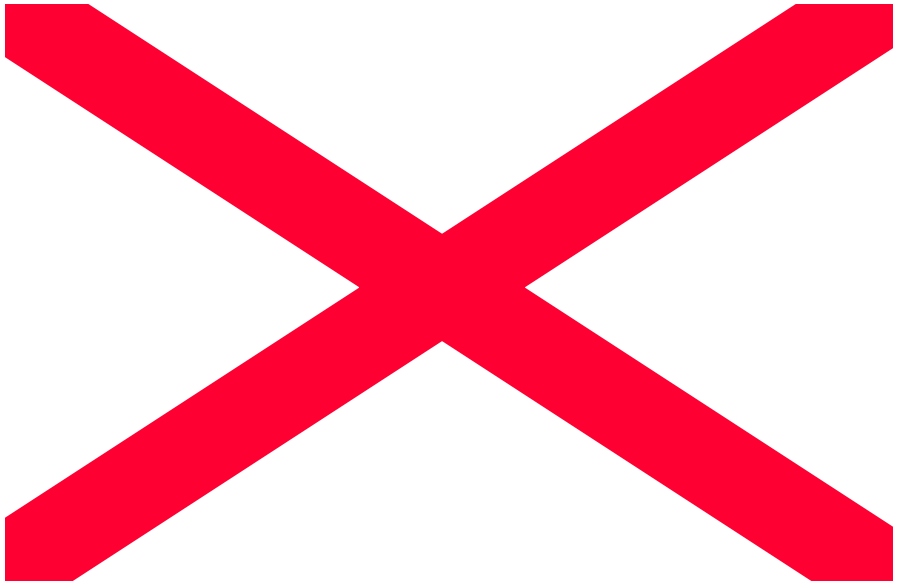


- **Magnetic contour maps**
  - **Bentley's Geopac digital terrain modeling software**
  - **Five-gamma contour interval with 100-gamma index contours**



- **Compared with Texas Railroad Commission pipeline and well head database**

SURVEY RESULTS

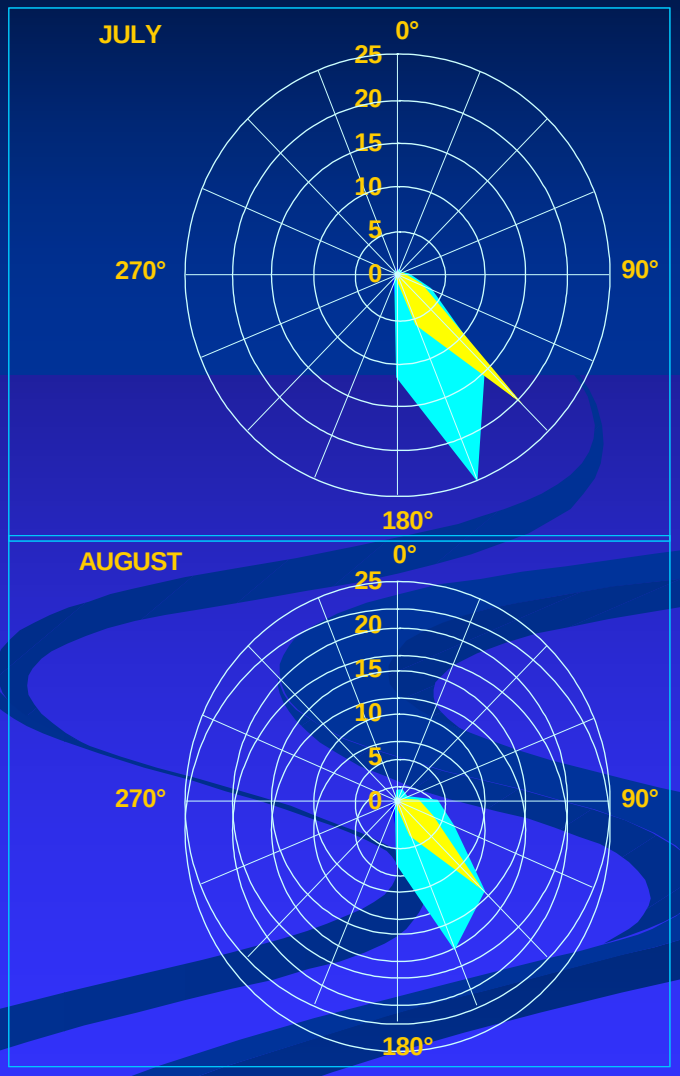


GEOTECHNICAL SURVEY

- **1974 NRCS Soil Survey:**
  - **Tatton Complex" (Tn)**
  - **60% Tatton loamy sand**
  - **40% other soils**
- **2002 Survey by PBS&J**
  - **25 Coring Locations**
  - **3-in diameter, 3-ft long**
- **Laboratory Testing:**
  - **Top 16 inches: clayey-sand (54.8% sand, 5.5% silt, 39.7% clay)**
  - **16-36 inches: silty-sand (81.2% sand, 18.8% silt, 0.0% clay)**

WIND ANALYSIS

- **Data Source**
  - TCOON 009 gage (Port Aransas) between 3/1/93 0:00 and 9/18/02 17:00
  - NWS Aransas County (Rockport) Airport gage between 7/1/96 03:00 and 9/13/02 08:00
- **Wind Roses**
  - Five wind speed categories
  - 16 wind directions
- **Dominate Winds**
  - SE wind at 22.5 knots
  - SSE wind at 22.5 knots
  - S wind at 15 knots



WAVE ANALYSIS

- **Wind Fetch**
  - **SE - 5.20 mi**
  - **SSE - 6.48 mi**
  - **S - 12.33 mi**
  - **Longest wind fetch (15.85 mi) from SSW**
- **Water Depths**
  - **Navigational Chart**
  - **TCOON 036 gage data**
- **Coastal Engineering Design & Analysis System program (CEDAS, version 2.01E)**
- **Decision not to design for extreme (hurricane) events**

WAVE ANALYSIS

Wind Direction (% Total Wind)	Wind Speed	Wind Fetch		Average Water Depth		Wave Height	Wave Period
	(knots)	(ft)	(miles)	Datum	(ft)	(ft)	(s)
SE (21.5%)	22.5	27,468	5.20	Deep Water		1.93	2.94
				MHW	4.86	1.18	2.31
				MSL	4.68	1.16	2.30
				MLW	4.49	1.14	2.29
SSE (14.9%)	22.5	34,228	6.48	Deep Water		2.15	3.17
				MHW	5.45	1.30	2.45
				MSL	5.27	1.28	2.44
				MLW	5.08	1.25	2.43
S (7.7%)	15.0	65,115	12.33	Deep Water		1.77	2.96
				MHW	7.83	1.34	2.57
				MSL	7.65	1.32	2.56
				MLW	7.46	1.31	2.55
SSE	29.2	34,228	6.48	Extreme	6.37	1.75	2.79

ALTERNATIVES ANALYSIS

- **Constraints**
- **Factors Considered**
  - **Bathymetry (water depths)**
  - **Potential impacts to existing seagrass and oyster habitats**
  - **Locations of potential wells, pipelines, and other metallic anomalies**
  - **Geotechnical conditions**
  - **Available quantities of dredged materials**
  - **Effectiveness against the design waves**
  - **Longevity**
  - **Aesthetics**
  - **Ease of construction**
  - **Construction timeline**
  - **Construction methods**
  - **Costs**

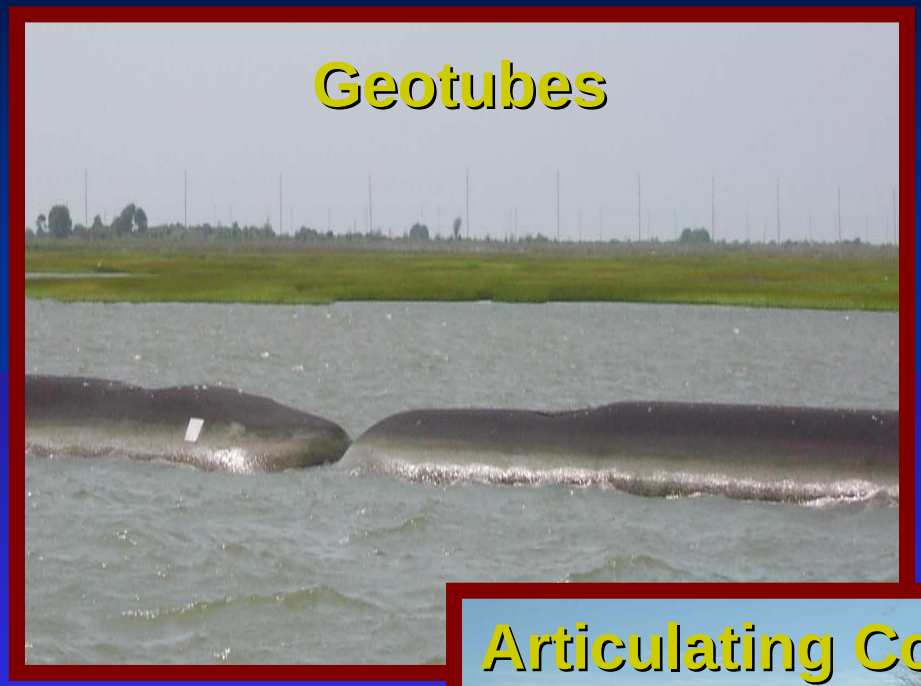
CONSTRAINTS

- **Alternatives need to address erosion problem**
- **Alternatives need to preserve and/or increase the quantity, quality, and diversity of habitats and living resources in Aransas Bay**
- **Alternatives need to be environmentally acceptable and able to be permitted**
- **Alternatives need to be acceptable to funding partners, resource agencies, park users, and local citizens**

SHORELINE PROTECTION

- **Construction of a breakwater was considered to be the best approach to addressing shoreline erosion by the project advisory team**
- **Types of breakwaters considered:**
  - **Geotube**
  - **Rock breakwater**
  - **Articulating Concrete Blocks**
  - **Gabions**

BREAKWATER TYPES

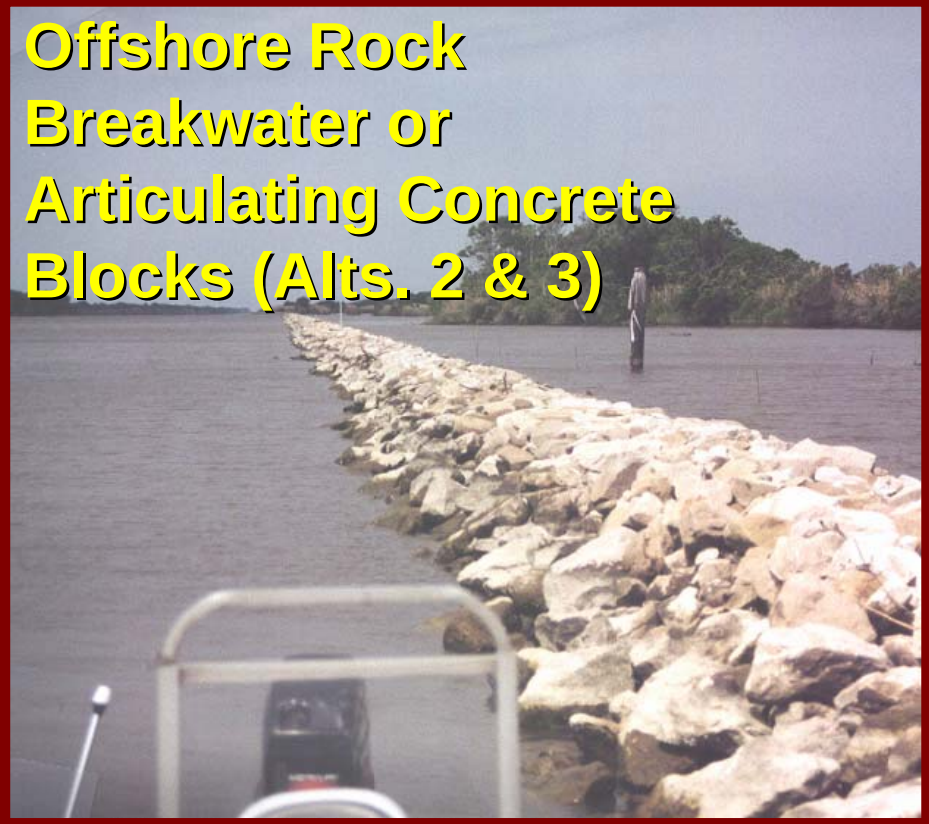


BREAKWATER CONSIDERATIONS

- **Type of Breakwater Considerations**
  - **Effectiveness at meeting project goals**
  - **Longevity**
  - **Maintenance requirements and cost**
  - **Safety of park visitors and boaters**
  - **Aesthetics**
- **Breakwater Location Considerations**
  - **Effectiveness of meeting goals**
  - **Safety of park visitors and boaters**
  - **Aesthetics**

BREAKWATER ALTERNATIVES

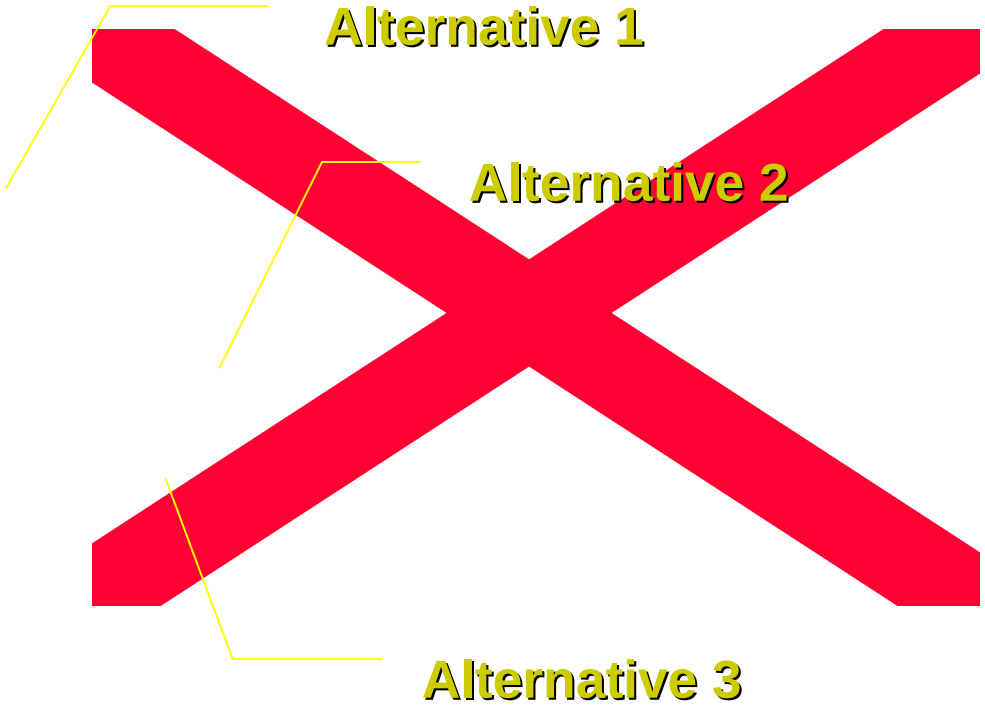
Offshore Rock Breakwater or Articulating Concrete Blocks (Alts. 2 & 3)



Rock Revetment Onshore (Alt. 1)

Articulating Concrete Blocks as Onshore Revetment (Alt. 1)

BREAKWATER LOCATIONS



Alternative 1 - Onshore Revetment

- **Advantages**
  - **Less expensive**
  - **Easier construction methodology**
- **Disadvantages**
  - **Only addresses shoreline erosion**
  - **Does not restore wetland habitats**
  - **Possible impacts to seagrass beds and smooth cordgrass marsh**

Alt. 2 - Breakwater @ 1969 Shoreline

- **Advantages**
  - **Opportunity to restore and/or enhance wetland and aquatic habitats between breakwater and existing shoreline**
- **Disadvantages**
  - **Footprint of breakwater structure would impact up to 2.75 acres of seagrass beds**

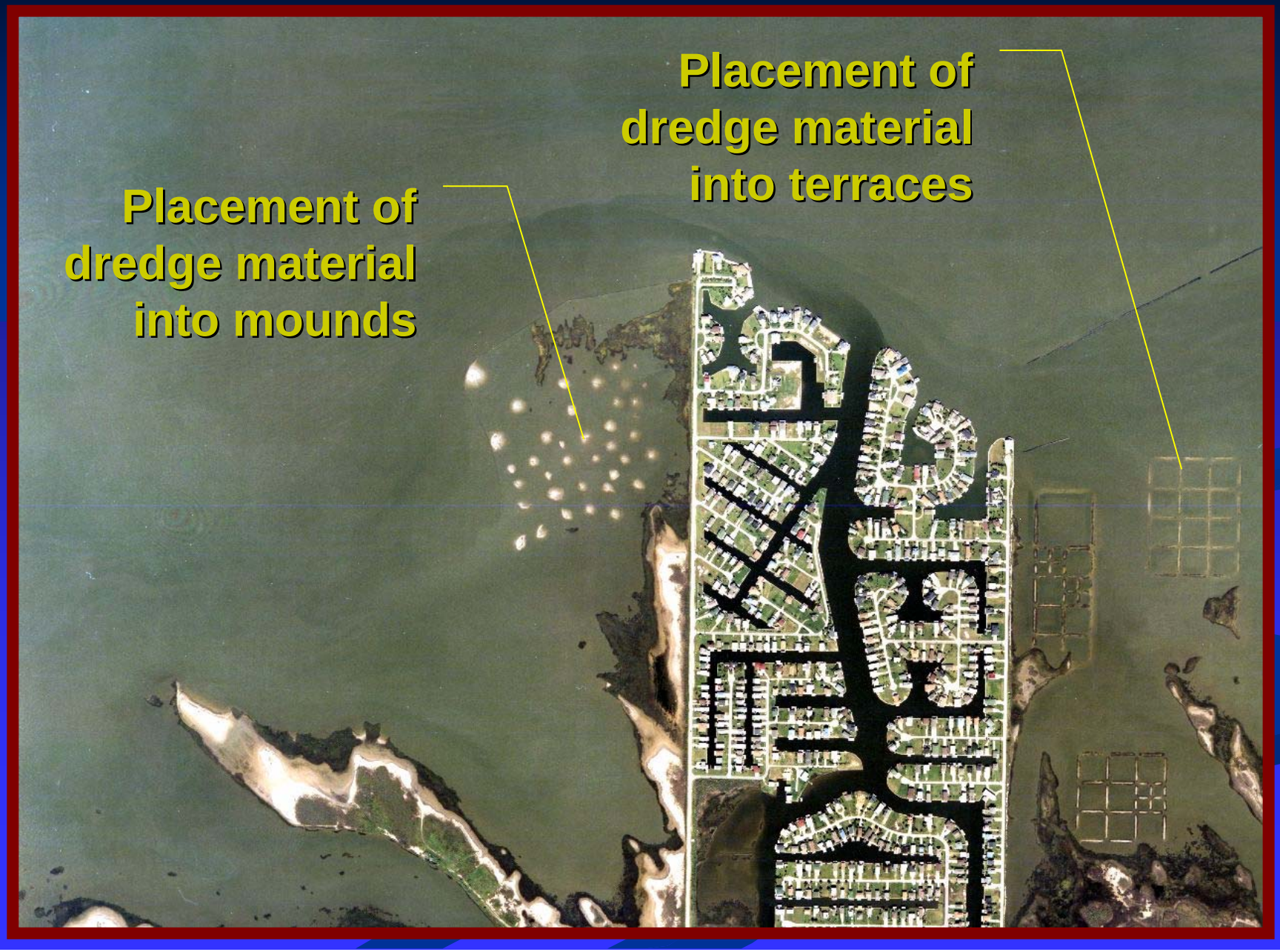
Alt. 3 - Offshore Breakwater (~400 ft)

- **Advantages**
  - Creates lagoon effect between breakwater and shoreline which may enhance seagrass habitat reestablishment of marsh
  - Less environmental impacts
- **Disadvantages**
  - Higher cost to build (more materials)
  - Has to be constructed using workboats

Offshore breakwater on Shamrock Island and the resulting lagoon effect

BREAKWATER WARNING

MARSH RESTORATION TECHNIQUES



MARSH RESTORATION ALTERNATIVES

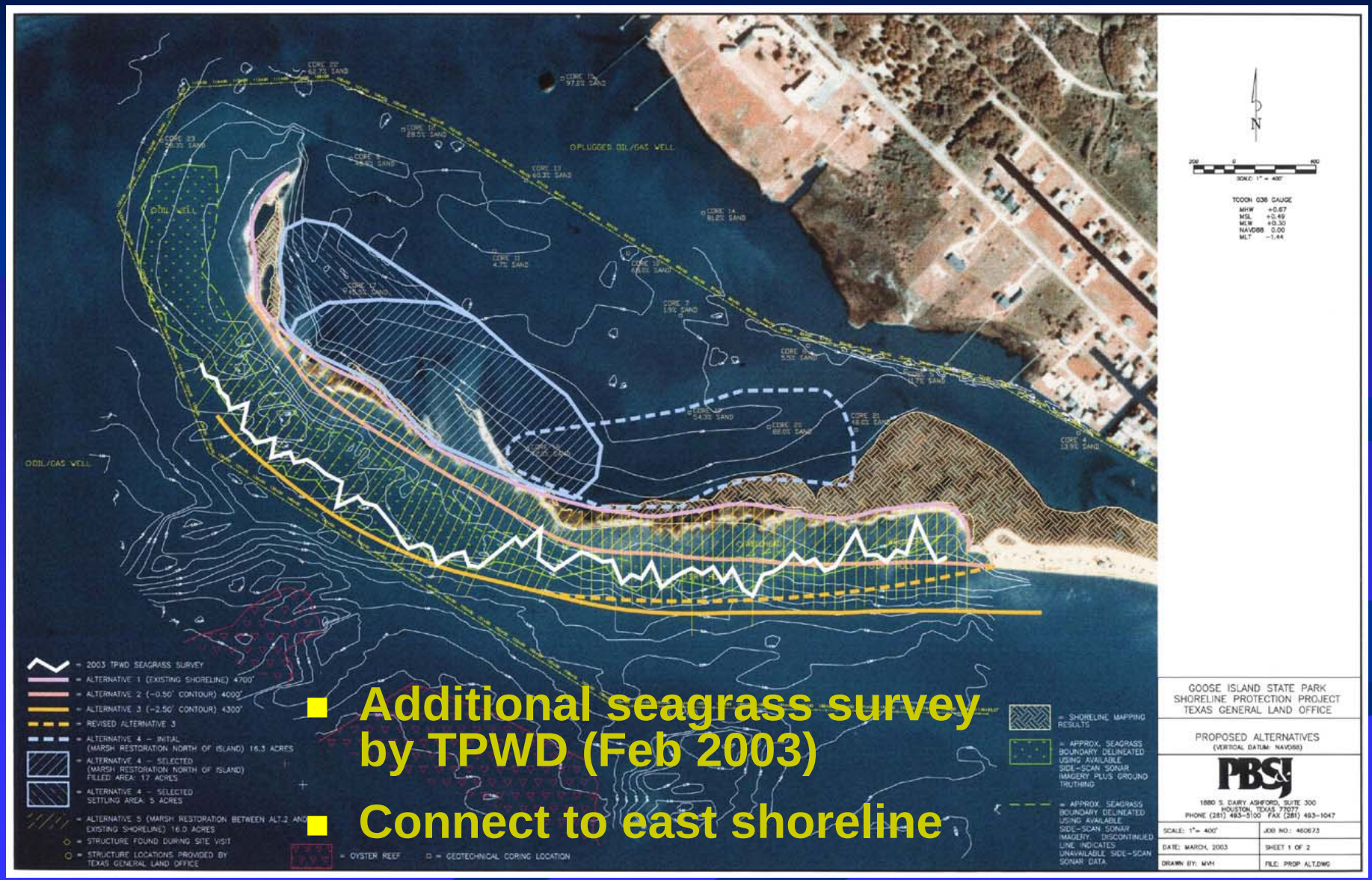
Placing dredge material from boating channels that access Neptune Harbor and Goose Island State Park boat ramp into confined marsh cells.

MARSH RESTORATION LOCATIONS

Community-based Marsh Restoration

Take clean, dry, innocent students and volunteers, place them in the water, plant marsh transplants, and finish with a good mud fight!

PREFERRED ALTERNATIVE



- **Additional seagrass survey by TPWD (Feb 2003)**
- **Connect to east shoreline**

GEOTECHNICAL INVESTIGATION

- Along preferred offshore breakwater alignment
- Soil-bearing capacity
- Vane-Shear Test
- Plate-Load Test
  - 6-inch round steel plate
  - Max 165 pounds of weight
  - 15 min loading time
  - Max 4 in settlement (mostly less than 1 in)
- Significant sand and shell composition found

PROJECT STATUS

- **Undergoing detailed design**
- **Expected Date to Start Construction: Spring, 2004**

Thank you!

TEXAS PARKS & WILDLIFE

PBS&J

Kay.Jenkins@tpwd.state.tx.us
ycsu@pbsj.com