WEST BELLE PASS BARRIER HEADLAND RESTORATION (TE-52): PHASE I INVESTIGATIONS

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WEST BELLE PASS BARRIER HEADLAND RESTORATION (TE-52): PHASE I INVESTIGATIONS

INTRODUCTION

West Belle Pass Barrier (WBPB) Headland is located immediately west of Port Fourchon within the Bayou Lafourche Delta Complex. The Bayou Lafourche delta complex lies approximately 47 miles west of the mouth of the Mississippi River and about 50 miles south of New Orleans. The WBPB Headland provides storm protection for a large marsh complex in Lafourche Parish and the western flank of Port Fourchon, which is one of the most important ports in the United States. WBPB Headland is approximately 2 miles long and is bounded on the east by the Bayou Lafourche Waterway west jetty and on the west by Timbalier Bay. A map showing the location of WBPB Headland is shown in Figure 1.

The headland is experiencing high shoreline retreat rates (averaging up to 55 feet/year) and has a large breach along the western segment. The breach widened significantly during the passage of Hurricanes Katrina and Rita in 2005 and now encompasses about 25% of the barrier where waters of the Gulf of Mexico exchange freely with Timbalier Bay. The jetties for the port entrance intercept sediment that would move naturally to the west and along the WBPB Headland. Rapid relative sea-level rise and coastal storms that frequently overwash the headland have caused severe degradation of the barrier such that it only provides minimal protection at this time. While dredge spoil is placed on the west side of the jetties, this volume, and or the location at which it is placed, appears to be only marginally effective at slowing shoreline retreat, especially to the western two-thirds of the headland.

The goals of the project are to increase headland longevity, restore valuable marsh habitat, and construct a beach and dune system that will protect the bayside marsh and port perimeter over a 20-year project life. To meet these objectives, an investigation will be conducted to identify beach compatible material for beach restoration and marsh fill for habitat restoration. This investigation will consist of three (3) phases: a Phase I investigation which will consist of a comprehensive review of the recipient beach and marsh as well as sediment resources offshore of the project area; a Phase II investigation that will consist of reconnaissance level geophysical and geotechnical surveys; and a Phase III investigation that will consist of design level geotechnical and geophysical investigations, a cultural resource investigation and borrow area design. This report summarizes the results of Phase I of this investigation. The results of the Phase I investigations were used to develop a plan for future Phase II investigations. This plan is detailed in this report.

PHASE I INVESTIGATIONS

During Phase I (review of historic data) of this investigation, CPE researchers conducted archival literature studies of the inner continental shelf area. CPE researchers also compiled historic geotechnical and geophysical data for the search area. This information was analyzed within the geologic context of the search area in order to identify potentially beach compatible sand resources and potential marsh fill for further investigation.

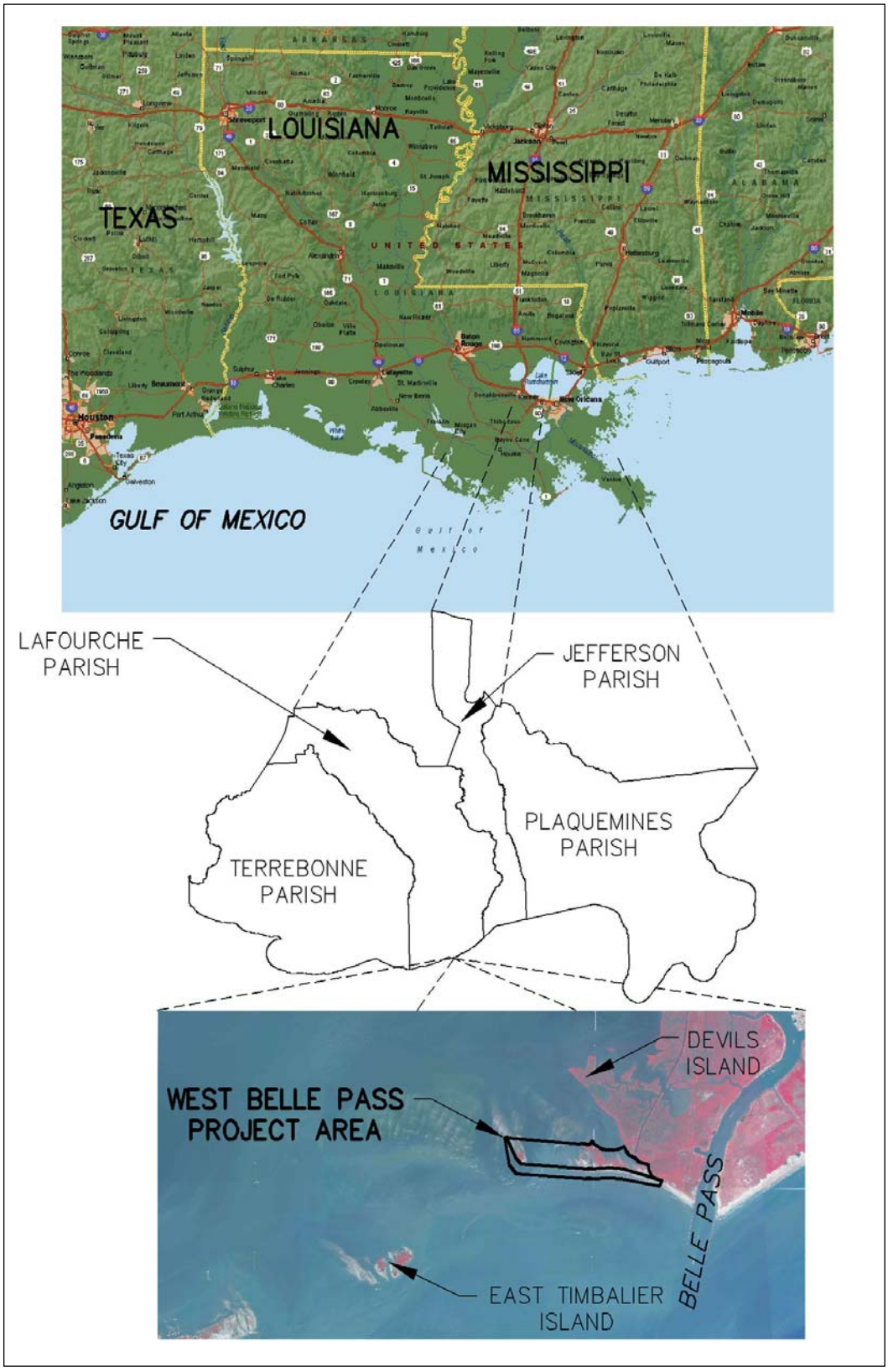

Figure 1. West Belle Pass Barrier Headland restoration location map.

Previous Investigations

Project design and success rely heavily on locating a suitable and viable sediment source for the project. Several marine surveys and geotechnical studies have been previously conducted within the vicinity of the project area. These are briefly summarized below.

Kindinger *et al.* (2001) and Suter *et al.* (1991) conducted regional sand resource assessments that encompassed offshore areas in the vicinity of Shell Island. The potential sand targets they identified are associated with depositional systems that include spit platforms, delta sheet sands, ebb-tidal deltas, distributary mouth bars, and distributary-channel fills, and inner shelf shoals. The Empire and Scofield area was investigated by CPE (2002) to search for sand deposits that would be suitable for beach-dune restoration. Finkl *et al.* (2003a,b) reviewed prior sand search investigations and collected additional geotechnical and geophysical data in the Sandy Point study area. Finkl *et al*. (2003a,b) also investigated the landward boundary of the Quatre Bayou Deep deposit and part of the Quatre Bayou Shallow with reconnaissance seismic reflection profile surveys. A borrow area within the Quatre-Bayou depositional area was defined by CPE (2004) for the restoration of East Grand Terre Island.

Potential sand and mixed-sediment borrow sources have been identified for various beach and marsh restoration projects along the Gulf coast of Louisiana. Although many of these deposits appear promising, they are located too far east of the WBPB headland project to be feasible.

Data Compilation

The second part of the Phase I investigation involved a search for geotechnical and geophysical data collected in the vicinity of the project area, as well as data related to infrastructure that could impact borrow area design. The information collected was compiled and evaluated within the context of the geologic framework. Several potential sand resources have been identified as a result of this effort. Table 1 provides a summary of the data that was compiled during this portion of the Phase I investigation.

Table 1. *Data compiled during the Phase I investigations.*

Dataset	***Source***	***Description***
LGS/USGS 1983-1992 Vibracores	USGS open file report 98-805 http://pubs.usgs.gov/of/1998/of98-805/	- vibracore locations -linked to vibracore logs, grain size analysis sheets, vibracore photos
UNO 2001 Vibracores	USGS open file report 98-805 http://pubs.usgs.gov/of/1998/of98-805/	- vibracore locations -linked to vibracore logs, grain size analysis sheets, vibracore photos
USGS 2000 Vibracores	USGS open file report 98-805 http://pubs.usgs.gov/of/1998/of98-805/	- vibracore locations -linked to vibracore logs, grain size analysis sheets, vibracore photos
EMAP 1991-1994 Grab Samples	USGS open file report 98-805 http://pubs.usgs.gov/of/1998/of98-805/	- vibracore locations -linked to vibracore logs, grain size analysis sheets, vibracore photos
UNO 2002 Vibracores	East Timbalier Island Sediment Restoration, Phase I (Project TE25) SONRIS- http://sonris-www.dnr.state.la.us/www_root/sonris_portal_1.htm	-point dataset of vibracore locations -linked to vibracore logs
Ocean Survey 2002 Vibracores	Timbalier Island Dune and Marsh Restoration (Project TE40) SONRIS- http://sonris-www.dnr.state.la.us/www_root/sonris_portal_1.htm	- vibracore locations -linked to vibracore logs
Hastings et al 2000 Grab Samples	USGS Open File report 2006-1195 http://pubs.usgs.gov/of/2006/1195/data/usseabed/la_ext.zip http://pubs.usgs.gov/of/2000/of00-358/text/chapter2.htm	- grab sample locations -limited grain size info
Texas A&M 1978 Grab Samples	USGS Open File report 2006-1195 http://pubs.usgs.gov/of/2006/1195/data/usseabed/la_ext.zip	- grab sample locations -limited grain size info
Krawiec 1966 Grab Samples	USGS Open File report 2006-1195 http://pubs.usgs.gov/of/2006/1195/data/usseabed/la_ext.zip	- grab sample locations -limited grain size info
UNO 2003 Grab Samples	USGS Open File report 2006-1195 http://pubs.usgs.gov/of/2006/1195/data/usseabed/la_ext.zip	- grab sample locations -limited grain size info
Gore Engineering Inc. 1997 Grab Samples	USGS Open File report 2006-1195 http://pubs.usgs.gov/of/2006/1195/data/usseabed/la_ext.zip	- grab sample locations -limited grain size info
USGS Cruise 00SCC02 (2000)	Louisiana Sedimentary and Environmental Database (LASEDS) internet map server. The seismic profiles are also archived at the University of New Orleans Coastal Research Laboratory.	-chirp seismic reflection data collected in the Barataria Basin, Louisiana, May 12-31 and June 17-July 2, 2000 -linked to seismic profiles

Dataset	*Source*	*Description*
USGS Cruise 00SCC04 (2000)	USGS-http://pubs.usgs.gov/of/2003/of03-402/html/04fsamap.htm (boomer) http://pubs.usgs.gov/of/2003/of03-156/html/04maps.htm (chirp)	-digital boomer and chirp seismic reflection data -linked to seismic profiles
USGS Cruise 01SCC01 (2001)	Louisiana Sedimentary and Environmental Database (LASEDS) internet map server. The seismic profiles are also archived at the University of New Orleans Coastal Research Laboratory.	- chirp and boomer seismic reflection data collected in Timbalier Bay and offshore East Timbalier Island, Louisiana, June 30-July 9 and August 1-12, 2001 -linked to seismic profiles
USGS Cruise 01SCC02 (2001)	Louisiana Sedimentary and Environmental Database (LASEDS) internet map server. The seismic profiles are also archived at the University of New Orleans Coastal Research Laboratory.	- chirp and boomer seismic reflection data collected in Timbalier Bay and offshore East Timbalier Island, Louisiana, June 30-July 9 and August 1-12, 2001 -linked to seismic profiles
USGS Cruise 02RCE01 (2002)	Louisiana Sedimentary and Environmental Database (LASEDS) internet map server. The seismic profiles are also archived at the University of New Orleans Coastal Research Laboratory.	- digital boomer seismic reflection data collected in the Lower Atchafalaya River, Mississippi River delta, and offshore SE Louisiana, October 23-30, 2001, and August 18-19, 2002 -linked to seismic profiles
USGS Cruise LACOSS-II (1982)	Louisiana Sedimentary and Environmental Database (LASEDS) internet map server. The seismic profiles are also archived at the University of New Orleans Coastal Research Laboratory.	-linked to seismic profiles
USGS Cruise LACOSS-V (1984)	Louisiana Sedimentary and Environmental Database (LASEDS) internet map server. The seismic profiles are also archived at the University of New Orleans Coastal Research Laboratory.	-linked to seismic profiles
USGS Cruise 06SCC03 (2006)	USGS-http://pubs.usgs.gov/ds/311/	-digital chirp seismic reflection data -linked to seismic profiles
USGS Cruise 06SCC01 (2006)	USGS- http://pubs.usgs.gov/ds/259/	- digital chirp seismic reflection data -linked to seismic profiles

Dataset	*Source*	*Description*
USGS Cruise 05SCC01 (2005)	USGS-http://pubs.usgs.gov/ds/2007/242/	-digital chirp seismic reflection data -linked to seismic profiles
Oil and Gas Wells (2008)	SONRIS- http://sonris-www.dnr.state.la.us/www_root/sonris_portal_1.htm	-statewide dataset of oil and gas wells classified according to status
MMS Platforms (2006)	Louisiana Oil Spill Coordinators Office (LOSCO)- http://lagic.lsu.edu/data/losco/platforms_mms_2006.zip	- dataset of Offshore Minerals Management platform locations for the Gulf of Mexico
MMS Pipelines (2007)	Louisiana Oil Spill Coordinators Office (LOSCO)- http://lagic.lsu.edu/data/losco/pipelines_vectors_mms_2007.zip	-dataset of Offshore Minerals Management pipeline locations for the Gulf of Mexico

Survey Plan Development

The data that was collected during the Phase I investigations was used to develop a survey plan for future Phase II investigations. The first step in the development of this plan was the classification of the vibracores and grab samples. The sediment data that was located during the Phase I investigation was reviewed by CPE (Figure 2). Grab samples were classified according to grain size (Figure 3). Vibracores were classified for sand resource potential based on the scheme shown in Table 2 (Figure 3).

Table 2. *Vibracore classification scheme developed by CPE for this project.*

Classification	Description
Very High Potential	No overburden with (1) fine sand, (2) sandy silt, (3) silty sand throughout profile (0-20')
High Potential	Less than 2' of overburden with (1) fine sand, (2) sandy silt, (3) silty sand in >50% of profile or fine sand in upper 10' or more of profile
Very Good Potential	Less than 2' of overburden with (1) fine sand, (2) sandy silt, (3) silty sand in >50% of profile or fine sand in upper 10' or more of profile, but may include silt/sandy clay or clayey sand in profile
Good Potential	Less than 3' of overburden with (1) fine sand, (2) sandy silt, (3) silty sand throughout profile and may contain silty clay in half or more of profile
Moderate Potential	Less than 5' of overburden with (1) fine sand, (2) sandy silt, (3) silty sand throughout profile but may contain silty clay, sandy clay, or clay loam in half or more of profile
Low Potential	More than 5' of overburden or contains silty clay, sandy clay, clayey sand, sandy silt, or silty sand in >50% of profile
No Potential	More than 10' of overburden with profile lacking fine sand or dominated by fine-grained particle sizes

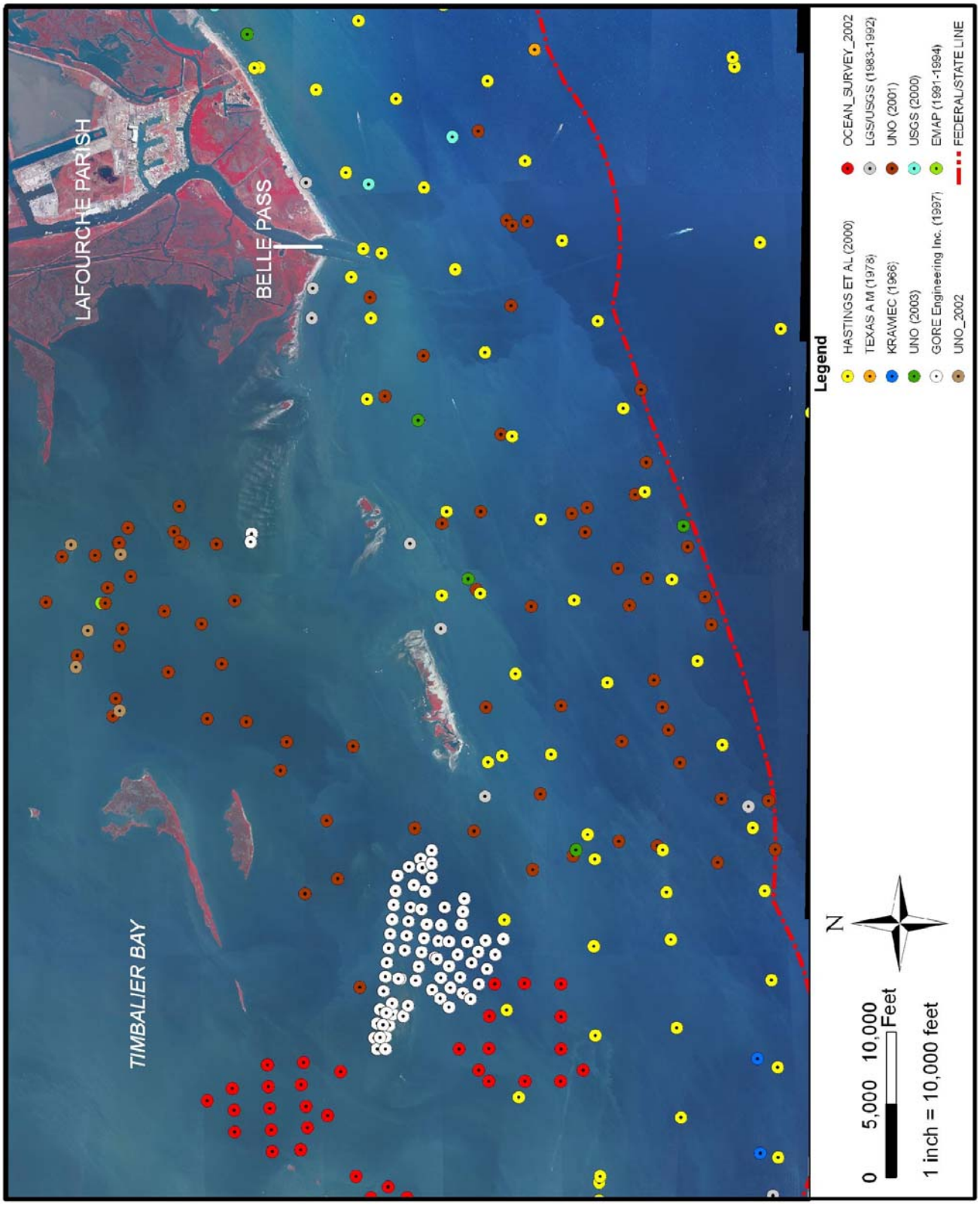

Figure 2. Sediment data located during the Phase I investigation.

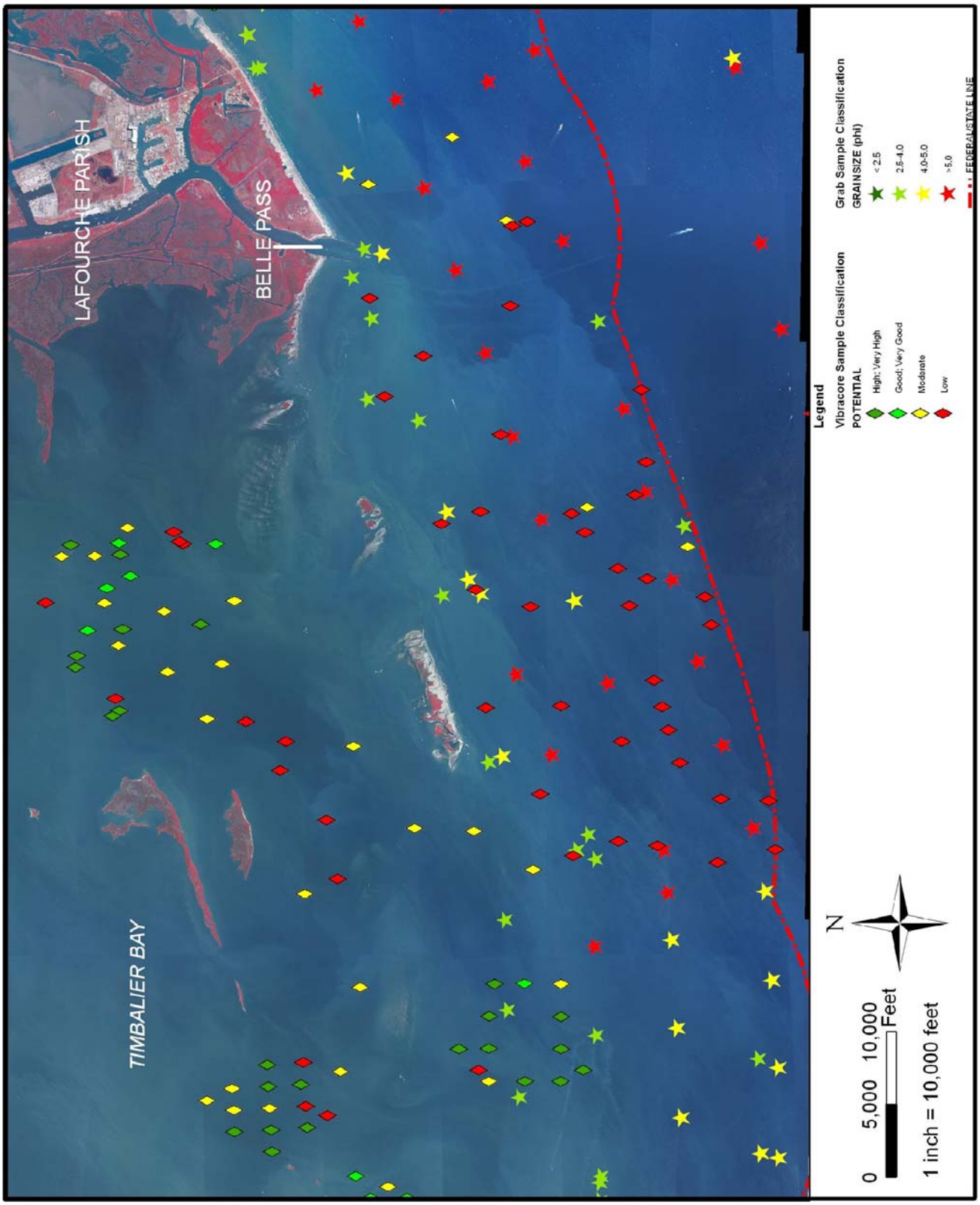

Figure 3. Classified grab samples and vibracores.

It is important to note that the system described in Table 2 is a general classification system and not all vibracore logs fit exactly into the proposed categories. This system was used as a guide to the classification of the vibracore logs.

The seismic data that was located during the Phase I investigation (Figure 4) was reviewed by CPE to identify potential sand resources. Most of the seismic data available for review had been collected and archived by the United States Geological Survey (USGS). These data sets consisted of electrodynamic "boomer" seismic data and high-resolution "chirp" sub-bottom data. Where possible, existing vibracore information was correlated to the seismic profiles to map the sedimentary units in the sub-bottom data. Unfortunately, most of the geotechnical data available for correlation in the vicinity of available seismic data consisted of mud and clay with very little sand.

After correlating the available geotechnical data to the seismic data, each available seismic profile in the project area was individually reviewed to determine the presence of specific geomorphic features known to produce large quantities of sand (e.g. large incised valleys, sand flats, submerged shoals, channel complexes). Unfortunately, none of these features were clearly evident in the data. At this point, each profile was reviewed for seismic facies, or unique acoustic seismic expressions, that were similar to areas of known sand deposits. These seismic facies can be characterized by acoustically transparent sections of the sub-bottom data, areas that are normally adjacent to well stratified clay beds where truncation of the beds are evident, but the presence of a channel is not obvious. Coarser grained sediments, such as sand, tend to reflect less acoustic energy generated by chirp sub-bottom systems, which accounts for the acoustically transparent signature. While seismic facies similar to the one just described generally represent sand-sized sedimentary units, there is a potential that non-compatible material could have a similar acoustic expression. This was witnessed in the geophysical survey conducted in support of the East Marsh Island Marsh Creation Project (Finkl *et al.,* 2008). This is why correlating the seismic data to in situ geotechnical sampling is so vital.

There were several areas where seismic facies indicative of potential beach-compatible sand deposits were evident. Each area where the seismic facies occurred was highlighted in green on the map view of the project area (Figure 5). These areas all occurred directly south of Belle Pass near the Federal/State boundary in a lobe shape. Unfortunately, there are no existing vibracores that occur in these areas to indicate if the seismic facies is indeed a sand deposit or not. There is one existing surface grab sample within the area that contains fine sand. Based on the existing seismic facies, location and lobe shape, the existence of one beach-compatible surface grab sample, and the lack of geotechnical data, the areas highlighted in green in Figure 5 represent areas worthy of additional investigation in order to determine potential for beach-compatible sand.

While every available seismic line was reviewed, there were instances where the data was of insufficient quality to make a determination of sand potential. This was particularly true for most of the "boomer" seismic datasets and several of the chirp sub-bottom datasets that were obviously collected during poor weather conditions. Even in areas where the potential sand seismic facies were evident, there was an occasional line adjacent to a green line that was either a

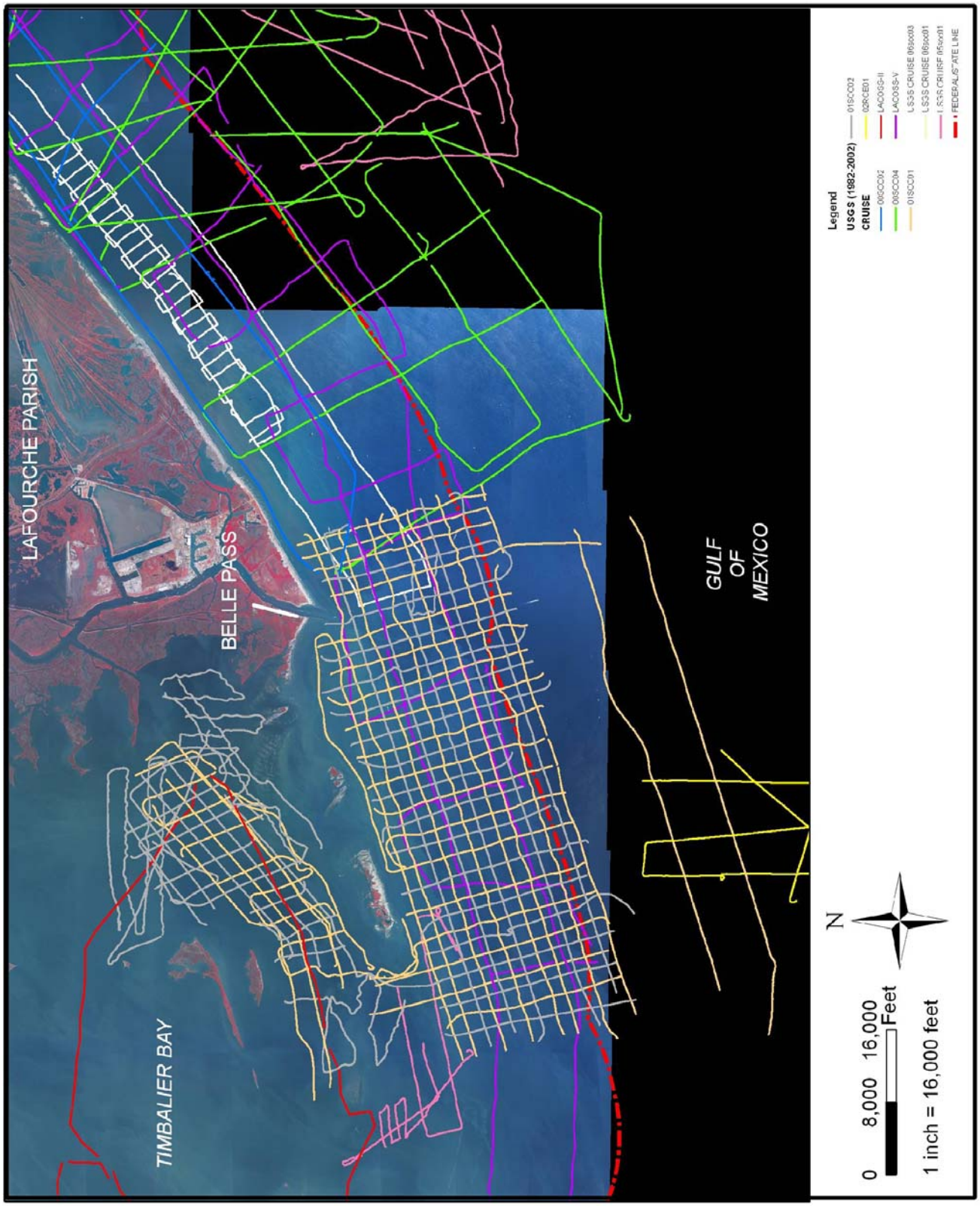

Figure 4. Seismic data compiled for the investigation area.

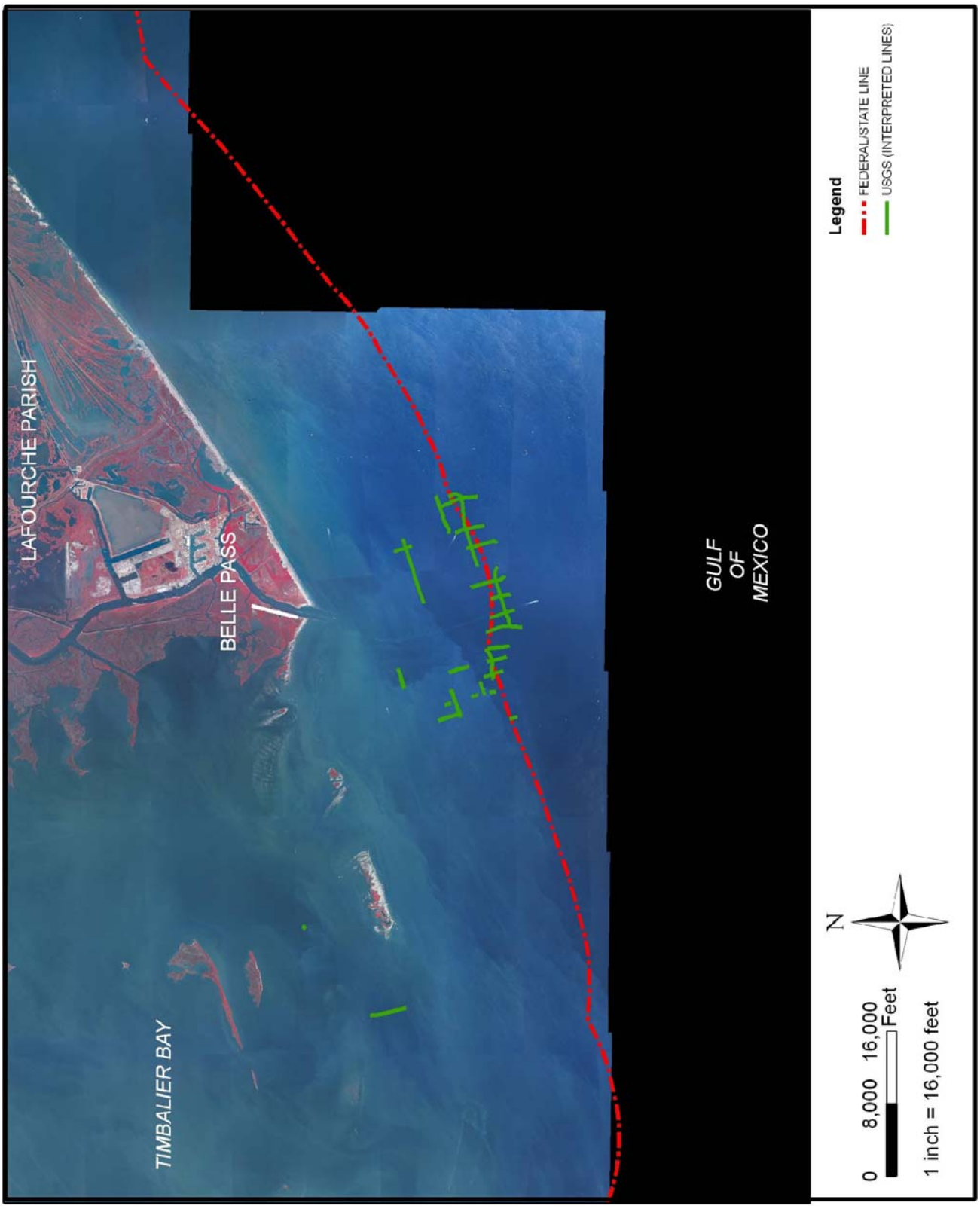

Figure 5. Seismic profiles indicating potentially beach compatible sediment.

boomer line, or a chirp line of poor quality, prohibiting interpretation of that line. Those lines were left uninterpreted, which accounts for the incomplete "lobe" shape of the potential sand facies offshore Belle Pass.

All geotechnical and geophysical data that was classified was then analyzed (Figure 6). The areas of highest potential were pinpointed for further investigation. The most promising areas appear to be approximately 3 miles south of Belle Pass. These areas were further refined based on the location of oil and gas pipelines. A 900 ft. buffer was placed around the pipelines based on previously permitted buffers. The location of oil and gas wells were also investigated (Figure 6).

Four (4) promising areas requiring further investigation were identified. These areas are shown in Figure 6. Area A covers an area of approximately 1 million square yards. Area B covers an area of approximately 1 million square yards. Area C covers an area of approximately 700,000 square yards. Area D covers an area of approximately 2 million square yards. Based on the area calculations and the assumption that the material is 10 feet thick, there is likely enough material worth investigating these areas (Table 3). With these large numbers in mind, it may also be useful to investigate some of the smaller areas between pipeline buffers in the vicinity of these four (4) areas.

Table 3. *Potential sand resources identified during the Phase I investigations*.

Potential Sand Resource	Area (square yd)	Estimated Volume (cy)
Area A	1,000,000	3,330,000
Area B	1,000,000	3,330,000
Area C	700,000	2,331,000
Area D	2,000,000	6,660,000

PHASE II SURVEY PLAN

Based on the results of the Phase I investigations, CPE has developed a primary survey plan designed to further investigate the sediment resources within Areas A, B, C and D. CPE will collect a total of seven (7) to ten (10) reconnaissance vibracores from Areas A, B, C, and D as well as from potential marsh fill areas to the north of Areas A and D (Figure 13). CPE will first collect five (5) reconnaissance cores, one (1) each in areas A, B, and C, and two (2) in Area D due to its large size. After the first five (5) reconnaissance cores are collected, one (1) core will be collected in each of the potential marsh fill areas north of Areas A and D. If the reconnaissance cores in the potential sand areas of A, B, C, and D yield beach-compatible material, CPE will then conduct a joint seismic, sidescan, magnetometer and bathymetric survey of the best sand areas within Areas A, B, C, and D, collecting up to 80 nautical line miles of data. The actual survey line spacing and design will be based on the results of the reconnaissance cores and will focus on covering a sufficient area to design both a beach-compatible sand borrow area and a marsh-compatible mud borrow area. At the conclusion of the geophysical survey,

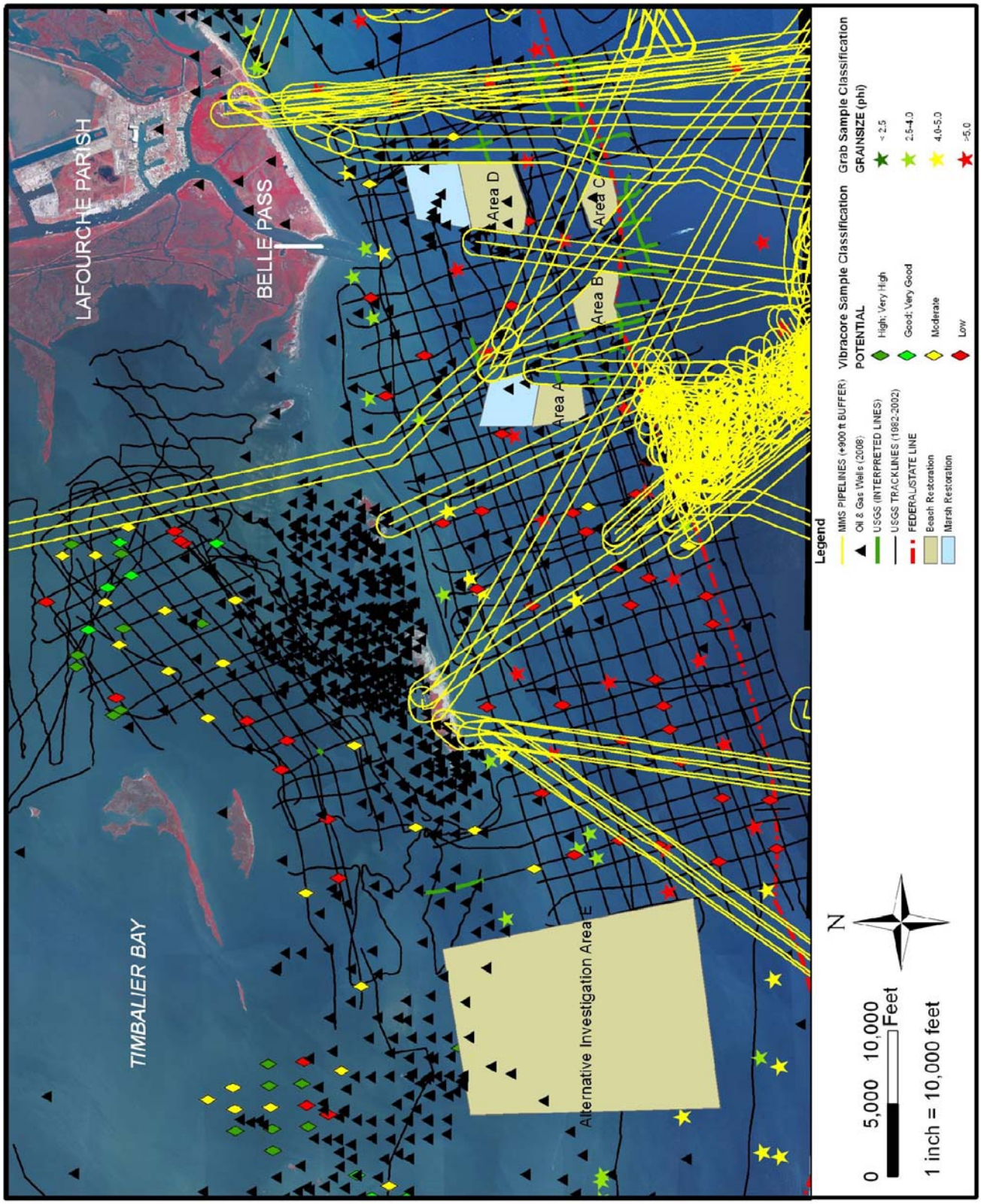

Figure 6. Areas identified as containing potentially beach compatible sediment. These areas require further investigation.

CPE will then remobilize for vibracore operations and collect the remaining forty (40) to forty-three (43) reconnaissance and design level cores (for a total of fifty (50) vibracores) in order to define both a beach-compatible sand borrow area and a marsh-compatible borrow area.

If all of the investigation areas contain sand, CPE recommends focusing on Area A because it has fewer pipeline and navigation issues to deal with. If the reconnaissance vibracores indicate that there is no material suitable for beach restoration, CPE will investigate Alternative Investigation Area E.

Alternative Investigation Area E is located between Timbalier and East Timbalier Islands. This area contains multiple vibracores collected by Ocean Survey in 2002 together with several surface grab samples collected by Hastings *et al*. (2000). These samples indicate a "Very High" and "High" potential for beach compatible sands. If sand is not present in the first 5 (five) reconnaissance cores collected within investigation areas A, B, C, and D, CPE will move the reconnaissance effort to Alternative Investigation Area E. Five (5) reconnaissance cores will be collected in this area (in addition to the five (5) to seven (7) collected in the potential sand and mud areas of A, B, C, and D) to further refine the potential sand body. Once these cores have been collected, CPE will remobilize the vessel for geophysical operations and collect 80 nautical line miles of a joint seismic, sidescan, magnetometer and bathymetric survey.

Once the geophysical data has been collected, CPE will then remobilize the survey vessel for vibracores and collect the 38 - 40 remaining cores (for a total of 50 vibracores) split between Alternative Investigation Area E and the potential marsh-fill area north of Area A or Area D. The ultimate goal for this secondary plan would be to define a beach-compatible sand borrow area in Area E and a marsh-compatible borrow area north of Area A or Area D.

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