APPENDIX A

FINAL REPORT

GEOPHYSICAL SURVEY RESULTS PENSACOLA BEACH, FLORIDA FEASIBILITY STUDY FOR BEACH RESTORATION SAND SEARCH INVESTIGATION

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1.0 INTRODUCTION

The Gulf coast beaches of Pensacola Beach, Florida, have been impacted by hurricanes and other on-going factors that have severely eroded the local shoreline. As a result, a feasibility study for beach restoration has been undertaken by Olsen Associates, Inc. of Jacksonville, Florida, to determine the location of potential offshore borrow sites. Alpine Ocean Seismic Survey, Inc. (Alpine), under contract to Olsen Associates, Inc., has conducted the fieldwork for this study. The fieldwork consisted of both geophysical surveying and Vibracore sampling. This report presents the sequence of the fieldwork, the methods used, and the results of the surveys.

1.1 Background

In projects of this nature, when little detailed information is available on the nature and distribution of sediments on and below the ocean bottom in the study area, a geophysical survey is the most cost effective method of determining the location and distribution of areas that may contain useful volumes of borrow sand. The sediments of greatest importance are those within the upper 10 to 15 feet below the ocean bottom, but the pattern of layering present to a depth of 50 feet below bottom describes the overall nature of the geologic history of the site, which is useful in determining the types of sediment that may be present in the study area.

During a geophysical survey, a high-power electronic pulse, generated at one-quarter second time intervals, is transmitted through a transducer array mounted on the survey vessel. The signal penetrates into the ocean bottom to a depth determined by the signal strength and the variation in sediment density below the ocean bottom. The returned signal, which is reflected off of the ocean bottom and the various density differences below the ocean bottom, is received back through the transducer, amplified and displayed on a video screen. The signal is recorded on a paper recorder, which is continuously monitored on the survey vessel by a geologist/geophysicist during the survey to ensure acquisition of suitable data. Signals returned as a series of continuous reflectors, similar to the ocean bottom, are generated by changes in density between adjacent sediment layers, such as from sand to an underlying softer, less dense silt layer. The data are interpreted by following and plotting the variations in the patterns of the seismic reflectors within the survey area.

The nature of the sediments represented by the various reflectors observed during the geophysical survey must be determined by collecting sediment samples with a coring device. The proposed locations of the cores are based on the interpretation of the seismic data by an experienced geologist/geophysicist, who will rely on all available geological information for the work area and surrounding environs to reach conclusions as to the likely nature of the sediments present in the various portions of the work site. Other considerations include the location of the cores relative to the proposed nourishment site. Proximity to the project site must be balanced against the sediment quality, quantity and accessibility and the potential impacts of the dredged borrow site n the adjacent shoreline. Once the cores are collected, the sediments present can be correlated with the various seismic reflectors to determine the distribution of sediments of proper grain size for use as beach fill.

1.2 Survey Schedules and Locations

The fieldwork for this project was conducted in three phases. Phase One, conducted in July 2000, consisted of a total of approximately 175 line miles of geophysical survey. Seven lines of data, spaced at 1000-foot intervals between the beach and approximately 8,000 offshore were collected along Pensacola Beach during this phase. In the area of Pensacola Pass, a total of 17 lines of survey were run, also spaced at 1000-foot intervals. Several cross lines were run in each portion of the survey area.

Phase Two was conducted in September 2000, with the core locations chosen based on the interpretation of the geophysical data collected during Phase One. During this phase, Vibracore samples were collected at 72 locations within the area surveyed in Phase One. The core were located primarily along several nearshore shoals offshore of Pensacola Beach, and in an area east of the offshore end of Pensacola Pass, where the geophysical data indicated an area of uniform sediment bedding to a depth of approximately 10 feet below the ocean bottom.

In addition, during this phase of the project, two lines of geophysical survey were collected in the area offshore of Pensacola Beach, to assist in the interpretation of data previously collected in that area. The cores collected during Phase two were subsequently split, described and sampled in order to determine the suitability of the sediments at these core sites for use on the project beaches. Based on the results of the sampling conducted in Phase Two, additional work was deemed to be required.

Phase Three, conducted in January 2001, consisted of an additional 125 line miles of geophysical survey and an additional 50 Vibracore samples. This geophysical survey was conducted adjacent to but offshore of the original survey grid, extending the area of coverage to include several broad topographic features. The geophysical data collected during the first part of this phase was analyzed on board the survey vessel, and coring commenced the following day, with emphasis on those areas which showed little evidence of internal bedding on the geophysical data, indicating the likelihood of uniform sands being present. The majority of the cores collected during this phase were collected in a grid across a broad topographic high, located offshore of Pensacola Beach. This area was chosen for detailed sampling in the field as the initial cores were observed to contain sand of a suitable grain size with no silt lenses. The sediment was also characterized by a white color. The cores collected during this phase were subsequently split, described and sampled in order to confirm the suitability of the sediments at these core sites for use on the project beaches.

The areas surveyed during these phases of the project are outlined in Figure 1.

This report presents the methods used for the both the geophysical surveys and the Vibracore sampling, along with the results of the surveys. The results are presented in a series of geological cross sections and plan maps.

2.0 PREVIOUS RESEARCH

Only four sets of data were available at the time of this study to assist in the interpretation of the data. Two of these data sets contain the results of localized core sampling conducted by others in the work area. The first includes descriptions of sediment samples collected from geotechnical borings conducted for the new pier at Pensacola Beach, and the other is the core logs from a series of Vibracore samples conducted in Pensacola Pass prior to previous dredging. The other two are reports containing information on the geology present in sites near the study area, and as such are useful in determining more about the local geological setting. These data are discussed below.

2.1 Pensacola Beach Pier Borings

Four borings were conducted for the new pier being constructed offshore of Pensacola Beach, two of which were on land, and two of which were in the ocean. The outermost core, labeled number three, was conducted at the outer end of the proposed pier, in 25 feet of water, and the remaining cores were conducted approximately 400 feet inshore of the outer end of the pier. The descriptions of the sediments encountered in the outer most pier core, along with the vertical distribution of those sediments, were compared to the geophysical data collected in line 1, which passed very close to that boring location. A copy of the boring log is presented in Appendix 1 of this report.

The sediments described in the log for boring No. 3 consisted of several feet of sand over a layer of silty sand, which in turn overlaid a thick unit of soft organic silt and clay. Below the clay unit was a dense sand. Based on the setting of the site, and the general geological history of the area, including the rise of sea level and the resultant transgression of the shoreline over the pre-existing lagoons, the sedimentological sequence present in the boring is hypothesized to represent, from the bottom up, a typical transitional sequence.

The lowest sediments, namely the hard sand, are the pre-existing sands, deposited either during a previous high stand of the sea or in streams during a low stand of the sea. Overlying these sediments are the clays and silts deposited in the back-barrier marshes, lagoons and open bays similar to those present inshore of the present barrier island. The upper few feet of this sequence of silts may have been eroded by wave action following the passage of the shore face to the north of the site. The final few feet of sediment consists of sands that have been reworked and deposited on the ocean bottom.

The erosion of the soft clays and silts continues in the offshore direction, until little or none of the soft sediments remains, and the pre-existing underlying sands are exposed on the ocean bottom or covered with only a thin layer of reworked recent sand.

2.2 Pensacola Pass Core Samples

The second set of sedimentological data collected within the survey area are the boring logs for a series of Vibracore borings conducted along the alignment of Pensacola Pass Channel prior to dredging and deepening of that channel. The majority of these borings encountered only undifferentiated sand. A few of these borings, located in the inshore portion of the project, encountered a clay layer. Some of the geophysical survey lines run during the present study passed near the borings with the clay layers and there was a good correlation in those areas with the geophysical data, in that a reflector was detected at the depth corresponding to the clay layer. However this reflector could not be followed outside of the channel, due to the increased sediment thickness over this layer outside the channel.

2.3 Published and Unpublished Research Papers

Of the other two sets of information available for the work area, the first is a 1999 publication, “Holocene stratigraphic architecture and a sand-rich shelf and the origin of linear shoal, northeast Gulf of Mexico” by McBride, Anderson, Tudoran and Roberts. McBride et al reviewed available bathymetric and sedimentological data for the study site, along with the results of 35 sediment cores collected on a broadly spaced grid across the survey area. They found that the sediments and associated morphological settings across the shelf could be broadly characterized as having been deposited in four types of environments. The first setting consists of shore-perpendicular bathymetric lows and associated shelf edge lobes, which are hypothesized to have been formed by erosion in river valleys during the last fall and rise of sea level. The second environment consists of long, linear shoals and associated bathymetric lows, oriented parallel to the edge of the shelf. These sediments may represent a series of former barrier islands and associated lagoons, formed during the most recent sea level rise. The third type of environment is the present near shore surficial sediments that are being reworked by ocean waves and currents. The fourth type of environment is a mixture of the first three, where the morphological features of various types are superimposed on each other.

The remaining data is contained in an unpublished study, similar to the present work, which was conducted for Olsen Associates, Inc., in 1999 offshore of Gulf Shores, Alabama, located approximately 20 miles west of Pensacola Pass. That survey, which consisted of approximately 60 line miles of geophysical survey and 48 Vibracore samples, was conducted in an area between the coastline and three miles offshore. The morphology in that area was similar to that found offshore of Pensacola Beach.

2.4 Summary

The geophysical data collected during the various portions of this survey show that there are significant regional variations in the nature of the seismic reflectors present in the subbottom sediments of the work area. This was confirmed by the Vibracore sampling.

3.0 FIELD METHODS

3.1 Survey Vessel and Navigation Equipment

During the Phase One geophysical survey, Alpine utilized a 26-foot outboard powered boat to conduct the survey. The vessel was equipped with a hull-mounted echo sounder transducer and digital recorder, and a Trimble DGPS navigation receiver interfaced to a computer with Hypack navigation software. The proposed survey track lines were stored in the computer and displayed by the software as guidance for the vessel operator. Navigation fix data generated by the computer were recorded on the geophysical instrument at pre-determined distance intervals along the track lines. Digital water depths were continuously recorded along the track lines.

In Phases Two and Three, the R/V Atlantic Twin, a 90 foot steel research vessel, was used to collect both the geophysical data and the Vibracore samples. This vessel was also equipped with a digital echo sounder, interfaced to a computer that received and displayed the Trimble DGPS data on a video display. Navigational data and bathymetric data were stored in the computer for later post plotting.

3.2 Geophysical Equipment

During Phase one of this project, Alpine utilized a DataSonics CHIRP subbottom profiler system to collect geophysical data. The system consisted of an on-board transceiver that provided a power pulse to a gimbaled transducer mounted on the port side of the vessel in front of the steering console. The unit was keyed at one-quarter second intervals and operated at a nominal 3.5 KHz frequency. The ocean bottom and subbottom reflections of the seismic pulse transmitted by the transducer were received by the transducer, amplified and presented on a video display monitor. The signal strength of the outgoing pulse, the level of returned signal amplification and the vertical scale of the presented data were controlled digitally in the DataSonics system. The data were also recorded on a paper record and on a magneto-optical (M-O) disc. The M-O data allowed the received signals to be later replayed at various alternative gains and vertical scales in order to attempt to improve on the definition of shallow or deeper seismic reflectors. During the survey, the upper 50 milliseconds of data were displayed on the video monitor and recorded on the paper recorder, while the entire 250 milliseconds of data generated on each sweep were recorded on the M-O disk.

In Phase Two, a GeoAcoustics Model 5410 Seismic System, operated at 3.5 KHz, was utilized. This system recorded the geophysical data on an EPC Model 1086 graphic recorder. A TSS Model 320 Heave Compensator was used during this phase of the project to remove the effect of water waves from the records, thus allowing greater resolution of closely spaced subbottom seismic reflectors.

With the systems operated as described above, subbottom reflectors were observed on the data to a depth of over 50 feet below the ocean bottom, while at the same time, layers as close together as two feet could be differentiated on the data.

3.3 Vibracore

A model 271 B Alpine Pneumatic Vibracore configured to take cores 20 feet in length was used on this project. The model 271 B is a self-contained, freestanding pneumatic Vibracore unit. The unit consists of: an air-driven vibratory hammer assembly; an aluminum H-beam which acts as the vertical guide for the vibrator; a set of four steel support pads and legs which hold the beam upright on the sea bottom; a steel coring pipe; a cutting edge; a core retainer; a 20-foot clear lexan core liner; and a penetrometer which records time and depth of penetration of the core pipe into the sea bottom. An air hose array provides passage of compressed air from the compressor on deck to drive the Vibracore. Whenever refusal occurred with initial penetration of less than an acceptable total depth, or recovery was less than 80% of penetration, the sampled portion was removed from the pipe, a new liner inserted, and a jet pump hose was attached just below the Vibracore head. The rig was lowered to the bottom and jetted to refusal depth, the jet turned off and vibrator turned on taking the additional part of the core.

4.0 DATA PRESENTATION

4.1 Navigation Data

The track lines run during Phase One of the survey were set up in two groups, referred to as the Pensacola Beach lines and the Pensacola Pass lines. The seven lines closest to the shore in the two areas are contiguous. Navigation fixes were initially generated at 200-foot intervals along the track lines. The interval was lengthened to 500 feet after the first few lines were run.

In Phase two, two short lines of data were collected to assist in the interpretation of the data from Phase 1. The first of these lines was oriented in a NW-SE direction down the axis of one of the nearshore sand ridges. The second line was oriented N-S and continued offshore from the south end of the first line.

The geophysical data collected during the first part of Phase three consisted of several groups of lines, all located offshore of the Pensacola Beach portion of the project. Initially, a group of six lines oriented parallel to the Phase One survey lines, were run. These lines were spaced at 1300 foot spacing. Then a series of lines were run across each of three broad topographic highs, located offshore of the main east-west lines. These lines were labeled as areas A, B and C.

Figure 2 is a post-plot of the navigation data. The map is presented in three parts to allow use of a scale large enough to show the details of the data, including fix marks and other pertinent control data.

4.2 Water Depth Contours

The digital water depths collected along the survey lines in all Phases of the survey were corrected for tidal variations above mean lower low water and contoured at two-foot intervals, as plotted on an overlay in Figure 2.

4.3 Vibracore Samples

The 20-foot Vibracores collected during this project were marked to show core and section number. The cores were then cut into sections approximately five feet long and stored vertically on the vessel. Once the field portion of the project was concluded, the core sections were delivered to an independent laboratory where the cores were split open, described and sampled. The sediment samples were analyzed for grain size distribution. The descriptions of the cores, as developed by the laboratory, were used in the preparation of this report. The details of the core descriptions, as well as the Vibracore penetration graphs, are presented as part of the overall borrow area assessment developed on the basis of this report and the core sample data.

The depths to significant sediment layers, as shown on the cross-sections, are based on analyses of the geophysical data, the Vibracore penetration graphs and the sediment core logs developed by others. The core logs were based primarily on the length of the sediment column recovered during the coring process, which, due to dilation of the sands during coring, may be slightly longer than the actual depth penetrated at a given core site.

4.4 Cross Sections

The geophysical layering present in the surveyed area was used as the basis for the initial characterization of the sediments in the area. The divisions are important as they include a characterization of the depositional environments that were likely present in these various areas. The sediment types represented by the various layering patterns were subsequently determined during the Vibracore sampling phases of the project.

A series of cross sections, which are representative of the various sediment patterns encountered in the project, have been developed. The sediments present in cores located on or near the cross section lines are shown on some of the sections. The locations of these sections are shown on the pertinent portion of Figure 2.

5.0 DISCUSSION

5.1 Depositional Environments

During the process of reviewing all the geophysical data collected during this project, by looking in detail at groups of adjacent seismic lines, indicators of subtle variations in the nature of the subbottom were detected. Since these variations may indicate changes in the average grain size distribution from one area to the next, the distributions of these patterns in the seismic data were mapped across the Pensacola Pass area, and the locations of the various types of layering are shown on Figure 2**.** The variations in the sedimentary stratigraphy between the different portions of the survey were verified during the Vibracore sampling conducted in Phases two and three of the project. Four distinct patterns of reflectors and sedimentary layering have been mapped, based on all the data collected during this project.

The first pattern, labeled Massive Unit, consisted of either one or two parallel, gently dipping or horizontal reflectors. The second pattern consisted of a variable number of non-parallel steeply dipping layers, and may represent a former inlet channel. The third pattern consisted of a single reflector, generally 3 to 5 feet below the ocean bottom at most under a series of small ridges, and not present between the ridges. The sediments below this shallow reflector contained no discernable reflectors. A fourth type of pattern was a series of closely spaced parallel reflectors of varying thickness, with the bottom reflector being at a depth of approximately 50 feet below the water surface. This pattern, which was observed to be present in the northeast quadrant of the Pensacola Pass area, continues through much of the Pensacola Beach area, especially in the nearshore shoals.

The data collected during Phase Three were used to extend the initial patterns further offshore. The descriptions of the various sediment pattern areas are given below. The cores collected during the project confirmed that the areas with the least prominent internal seismic reflectors were those areas which contained the greatest amount of uniform usable sand. On the other hand, the areas with the most significant reflectors contained the greatest amount of silt or other unsuitable sediments.

5.1.1 Massive Sand Units

The sediments containing a few gently dipping or horizontal parallel reflectors are thought to represent a poorly differentiated or massive sand unit. The lack of strong reflectors indicates that the sediment densities are similar above and below those reflectors.

A significant portion of the Pensacola Pass areas containing the gently dipping layers appears to be associated with the remnant headland sediments present in the area of Fort Pickens on the east side of Pensacola Pass. There is a prominent ridge in the ocean bottom topography offshore of this island, and the ridge is oriented in a northwest-southeast direction similar to the western terminus of the island. This orientation is continued in the subsurface reflectors present on both flanks of the shoal, indicating that the continuation of the former headland was slightly wider than the present exposed landform. The offshore area of this former headland may contain a significant quantity of sediments similar in grain size distribution to those exposed on land at Fort Pickens.

The other portions of the Pensacola Pass area which were found to have generally flat-lying layers are also thought to be representative of either pre-existing headland sediments, which contain little internal variation, and therefore, little internal layering, or a large offshore ebb-tidal delta from the present inlet. Such a feature would also contain little internal bedding.

An interesting subbottom feature in the Pensacola Pass survey was detected at the intersection of cross line 19 and survey lines 5, 6 and 7. This feature, shown on Figure 2, is semi-circular in shape and up to 20 feet thick, and appears to be the remnants of a small inlet. There is a prominent reflector separating the underlying sediments from those infilling the feature. The feature is best shown on the data collected along cross line 19, a section of which is reproduced as Figure 3. The ridges on the bottom of the feature appear to be sand waves that were active on the bottom of the channel. It is hypothesized that the inlet was abandoned suddenly, when another nearby inlet opened and cut off the flow of water, allowing the sand waves to be preserved. The seismic data do not indicate whether the sediments filling the feature are more likely sands or silts.

5.1.2 Irregular Bedding

The second type of seismic bedding pattern is an elongate area of vague but irregular bedding, located on the east side of the present Pensacola Pass channel within the otherwise undifferentiated sediments. This area runs from the offshore edge of the surveyed area to the northwest, toward the location of the present inlet through the barrier islands. This area of irregular bedding may represent either an older inlet channel, formed at a slightly lower stand of sea level, or a stream channel cut down through the sands and then backfilled with other sediments when the sea level was lower. Sediments within this area are likely to be inconsistent in grain size, varying from coarser to finer sediments over relatively short distances.

5.1.3 Single Reflector

A slight variation of the massive unit description is used to describe those areas where one seismic reflector, lying close to the ocean bottom under low irregular ridges, separates the few feet of sediments present in low ridges from the underlying undifferentiated sand. This pattern variation is not differentiated from the remaining massive sand area, as the areas are too small to be individually plotted. This type of pattern is interpreted as being present where the overlying clays and silts which may have been deposited in lagoons were either not originally present, or have been eroded following passage of the barrier island with rise of the sea level. This variation in the massive sand pattern was found primarily in the southeast quarter of the Pensacola Pass study area, but similar patterns exist in portions of the area offshore of Pensacola Beach.

5.1.4 Flat-lying Shallow Reflectors

The most significant set of seismic reflectors in the Pensacola Pass area is the series of parallel horizontal reflectors present in the shallower, northeast quarter of the study area. This pattern of reflectors continues along the shoreline through much of the Pensacola Beach study area, as discussed in the Pensacola Beach portion of the report below. In these areas, there are a series of topographic ridges, some of which are more than 15 feet high. The ridges are oriented in a northwest-southeast direction and open to the east. The seismic data collected in both areas show that this series of significant seismic reflectors represents a sequence of sand and clay layers similar to the sequence encountered in Boring No. 3 for the Pensacola Beach Pier. These reflectors continue both parallel to the shore and offshore until the upper sections of the sequence are gradually removed with distance from shore and increasing water depth. On the basis of the likely presence of significant thickness of silt and clay in the sediments within the area outlined by this pattern, the areas shown as having this type of pattern may not be useful as sources for beach nourishment sediment. Exceptions to this, in the form of two larger ridges present in the Pensacola Beach study area, are discussed below.

5.2 Pensacola Beach Area

5.2.1 Flat-lying Shallow Reflectors

The sequence of shallow, close spaced reflectors present in the northeast portion of the Pensacola Pass study area continues along the coastline through approximately two thirds of the Pensacola Beach Study area, as shown on Figure 2. The predominant reflectors have been transferred to a series of cross sections in this portion of the study area. The cross sections are shown in Figures 3 and 4.

The lower horizontal reflector, present at a depth of between 50 and 55 feet below the ocean surface on the cross sections, appears to correlate with the bottom of lagoonal clay present in the outer boring for the pier. This prominent reflector can be traced from line to line through much of the data collected in the central and western portions of the Pensacola Beach survey area. Where this reflector is present, the Vibracore samples confirmed that the sediments directly above the reflector contain at least some clay. Where the sequences of sediments above the reflector are thickest, as along Line 1, the Vibracore samples showed that much of that sequence is composed of clay and silty sand, as shown in the pier boring. The areas where these alternating sequences of sand and clay were found in the cores were determined to be unsuitable for use as borrow sites.

The topographic ridges trending to the southeast from the coastline near Pensacola Beach are underlain by a series of sand and silt layers, while the areas in between the ridges have only one or two layers. The indication is that the ridges are erosional remnants of the Holocene transgressive sediments similar to those currently being deposited in Pensacola Bay. The predominant currents along the coastline at Pensacola Beach run to the west, eroding the east side of the ridges and depositing the sand on the west side.

5.2.2 Sand Ridges Within the Area of Shallow Reflectors

A possible exception is the crest of a prominent sand ridge located in the center of the Pensacola Beach survey area. Cross lines 4, 5 and 6 were run across this ridge, and those cross sections are presented in Figure 3, along with portions of some of the long lines which pass through the ridge. It appeared from the geophysical data that the upper 10 feet of the sediments on the outer half of the ridge did not contain the close spaced layering present in sediments at similar elevations near shore.

A similar but smaller ridge is present in the western portion of the Beach survey area. That smaller ridge is crossed by cross lines 8 and 9. The interpreted layering in this ridge is also presented in Figure 3.

In both cases, it appears that there has been at least a limited amount of sediment deposition across the western side of the ridges, whereas the majority of the features at the site seem to be forming as the result of the longshore currents in the area. The currents in the area appear to be eroding the east side of the ridges, and in the cases of these two larger ridges, depositing sand on the down drift side of the ridges. The data from Cross line 9 are particularly interesting, as this is the best presentation found during this study of a reflector along the steep side of a shoal, separating the flat-lying reflectors under the inshore side of a ridge sequence from the sediments being deposited on the down drift side.

However, cores taken in these areas determined that the sediments present in the depositional portions of the ridges contained too much fine grained sediment to be considered suitable borrow sites. The process has not yet had enough time to rework the sediments in this area as required to remove the silts. Thus these ridges are not suitable borrow areas for beach nourishment sand.

5.2.3 Massive Sands

The portion of the study area toward the east end of Pensacola Beach is typified by a lack of closely spaced reflectors. This portion of the site is offshore of an area where the lagoon is relatively narrow, compared to that portion to the west of Pensacola Beach. The presence of a narrow lagoon indicates that there is likely to be a thinner sequence of lagoonal silts and clays than would be present where there is a wide lagoon. Therefore, it is hypothesized that the recent silty sediments that may have existed in this portion of the study area were relatively thin and have been eroded away.

The only horizontal reflectors near the ocean bottom in the eastern portion of the Pensacola Beach study area are present below low sand ridges, separating those small ridges from the massive sands underneath, as was the case in portions of the Pensacola Pass area. There are no significant seismic reflector patterns in the deeper sediments present in the eastern portion of the Pensacola Beach study area.

The seismic surveys conducted in Phase Three, concentrating in the area between approximately 1.5 and 4 miles offshore of Pensacola Beach, determined that the majority of these portions of the project contained sediments similar in pattern to the Massive sand units identified in the adjacent inshore areas in Phase One. The ocean bottom in the majority of the area is relatively flat lying, out to a distance of about 2.5 miles offshore.

Three ridge-like areas of interest, located farther offshore of Pensacola Beach were investigated during the geophysical survey portion of Phase Three of this project. The bathymetric contours developed from the data, as shown in Figure 2, show that two of the ridges, namely ridge A, centered at 474,000 N and 1,118,000 east on the west side of the survey area, and ridge C, centered at 480,000 N and 1,154,000 E on the east side of the survey area, trend in the NW-SE direction. These two ridges have relatively well defined topographic outlines.

The orientation of the area labeled Ridge B, centered at 474,000 N and 1,144,000 E, on the other hand, is defined by a linear depression on the west side, with water depths ranging down to at least 79 feet within the bounds of the surveyed area. The east side of the Ridge B area does not have a definitive slope, however.

The geophysical data collected at Ridge B, including the depression to the west, indicates that there may have been a channel located where the depression is now defined. This may mean that the area labeled Ridge B is an erosionally defined inshore extension of the larger Perdido Sand sheet, defined by others. This sand sheet is an older remnant of the latest marine transgression. On the other hand, the smaller A and B shoals, along with inshore shoals, appear to have been formed in response to the westward trending longshore currents.

The B ridge was found to be typical of the sediments in the massive sand area, in that the seismic pattern was characterized by the presence of a first reflector at 15 to 18 feet below ocean bottom. The cores taken initially in this ridge found the sand to be fairly uniform and of good grain size distribution and color for use on the project beaches. For these reasons, this area was chosen as the area of greatest concentration of cores in the offshore area. The analyses of the cores collected in this ridge confirmed that the grain size and color are consistent and suitable for use on the project.

A series of three cross sections through the B ridge borrow area, presented in Figure 4, shows the relationship between the sediments in the cores and the first seismic reflector. The seismic reflector correlates with a change from sand above to silt below the reflector. The reflector is relatively flat-lying and the sediments in the cores above the reflector are relatively uniform, so that extending the borrow area beyond the area sampled by the cores collected in this project in the future should find good borrow sand.

6.0 SUMMARY

The geophysical data and Vibracore samples collected in the surveyed area have identified at least two potential borrow areas. These areas consist of the following:

Pensacola Beach Area
Shoal B, located offshore of Pensacola Beach, where there are at least 15 feet of sand suitable for use on the project beaches. This thickness allows a dredge to make a significant cut without moving too much, a prime factor in considering the usefulness of a potential borrow area.

Pensacola Pass Area
The area to the east of the offshore end of the Pensacola Pass has been found to contain a significant volume of sand suitable in grain size and color for use on the project beaches. However, the first seismic reflector below the ocean bottom in this area is located at 8 to 10 feet below ocean bottom, where the cores contain a clay lens. This area is smaller in size than the area offshore of Pensacola Beach and significantly farther away from the project beaches than Shoal B, indicating

that barges may have to be used to move the sand from the borrow area to the project beaches.

Additional Future Areas

Additional future areas of consideration offshore of Pensacola Beach have been identified with one to three cores, such as the inshore end of shoal C. No samples have been collected in ridge A, but the seismic surveys indicated that the patterns of internal reflectors are similar to those found in Ridge B. Additional work would have to be conducted to prove the extent of the usable sediments in these alternative areas.

REFERENCES

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TABLE 1 – PHASE TWO, CORE LOCATIONS

			Florida North – NAD-83		WGS-84		MLLW
Date	Time	Core No.	Easting	Northing	Latitude	Longitude	Depth
9/8/00	12:21	P1	1134961.6	490073.3	30° 19.2605’	87° 08.5235	37.7
9/8/00	13:12	P2	1134019.0	490026.7	30° 19.2492’	87° 08.7025	34.0
9/8/00	14:12	P3	1132483.2	491028.2	30° 19.4085’	87° 08.9989’	29.1
9/8/00	14:40	P4	1130954.5	490501.1	30° 19.3157’	87° 09.2872’	27.6
9/8/00	15:14	P5	1133980.0	489004.1	30° 19.0804’	87° 08.7054’	44.8
9/8/00	16:05	P6	1131911.0	489542.1	30° 19.1615’	87° 09.0859’	37.8
9/8/00	16:32	P7	1133971.3	488018.5	30° 18.9178’	87° 08.7027’	47.7
9/8/00	17:03	P8	1133967.5	486879.9	30° 18.7300’	87° 08.6984’	50.7
9/9/00	09:14	P9	1105034.4	486075.6	30° 18.4847’	87° 14.1947’	34.9
9/9/00	09:58	P10	1114980.5	488516.9	30° 18.9265’	87° 12.3151’	28.0
9/9/00	10:30	P11	1117994.3	486361.6	30° 18.5828’	87° 11.7325’	36.3
9/9/00	11:00	P12	1119947.2	485610.3	30° 18.4665’	87° 11.3579’	42.6
9/9/00	11:25	P13	1119199.7	486525.9	30° 18.6146’	87° 11.5014’	39.9
9/9/00	11:54	P14	1118164.9	485301.9	30° 18.4087’	87° 11.6953’	47.5
9/9/00	13:01	P15	1118801.3	486075.1	30° 18.5387’	87° 11.5778’	42.9
9/9/00	13:34	P16	1117011.6	486586.7	30° 18.6161’	87° 11.9203’	37.4
9/9/00	14:21	P17	1116525.5	487584.7	30° 18.7788’	87° 12.0172’	31.7
9/9/00	15:01	P18	1120903.5	484957.2	30° 18.3625’	87° 11.1732’	46.8
9/9/00	15:37	P19	1122959.2	484089.0	30° 18.2273’	87° 10.7785’	50.7
9/9/00	16:19	P20	1124949.1	480022.5	30° 17.5643’	87° 10.3822’	59.2
9/9/00	16:58	P21	1127471.5	483082.3	30° 18.0787’	87° 09.9164’	58.0
9/10/00	10:00	P22	1163976.2	493988.9	30° 20.0153’	87° 03.0240’	52.2
9/10/00	10:36	P23	1160427.6	496509.5	30° 20.4179’	87° 03.7095’	37.4
9/10/00	11:08	P24	1156959.8	492846.1	30° 19.8008’	87° 04.3532’	50.1
9/10/00	11:45	P25	1156966.7	495904.1	30° 20.3052’	87° 04.3650’	35.6
9/10/00	12:19	P26	1156967.5	494797.0	30° 20.1226’	87° 04.3601’	47.2
9/10/00	13:23	P27	1153644.0	494301.0	30° 20.0284’	87° 04.9899’	42.4
9/10/00	13:58	P28	1150484.2	492540.5	30° 19.7262’	87° 05.5831’	46.9
9/10/00	14:37	P29	1150002.4	485077.5	30° 18.4935’	87° 05.6424’	65.0
9/10/00	15:17	P30	1146990.0	490827.9	30° 19.4306’	87° 06.2400’	51.3
9/10/00	15:47	P31	1142961.5	488557.4	30° 19.0409’	87° 06.9960’	54.8
9/10/00	16:17	P32	1138937.3	486818.9	30° 18.7389’	87° 07.7534’	57.9
9/12/00	08:01	P33	1087307.6	478007.8	30° 17.0832’	87° 17.5267’	40.4
9/12/00	08:33	P34	1088225.6	478341.9	30° 17.1420’	87° 17.3538’	42.4
9/12/00	09:09	P35	1088487.7	477162.2	30° 16.9485’	87° 17.2788’	36.9
9/12/00	09:40	P36	1087451.3	476979.6	30° 16.9142’	87° 17.4946’	36.2
9/12/00	10:20	P37	1087921.9	476014.9	30° 16.7570’	87° 17.4007’	37.8
9/12/00	10:49	P37R2	1087929.3	476016.6	30° 16.7573’	87° 17.3996’	37.8
9/12/00	11:22	P38	1088984.4	476276.9	30° 16.8045’	87° 17.2000’	39.2
9/12/00	11:53	P39	1090010.8	476522.9	30° 16.8492’	87° 17.0061’	37.7

			Florida North – NAD-83		WGS-84		MLLW
Date	Time	Core No.	Easting	Northing	Latitude	Longitude	Depth
9/12/00	13:19	P40	1091037.9	477037.5	30° 16.9382’	87° 16.8133’	45.9
9/13/00	08:18	P41	1088146.7	474922.9	30° 16.5778’	87° 17.3529’	37.6
9/13/00	10:07	P42	1089247.9	475278.6	30° 16.6409’	87° 17.1453’	38.0
9/13/00	10:38	P43	1090330.5	475497.7	30° 16.6814’	87° 16.9406’	40.1
9/13/00	11:09	P44	1090774.9	476246.6	30° 16.8067’	87° 16.8596’	36.3
9/13/00	11:41	P45	1089506.6	474536.8	30° 16.5196’	87° 17.0927’	36.3
9/13/00	12:59	P46	1088514.6	473999.0	30° 16.4269’	87° 17.2787’	42.1
9/13/00	13:26	P47	1087521.7	475511.2	30° 16.6723’	87° 17.4744’	35.9
9/13/00	14:17	P48	1088619.4	475702.0	30° 16.7082’	87° 17.2667’	36.1
9/13/00	14:51	P49	1086204.8	477005.3	30° 16.9134’	87° 17.7316’	43.9
9/13/00	15:44	P49R2	1086230.9	476974.9	30° 16.9085’	87° 17.7265’	44.2
9/13/00	16:22	P50	1089528.4	477475.1	30° 17.0043’	87° 17.1022’	41.4
9/14/00	07:57	P51	1086696.3	475501.72	30° 16.6674’	87° 17.6312’	45.3
9/14/00	08:32	P52	1084999.4	477998.36	30° 17.0723’	87° 17.9653’	35.2
9/14/00	08:59	P53	1086250.6	478252.0	30° 17.1192’	87° 17.7287’	43.3
9/14/00	09:31	P54	1085500.9	479006.5	30° 17.2406’	87° 17.8747’	44.7
9/14/00	09:55	P55	1086498.7	479011.7	30° 17.2455’	87° 17.6851’	33.9
9/14/00	10:24	P56	1087499.6	479251.0	30° 17.2890’	87° 17.4960’	34.8
9/14/00	10:48	P57	1086696.5	478324.8	30° 17.1330’	87° 17.6443’	38.1
9/14/00	11:11	P58	1086400.4	480004.3	30° 17.4088’	87° 17.7084’	34.8
9/14/00	11:40	P59	1084519.7	480018.3	30° 17.4035’	87° 18.0659’	31.2
9/14/00	12:05	P60	1084998.8	481014.2	30° 17.5697’	87° 17.9795’	44.4
9/14/00	12:28	P61	1085899.9	481006.1	30° 17.5720’	87° 17.8082’	29.6
9/14/00	12:51	P62	1083902.8	482002.2	30° 17.7282’	87° 18.1924’	27.8
9/15/00	09:11	P63	1163996.0	497250.4	30° 20.5533’	87° 03.0341’	35.3
9/15/00	09:37	P64	1164009.4	495989.6	30° 20.3454’	87° 03.0262’	49.3
9/15/00	10:00	P65	1160496.4	495404.5	30° 20.2359’	87° 03.6917’	46.6
9/15/00	10:28	P66	1153494.5	495247.8	30° 20.1840’	87° 05.0224’	33.7
9/15/00	11:00	P66R2	1153507.0	495242.1	30° 20.1831’	87° 05.0200’	32.9
9/15/00	12:00	P67	1147005.1	494206.5	30° 19.9879’	87° 06.2518’	33.6
9/15/00	12:33	P68	1138961.6	488990.8	30° 19.0972’	87° 07.7583’	42.8
9/15/00	12:54	P69	1136997.4	489510.2	30° 19.1754’	87° 08.1340’	38.6
9/15/00	13:14	P70	1137999.0	490014.0	30° 19.2623’	87° 07.9458’	45.1
9/15/00	13:41	P71	1136493.7	488340.2	30° 18.9805’	87° 08.2246’	47.8
9/15/00	14:03	P72	1139001.5	492842.3	30° 19.7326’	87° 07.7676’	27.7

TABLE 2 – PHASE THREE, CORE LOCATIONS

		Florida North NAD-83		WGS 84		MLLW
Date	Number	East	North	Lat	Lon	Depth
01-10-01	P-73	1173241.2	497805.4	30° 20.6788’	87° 01.2784’	45.4
01-10-01	P-74	1169077.2	494782.3	30° 20.1649’	87° 02.0574’	52.9
01-10-01	P-75	1173202.0	491162.0	30° 19.5829’	87° 01.2579’	54.0
01-10-01	P-76	1174002.5	490051.4	30° 19.4026’	87° 01.1010’	53.3
01-10-01	P-77	1174223.4	491021.5	30° 19.5634’	87° 01.0631’	57.1
01-10-01	P-78	1171994.9	491000.3	30° 19.5518’	87° 01.4867’	57.8
01-10-01	P-79R1	1152979.1	481002.4	30° 17.8358’	87° 05.0591’	56.9
01-10-01	P-79R2	1153041.0	481023.7	30° 17.8363’	87° 05.0473’	56.8
01-10-01	P-80	1154007.8	480048.6	30° 17.6790’	87° 04.8594’	55.9
01-10-01	P-81	1154008.9	481114.2	30° 17.8548’	87° 04.8638’	58.5
01-11-01	P-82	1121674.4	486820.8	30° 18.6729’	87° 11.0350’	39.5
01-11-01	P-83	1126922.2	487831.8	30° 18.8599’	87° 10.0419’	46.2
01-12-01	P-84	1138048.1	483991.1	30° 18.2691’	87° 07.9100’	56.0
01-12-01	P-85	1140328.4	482989.0	30° 18.1125’	87° 07.4722’	56.6
01-12-01	P-86	1140039.7	483958.5	30° 18.2713’	87° 07.5313’	58.9
01-12-01	P-87	1138870.2	484000.7	30° 18.2738’	87° 07.7538’	55.1
01-12-01	P-88	1143263.1	473566.8	30° 16.5696’	87° 06.8733’	63.1
01-12-01	P-89R1	1143496.2	474539.9	30° 16.7310’	87° 06.8332’	64.0
01-12-01	P-98R2	1143502.4	474535.1	30° 16.7302’	87° 06.8320’	64.1
01-12-01	P-90R1	1143778.4	475609.9	30° 16.9085’	87° 06.7843’	66.8
01-12-01	P-90R2	1143808.3	475593.1	30° 16.9059’	87° 06.7785’	66.6
01-12-01	P-91	1144708.2	475569.6	30° 16.9054’	87° 06.6074’	64.3
01-12-01	P-92	1145218.3	476637.2	30° 17.0834’	87° 06.5151’	64.9
01-12-01	P-93	1144299.7	476589.7	30° 17.0721’	87° 06.6895’	65.9
01-13-01	P-94	1166375.4	489056.6	30° 19.2106’	87° 02.5469’	56.0
01-13-01	P-95	1160497.9	492348.8	30° 19.7319’	87° 03.6784’	53.1
01-13-01	P-96	1158923.3	488756.9	30° 19.1337’	87° 03.9624’	55.1
01-13-01	P-97	1153998.0	488000.2	30° 18.9905’	87° 04.8955’	54.7
01-13-01	P-98	1155506.1	485495.0	30° 18.5829’	87° 04.5980’	56.4
01-13-01	P-99	1147007.7	482005.4	30° 17.9755’	87° 06.1983’	57.7
01-13-01	P-100	1149026.5	481020.5	30° 17.8207’	87° 05.8103’	61.6
01-13-01	P-101	1151007.8	482010.2	30° 17.9914’	87° 05.4380’	59.1
01-13-01	P-102	1152048.4	482173.6	30° 18.0222’	87° 05.2410’	61.3
01-13-01	P-103	1145024.6	479655.4	30° 17.5805’	87° 06.5651’	64.7
01-13-01	P-104	1146012.8	479021.5	30° 17.4796’	87° 06.3745’	64.4
01-13-01	P-105	1140011.8	489001.6	30° 19.1030’	87° 07.5587’	46.2
01-14-01	P-106	1145333.4	477644.8	30° 17.2500’	87° 06.4976’	65.5
01-14-01	P-107	1145142.6	480608.4	30° 17.7381’	87° 06.5468’	65.5
01-14-01	P-107A	1145149.9	480608.7	30° 17.7382’	87° 06.5454’	65.6
01-14-01	P-108	1146397.1	477659.4	30° 17.2564’	87° 06.2955’	66.0
01-14-01	P-109	1146232.2	476613.8	30° 17.0834’	87° 06.3223’	65.4
01-14-01	P-110	1147235.2	476643.7	30° 17.0921’	87° 06.1318’	66.3
01-14-01	P-111	1145857.0	475614.2	30° 16.9171’	87° 06.3893’	65.1

		Florida North NAD-83		WGS 84		MLLW
Date	Number	East	North	Lat	Long	Depth
01-14-01	P-112	1144511.7	474549.5	30° 16.7364’	87° 06.6403’	63.5
01-14-01	P-113	1145522.6	474570.2	30° 16.7436’	87° 06.4483’	63.1
01-14-01	P-114	1146514.1	474576.5	30° 16.7484’	87° 06.2599’	64.5
01-14-01	P-115	1145256.6	473557.5	30° 16.5756’	87° 06.4944’	63.0
01-14-01	P-116	1146241.0	473555.4	30° 16.5790’	87° 06.3074’	63.1
01-15-01	P-117	1146884.4	475627.3	30° 16.9231’	87° 09.1941’	65.3
01-15-01	P-118R1	1144237.4	472552.0	30° 16.5708’	87° 06.6881’	61.7
01-15-01	P-118R2	1144239.5	473552.5	30° 16.5709’	87° 06.6877’	61.9
01-15-01	P-118R3	1144247.2	473559.6	30° 16.5721’	87° 06.6863’	62.1
01-15-01	P-119	1142515.3	474557.6	30° 16.7302’	87° 07.0197’	63.0
01-15-01	P-120	1142838.9	475580.1	30° 16.9001’	87° 06.9627’	67.0
01-15-01	P-121R1	1147359.2	477620.6	30° 17.2537’	87° 06.1125’	66.6
01-15-01	P-121R2	1147342.9	477600.6	30° 17.2503’	87° 06.1155’	66.7
01-15-01	P-122	1144284.2	477613.0	30° 17.2408’	87° 06.6969’	65.8

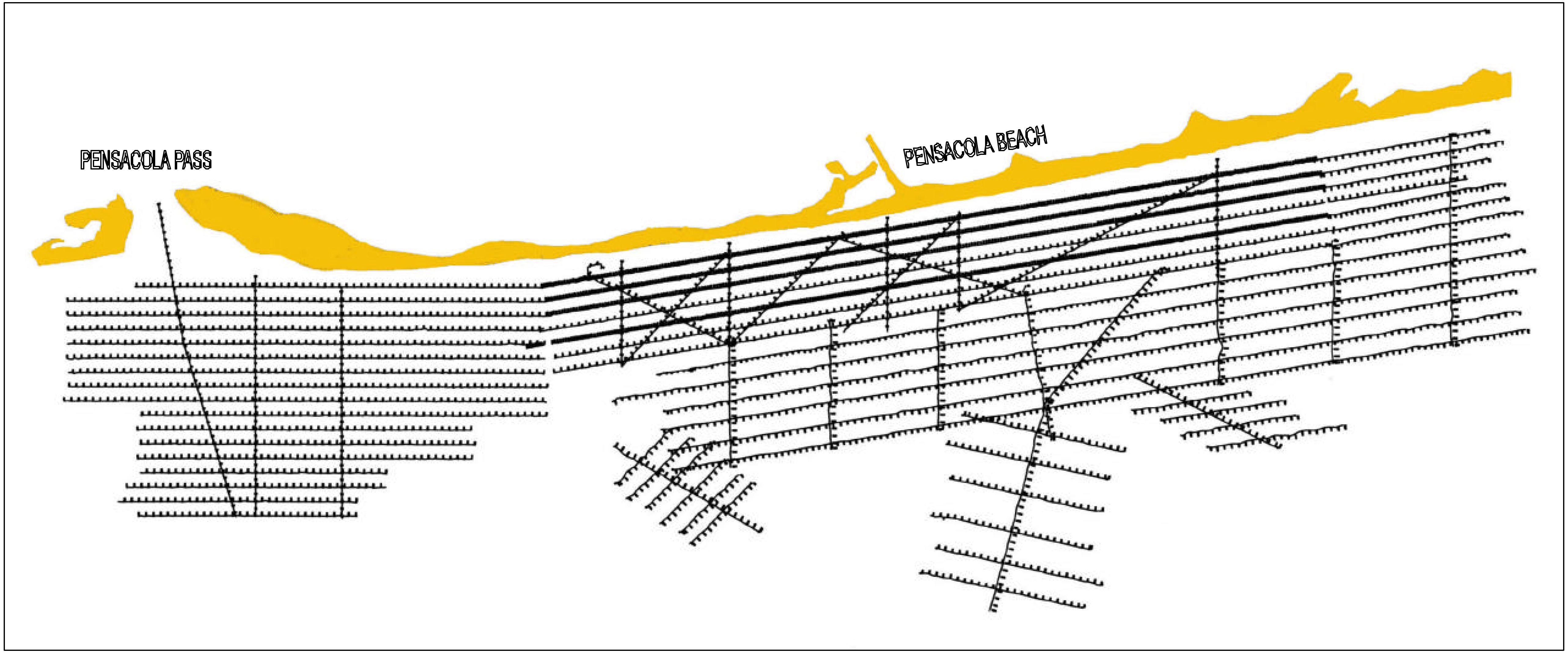
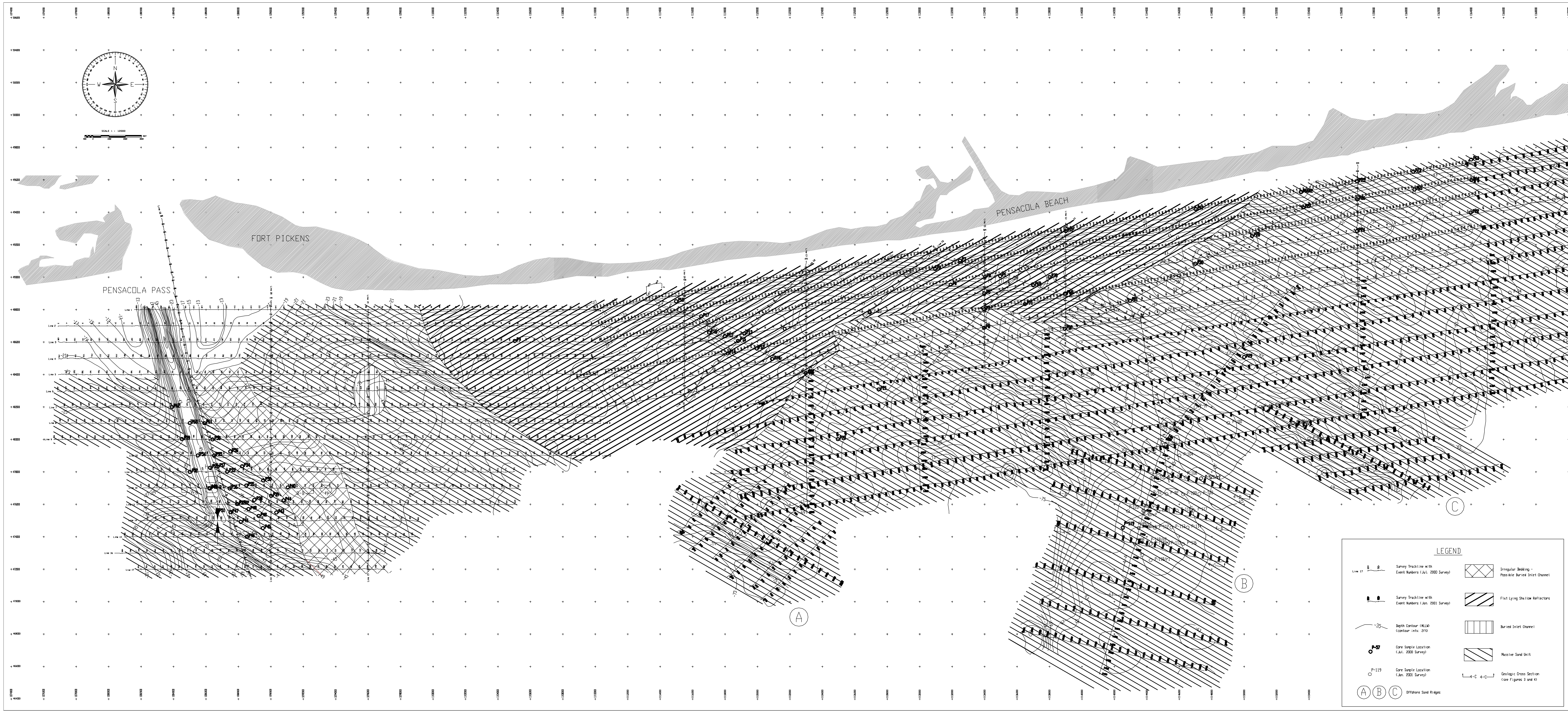


Fig. 1: Survey Area



OLSEN ASSOCIATES, INC.

GEOPHYSICAL SURVEY RESULTS
PENSACOLA BEACH - FL

Feasibility Study for Beach Restoration
Sand Search Investigation

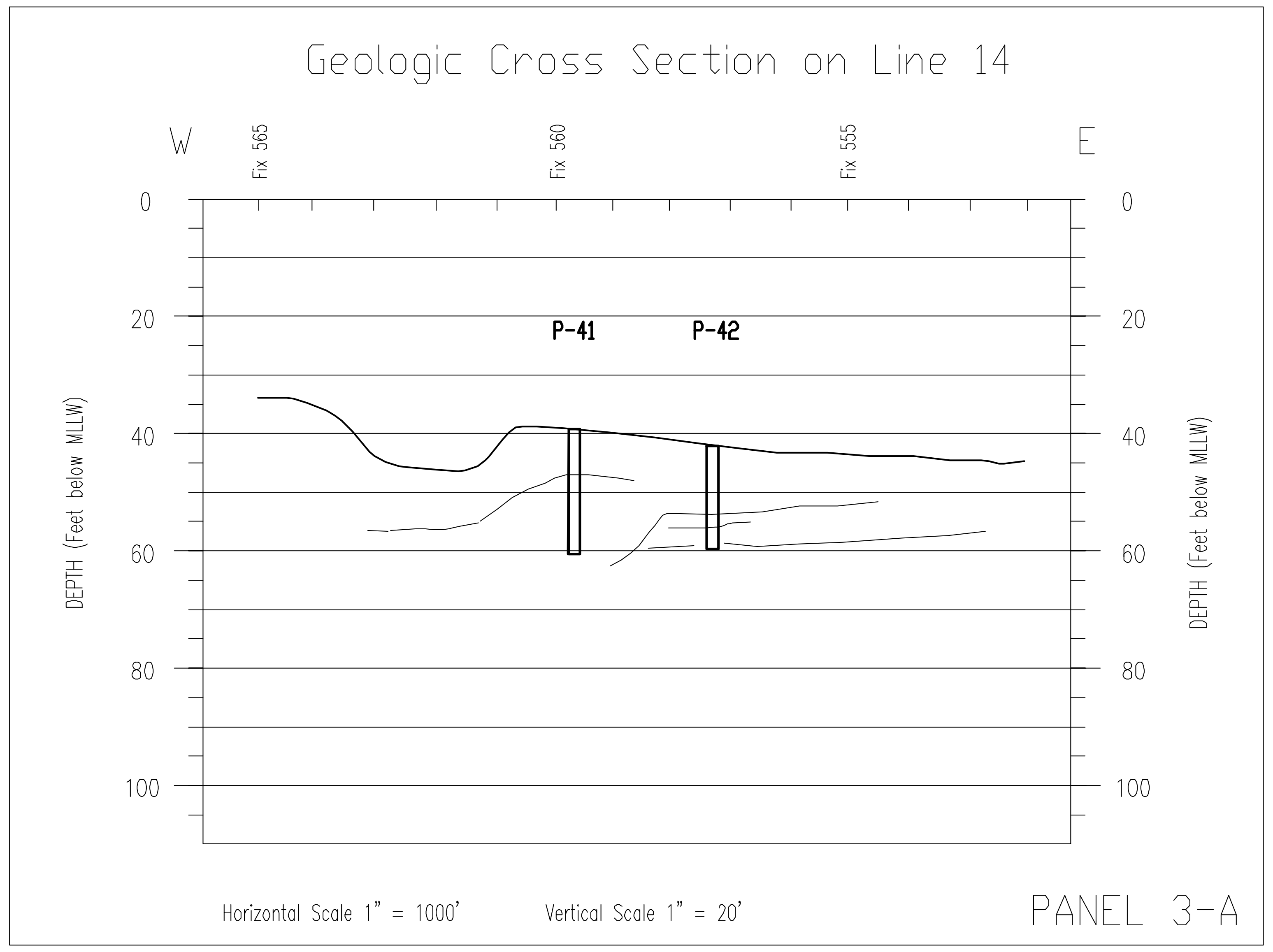
Horiz. Scale: 1 in : 2,000ft
Projection: FL-0903 NAD 83
Spheroid: WGS 84
Site: PENSACOLA BEACH, FL

Vessel:
Plot Date: JUN. 2001
JOB 1346

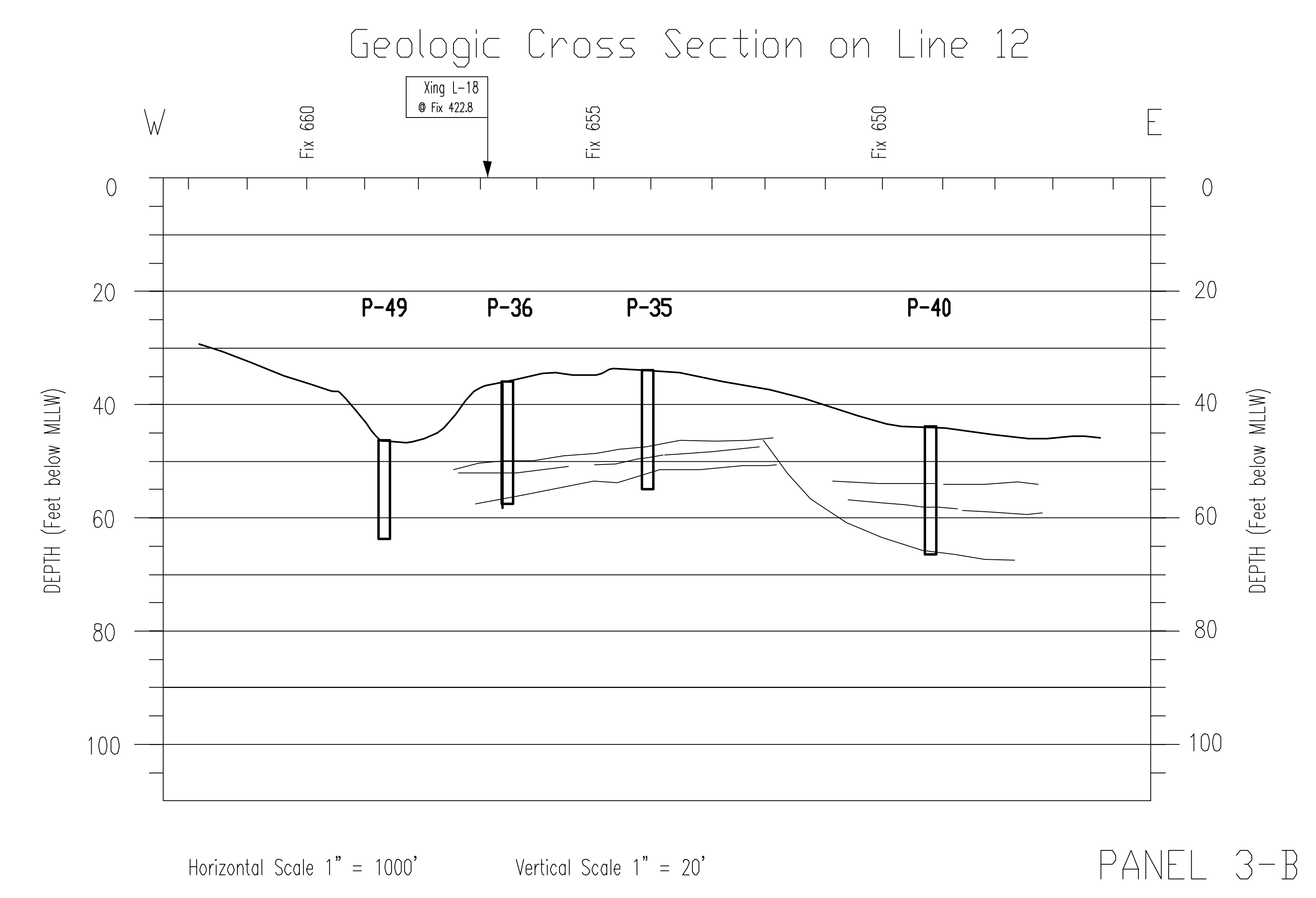
Prepared by:

ALPINE OCEAN SEISMIC SURVEY, INC.
Norwood, New Jersey

- Figure 2 -
TRACKLINES, BATHYMETRY AND GEOPHYSICAL FEATURES DISTRIBUTION


Geologic Cross Section on Line 14

PANEL 3-A


Geologic Cross Section on Line 12

PANEL 3-B

OLSEN ASSOCIATES, INC.

GEOPHYSICAL SURVEY RESULTS
PENSACOLA BEACH - FL

Feasibility Study for Beach Restoration
Sand Search Investigation

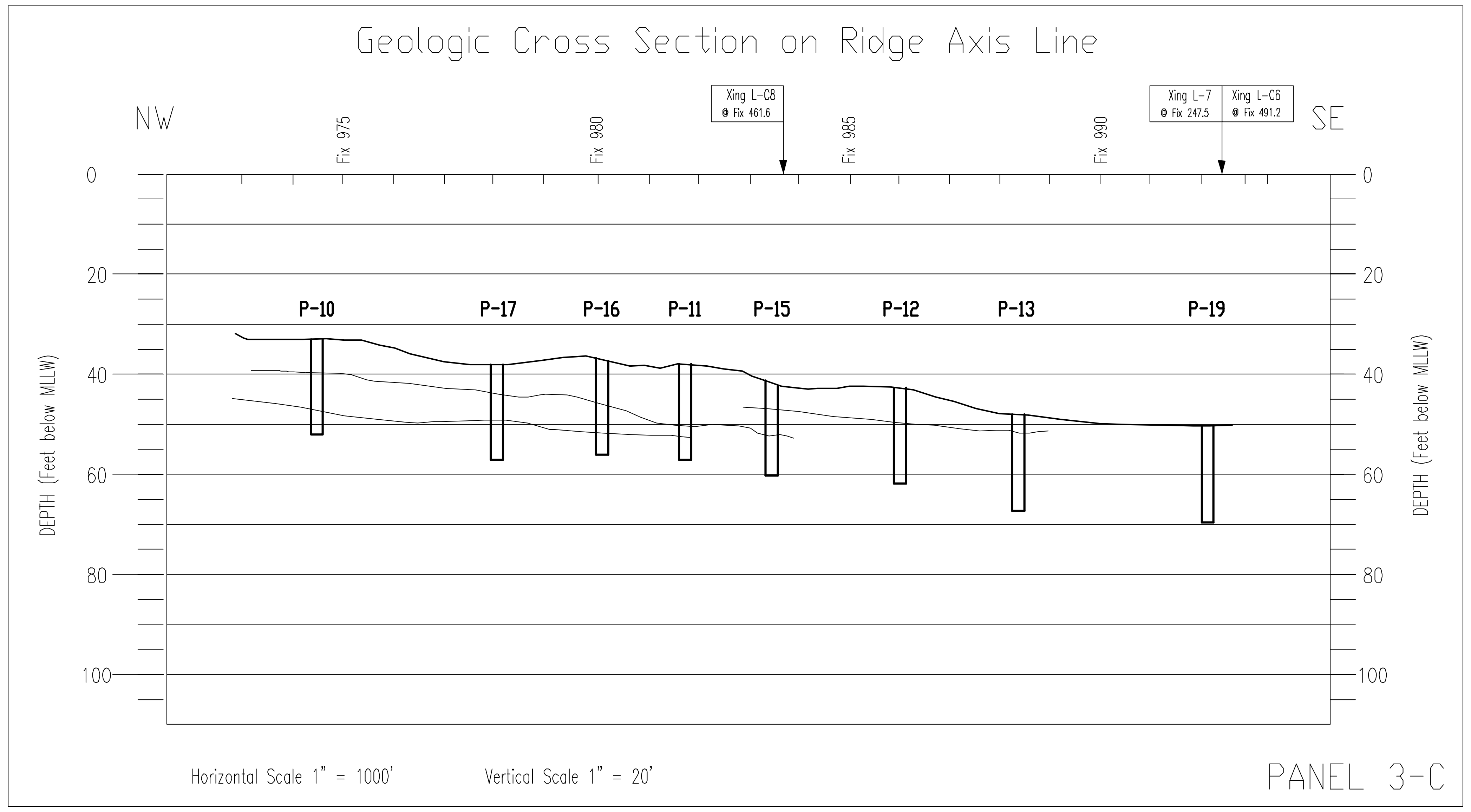
Projection:	FL-0903 NAD 83	Plot Date:	JUN. 2001
Spheroid:	WGS 84	JOB 1366	
Site:	PENSACOLA BEACH, FL		

Prepared by:

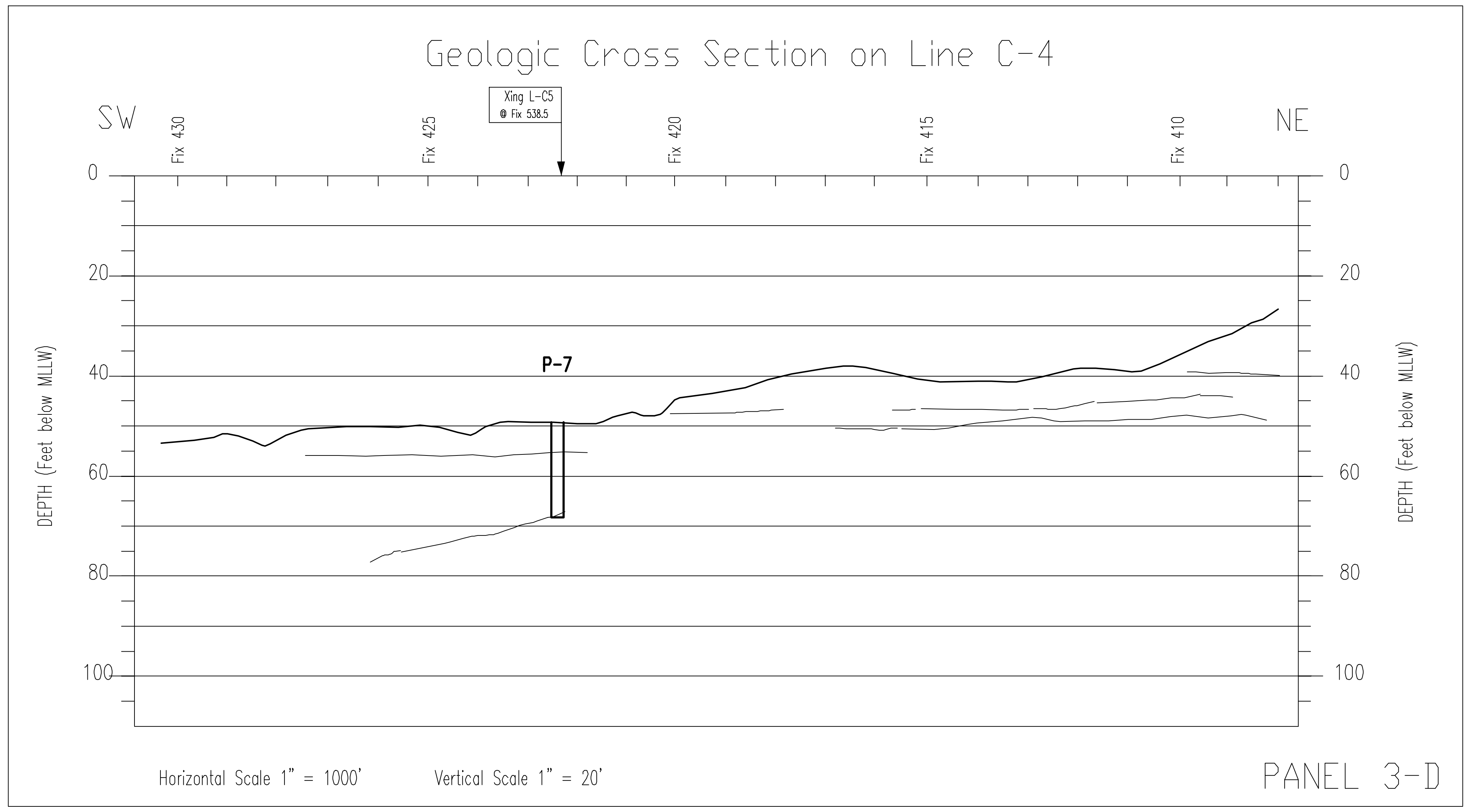
ALPINE OCEAN SEISMIC SURVEY, INC.
Norwood, New Jersey

- Figure 3 -

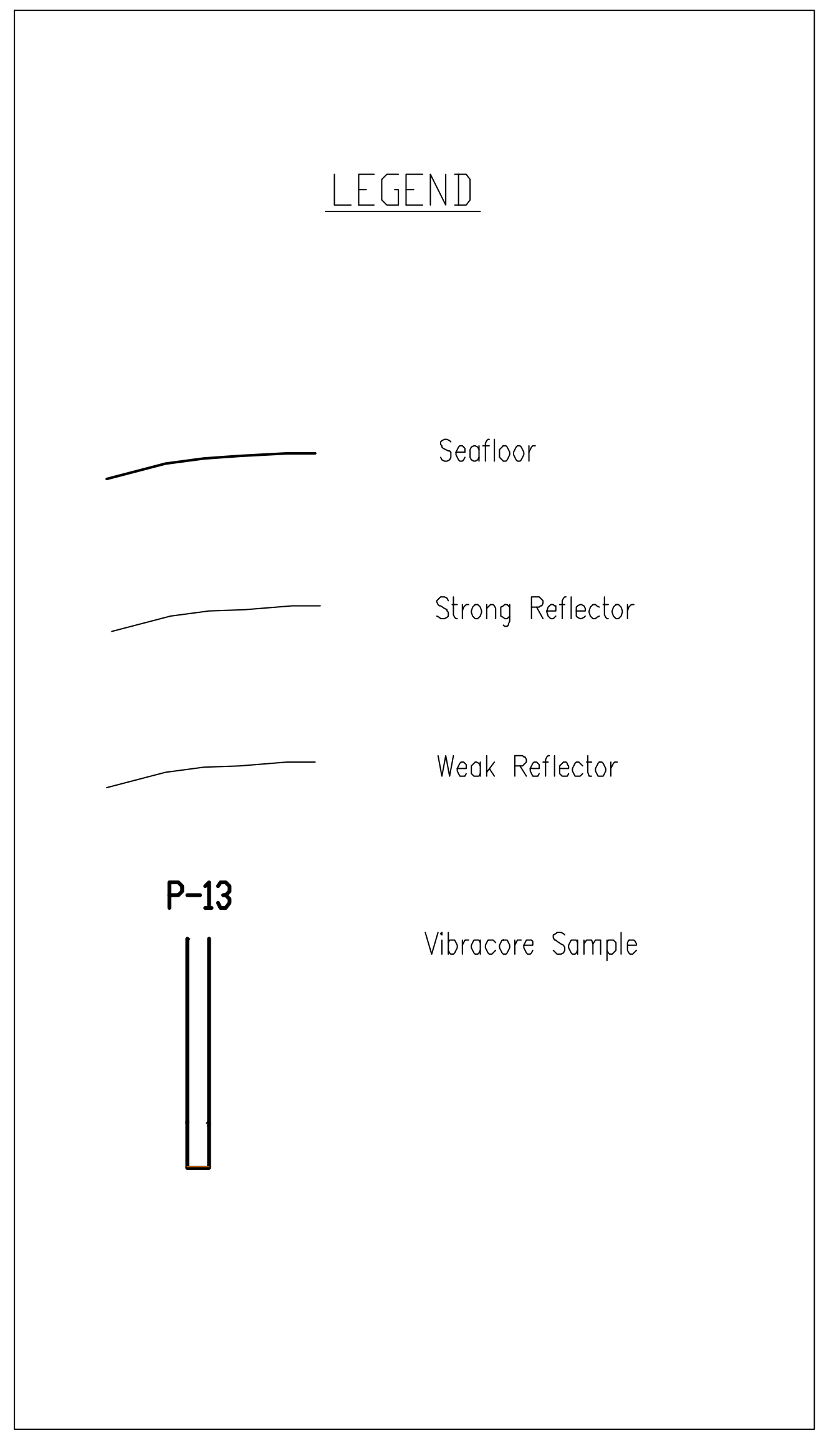
INSHORE GEOLOGIC CROSS SECTIONS

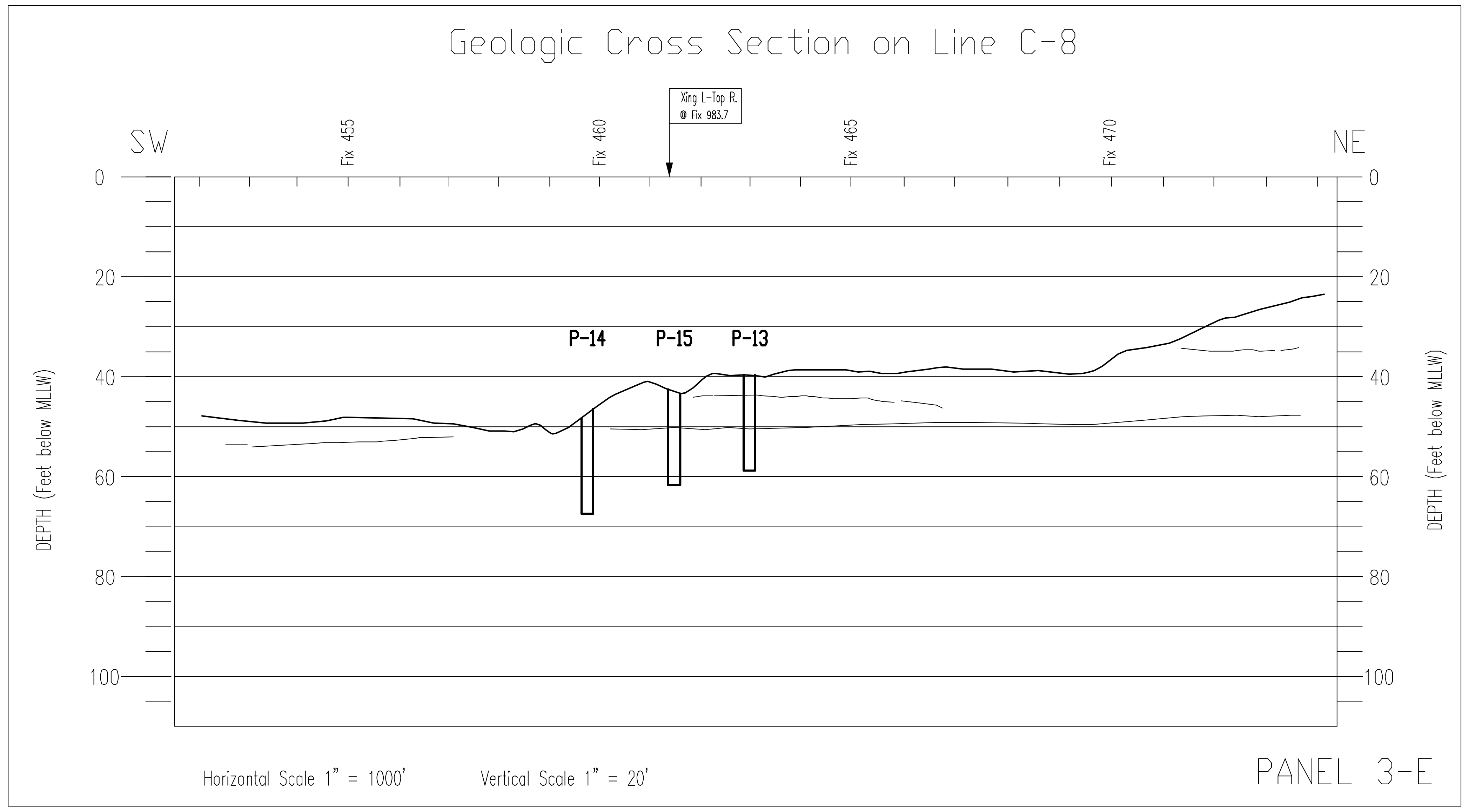

Geologic Cross Section on Ridge Axis Line

PANEL 3-C

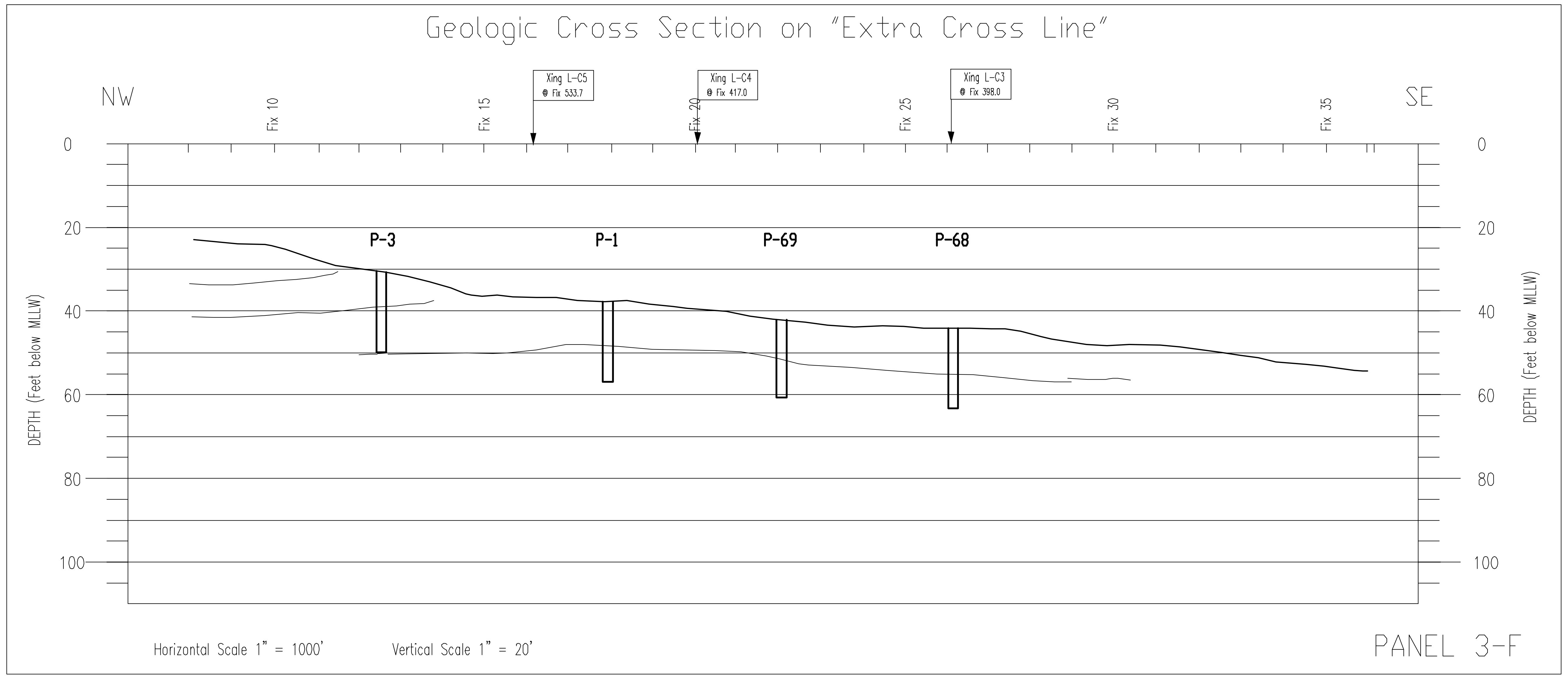

Geologic Cross Section on Line C-4

PANEL 3-D

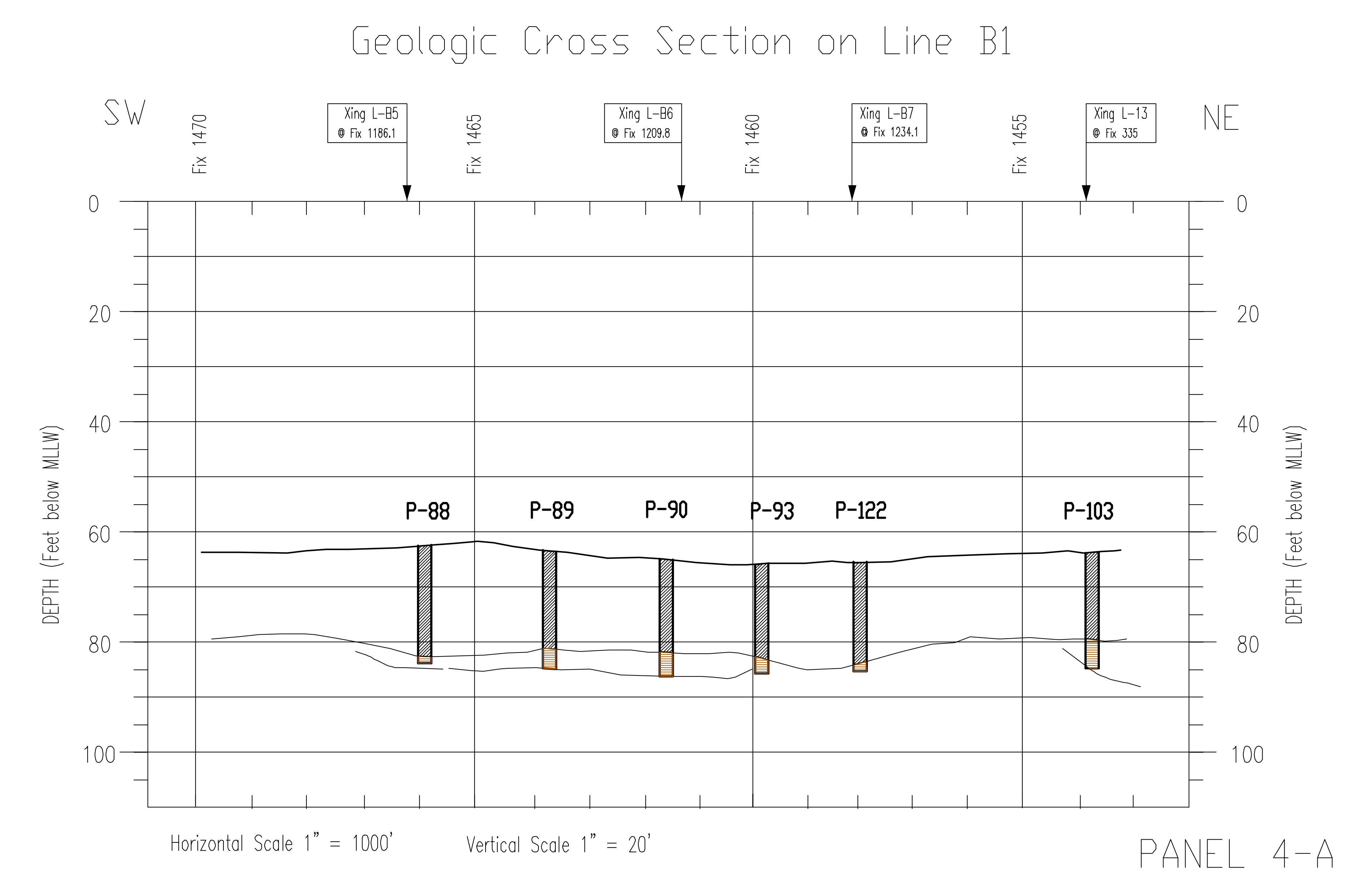



Geologic Cross Section on Line C-8

PANEL 3-E

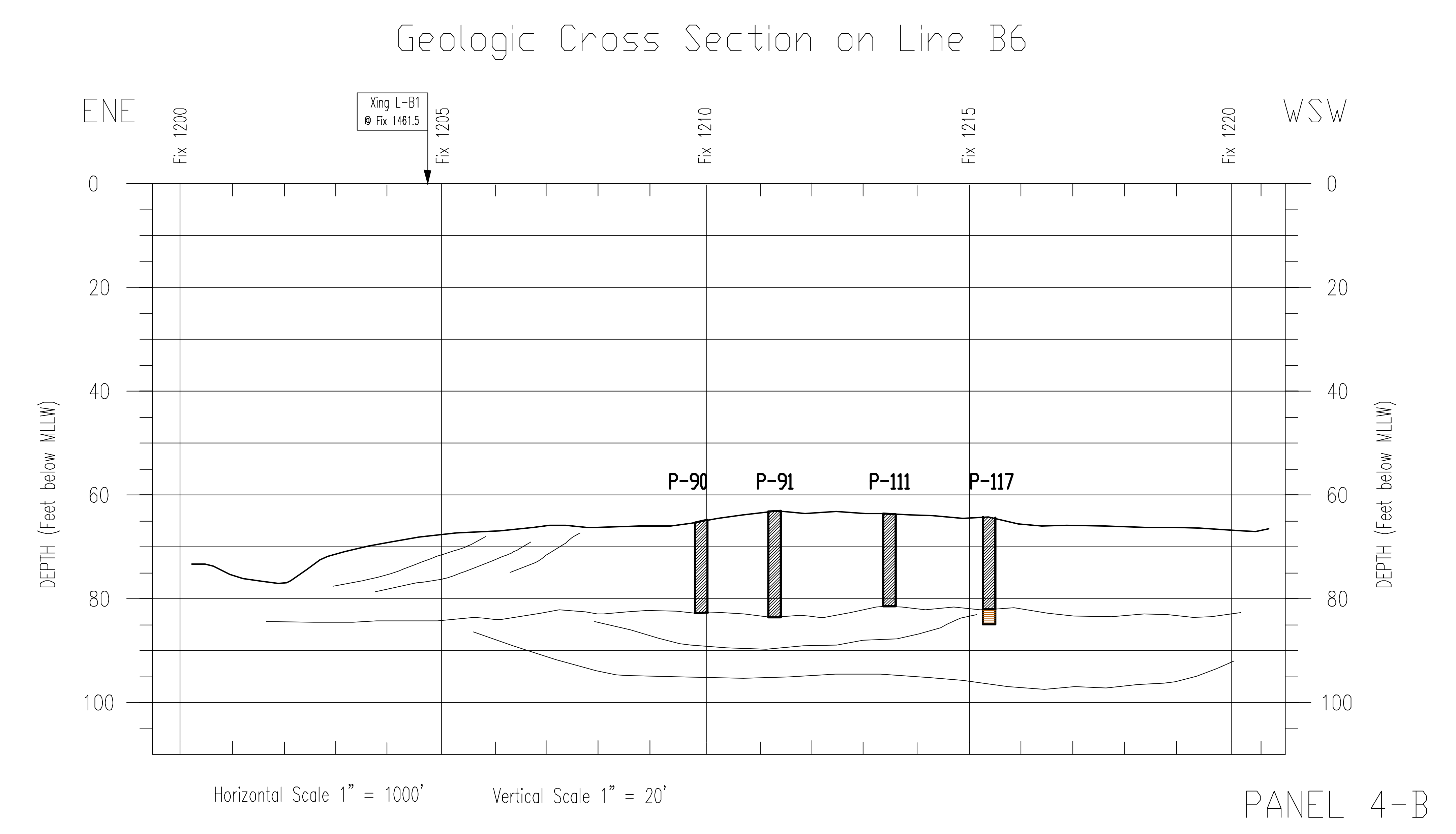

Geologic Cross Section on "Extra Cross Line"

PANEL 3-F



Geologic Cross Section on Line B1

PANEL 4-A



Geologic Cross Section on Line B6

PANEL 4-B

OLSEN ASSOCIATES, INC.

GEOPHYSICAL SURVEY RESULTS
PENSACOLA BEACH - FL

Feasibility Study for Beach Restoration
Sand Search Investigation

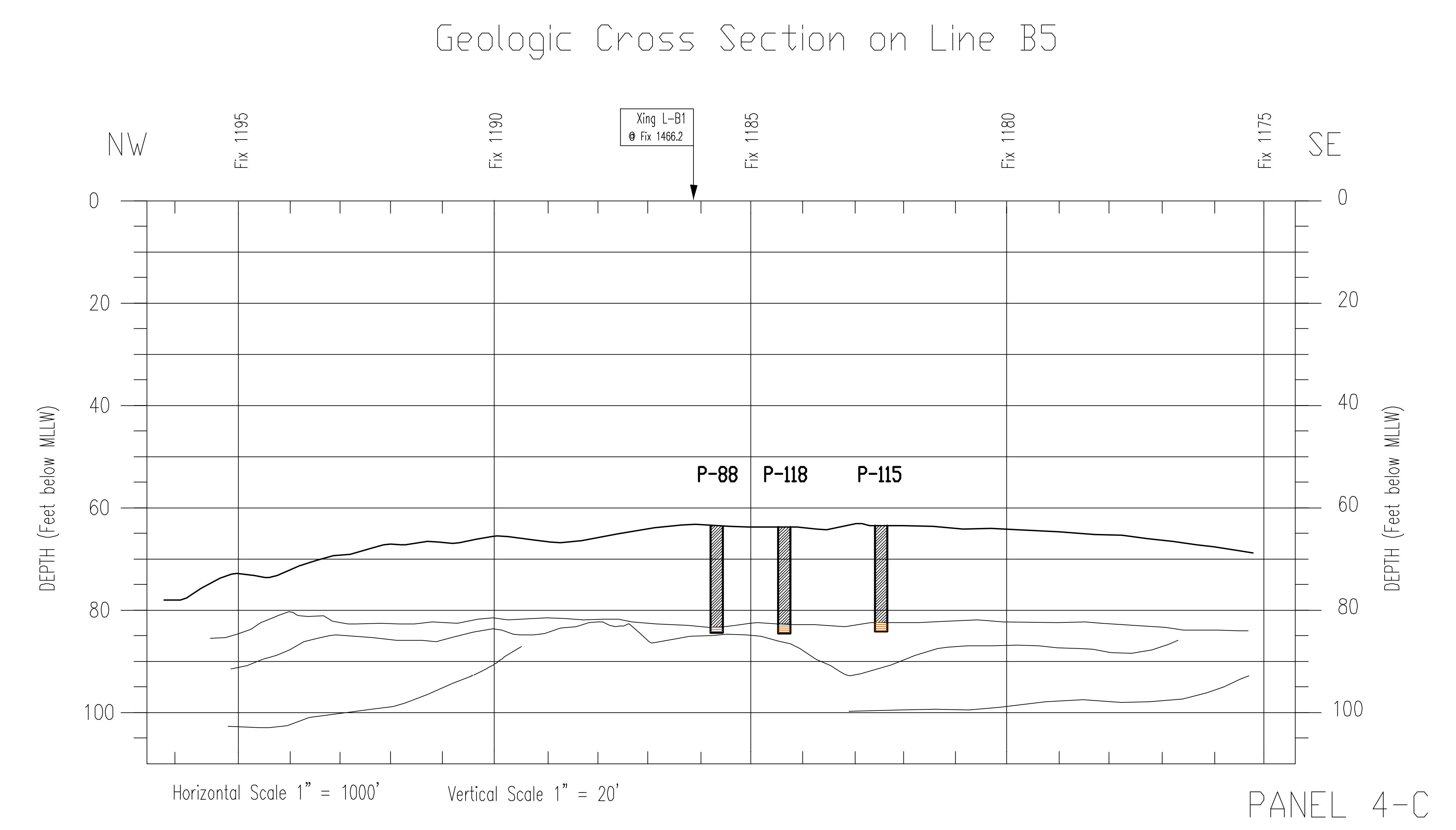
Projection:	FL-0903 NAD 83	Plot Date:	JUN. 2001
Spheroid:	WGS 84	JOB 1366	
Site:	PENSACOLA BEACH, FL		

Prepared by:

ALPINE OCEAN SEISMIC SURVEY, INC.
Norwood, New Jersey

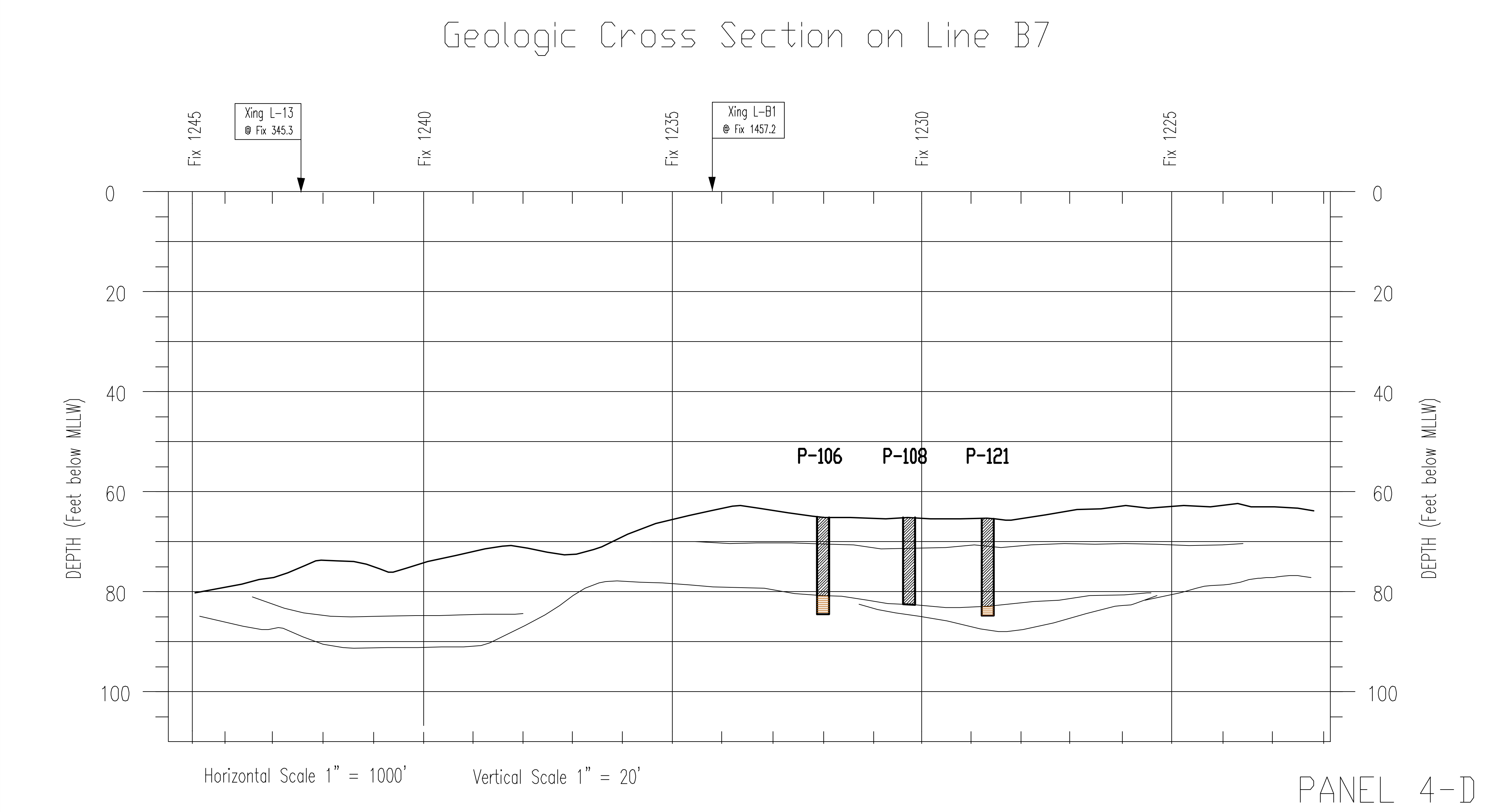
- Figure 4 -

OFFSHORE GEOLOGIC CROSS SECTIONS



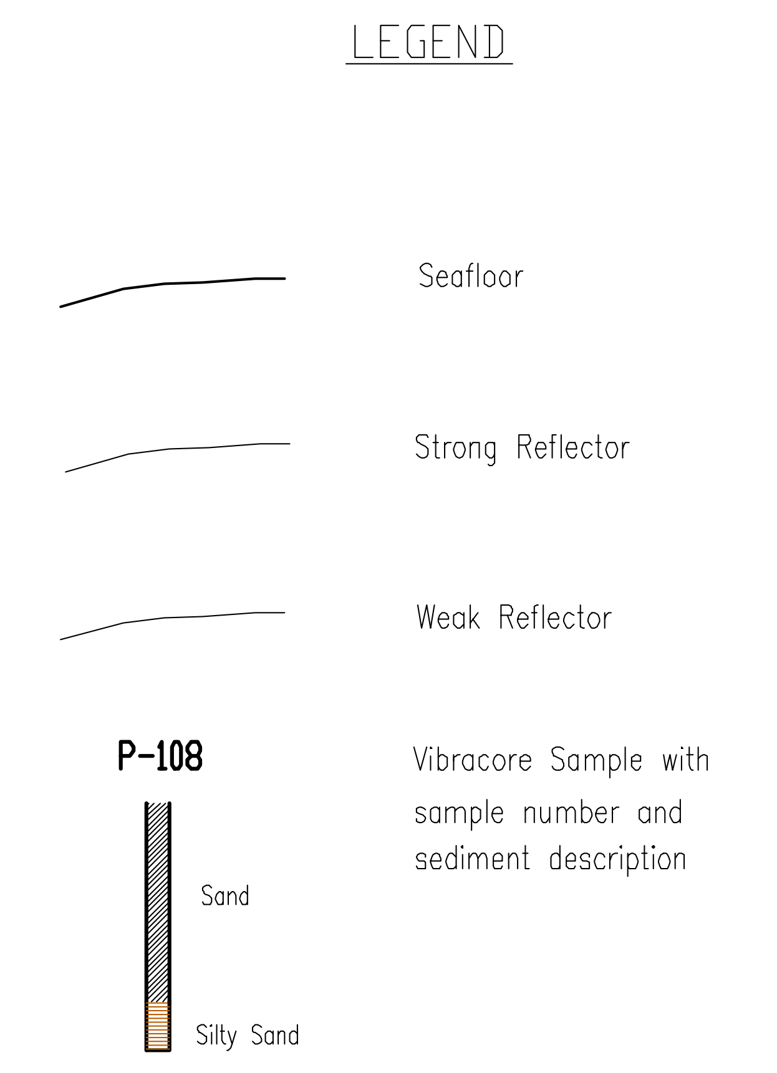
Geologic Cross Section on Line B5

PANEL 4-C



Geologic Cross Section on Line B7

PANEL 4-D



LEGEND

APPENDIX 1 Pensacola Beach Pier Boring Logs

AOSS Appendix 1

Larry M. Jacobs & Associates, Inc.

Geotechnical Engineering / Material Testing / Drilling

December 31, 1998

Mr. Dave Hemphill
Baskerville-Donovan, Inc.
316 S. Baylen Street, Suite 300
Pensacola, FL 32501

SUBJECT: Pensacola Beach Pier
LMJ&A File #98-330

Dear Dave:

This letter forwards the results of the to-date borings on the project. Boring B-1 was drilled in mid November at the edge of the beach, and was forwarded in our letter of November 30, 1998 (attached as appendix A). Boring B-2 was located at the north end of the pier just south of the parking lot. Borings B-3 and B-4 were drilled in the Gulf from a barge, and we were forced to pull off the B-4 location before completion due to hazardous working conditions. As you know the weather has been extremely erratic and we were forced to pull off the barge, as the weather fronts were too close together to allow for barge remobilization and enough safe working time, and continuing to stand by on the barge wasn't practical. We will have to return to the Gulf to drill 2 additional borings and complete B-4 some time next year when acceptable weather conditions are more likely to be encountered.

Boring B-2 at the north end of the pier encountered 4' of off-white very loose sand over white very loose to medium dense sand with some organic stain to 13' where brown medium dense sand and slightly silty sand with organic stain and some roots was present to 18'. The boring continued with white very dense to dense sand from 18' to 39' where off-white very dense fine to medium sand with shell was encountered to 41' underlain by gray very dense fine and medium sand to the bottom of the boring at 46'. Groundwater was present at 10' below grade at the time of drilling.

Boring B-3 was located 1200' south of the beach. The boring had 5' of barge above the water (assumed to be approximately elevation 0' MSL to 26' below barge deck where

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white medium dense sand was encountered to 34' over gray medium dense slightly silty sand with some shell to 38' which was underlain by gray/brown soft marine clay with some wood to 49' and gray soft clay from 49' to 59' below barge deck. Gray loose clayey silty sand with seams of sand and shell was present from 59' to 63' over gray very dense silty sand to 69' where white/gray very dense sand continued to the bottom of the boring at 76' below the barge deck.

Boring B-4 was located at roughly 960' south of the beach. The boring had 5' of barge over water to 13' below the barge deck where white medium dense sand was encountered which became very dense in the 25'-26' sample continuing very dense or just very dense to the bottom of the layer at 39'. The boring continued to 51' with gray medium to very soft clay soils to the bottom of the boring at 51' below the barge deck where the drilling was terminated due to hazardous working conditions.

Based on our subsequent discussions with you and Steve Nichols, we understand that the study on bottom erosion has determined that the bottom levels are currently at the most shallow levels that would be expected as a result of accretion from the recent hurricanes. Reportedly, the study indicated that bottom levels could be on the order of 7' below the current levels. This will have a substantial effect on the embedment depth required for the piles in the water and will preclude a shallow placement of the piles in most of the pier length, as sufficient sand cover over the clays will not be available to develop tip capacity in the sands. Figure #3 shows a soil profile for the borings which indicates that the top of the clay was more shallow in the water and the bottom was roughly 4' deeper at B-3 than on land at B-1. Establishing the piles in the clay no longer appears to be an option, as the clays were softer in B-3 and B-4 than had been encountered on land in B-1 and penetrometer testing in the clays in the undisturbed sample taken from 41.0'-43.5' in B-4 indicated a cohesion on the order of 750 psf for the clay, which was substantially below the 1200 psf for the clays encountered in B-1.

In our opinion, establishing the in water pile tips several feet into the dense sands or silty sands encountered at roughly elevation -53' (B-1) to -58' (B-3) will be necessary to handle the anticipated loadings from the top down construction method. We understand that either 24" octagonal piles or round roughly 16" composite piles are being considered to support the pier in the water. Capacity is not expected to be a problem in the very dense sandy soils for the pile sizes that are being planned for the job and allowable loadings of 60 tons/ft^2 from tip capacity only were calculated for the probable worst case condition at the south end of the pier where the embedment will be the least using the existing conditions. Skin friction will increase these values, particularly as the clay soils regain strength. Boring B-2 encountered similar and somewhat better condition for piles than at B-1, and our recommendations for on land piles are unchanged from our November 30, 1998 letter.

We hope that this letter provides sufficient information for your current requirements. Our invoice for these services is attached. Please feel free to call us if you have any questions or comments.

Very truly yours,

LARRY M. JACOBS & ASSOCIATES, INC.

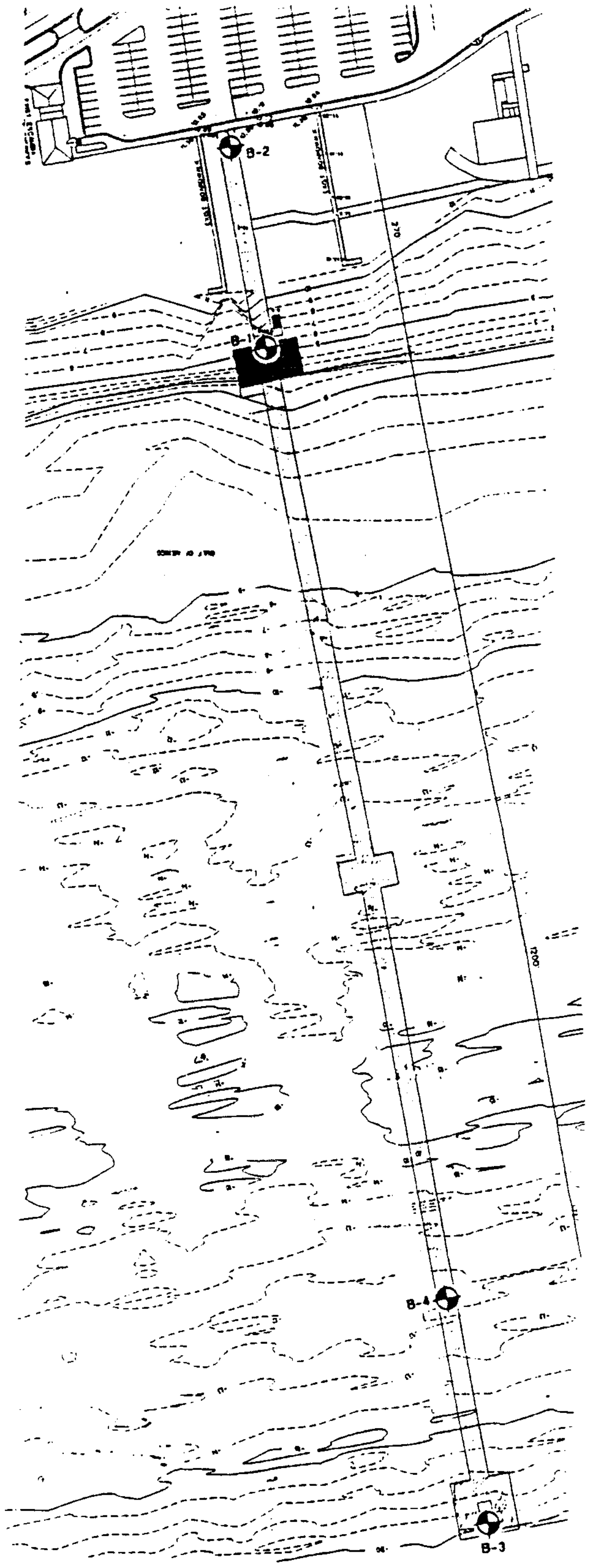
LARRY M. JACOBS, P.E.
Geotechnical Engineer
Florida Reg. #19690

LMJ-69/pb/PENPIER4

Attachment(s)

FIGURE #1

BORING LOCATION PLAN



⊕ STANDARD PENETRATION TEST BORING

ALL BORING LOCATIONS ARE APPROXIMATE

N

PROJECT: Pensacola Beach Fishing Pier

JOB: 98-330

SCALE: 1"=200'

DATE: 12/31/98

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BY: PB

Larry M. Jacobs & Associates, Inc.
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LOG OF BORING

PROJECT:
JOB NO.:
ELEVATION:
BORING NO.: BORING LOG KEY
TYPE BORING:
DATUM:
LOCATION:
DATE:
GR. WATER:

DEPTH IN FEET	LOG	DESCRIPTION	SAMPLE NO.	S.P.T.		W.C. %	ATTERBERG LIMITS		UNIT WT. pcf	% MINUS #200	SHEAR STRENGTH	Visual U/S
				Nf	Nc		L.L.	P.L.				
	⁙	SAND		N_f - FIELD HAMMER BLOWS FROM PENETRATION TEST BORING	N_c - OVERBURDEN CORRECTION IN COHESIONLESS SOIL ONLY	W.C. - NATURAL WATER CONTENT	L.L. - LIQUID LIMIT TEST RESULTS	P.L. - PLASTIC LIMIT TEST RESULTS	P.I. - PLASTICITY INDEX	% PASSING THE #200 SIEVE		SP
	▥	SILTY SAND										SM
	▥	SLIGHTLY SILTY SAND										SM/SP or SP/SM
	▥	SILT										ML or MH
	▨	CLAY										CL or CH
	▨	CLAYEY SILTY SAND or SILTY CLAYEY SAND										SM/SC or SC/SM
	⁓	PEAT or ORGANICS										PT
	▼	WATER TABLE										
	☐	SAMPLE TAKEN AT THIS DEPTH										
	■	UD = UNDISTURBED SAMPLE										
	▽	PERCHED WATER										

REMARKS: All soil classifications visual unless test results are shown.

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LOG OF BORING

PROJECT: Pensacola Beach Pier
JOB NO.: 98-330
ELEVATION: +4' MSL (Approx.)
BORING NO.: B-1
TYPE BORING: ASTM-D1586
DATUM: Existing Grade
LOCATION: As per Figure #1
DATE: 11/11/98
GR. WATER: 2.0' Below Datum At Time of Boring

DEPTH IN FEET	LOG	DESCRIPTION	SAMPLE NO.	S.P.T.		W.C. %	ATTERBERG LIMITS		UNIT WT. pcf	% MINUS #200	SHEAR STRENGTH	Visual U/S
				N1	Nc		L.L.	P.L.				
		White very loose to medium dense fine sand	1	4								SP
			2	12								
5		White medium dense medium to fine sand with slight organic stain	3	15								SP
			4	12								
10		White medium dense to dense to medium dense fine and medium sand	5	17								SP
15			6	36								
20			7	30								
25		Light brown dense sand with slight organic stain	8	35								SP
30		White medium dense sand with slight organic stain	9	18								SP
35		Gray/brown medium dense silty sand	10	17								SM
40		Gray/brown loose slightly clayey silty sand	11	7								SC
		Gray medium clay with seams of sand	*UD			62.2	117	38			q_u=2400 psf	OH to OL/SC
45			12	7								
50			13	8								
55		Gray very loose clayey silty sand to sandy clay	14	4								SC/OL
		Gray dense sand										SP
60												

REMARKS: All soil classifications visual unless test results are shown.

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LOG OF BORING

PROJECT: Pensacola Beach Pier
JOB NO.: 98-330
ELEVATION: +4' MSL (Approx.)
BORING NO.: B-1
TYPE BORING: ASTM-D1586
DATUM: Existing Grade
LOCATION: As per Figure #1
DATE: 11/11/98
GR. WATER: 2.0' Below Datum At Time of Boring

DEPTH IN FEET	LOG	DESCRIPTION	SAMPLE NO.	S.P.T.		W.C. %	ATTERBERG LIMITS		UNIT WT. pcf	% MINUS #200	SHEAR STRENGTH	Visual U/S
				N1	Nc		L.L.	P.L.				
			15	31								SP

*UD = Undisturbed Sample taken from 41.0'-43.5'

65
70
75
80
85
90
95
100
105
110
115
120

REMARKS: All soil classifications visual unless test results are shown.

FIGURE #2

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LOG OF BORING

PROJECT: Pensacola Beach Pier

JOB NO.: 98-330

ELEVATION: +11' MSL (Approx.)

BORING NO.: B-2

TYPE BORING: ASTM-D1586

DATUM: Existing Grade

LOCATION: North End of Pier

DATE: 12/14/98

GR. WATER: 10.0' Below Datum At Time of Boring

DEPTH IN FEET	LOG	DESCRIPTION	SAMPLE NO.	S.P.T.		W.C. %	ATTERBERG LIMITS		UNIT WT. pcf	% MINUS #200	SHEAR STRENGTH	Visual U/S
				Nf	Nc		L.L.	P.L.				
		Off-white very loose sand	1	3								SP
			2	3								
5		White very loose to medium dense sand with some organic stain	3	4								SP
	▼		4	14								
10			5	12								
15		Brown medium dense sand and slightly silty sand with organic stain and roots	6	20								SP & SP/SM
20		White very dense to dense sand	7	57								SP
25			8	39								
30			9	42								
35			10	32								
40		Off-white very dense fine to medium sand with shell	11	62								SP
45		Gray very dense fine and medium sand	12	79								SP
50												
55												
60												

REMARKS: All soil classifications visual unless test results are shown.

FIGURE #2

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LOG OF BORING

PROJECT: Pensacola Beach Pier
JOB NO.: 98-330
ELEVATION: +5' MSL (Approx.)

BORING NO.: B-3
TYPE BORING: ASTM-D1586
DATUM: Existing Grade

LOCATION: Approximately 1200' South of Beach
DATE: 12/15/98
GR. WATER: Assumed at 0' Elevation

DEPTH IN FEET	LOG	DESCRIPTION	SAMPLE NO.	S.P.T.		W.C. %	ATTERBERG LIMITS		UNIT WT. pcf	% MINUS #200	SHEAR STRENGTH	Visual U/S
				Nf	Nc		L.L.	P.L.				
		Barge										
5 10 15 20 25		Water										
30		White medium dense sand	1 2	14 18								SP
35		Gray medium dense slightly silty sand with some shell	3 *UD	23								SP/SM
40 45		Gray/brown soft clay with some wood	4 5	3 2								OH
50 55		Gray very soft to soft clay	6 7	2 3								OH
60		Gray loose clayey silty sand with seams of sand and shell										SC/OL

REMARKS: All soil classifications visual unless test results are shown.

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LOG OF BORING

PROJECT: Pensacola Beach Pier

JOB NO.: 98-330

ELEVATION: +5' MSL (Approx.)

BORING NO.: B-3

TYPE BORING: ASTM-D1586

DATUM: Existing Grade

LOCATION: Approximately 1200' South of Beach

DATE: 12/15/98

GR. WATER: Assumed at 0' Elevation

DEPTH IN FEET	LOG	DESCRIPTION	SAMPLE NO.	S.P.T.		W.C. %	ATTERBERG LIMITS		UNIT WT. pcf	% MINUS #200	SHEAR STRENGTH	Visual U/S
				Nf	Nc		L.L.	P.L.				
	▨		8	5								SC/CL
65	▥	Gray very dense silty sand	9	89+								SM
70	░	White/gray very dense sand	10	89								SP
75			11	100+								
80												
85												
90												
95												
100												
105												
110												
115												
120												

*UD = Undisturbed Sample attempted from 36.0'-38.5'

REMARKS: All soil classifications visual unless test results are shown.

FIGURE [illegible]

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LOG OF BORING

PROJECT: Pensacola Beach Pier
JOB NO.: 98-330
ELEVATION: +5' MSL (Approx.)

BORING NO.: B-4
TYPE BORING: ASTM-D1586
DATUM: Existing Grade

LOCATION: Approximately 960' South of Beach
DATE: 12/16/98
GR. WATER: Assumed at 0' Elevation

DEPTH IN FEET	LOG	DESCRIPTION	SAMPLE NO.	S.P.T.		W.C. %	ATTERBERG LIMITS		UNIT WT. pcf	% MINUS #200	SHEAR STRENGTH	Visual U/S
				Nf	Nc		L.L.	P.L.				
		Barge										
5		Water										
10												
		White medium dense to very dense										SP
15												
			1	17								
20												
25			2	100+								
30			3	50								
35			4	86								
		Gray medium to very soft to soft clay										OH
40			5	7								
			*UD									
45			6	2								
50			7	4								
55												
60												

*UD = Undisturbed Sample taken from 41.0'-43.5'

REMARKS: All soil classifications visual unless test results are shown.

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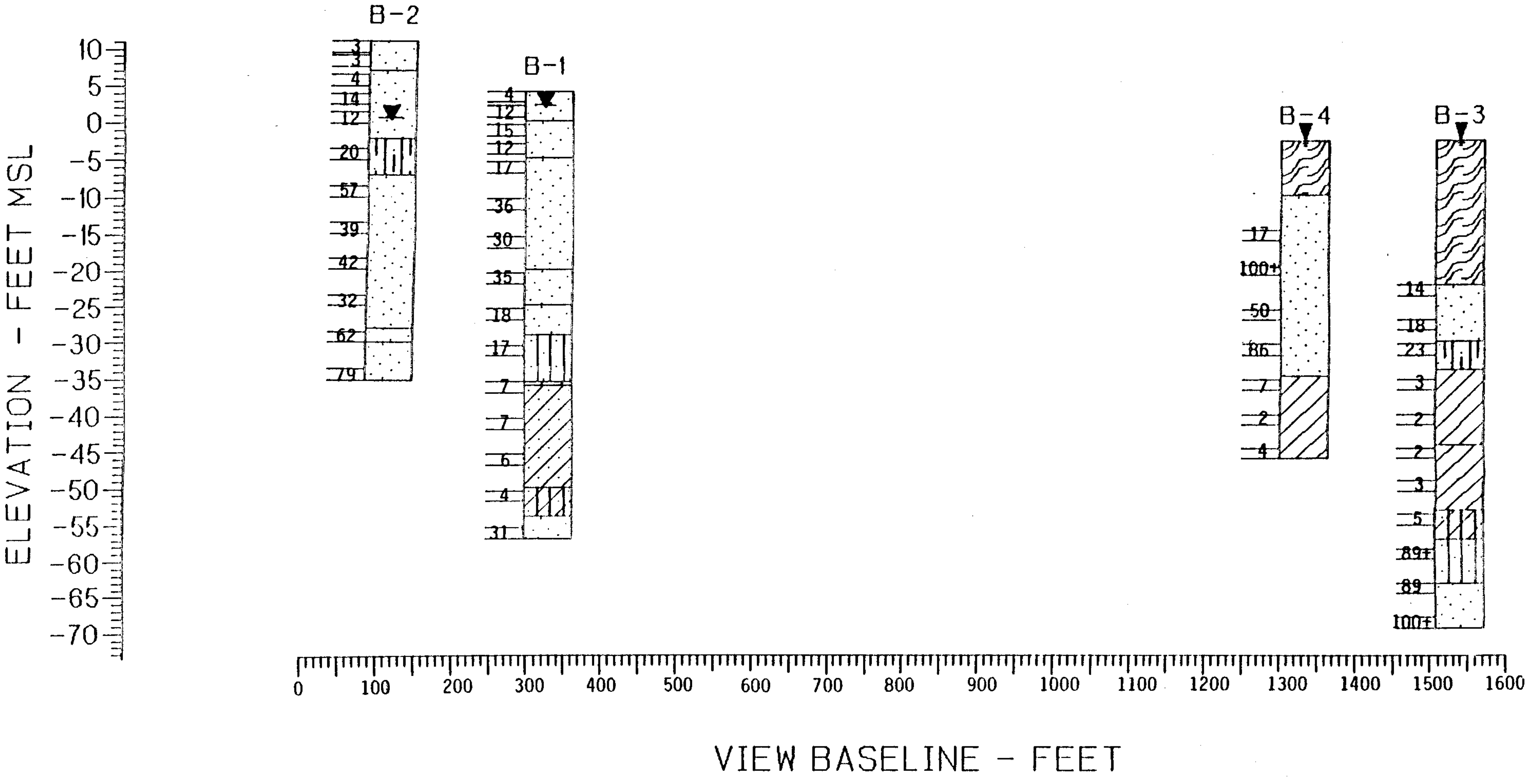

FIGURE #3

Cross Section View
Pensacola Beach Pier
11/11/98