Indian River County
Beach Restoration Projects

Geotechnical Investigation of Offshore Sand Sources

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Prepared for:
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1.0 Introduction

1.1 Purpose

The purpose of this study was to conduct geophysical and geotechnical investigations necessary to locate and identify potential Atlantic Ocean offshore sources of suitable sand material for the Indian River County Beach Restoration Plan. After reviewing previous sand source investigations conducted by the U.S. Army Corps of Engineers, two target areas within state of Florida waters were identified for detailed investigation. The northernmost area is located offshore of the Sebastian Inlet State Recreation Area approximately three miles south of Sebastian Inlet. The second general area investigated was a portion of the Indian River Shoal complex, which extends from offshore of Riomar into the waters offshore of St. Lucie County. The potential borrow site in the northern part of the County is referred hereafter as the North borrow site. The Indian River Shoal feature contains two target areas, the Central borrow site (located in the northern portion of the Shoal) and the South borrow site located in the southern portion. Figure 1 presents a general location map depicting these potential sand source sites and the desired beach nourishment areas in Indian River County.

1.2 Scope

Geophysical and subsurface physical testing of these three offshore sites was conducted to provide the necessary data and information to evaluate and delineate specific sand deposits suitable for use as beach fill material. The potential borrow areas investigated were subsequently assessed for sediment quality and quantity, and potential environmental impacts.

Beach and nearshore field investigations were conducted to determine the characteristics of the native beach material in the proposed beach nourishment areas Sectors 1, 2, and 3. The compatibility of the potential fill material and the native beach material was then analyzed based on the sediment characteristics. Analyses and technical evaluations of the compatibility will provide the basis for final project design, costing, and performance projections for the proposed beach nourishment projects.

The following field investigations, tests, and analyses were performed:

- Hydrographic surveys
- Subsurface jet probes
- Core borings
- Native beach sand sampling
- Sediment testing and analysis
- Quantitative analysis of borrow site sediments
- Compatibility analysis between native beach and borrow area sediments

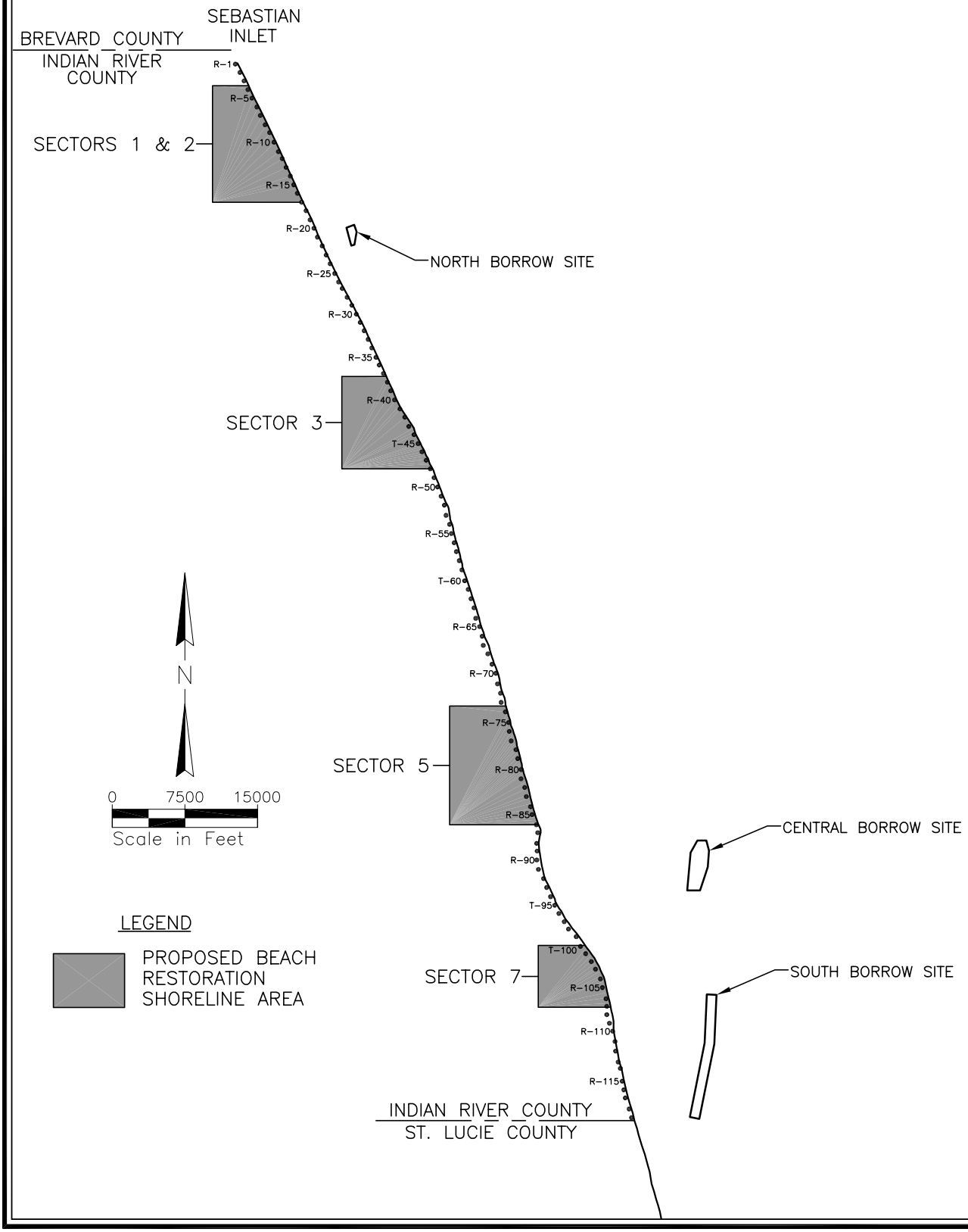

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Figure 1
Indian River County
Proposed Beach Restoration Shoreline Area
and Potential Offshore Sand Sources

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2.0 Background

2.1 Geographic Setting

Indian River County has 22.4 miles of barrier island beaches fronting the Atlantic Ocean. Sebastian Inlet delineates the north county boundary. The inlet is locally maintained to depths of -10 to -12 feet MLW. The inlet is stabilized by two jetties, north and south of the inlet channel, which extend out approximately 1,000 feet and 400 feet from the mean high water lines of the north and south shorelines, respectively. Jetty structures tend to block the littoral transport of sand, and result in an updrift impoundment and downdrift deficit. In Indian River County, the net littoral transport direction is from north to south.

The presence and configuration of Sebastian Inlet has disrupted transport, resulting in severe erosion of the beaches south of the inlet. Additionally, some of the sand that naturally bypasses the inlet is deposited on the ebb shoal located offshore and south of the inlet. It has been estimated that the inlet is the cause of an annual 70,000 to 75,000 cubic yard deficit to the downdrift shoreline (BPP Update, 1998). Currently, the Sebastian Inlet Tax District is mechanically bypassing (on average) 75,000 cubic yards each year through a combination of interior sand trap dredge disposal and truck transfer from an approved upland sand source, and depositing sand on the beaches in varying locations within 2 miles south of the inlet. However, to date this activity has failed to completely stabilize the eroding shorelines.

One feature that is predominant along the coastline of Indian River County is a nearshore reef, or hardbottom system. The hardbottom spans nearly the entire County except along an approximately 6,000 foot shoreline segment at Riomar, and is oriented parallel to the coastline. Generally, the shore-parallel ridges begin at water depths of 5-8 feet and extend over 2,000 feet offshore. This hardbottom feature is made of limestone rock outcrops colonized by marine life consisting of sabellariid worms, sponges, algae and bio-fouling communities (CSAi, 2000).

The Indian River County shoreline is a constituent of the Barrier Island Overwash and Relic Inlet Zone of the east central Florida Barrier Island System. Along this section of coast extending from Melbourne to Ft. Pierce Inlet, the barrier island superstructure is relatively narrow. Numerous overwash terraces, now coalescing to form a storm surge platform, form the landward side of the superstructure. The lower areas of this platform are vegetated wetlands or mangrove swamps. This low, sandy platform was likely generated by a combination of storm surge overwash and inlet breaching of the barrier superstructure. Thus, the barrier island system consists of a wave-built shoreface extending seaward to depths of 30 feet or more to which a series of sandy platforms generated by tidal inlet and storm processes become attached on the landward side.

Migrating inlets can extend barrier island width through deposition of flood shoals that become incorporated in the barrier superstructure once the inlet has closed or migrates to another location (Zarillo and Liu, 1990). Relic inlets can also create features offshore. As a tidal inlet opens and evolves by migrating, ebb shoals become elongated and are

eventually "disconnected" from the lower shoreface due to rising sea level and retreating shorelines. The time scale for this process is millennial. During this long-term process, a shoal originating at a tidal inlet becomes part of the hydraulic regime of the inner continental shelf and is re-worked by the numerous strong storm flows that occur over long time periods. It is believed that Indian River Shoal was formed this way. The shoal lies in an area off the southern end of Indian River County and extends on a southerly trending orientation into northern St. Lucie County. The shoal is approximately 1,477 acres in size. Figure 2 is a conceptual model showing the origin and evolution of continental shelf sand ridges from ebb-tidal shoals. Indian River Shoal corresponds to Stage 5 of development (from Moody, 1964).

2.2 Geologic Setting

The geomorphic setting of Indian River County is an important factor in determining the stability of the County's beaches, and is particularly important in determining the availability of sand resources. To better understand the recent changes impacting the shoreline, one must also be cognizant of the longer-term, large-scale geologic features unique to this segment of the Atlantic Ocean barrier island coast.

The results of core borings completed by this study, coupled with limited seismic records collected by the U.S. Army Corps of Engineers, indicate that there are several distinctive sedimentary layers. Suitable sand for beach restoration can often be found within these layers. Figure 3 displays an idealized transgressive sedimentary layer sequence for the inner continental shelf of central Florida (Zarillo et al, 1993). The Pleistocene Carbonate layer corresponds to the Anastasia Formation, which underlies east Florida and the inner continental shelf. Back barrier organic-rich mud and peat directly overlying the Pleistocene layer demarcate the first occurrence of marine conditions with post-Pleistocene rising sea level. Lagoonal mud, washover sand, and flood shoal deposits may rest on top of basal organic and peat deposits. The entire back barrier layer, when found in cores from the inner continental shelf, is evidence that barrier islands were situated further seaward during early Holocene time, and that modern barrier islands evolved from these early systems with rising sea level over the past 10,000 years.

The two upper layers in Figure 3 are the primary targets of exploration for sand resources. The transgressive sand can be considered the remnants of earlier shoreface beach and barrier island deposits. The modern post-transgressive sand sheet is episodically re-worked by storm and wave-generated currents and has a narrower size distribution. At some locations, this sedimentary layer has been thickened into linear shoals by a combination of inlet and storm processes. Indian River Shoal, as well as numerous other linear shoals found on the Florida continental shelf, fits into this category of sand deposit. These shoals are likely to be excellent sources of clean and relatively coarse-grained sand due to nearly continuous re-working by a modern shelf hydraulic regime.

2.3 Previous Work and Existing Data

A thorough review of all existing geotechnical data in the County files, as well as a search in the University of Florida's Coastal Engineering Archives, was conducted to determine the qualitative and quantitative findings of prior sand source investigations offshore of Indian River County. Dr. Gary Zarillo, P.G. of Scientific Environmental Applications, Inc. (SEA) was additionally contracted to provide documentation and recommendations from his past works regarding the Indian River Shoal complex. Previous studies and reports conducted by others (Meisburger and Duane, 1971; USACE, 1987; CP&E, 1989) were reviewed, and served to guide the offshore investigation of the Indian River Shoal and the area offshore and south of the Sebastian Inlet State Recreation Area.

Upon completion of the existing data review of the two above named areas, three target sites were identified for further detailed investigation. These sites were identified as: the North borrow site, located in the same general area as that explored by the USACE (which was designated by the USACE as the Sebastian Inlet State Recreation Area potential borrow site); and the Central and South borrow sites, located within the Indian River Shoal complex.

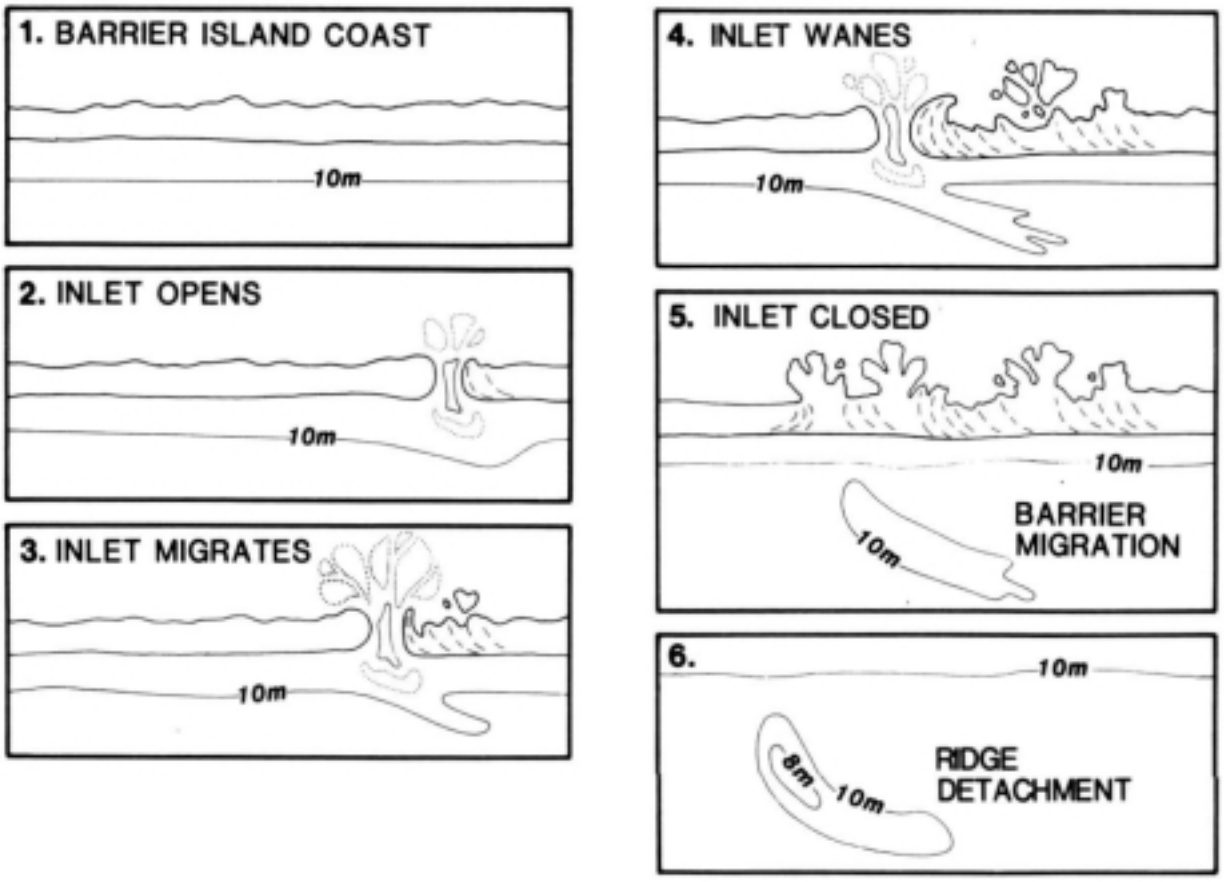

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Figure 2
Conceptualized Model Showing the Origin and Evolution of Continental Shelf Sand Ridges from Ebb-Tidal Shoals--Indian River Shoal Corresponds to Stage 5 of Development (from Moody, 1964)

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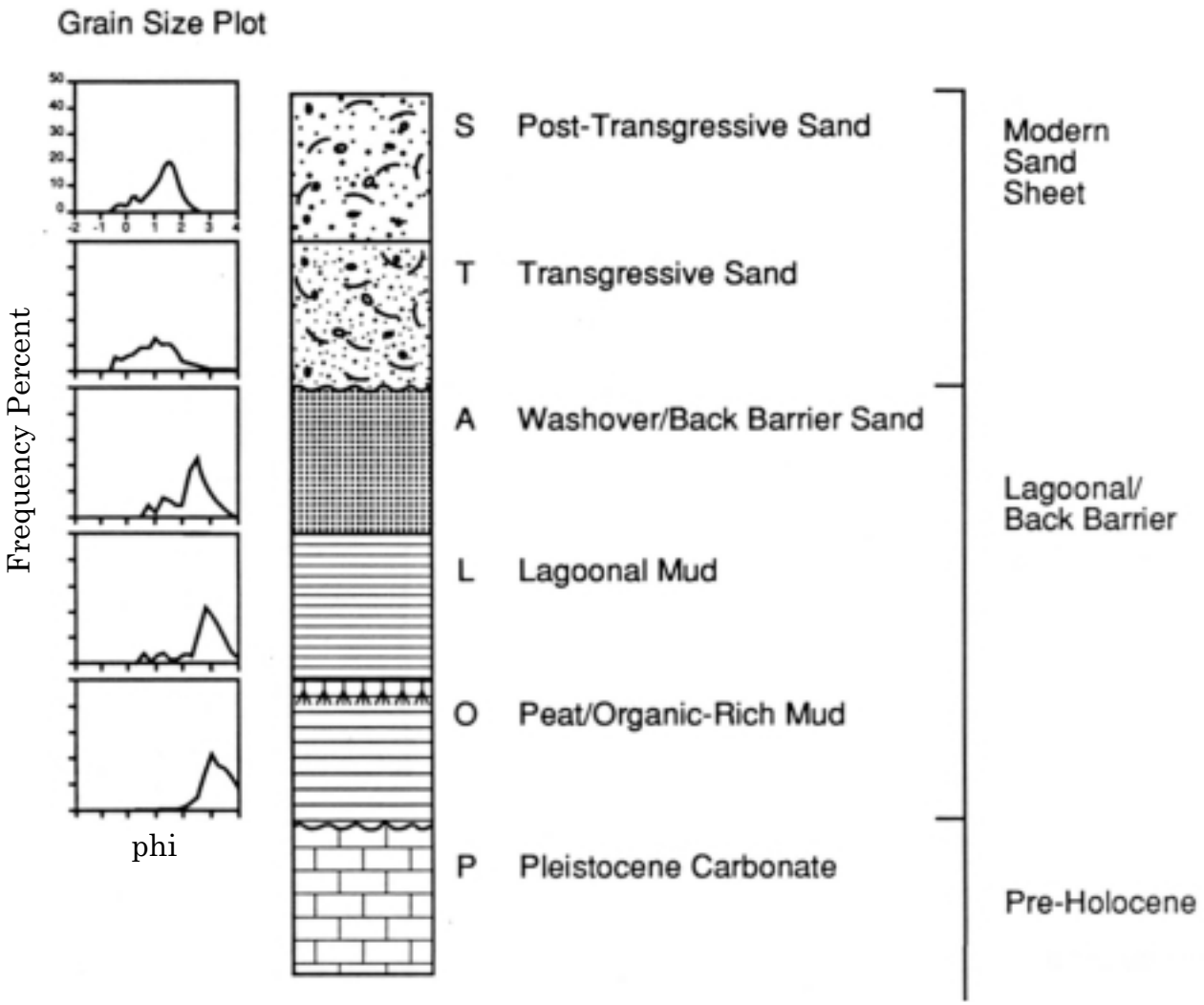

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Figure 3
Idealized Transgressive Sedimentary Sequence
for the Inner Continental Shelf of Central Florida
(Zarillo et al., 1993)

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3.0 Field Investigations

3.1 Preliminary Target Area Delineation and Subsurface Determination

The previous investigation work and acquired geophysical data were utilized to guide decision making to identify locations of search areas with the highest potential to contain beach-quality sands. Following the acquisition of coarse survey grid bathymetry conducted by Morgan & Eklund, Inc. in February 1999, and in review of the NOAA Coast Charts of the area, jet probe target areas were identified as the initial basis for gathering subsurface information.

Jet Probes

Jet probes are used to determine the depths and characteristics of the sediment. Jet probe samples were collected using a 15-foot long steel pipe probe connected to a surface pump assembly. A water jet was directed from the centrifugal pump to the tip of the probe, which the divers inserted vertically into the underlying sediments. Target sites were determined based on the results of the coarse-grid bathymetry survey. During May 1999, Underwater Engineering Sciences, Inc. (UES) divers, directed and placed on each target site by ATM, conducted the jet probe investigation.

Thirty-two (32) jet probes were collected in and around the North borrow site, 17 in and around the Central borrow site, and 30 in the South borrow site. In addition, the divers recorded visual observations of surrounding bottom features along with the depth and character of the probing activity. They also acquired surficial and wash sediment grab samples at each probe site. The surficial samples were used to assess the energy of the environment as well as the long-term processes and movement of the material. The wash sediment samples were collected to analyze general grain size distribution characteristics of the underlying sediments. Water depths were recorded and the sand samples were labeled by site.

A plan view map of the probe locations and tabular summary of individual probe findings were prepared and submitted to the County Coastal Engineer in June 1999 and are attached in Appendix A. A total of 12 sediment grab samples from all three sites were subjected to grain size distribution sediment analysis in accordance with ASTM Standard D-422 to determine relative quality of the material (results are also presented in Appendix A). Due to suspension of fine-grained sediments in the surrounding water column caused by the jet probing activity, the silt/clay content of the jet probe samples is not a true representation of the actual grain size distribution. Rather, it merely represents the general characteristics of the sediments.

The results of the jet probe investigation confirmed that the material found at the potential borrow sites is of adequate sediment quality and quantity to warrant an additional, more detailed sand source investigation.

3.2 Subsurface

Vibracore borings allow sediment samples to be collected and retained for analysis in order to determine, in further detail, the characteristics of the materials contained in the target borrow sites.

Vibracores

Vibracore samples were collected with a 4-inch diameter, 20-foot long schedule 40 galvanized steel core pipe and cutting edge collar driven vertically into the sea floor by a pneumatic impacting piston. The core sample was retained in a 3 7/8-inch OD clear lexan liner located inside the core barrel. This method of subsurface investigation allows for the detailed analysis of the quality of material in the potential borrow areas. A total of 60 vibracore samples were collected between June 26 and July 2, 1999 by Alpine Ocean Seismic Survey, Inc. (AOSS), with vessel position and core acquisition locations supervised and directed by ATM. Ten additional vibracores were collected within the North borrow site in October 2000 by AOSS and ATM.

During the June-July 1999 investigation, a total of 30 vibracores were acquired at the North site, 14 were acquired at the Central site, and 26 were acquired at the South site. The average depth of penetration at all three sites was 18 feet. All vibracores were transported to SEA's Melbourne Village, Florida laboratory, where they were subjected to splitting, visual logging, color photography at 1-foot intervals, and sampling at distinct sediment horizons by Dr. Gary A. Zarillo, P.G. SEA extracted a total of 250 sediment samples from the acquired vibracores. Following review of the draft vibracore logs by ATM, SEA was directed to subject a total of 236 of the original 250 sediment samples to grain size analysis and percent silt/clay content determination. The 14 samples not subjected to analysis were determined to be unsuitable based on vertical location within the vibracore and/or visual representation of poor sediment quality (i.e., not viable for beach placement).

The sediment sample classifications were prepared in accordance with the Unified Soils Classification System as described in ASTM Standard D-2487. The grain size analyses were conducted according to ASTM Standard D-422 for mechanical particle size analysis of the soils. Grain size distribution of samples processed in accordance with the above procedures was analyzed using the methods of moments and graphic procedures for calculating grain-size statistics (USACE, 1995). Tabular summaries of each sample were generated reporting sieve size, phi size, mesh opening size in mm, weight of sediment retained, cumulative percent retained, and cumulative percent passing. Sample statistics were also calculated including mean, standard deviation, skewness, and kurtosis in accordance with USACE Form 2087. A summary of the percent silt/clay content and the individual logs are provided in Appendix B. Complete copies of the laboratory analyses (vibracore logs, sediment analysis data sheets, and grain size distribution curves) are provided in three separately bound notebooks (SEA, 1999), previously furnished to the Florida Department of Environmental Protection and Indian River County.

Results of the analysis of sediment initially acquired at the North site indicated an inconsistent quality of surficial sand and shell material overlaying a quartz-rich poorly-sorted sand deposit. Due to the proximity of this site to the northern (Sectors 1, 2 and 3) project areas (and thus the potential cost savings to the project by utilizing the North site as opposed to the Central or South Borrow Areas for the Sectors 1, 2 and 3 projects), supplemental vibracores were acquired in October 2000 by AOSS under the direction of ATM. A total of 10 supplemental cores were obtained, from which SEA extracted a total of 78 sub-samples. Of these, 74 were subjected to mechanical particle size and percent calcium carbonate analyses (SEA, 2001). In addition, one mechanical composite was created from each of the 10 individual cores. The locations of these cores are depicted on the drawings in Appendix B.

3.3 Geophysical

After designating the three target borrow sites via acquisition and analysis of jet probe and vibracore samples, detailed, site-specific offshore geophysical investigations were completed. The geophysical investigations included bathymetric, side-scan sonar, and magnetometer surveys. The information was utilized to determine the horizontal margins of the potential borrow areas by examining the contours and sediment layer densities, and locating any existing significant ferrous materials.

Bathymetry

To better delineate the potential borrow area topography, and to determine the dominant contour locations of the Indian River Shoal area and the North borrow site, Morgan & Eklund, Inc. conducted a detailed bathymetric survey of the three borrow area locations. Track lines were run in an east-west direction at 500 feet on center and north-south at 1000 feet on center. All instrumentation was integrated to an onboard vessel navigation and tracking system (HYPACK™). Vessel positioning was interfaced with a Trimble™ Differential Global Positioning System (DGPS).

The detailed bathymetric survey of the North borrow site, conducted on February 7, 2000, covered an area approximately 5,600 feet by 2,500 feet (approximately 321 acres). The results show a generally shore-parallel offshore contour orientation with a visible change in orientation at the –36 foot contour.

The survey of the Central borrow site (completed on December 22, 1999) covered an area approximately 7000 feet by 3000 feet (approximately 482 acres). The bathymetry shows the large depositional mound, which lies in the center of the survey area. The mound has a wide plateau and surface elevations ranging from –24 to –45 feet NGVD.

Based on bathymetric survey data collected on January 13, 2000, the South borrow site assumes the shape of two rectangular geometries, joined at an angle to follow the contours of the large depositional feature. The bathymetric survey followed the site geometry, examining rectangular areas of approximately 2,500 feet wide by 5,700 feet long and 2,500 feet wide by 8,300 feet long (a total of approximately 808 acres). The bathymetry revealed that the shoal has a wide plateau in the center of the survey area with

surface elevations ranging from –17 to –32 feet NGVD. Results of the survey are presented in Appendix C.

Side-Scan Sonar

Side-Scan Sonar technology utilizes acoustic signals, towed from a surface vessel, to produce a continuous image of the seafloor. The results provide a relative distinction between surface sediment types such as rock outcrops, underlying rock, and sediment layers. The purpose of this survey was to locate areas that would require modification of the dredging limits for each borrow site. The acoustic signals are emitted from a source called a towfish that is dragged below the water's surface along vessel track lines parallel to the dominant bathymetric contour direction. As the signals are propagated from the source, the lapsed time is measured between the pulse initiation and the arrival of the return signals reflected from the various features on or beneath the bottom (USACE, 1995).

To optimize feedback, a Klein 595 Dual Frequency Side-Scan Sonar System was towed along a north-south track line grid with a line spacing of 300 feet, and was run along the same boundary as the detailed bathymetry survey. Morgan & Eklund, Inc. completed the side scan survey of each of the three sites on February 17, 2000 (South), April 28, 2000 (Central), and April 29, 2000 (North). A detailed description of the survey process and results are presented in the Submerged Cultural Resource Remote Sensing Survey Report (Baer, 2000), developed by marine archaeological investigator Dr. Robert Baer for Morgan & Eklund, Inc.

A total of 14 side scan transects were run in the North borrow site, detecting four sonar targets. All targets were located close to the outer boundaries of the *survey* area, outside of the designated borrow area boundaries. A total of 15 transects were run in the Central borrow site, recording eight sonar targets. Several of these targets were significant enough to require diver verification. All of the targets were identified as variations in the surface sediments, revealing areas of fine shell and dark drifted sand. A total of 13 transects were run in the South borrow site with no sonar targets identified. These results are presented in drawings in Appendix C.

Magnetometer

Morgan & Eklund, Inc. also conducted a magnetometer survey to detect the presence, location, and magnitude of magnetic anomalies such as historical wreckage or other such potential submerged cultural resources that need to be avoided during dredging of the borrow sites. This survey was conducted in accordance with standards established by the Florida Department of State, Division of Historical Resources, and applicable Federal standards and guidelines. This included running "sweeps" along track lines with 100 feet on-center spacing, with the magnetic sensor being towed at no more than 10 feet above the sea bottom.

The focus of the magnetometer investigation encompassed a slightly smaller area than the bathymetry and side scan surveys, essentially covering the area of the defined borrow area boundaries. The positioning control of the vessel was maintained using the DGPS

system described above. The magnetometer data was acquired using a Geometrics™ G-881 Marine Cesium Magnetometer, which detects external magnetic fields caused by geological and man-made objects. A detailed description of the survey process and results are presented in the Submerged Cultural Resource Remote Sensing Survey Report (Baer, 2000).

Between May 10 and 12, 2000, a total of 15 transects were run in the North borrow site with one magnetic anomaly of low intensity detected. A total of 26 transects were run in the Central borrow site, recording 79 anomalies. In the South borrow site, 16 magnetometer transects were run, detecting a total of 12 anomalies. The locations of the respective anomalies are plotted in the drawings in Appendix C.

The anomaly in the North borrow site was considered insignificant due to its size and location outside of the designated borrow area boundaries. When the anomalies in the Central borrow site were plotted in plan view, the data depicted three linear trending features. Divers verified these objects to be cables, one of which is confirmed to be an AT&T fiber optic, armored telephone cable (Baer, 2000). Two of the cables are parallel and lie in close proximity to each other, running east-west across the center of the borrow site. The third cable also runs east-west, crossing the southern portion of the borrow site.

The more significant anomalies in the South borrow site (based on apparent mass as measured by the magnetometer) were also subjected to diver investigation. These occurred in the center of the designated borrow area. Although unidentified (not visually documented by divers), they are believed to be the remains of an anchor, which once served as a mooring for a navigation buoy on the shoal (personal communication, Indian River County). The Submerged Cultural Resource report (Baer, 2000) recommends that a 200-foot radius buffer zone be placed around these anomalies for dredging purposes.

3.4 Analysis and Results

The geophysical and subsurface investigation results serve to establish the limits of the target borrow areas. The data was analyzed to determine the areas which had the highest potential to contain the quality and quantity of sand required for the beach restoration project initiatives as identified by Indian River County and ATM. It was concluded that there are no hardbottom or submerged cultural resources present in these target sites and the only areas requiring buffer zones to avoid during dredging are the cables in the Central borrow site, and the magnetic anomalies in the approximate center of the South borrow site boundary (Baer, 2000). The State Historic Preservation Officer has approved use of these sites with the recommended buffer zones.

Analyses of the sediment found in the North borrow site revealed layers of coarse shell and medium to fine-grained sand with overlying layers of muddy carbonate sand and/or silty sand. The overlying layers range in thickness from 0 to approximately 5 feet, with silt/clay contents between approximately 0 to 22 percent by weight. When vertically composited with the underlying quartz-rich sands, however, the silt/clay content over the composited cores within the designated cut boundaries is less than 4 percent overall.

Sediment analyses conducted on the Central and South borrow sites indicates that the majority of the sediments deposited on the Indian River Shoal feature are comprised of high quality, fine to medium-grained, tan to brown, shelly sand with shell fragments. The 14 vibracores collected at the Central site indicate the entire limits of the area investigated contain an 11 to 15-foot layer of this material with sand and shell deposits generally comprising 97 to 98 percent. The 26 vibracores collected throughout the South borrow site contained a 5 to 14-foot layer of material with sand and shell comprising 95 to 96 percent.

By developing a preliminary horizontal and vertical cut boundary composite of the sediment characteristics represented by the collected vibracores, the quantity and quality of material in each borrow site was determined. Four areas were delineated at the North borrow area. Each area (option) represents different cut boundaries and contains different sediment characteristics.

The composite mean grain size of the North borrow area Option 1 indicates poorly sorted medium-grained sand at 0.69 mm, with 3.16% silt/clay and 8.4% gravel sized (shell) content. Potential sand volume is approximately 1,096,800 cubic yards. The composite mean grain size of the North borrow area Option 2 indicates poorly sorted medium-grained sand at 0.68 mm, with 3.13% silt/clay and 7.5% gravel sized (shell) content. Potential sand volume is approximately 886,400 cubic yards. The composite mean grain size of the North borrow area Option 3 indicates poorly sorted medium-grained sand at 0.65 mm, with 3.35% silt/clay and 6.8% gravel sized (shell) content. Potential sand volume is approximately 788,400 cubic yards. The composite mean grain size of the North borrow area Option 4 indicates poorly sorted medium-grained sand at 0.66 mm, with 3.24% silt/clay and 6.6% gravel sized (shell) content. Potential sand volume is approximately 662,400 cubic yards.

Analyses of the Central borrow site composite determined that the site contains approximately 2,967,000 cubic yards of poorly sorted, mostly fine sand with a high concentration of medium-grained sand and 2% silt/clay and 4% gravel sized fraction content. The mean grain size of the composite cores is 0.51mm (using the moment method).

The South borrow site was estimated to contain approximately 4,065,400 cubic yards of quality sand. The site was divided into three sub-areas according to the sediment characteristics. Material classification of the South borrow site composite of sub-area 1 indicates that it contains approximately 0.92% silt/clay and 5.5% gravel sized fraction, with most of the material being fine sand. However, there is also a high content of medium-grained sand. Sub-area 1 contains approximately 1,442,000 cubic yards of poorly sorted material with a mean grain size of 0.55 mm. The sub-area 2 composite contains approximately 1,898,400 cubic yards of mostly fine sand with a high concentration of medium sand. Classification indicates an average of 1.45% content of silt/clay and 2.7% gravel. The material is poorly sorted with a mean grain size of 0.46 mm. The sub-area 3 composite contains approximately 871,800 cubic yards of mostly

fine sand with a high concentration of medium sand. Classification indicates an average of 1.04% content of silt/clay and 1.7% gravel. The material is poorly sorted with a mean grain size of 0.45 mm. The composite grain size distributions are presented in Appendix B.

4.0 Beach and Nearshore Investigations

With the borrow areas thoroughly investigated for quality sand, it is important to compare such data with that of the native beach sand to determine compatibility between the source and placement areas. Investigations of the native beach sand include the analysis of composition and grain size distribution characteristics of the sand found on the beach (as measured in a cross-shore series) from the upper berm to the nearshore zone.

4.1 Sand Sample Collection

Indian River County provided ATM with push core laboratory data, compiled by the Florida Geologic Survey (FGS), which had been acquired along the county shoreline in 1995 and 1997. ATM calculated vertical composites over the top 1-foot of each of the push core samples acquired on or near the shoreline areas targeted for restoration, and were compared to the proposed borrow area composites.

In order to update the data and to better determine the composite grain-size characteristics for the native beach material in Indian River County, a thorough beach and nearshore sediment investigation was conducted in accordance with CERC Coastal Engineering Technical Note II-29, "Native Beach Assessment Techniques for Beach Fill Design." A series of beach profiles in the northern three beach areas (Sectors 1, 2, and 3) designated for restoration were subjected to the cross-shore sampling and analysis techniques detailed in this guidance document during project permit processing. This effort was undertaken at the request of the Office of Beaches and Coastal Systems to ensure that the native sand characteristics are documented for final design purposes, and to provide information relevant to marine turtle nesting concerns**.**

A team of Morgan & Eklund, Inc. surveyors conducted both the beach and nearshore sand sampling investigations during May and June 2000. The team collected sand along nine longshore transects, corresponding to DEP monuments R-4, R-7, R-10, R-13, T-17, R-37, R-40, R-43, R-46. This sampling interval was selected to comply with standard DEP requirements of one transect per approximately 3,000 ft of project area shoreline. The sand samples were gathered at the following NGVD-referenced elevations: top of dune/dune face (~+12), toe of dune (~+9), +6, +3, 0, –3, –6, –9, and –12 feet NGVD. Gathered sand was evaluated for grain size variation and distribution. Similar sampling will be conducted along the Vero Beach and South County shorelines in 2002.

4.2 Analysis and Results

The samples were analyzed in accordance with ASTM Standard D-422 for mechanical partial size analysis to determine the grain size distribution for each sample. A physical composite sample of sediment at each DEP monument was collected from the available samples between +9 and –6 feet NGVD. These samples were combined to reduce the high variability in spatial grain size distribution across the beach face. Each composite sample was also subjected to a grain size analysis in accordance with ASTM Standard D-422. These physical composite results were then mathematically averaged to determine a

composite grain size distribution for each of the project Sectors using the moment method.

The Sectors 1&2 composite is the average of sand samples collected at transects along DEP monuments R-4, R-7, R-10, R-13, and T-17, with a resulting mean grain size of 0.27mm. Sediment analysis found the Sector composite to contain approximately 0.89% silt/clay and 99.11% sand (of which approximately 1% of the content is gravel-sized material (shell)). The samples indicate that most of the material on the native beach is poorly-sorted fine sand.

The Sector 3 composite is the average of DEP monuments R-37, R-40, R-43, and R-46 with a resulting mean grain size of 0.37mm. Analysis of the composite determined the sample to contain approximately 1.23% silt/clay and 98.78% sand. The Unified Soils Classification scale indicates that the material on the beach is predominantly fine sand, poorly-sorted, with approximately 2% gravel.

Tables in Appendix D summarize the native beach grain size distributions, the composite native beach cumulative grain size distributions, and a summary of the percent silt/clay for each sample and the composites at each DEP monument.

5.0 Material Compatibility Results and Discussion

The results of the geotechnical evaluation indicate that, in general, sufficient quantities of quality sand exist in the North borrow area and Indian River Shoal (Central and South borrow areas) for the beach nourishment project specified in the Indian River County Beach Preservation Plan.

Tables 1 and 2 compare the Unified Soils Classifications of the native beach sand composites vs. the borrow area sediment composites for Sectors 1&2 and Sector 3. Figures 4 and 5 show the grain size distributions for each borrow site composite compared to the native beach composites for Sectors 1&2 and Sector 3.

The majority of sediment in the North borrow site is comprised of fine to medium-grained gray sand with shell fragments and occasional layers of gravel and mud. The majority of sediment in the Central and South borrow sites is comprised of fine to medium-grained, tan to brown, shelly sand with shell fragments. The native beach is also comprised of fine to medium-grained, tan to brown, shelly sand with shell fragments.

The North borrow site Option 1 contains approximately 8% gravel/shell fragments, 3.2% silt/clay, and 39% fine sand with a mean grain size of 0.69mm. The North borrow site Option 2 contains approximately 8% gravel/shell fragments, 3.1% silt/clay, and 39% fine sand with a mean grain size of 0.68mm. The North borrow site Option 3 contains approximately 7% gravel/shell fragments, 3.4% silt/clay, and 41% fine sand with a mean grain size of 0.65mm. The North borrow site Option 4 contains approximately 7% gravel/shell fragments, 3.2% silt/clay, and 39% fine sand with a mean grain size of 0.66mm.

The Central borrow area composite contains approximately 4% gravel/shell fragments, 2% silt/clay, and 50% fine sand with a mean grain size of 0.51mm. The South borrow site sub-area 1 contains approximately 6% gravel/shell fragments, 0.9% silt/clay, and 45% fine sand with a mean grain size of 0.55 mm.

The South borrow site sub-area 2 contains approximately 3% gravel/shell fragments, 1.5% silt/clay, and 50% fine sand with a mean grain size of 0.46 mm. The South borrow site sub-area 3 contains approximately 2% gravel/shell fragments, 1.0% silt/clay, and 52% fine sand with a mean grain size of 0.45 mm.

The native beach in Sectors 1&2 has a mean grain size of 0.27mm with approximately 1% gravel/shell fragments, 1% silt/clay, and 74% fine sand. The native beach in Sector 3 has a mean grain size of 0.37mm with approximately 2% gravel/shell fragments, 1.7% silt/clay, and 61% fine sand. The lower mean grain size value and higher fine sand content in Sectors 1 and 2 may in part be attributed to the placement of 50,000 cubic yards of sand from an upland source on the Sebastian Inlet State Recreation Area shoreline in April 2000.

In general, the Central and South borrow sites have more coarse material content. However, once the material is placed on the beach, it is reworked by the wind and waves, redistributing to a more natural equilibrium state with the coarser material settling in the higher energy zones and the fines settling higher up the beachface. The resulting equilibrium beach will be more stable because the coarser sediment is less likely to be moved offshore by waves, and thus increase the longevity of the project (Dean and Dalrymple, 1997).

According to the sediment characteristic statistics, the South borrow site, sub-area 2 appears to be the most compatible with the native beach for Sectors 1&2 and Sector 3. However, volume requirements beyond the initial restoration efforts, and significant transport distances may dictate additional investigation of potential sand resources closer to these Sector shorelines.

Final project design (following reconfiguration and compositing of the Central borrow area due to the presence of the fiber optic cables, reduction in fill volume to minimize nearshore hardbottom impacts, and recognition of schedule sequencing needs for each project sector) will dictate the borrow areas and specific cuts to be utilized for each respective beach nourishment Sector.

Table 1

Indian River County Shore Protection Project

Compatibility of Borrow Material

Sectors 1 & 2

Unified Soils Classification (USC)	Native Beach	North Borrow Area Option 2	Central Borrow Area	South Borrow Area Sub Area 1	South Borrow Area Sub Area 2	South Borrow Area Sub Area 3
Mean Grain Size (mm)	0.29	0.68	0.51	0.55	0.46	0.45
% Gravel (shell)	1	8	4	6	3	2
% Coarse Sand	2	11	5	6	4	3
% Medium	22	39	38	43	42	42
% Fine Sand	74	39	50	45	50	52
Sorting (phi)	1.2	1.7	1.4	1.4	1.6	1.13
Sorting Categorization	poorly sorted	poorly sorted	poorly sorted	poorly sorted	poorly sorted	poorly sorted
Silt + Clay (%)	1.03	3.13	1.99	0.92	1.45	1.04
Volume Available (cubic yards)	-	886,400	3,127,400	1,442,000	1,898,400	871,800

Table 2

Indian River County Shore Protection Project

Compatibility of Borrow Material

Sector 3

Unified Soils Classification (USC)	Native Beach	North Borrow Area Option 2	Central Borrow Area	South Borrow Area Sub Area 1	South Borrow Area Sub Area 2	South Borrow Area Sub Area 3
Mean Grain Size (mm)	0.38	0.68	0.51	0.55	0.46	0.45
% Gravel (shell)	2	8	4	6	3	2
% Coarse Sand	3	11	5	6	4	3
% Medium	33	39	38	43	42	42
% Fine Sand	61	39	50	45	50	52
Sorting (phi)	1.26	1.7	1.4	1.4	1.6	1.13
Sorting Categorization	poorly sorted	poorly sorted	poorly sorted	poorly sorted	poorly sorted	poorly sorted
Silt + Clay (%)	1.68	3.13	1.99	0.92	1.45	1.04
Volume Available (cubic yards)	-	886,400	3,127,400	1,442,000	1,898,400	871,800

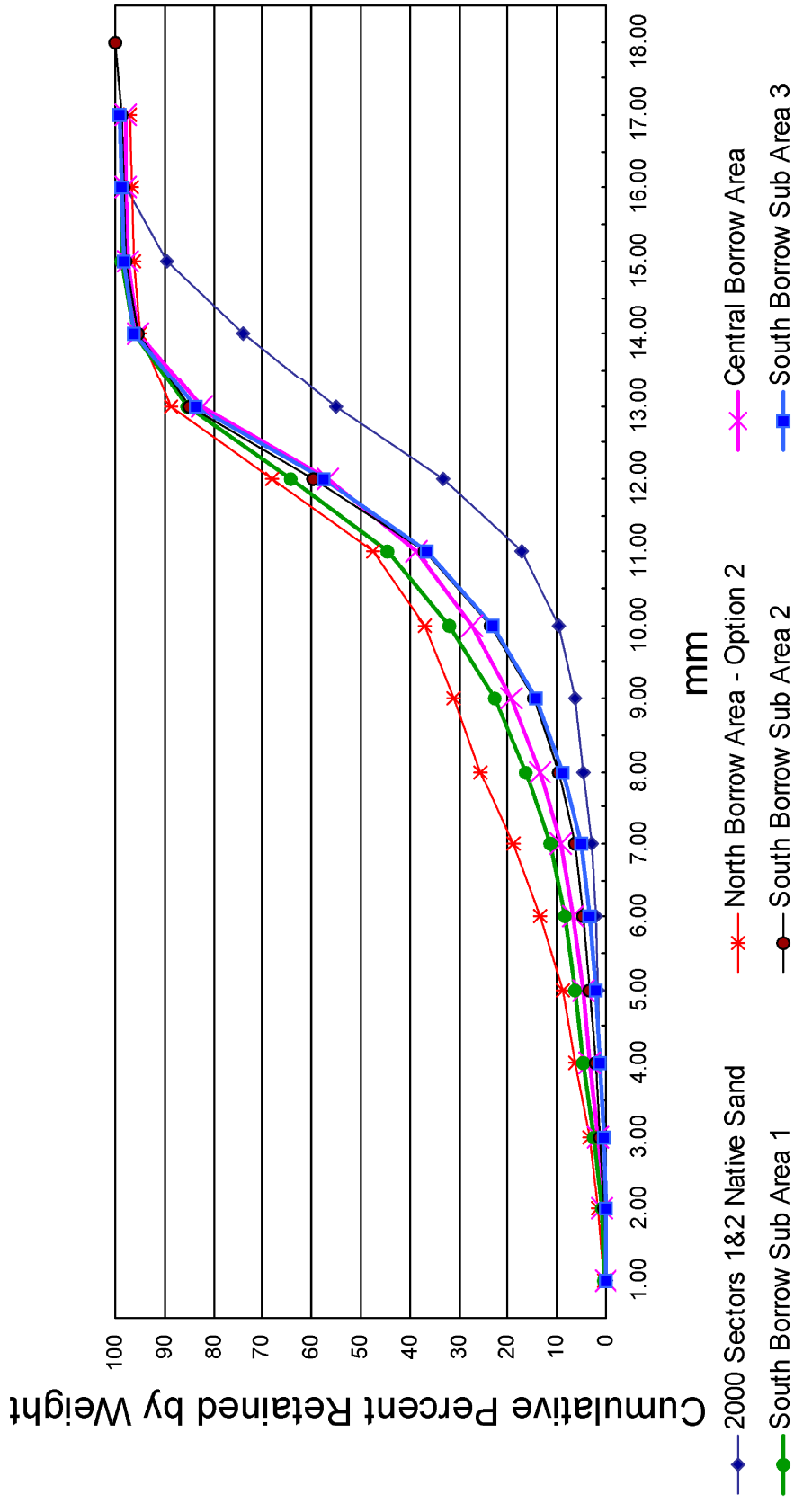

Figure 4
Indian River County Beach Nourishment
Native Beach Composite For Sectors 1 & 2
and Borrow Site Composites

APPLIED TECHNOLOGY & MANAGEMENT, INC

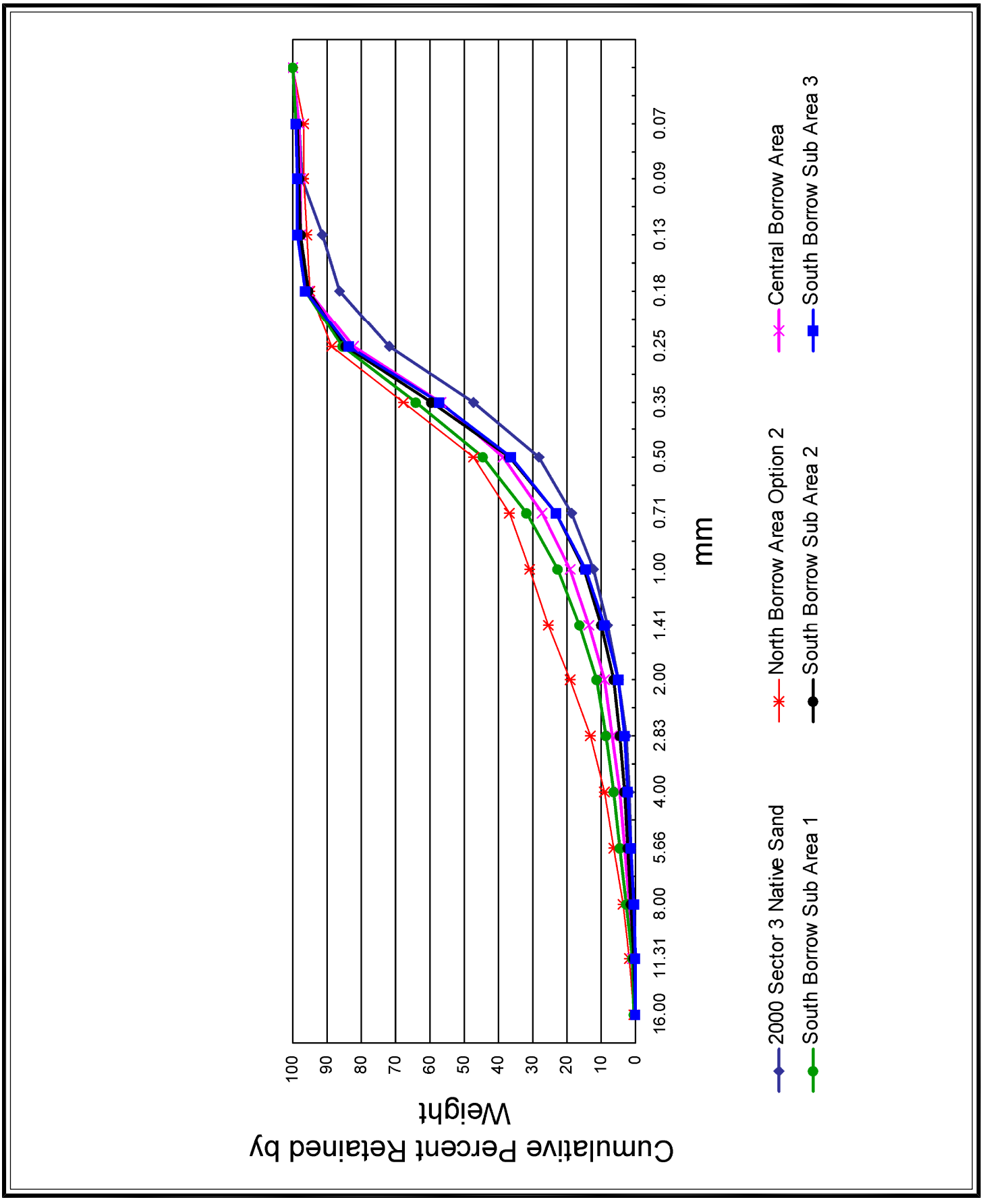

Figure 5
Indian River County Beach Nourishment
Native Beach Composite For Sector 3
and Borrow Site Composites

APPLIED TECHNOLOGY & MANAGEMENT, INC

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ATLANTIC OCEAN

X= 692,053.49
Y=1,262,645.07

X= 690,343.38
Y=1,267,977.57

X= 689,672.91
Y=1,261,881.63

X= 687,962.81
Y=1,267,214.13

SIDE-SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

N 1269000 N 1268000 N 1267000 N 1266000 N 1265000 N 1264000 N 1263000 N 1262000 N 1261000 N 1260000

E 693000 E 692000 E 691000 E 690000 E 689000 E 688000

CB-46 CB-IR-64 CB-5 CB-IR-62 CB-IR-63 CB-27 CB-IR-54 CB-IR-55 CB-IR-56 CB-IR-57 CB-25 CB-4 CB-IR-53 CB-IR-52 CB-IR-50

NA-8 40 5
NA-27 39.2 15
NA-25 40.3 15
NA-7 43.9 6
NA-18 38.5 2
NA-13 44.8 5
NA-12 42.5 3
NA-3 43.2 1
NA-26 38.8 2
NA-17 36.7 2
NA-10 43 3
NA-24 38.8 15
NA-6 37.6 5
NA-20 42.2 8
NA-23 40.4 13
NA-2 40.8 2
NA-21 40.7 8
NA-22 38.3 6
NA-11 42.8 6
NA-19 39.6 8
NA-14 37.9 8
NA-15 27.5 6
NA-1 34.4 4
NA-5 17.3 1
N-7 34.3 2
N-14 22.8 11
N-13 24.6 9
N-5 34 5
N-4 33.8 5.5
N-3 32.8 3
N-12 23.3 13
N-11 20.1 9
N-2 38.3 8
N-1 35.1 6
N-10 24.2 11
N-9 21.8 8
N-8 25.3 10

R-27 R-26 R-25 R-24 R-23 R-22 R-21 R-20 R-19 R-18

N

0 800
Scale in Feet

LEGEND

———	APPROXIMATE SHORELINE
R-20 ∘	DEP MONUMENT
N-11 22.8 11	ATM MAY, 1999 JET PROBE, WATER DEPTH & DEPTH OF PENETRATION
CB-IR-52 ○	USACE VIBRACORE

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE-SCAN SONAR SURVEY CONDUCTED APRIL 29, 2000.

ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure A-1
Indian River County Geotechnical Investigation
North Borrow Area Jet Probe Locations

11/07/01 99-219 Jet Probe Locations.dwg

ATLANTIC OCEAN

X= 728,472.18
Y=1,201,892.42

SIDE-SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

X= 727,521.17
Y=1,194,957.33

X= 725,500.00
Y=1,202,300.00

X= 724,548.99
Y=1,195,364.90

CA-9 O/S
27.1
9

C-9 O/S
40.8
3

CA-5 O/S
40.2
3

C-18
27.5
13

C-20
22.2
10

CERC38

C-12
23.5
13

C-6
24.6
11

C-14
22
11

C-11
22.3
10

C-8
22.1
12

C-2
21.1
11

CA-7
26.6
13

C-16
25.2
10

C-10
25.8
9

C-4
23.7
11

CA-4
23
10

CA-1 O/S
34.4
8

E 729000
E 728000
E 727000
E 726000
E 725000
E 724000

N 1203000
N 1202000
N 1201000
N 1200000
N 1199000
N 1198000
N 1197000
N 1196000
N 1195000

LEGEND

C-4 23.7 11 — ATM MAY, 1999 JET PROBE, WATER DEPTH & DEPTH OF PENETRATION

CERC38 — USACE VIBRACORE

N

0 600
Scale in Feet

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON DECEMBER 22, 1999.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE-SCAN SONAR SURVEY CONDUCTED APRIL 28, 2000.

APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure A-2
Indian River County Geotechnical Investigation
Central Borrow Area Jet Probe Locations

11/07/01 99-219 Jet Probe Locations.dwg

ATLANTIC OCEAN

X= 729,020.42
Y=1,185,999.49

X= 728,759.41
Y=1,180,170.99

X= 727,100.38
Y=1,171,901.41

X= 726,522.92
Y=1,186,111.33

X= 726,270.50
Y=1,180,474.56

X= 724,649.22
Y=1,172,393.16

SIDE–SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

N 1186000 N 1185000 N 1184000 N 1183000 N 1182000 N 1181000 N 1180000 N 1179000 N 1178000 N 1177000 N 1176000 N 1175000 N 1174000 N 1173000 N 1172000

E 731000 E 730000 E 729000 E 728000 E 727000 E 726000 E 725000 E 724000 E 723000

N 1184000 N 1173000

SA–26 22.7 13
SA–2 20.7 11
SA–12 21.4 11
SA–7R 25.1 10
S–1R 25.6 9
S–3R 24.3 12.5
S–15R 29.4 11.5
S–2 17.3 12
S–5 16.1 11
S–8 14.9 11
S–14 14.4 11
S–11 14.3 11
S–4 19.6 10
S–17 15.7 10
S–20 15.5 11
S–23 15.8 11
S–26 15.6 10
S–29 15.9 10
S–30 21 13
S–32 16.2 11
S–35 16.4 11
S–36 22.3 8
S–38 16.8 9
S–42 19.6 12
S–41 16.3 12
S–40 17.4 11
S–34 21.5 12
S–28 22 14
S–22 21.2 15+
S–13R 23.9 14

LEGEND

S–1R 25.6 9 — ATM MAY, 1999 JET PROBE, WATER DEPTH & DEPTH OF PENETRATION

CB–22 ○ — USACE VIBRACORE

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED ON JANUARY 13, 2000 BY MORGAN & EKLUND, INC.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE–SCAN SONAR SURVEY CONDUCTED FEBRUARY 17, 2000.

N

0 1000

Scale in Feet

11/07/01 99–219 Jet Probe Locations.dwg

APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure A–3
Indian River County Geotechnical Investigation
South Borrow Area Jet Probe Locations

Indian River County Jet Probes
Horizontal Datum : FL SPC East Zone NAD 27

5/25/1999

Probe ID	Sounding Ft	Time	Tide Ft	Reduced Sounding Ft	Depth of Probe Ft	Diver Description of Bottom/Probe Characteristics	Probe Location* Northing	Easting
S-2	18.5	10:05	-1.2	17.3	12	Sandy bottom with shells, probed to refusal, no hard layers encountered	1180348	727543
S-5	17.6	10:40	-1.5	16.1	11	Sandy bottom with shells, probed to refusal, only resistance from sand pressure on probe	1179843	727563
S-8	16.5	10:52	-1.6	14.9	11	Sandy bottom with shells, probed to refusal *Note: diver reports very little material coming up out of hole, diver sticks his arm down hole to collect "wash" sand sample	1179371	727410
S-11	15.9	11:03	-1.6	14.3	11	Sandy bottom with shells, probed to refusal, no problem	1178890	727251
S-14	16.1	11:25	-1.7	14.4	11	Sandy bottom with shells, some resistance at 8', moved over 1' & probed to 11', Note: probe slides into bottm very easy to 8' +/-, below this diver has to "work" probe to achieve further penetration	1178402	727104
S-17	17.3	11:39	-1.6	15.7	10	Sandy bottom with shells, encountered resistance at 6'-8', broke through this and probed to refusal at 10'	1177935	726947
S-20	17.1	11:55	-1.6	15.5	11	Sandy bottom, easy probe to 10'	1177465	726790
S-23	17.4	12:05	-1.6	15.8	11	Sandy bottom, probed 3 times at this position, encountered resistance at 9', pushed thru this & probed to 13', 11', &11'	1176970	726750
S-26	17.1	12:24	-1.5	15.6	10	Sandy bottom with shells, easy probe to 10'	1176478	726700
S-29	17.4	12:26	-1.5	15.9	10	Sandy bottom with shells, probed 3 times at this position resistance at 7', then probed to 10 - all 3 times	1175975	726651

S-32	17.7	12:28	-1.5	16.2	11	Sandy bottom-few shells, 2 probes at this position both to 11', no problem	1175463	726612
S-35	17.8	12:30	-1.4	16.4	11	Sandy bottom-few shells, 2 probes at this position, 1st to 11', 2nd to 10.5', no problem	1174978	726555
S-38	17.8	13:22	-1	16.8	9	Diver 2 in, Sandy bottom few shells, probe to refusal	1174504	726396
S-41	17.2	13:29	-0.9	16.3	12	Sandy botom, easy probe to refusal	1174027	726249
S-40	18.3	13:28	-0.9	17.4	11	Sandy bottom, high resistance at 7'-9', then very soft to 11'	1174116	725859
S-42	20.1	13:56	-0.5	19.6	12	Sandy bottom with shells, easy probe to refusal	**1174017**	**726644**
S-34	21.3	14:50	0.2	21.5	12	Sandy bottom with shells, easy probe to refusal	1175092	726061
S-36	22	14:54	0.3	22.3	8	Sandy bottom with shells, 2 probes at this position, much resistance beyond 7'	1174864	727046
S-30	20.7	14:59	0.3	21	13	Brown sandy bottom with crushed shell	1175900	727054
S-28	21.7	15:02	0.3	22	14	Brown sandy bottom with crushed shell, probed to 11' easily, refusal at 14'	1176060	726266

* - Boldface type for coordinates denotes field-modified probe position

Indian River County Jet Probes
Horizontal Datum : FL SPC East Zone NAD 27

5/26/1999

Probe ID	Sounding Ft	Time	Tide Ft	Reduced Sounding Ft	Depth of Probe Ft	Diver Description of Bottom/Probe Characteristics	Probe Location Northing	Probe Location Easting
S-15R	29.8	9:17	-0.1	29.7	11.5	Sandy bottom, few shells, probed to refusal,slight resistance at 9',broke thru easily	**1178125**	**728270**
S-22	21.6	9:41	-0.4	21.2	15+	Light colored sandy bottom, no shells, probed to total probe length (15'), no resistance	1177047	726354
S-13R	24.6	9:54	-0.7	23.9	14	Sandy bottom with shells, resistance from 13'-14'	**1178600**	**726320**
S-4	20.4	10:08	-0.8	19.6	10	Sandy bottom with shells, hit hard material at 10'	1179978	727078
S-1R	26.7	10:19	-1.1	25.6	9	Sandy bottom with shells, hit hard material at 9' (rock?)	**1180480**	**726300**
S-3R	25.5	10:32	-1.2	24.3	12.5	Sandy bottom no shells, hard material at refusal	**1180260**	**728375**
SA-12	22.8	10:45	-1.4	21.4	11	Sandy bottom, shells, hard material at refusal	1181804	727783
SA-7R	26.6	10:56	-1.5	25.1	10	Sandy bottom with shells, hard resistance from 9' to 10'	**1182580**	**726530**
SA-2	22.2	11:16	-1.5	20.7	11	Sandy bottom with shells, hit hard material at refusal	**1183367**	**727736**
SA-26	24.3	11:29	-1.6	22.7	13	Sandy botton with shells	**1184286**	**728291**
CA-4	24.7	12:00	-1.7	23	10	Sandy bottom, few shells, probe to refusal	1196410	725970
C-2	22.8	12:12	-1.7	21.1	11	Sandy bottom, few shells, probe to refusal	1197329	726328
C-4	25.4	12:21	-1.7	23.7	11	Sandy bottom, few shells, probe to refusal	1197869	725912
C-6	26.3	12:31	-1.7	24.6	11	Sandy botom, light shells, probe to refusal	1197826	7268423

C-8	23.7	12:41	-1.6	22.1	12	Sandy bottom, heavy shells, probe to refusal	1198331	726433
C-10	27.4	12:52	-1.6	25.8	9	Sandy bottom, light shells, probe to refusal,	1198862	725955
C-16	26.8	13:04	-1.6	25.2	10	Sandy bottom, light shells, probe to refusal	1199920	726036
C-14	23.5	13:19	-1.5	22	11	Sandy bottom, light shells, probe to refusal	1199343	726421
C-11	23.7	13:29	-1.4	22.3	10	Sandy bottom, heavy shells, probe to refusal	1198834	726481
C-12	24.8	13:41	-1.3	23.5	13	Sandy bottom, light shells, probe to refusal	1198840	726863
C-18	28.6	13:58	-1.1	27.5	13	Sand bottom, light shells, probe to refusal	1199795	727019
C-20	23.2	14:09	-1	22.2	10	Sandy bottom, light shells, probe to refusal	1200323	726641
CA-7	27.4	14:25	-0.8	26.6	13	Sandy bottom, light shells, probe to refusal	1200850	726221
CA-9 O/S	27.4	15:01	-0.3	27.1	9	Clean sand bottom, probe to refusal	**1200866**	**727532**
C-9 O/S	40.7	15:31	0.1	40.8	3	Clean sand bottom, probed twice at this position, hit hard bottom at 3' both probes	**1198359**	**727481**
CA-5 O/S	40	15:38	0.2	40.2	3	Sand bottom, light shells, polychaete worms (Sabellaria?) probed 2X at this position-hit hard bottom at 3' both probes	**1196900**	**727233**
CA-1 O/S	33.8	16:08	0.6	34.4	8	Sandy bottom, light shells, probe to refusal	**1197030**	**725028**

* - Boldface type for coordinates denotes field-modified probe position

Indian River County Jet Probes
Horizontal Datum : FL SPC East Zone NAD 27

5/27/1999

Probe ID	Sounding Ft	Time	Tide Ft	Reduced Sounding Ft	Depth of Probe Ft	Diver Description of Bottom/Probe Characteristics	Probe Location Northing	Probe Location Easting
NA-15	26.9	8:48	0.6	27.5	6	Sandy bottom, probed to hard bottom, multiple layers of resistance	1265810	687801
NA-11	42.3	9:01	0.5	42.8	6	Sandy bottom, probed to hard bottom, multiple layers of resistance, heavy shells	1266617	689631
NA-13	44.5	9:18	0.3	44.8	5	Sandy bottom with shells, 3 probes at this position, 2' probe on 1st and 2nd , broke thru hard layer on 3rd probe to 5'	1267423	691461
NA-3	43.2	9:39	0	43.2	1	Hard sand bottom, medium shells, 3 probes at this position all to 1' max	1266105	690949
NA-1	34.8	10:07	-0.4	34.4	4	Hard sand bottom, heavy shells, 3 probes at this position all to 4' max	1258893	691942
NA-5	18	10:28	-0.7	17.3	1	Sand bottom 5' +/- from live reef/rock ledge, heavy shells	1258490	691027
N-7	35.3	10:43	-1	34.3	2	Sandy bottom, heavy shells, 3 probes this position, all to 3'	1259808	691539
N-1	36.3	11:15	-1.2	35.1	6	Sandy bottom,heavy shells,2 probes resistance at 4',	**1265334**	**689126**
N-9	23.3	11:30	-1.5	21.8	8	Sandy bottom, medium amount of shells, probe to refusal	1263980	688607
NA-6	39.2	11:51	-1.6	37.6	5	Sand, medium shells, 3 probes to 5'	1264787	690438
NA-8	41.8	12:28	-1.8	40	5	Sand, heavy shells, 3 probes to 5'	1265593	692268
N-3	34.6	12:52	-1.8	32.8	3	Sand, few shells, 2 probes to refusal	1263468	689926

N-4	35.6	13:04	-1.8	33.8	5.5	Sand,few shells,probe to refusal	1262553	690329
N-11	21.8	13:21	-1.7	20.1	9	Sand, few shells, probe to refusal	1262150	689414
NA-17	38.4	13:37	-1.7	36.7	2	Sand, medium shells, 2 probes 1st to 1', 2nd to 2'	1269256	691244
NA-18	40.1	13:57	-1.6	38.5	2	Sand, heavy shells, probe to hard material	1262444	692562
N-5	35.5	14:20	-1.5	34	5	Sand, medium shells	1261638	690732
N-12	24.5	14:42	-1.2	23.3	13	Sand, no shells, probe to refusal	1261235	689817
N-13	25.6	14:56	-1	24.6	9	Sand, no shells, probe to refusal	1260320	690220
N-14	23.7	15:12	-0.9	22.8	11	Sand, no shells, hit multiple hard layers,probe to refusal	1259405	690624
N-10	24.7	15:31	-0.5	24.2	11	Sand, no shells, hard material at 11'	1263065	689011
N-8	25.4	15:53	-0.1	25.3	10	Sand, few shells, probe to refusal	1264895	688204

* - Boldface type for coordinates denotes field-modified probe position

Indian River County Jet Probes
Horizontal Datum : FL SPC East Zone NAD 27

5/28/1999

Probe ID	Sounding Ft	Time	Tide Ft	Reduced Sounding Ft	Depth of Probe Ft	Diver Description of Bottom/Probe Characteristics	Probe Location* Northing	Easting
NA-10	41.8	8:37	1.2	43	3	Sand, heavy shells, 2 probes to 3', hard bottom at 3'	**1263854**	**690875**
N-2	37.5	9:16	0.8	38.3	8	Sand, medium shells, hard bottom at 8'	**1264356**	**689467**
NA-7	43.6	9:42	0.3	43.9	6	Sand, heavy shells, 2 probes to 6', lot of resistance below 1'	1265190	691353
NA-2	40.6	10:03	0.2	40.8	2	Sand, heavy shells, 2 probes to 2', solid feeling bottom,diver reports lots of large old clam shells, has to really work to break thru them-maybe stopped by dense shell rather than rock	1265702	690034
NA-14	38.2	10:35	-0.3	37.9	8	Sand bottom, light shells, polychaete worms (Sabellaria?) probe to refusal	1266214	688716
NA-12	43.2	11:01	-0.7	42.5	5	Sand bottom, medium shells, polychaete worms(Sabellaria?) 2 probes to 5', hard layer at 1'	1267020	690546
NA-20	43.3	11:30	-1.1	42.2	8	Sand bottom, heavy shells, polychaete worms (Sabellaria?) later of resistance at 3', probe to refusal	**1267400**	**690370**
NA-21	42.1	12:03	-1.4	40.7	8	Sand bottom, heavy shells, polychaete worms (Sabellaria?) probe to refusal	**1267200**	**689870**
NA-19	41.3	12:26	-1.7	39.6	8	Sand bottom, heavy shells, polychaete worms (Sabellaria?)	**1267343**	**689358**
NA-22	40.2	12:55	-1.9	38.3	6	Sand, medium shells, 2 probes,1st to 3', 2nd hard layer at 3' broke through, refusal at 6'	1266240	689800
NA-23	42.3	13:14	-1.9	40.4	13	Nice sand!, crushed shell, probe to refusal	1266990	690290

NA-24	40.7	13:34	-1.9	38.8	15	Sand, crushed shell, probe to refusal	1265520	690740
NA-25	42.2	13:58	-1.9	40.3	15	Sand, little crushed shell, probe to refusal	1265775	691725
NA-26	40.5	14:26	-1.7	38.8	2	Sand, heavy shells, 3 probes to 2'	1264560	691000
NA-27	40.8	14:45	-1.6	39.2	15	Sand bottom, heavy shells, polychaete worms (Sabellaria?)	1264800	691960

* - Boldface type for coordinates denotes field-modified probe position

Indian River County - Jet Probe Samples - June 1999

SAMPLE	Silt/Clay %
C11-SURACE	0.12%
C11-WASH	0.68%
CA7-SURFACE	42.00%
CA7-WASH	28.00%
NA11-SURFACE	14.00%
NA11-WASH	89.00%
NA20-SURFACE	16.14%
NA20-WASH	3.77%
SI4-SURFACE	0.30%
SI4-Wash	1.19%
SIR-SURFACE	0.05%
SIR_WASH	1.01%

ATLANTIC OCEAN

X= 692,053.49
Y=1,262,645.07

X= 690,343.38
Y=1,267,977.57

X= 689,672.91
Y=1,261,881.63

X= 687,962.81
Y=1,267,214.13

SIDE-SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

N 1269000 N 1268000 N 1267000 N 1266000 N 1265000 N 1264000 N 1263000 N 1262000 N 1261000 N 1260000

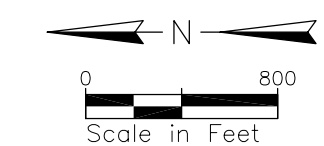
E 693000 E 692000 E 691000 E 690000 E 689000 E 688000

CB-46 CB-IR-64 CB-5 CB-IR-62 CB-IR-63 CB-27 CB-IR-54 CB-IR-55 CB-IR-56 CB-IR-57 CB-25 CB-4 CB-IR-53 CB-IR-52 CB-IR-50

IR-N-17 38.3
IR-N-18 39.4
IR-N-15 40.8
IR-N-1 40.0
IR-N-5 37.7
IR-N-13 41.6
IR-N-14 40.0
IR-N-4 38.1
IR-N-19 40.6
IR-N-9 41.7
IR-N-11 40.2
IR-N-6 41.6
IR-N-20 39.7
IR-N-16 38.0
IR-N-7 39.2
IR-N-10 37.3
IR-N-12 36.6
IR-N-3 41.0
IR-N-8 37.8
IR-N-2 39.6

IN-6 40.5
IN-5 39.8
IN-8B 40.4
IN-7 40.8
IN-1R2 39.7
IN-3 38.8
IN-4AR2 38.6
IN-9B 39.8
IN-2 39.3
IN-10 38.7

R-27 R-26 R-25 R-24 R-23 R-22 R-21 R-20 R-19 R-18



LEGEND

- APPROXIMATE SHORELINE
- R-20 ∘ DEP MONUMENT
- IR-N-25 17.3 ATM JUNE-JULY 1999 VIBRACORE AS-BUILT LOCATION & WATER DEPTH
- CB-46 ○ USACE VIBRACORE
- IN-5 39.8 △ ATM OCTOBER 2000 VIBRACORE AS-BUILT LOCATION & WATER DEPTH.

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE-SCAN SONAR SURVEY CONDUCTED APRIL 29, 2000.

ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure B-1
Indian River County Geotechnical Investigation
North Borrow Area Vibracore Locations

11/07/01 99-219 Geotech Appendix B Plan Views.dwg

ATLANTIC OCEAN

IR-N-18 39.4
IR-N-15 40.8
IR-N-1 40.0
IR-N-5 37.7
IR-N-13 41.6
IR-N-4 38.1
IR-N-14 40.0
IR-N-9 41.7
IR-N-11 40.2
IR-N-6 41.6
IR-N-7 39.2
IR-N-10 37.3
IR-N-12 36.6
IR-N-16 38.0
IR-N-19 40.6
IR-N-20 39.7
IR-N-3 41.0
IR-N-8 37.8
IR-N-2 39.6

IN-6 40.5
IN-5 39.8
IN-8B 40.4
IN-4AR2 38.6
IN-7 40.8
IN-1R2 39.7
IN-3 38.8
IN-2 39.3
IN-9B 39.8
IN-10 38.7

A A'
B B'

N 1265000
N 1264000
N 1263000
N 1262000
E 691000
E 690000
E 689000
E 688000

R-23
R-22

0 500
Scale in Feet

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.

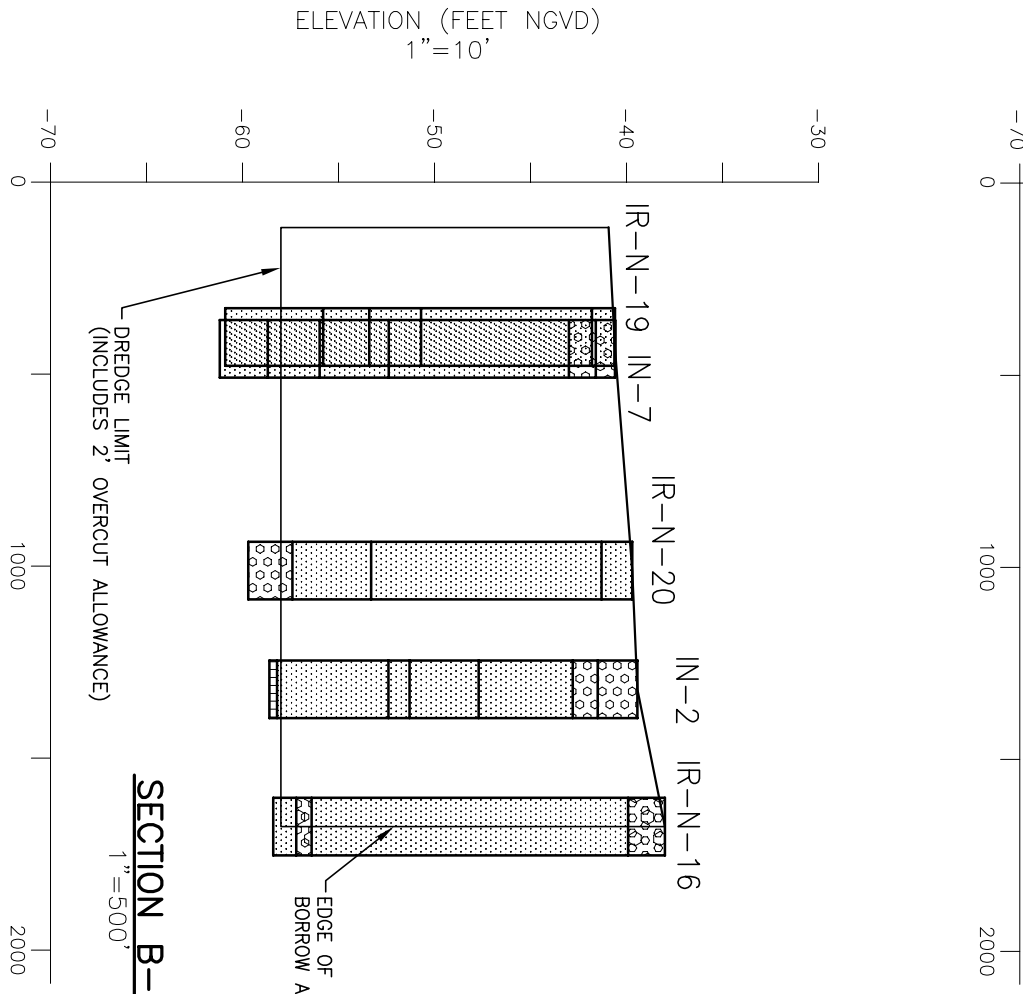
LEGEND

- APPROXIMATE SHORELINE
- R-23 DEP MONUMENT
- IR-N-25 17.3 ATM JUNE-JULY 1999 VIBRACORE AS-BUILT LOCATION & WATER DEPTH
- IN-5 39.8 ATM OCTOBER 2000 VIBRACORE AS-BUILT LOCATION AND WATER DEPTH
- PROPOSED BORROW AREA EXCAVATION LIMIT

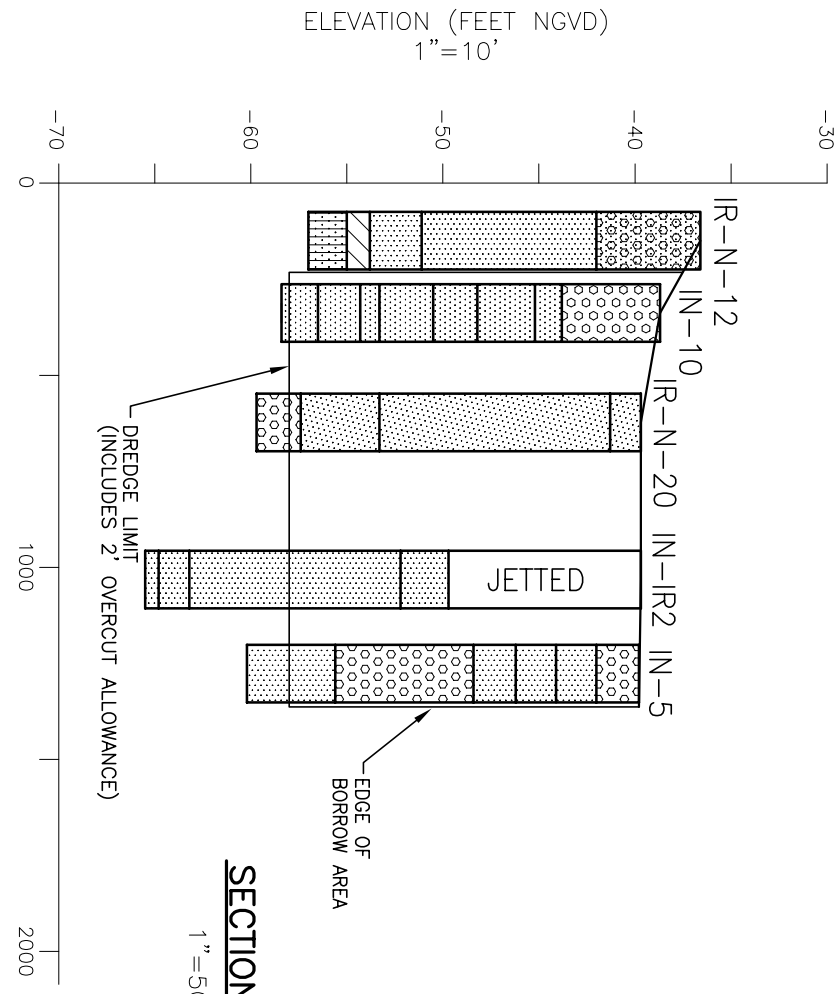
ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure B-2
Indian River County Geotechnical Investigation
North Borrow Area Option 1 - Vibracore Locations

99-219 North Borrow Option 1.dwg 11/07/01



SECTION B-B'
1"=500'



SECTION A-A'
1"=500'

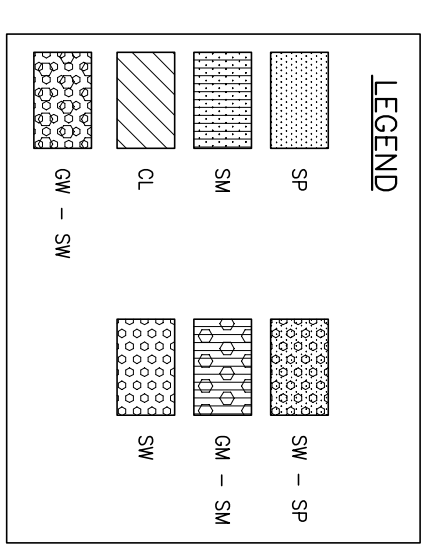


Figure B-3
Indian River County Geotechnical Investigation
North Borrow Area Option 1 - Cross Sections

APPLIED TECHNOLOGY & MANAGEMENT, INC

ATLANTIC OCEAN

IR-N-18 39.4
IR-N-15 40.8
IR-N-1 40.0
IR-N-5 37.7
IR-N-13 41.6
IR-N-4 38.1
IR-N-14 40.0
IR-N-9 41.7
IR-N-11 40.2
IR-N-16 38.0
IR-N-19 40.6
IR-N-20 39.7
IR-N-6 41.6
IR-N-12 36.6
IR-N-7 39.2
IR-N-10 37.3
IR-N-3 41.0
IR-N-8 37.8
IR-N-2 39.6

IN-6 40.5
IN-5 39.8
IN-4AR2 38.6
IN-8B 40.4
IN-7 40.8
IN-1R2 39.7
IN-3 38.8
IN-2 39.3
IN-9B 39.8
IN-10 38.7

A
A'
B
B'

N 1265000
N 1264000
N 1263000
N 1262000
E 691000
E 690000
E 689000
E 688000

-44 -43 -42 -41 -40 -39 -38 -37 -36 -35 -34 -33 -32 -31 -30 -29 -28 -27 -26 -25 -24 -23 -22 -21 -20 -19 -18 -17 -16 -15

R-23°
R-22°

N
0 500
Scale in Feet

LEGEND

- APPROXIMATE SHORELINE
- R-23° DEP MONUMENT
- IR-N-25 17.3 ATM JUNE-JULY 1999 VIBRACORE AS-BUILT LOCATION & WATER DEPTH
- IN-5 39.8 ATM OCTOBER 2000 VIBRACORE AS-BUILT LOCATION AND WATER DEPTH
- PROPOSED BORROW AREA EXCAVATION LIMIT

NOTES:

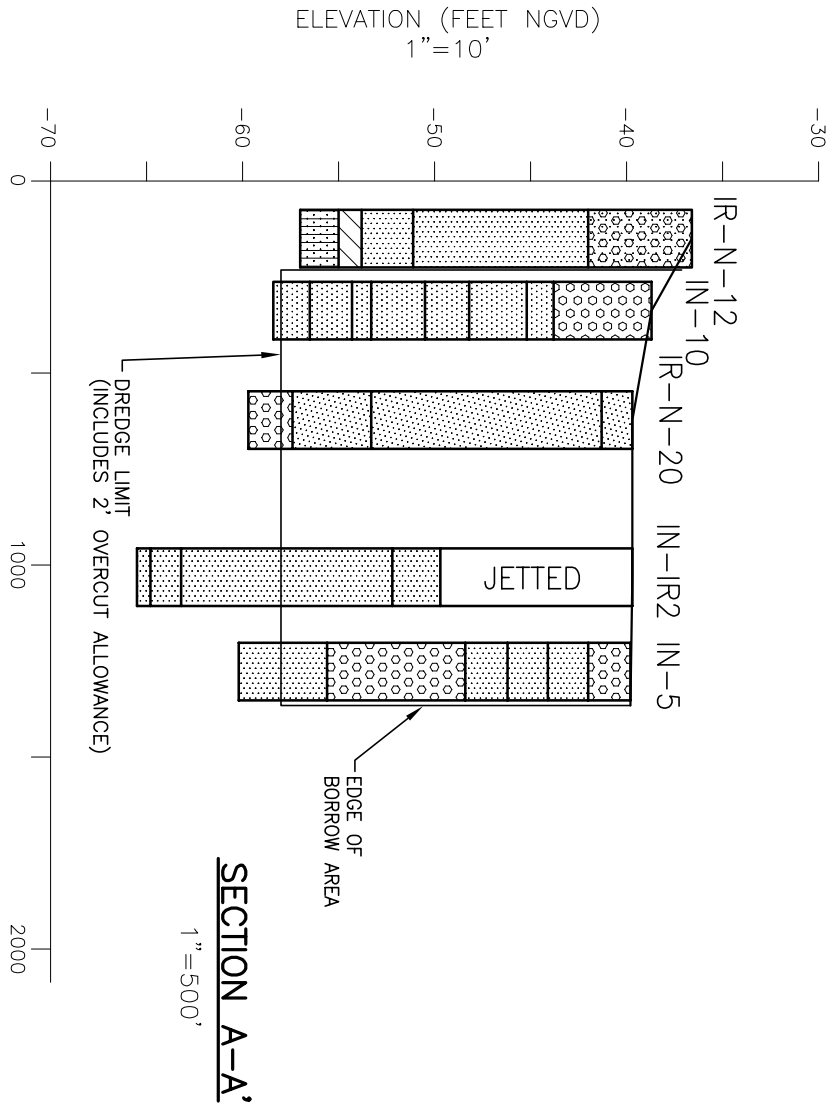
1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.

ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC

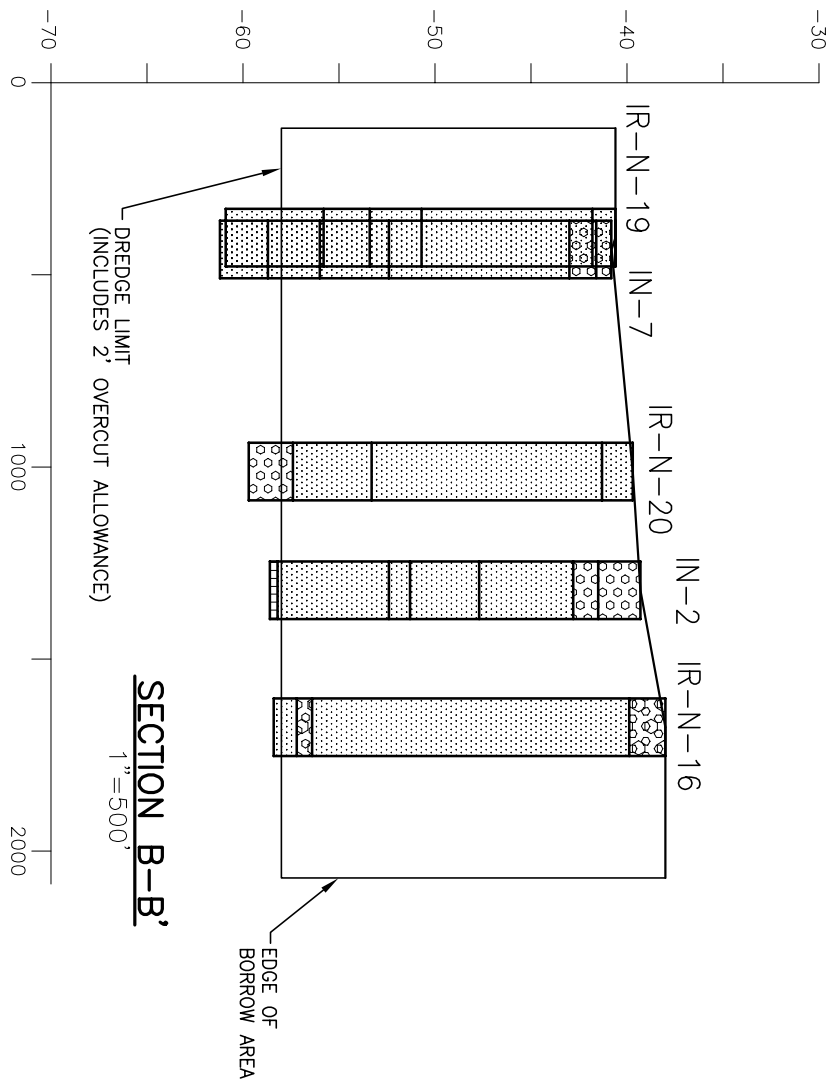
Figure B-4
Indian River County Geotechnical Investigation
North Borrow Area Option 2 - Vibracore Locations

99-219 North Borrow Option 2.dwg 11/07/01

99-219 North Borrow Option 2.dwg 11/07/01



SECTION A-A'
1"=500'



SECTION B-B'
1"=500'

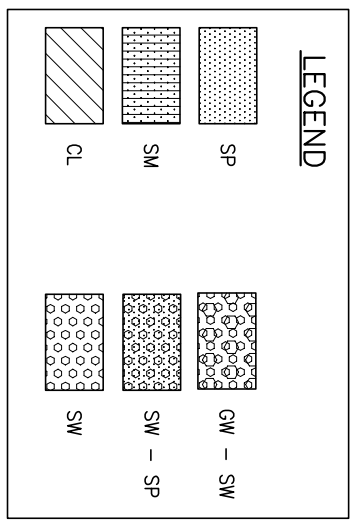


Figure B-5
Indian River County Geotechnical Investigation
North Borrow Area Option 2 - Cross Sections

APPLIED TECHNOLOGY & MANAGEMENT, INC

ATLANTIC OCEAN

IR-N-17 38.3
IR-N-18 39.4
IR-N-15 40.8
IR-N-1 40.0
IR-N-5 37.7
IR-N-13 41.6
IR-N-4 38.1
IR-N-14 40.0
IN-6 40.5
IN-5 39.8
IN-4AR2 38.6
IN-8B 40.4
IN-1R2 39.7
IN-3 38.8
IN-7 40.8
IR-N-9 41.7
IR-N-19 40.6
IR-N-16 38.0
IR-N-11 40.2
IN-2 39.3
IN-9B 39.8
IR-N-20 39.7
IR-N-6 41.6
IN-10 38.7
IR-N-12 36.6
IR-N-7 39.2
IR-N-10 37.3
IR-N-3 41.0
IR-N-8 37.8
IR-N-2 39.6
A
A'
B
B'
N 1265000
N 1264000
N 1263000
N 1262000
E 691000
E 690000
E 689000
E 688000
R-24
R-23
R-22

LEGEND

- APPROXIMATE SHORELINE
- R-23 ° DEP MONUMENT
- IR-N-25 17.3 ATM JUNE-JULY 1999 VIBRACORE AS-BUILT LOCATION & WATER DEPTH
- IN-5 39.8 ATM OCTOBER 2000 VIBRACORE AS-BUILT LOCATION AND WATER DEPTH
- PROPOSED BORROW AREA EXCAVATION LIMIT

N

0 500

Scale in Feet

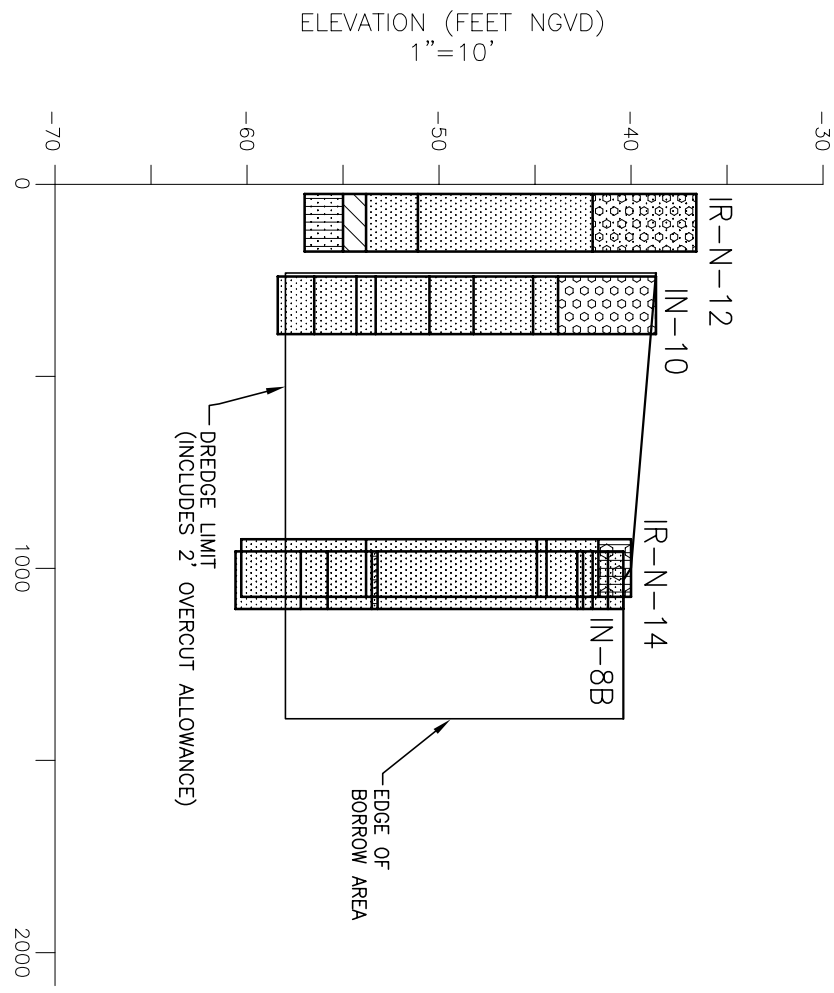
NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.

99-219 North Borrow Option 3.dwg 11/07/01

ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure B-6
Indian River County Geotechnical Investigation
North Borrow Area Option 3 - Vibracore Locations



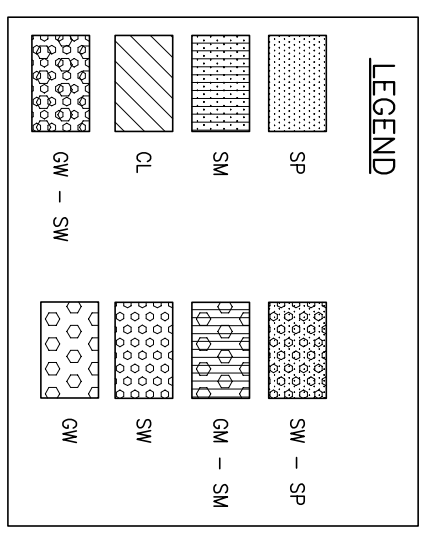


Figure B-7
Indian River County Geotechnical Investigation
North Borrow Area Option 3 - Cross Sections

APPLIED TECHNOLOGY & MANAGEMENT, INC

ATLANTIC OCEAN

IR-N-17 38.3
IR-N-18 39.4
IR-N-15 40.8
IR-N-1 40.0
IR-N-5 37.7
IR-N-13 41.6
IR-N-4 38.1
IR-N-14 40.0
IN-6 40.5
IN-5 39.8
IN-4AR2 38.6
IN-8B 40.4
IN-7 40.8
IN-1R2 39.7
IN-3 38.8
IR-N-9 41.7
IR-N-19 40.6
IR-N-16 38.0
IN-2 39.3
IR-N-11 40.2
IN-9B 39.8
IR-N-20 39.7
IR-N-6 41.6
IN-10 38.7
IR-N-12 36.6
IR-N-7 39.2
IR-N-10 37.3
IR-N-3 41.0
IR-N-8 37.8
IR-N-2 39.6

A
A'
B
B'

N 1265000
N 1264000
N 1263000
N 1262000
E 691000
E 690000
E 689000
E 688000

-44 -43 -42 -41 -40 -39 -38 -37 -36 -35 -34 -33 -32 -31 -30 -29 -28 -27 -26 -25 -24 -23 -22 -21 -20 -19 -18 -17 -16 -15

R-24
R-23
R-22

N

0 500
Scale in Feet

LEGEND

- APPROXIMATE SHORELINE
- R-23 ○ DEP MONUMENT
- IR-N-25 17.3 ATM JUNE-JULY 1999 VIBRACORE AS-BUILT LOCATION & WATER DEPTH
- IN-5 39.8 △ ATM OCTOBER 2000 VIBRACORE AS-BUILT LOCATION AND WATER DEPTH
- PROPOSED BORROW AREA EXCAVATION LIMIT

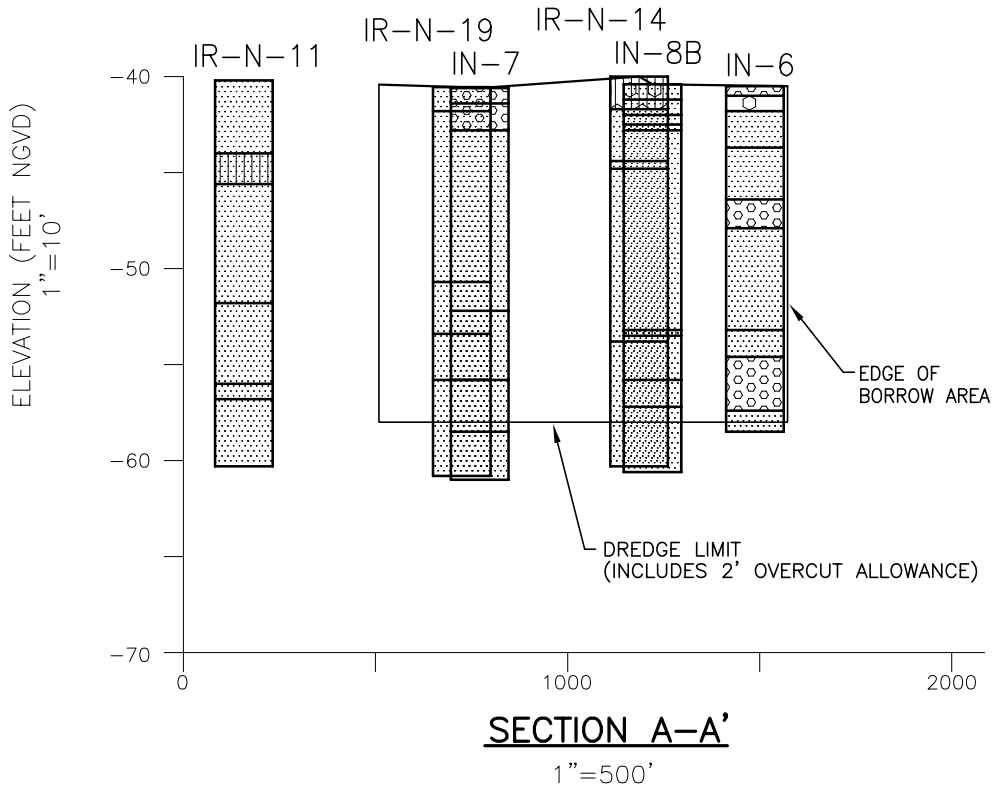
NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.

99-219 North Borrow Option 4.dwg 11/07/01

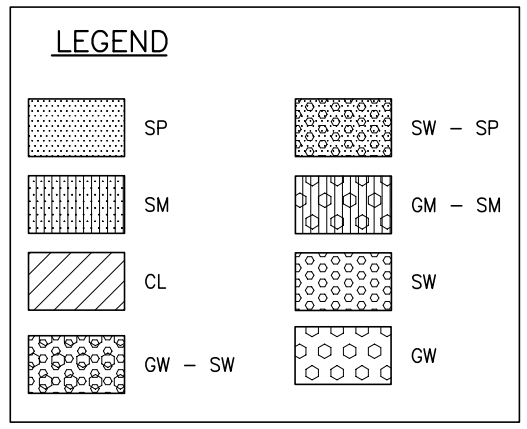
APPLIED TECHNOLOGY & MANAGEMENT, INC

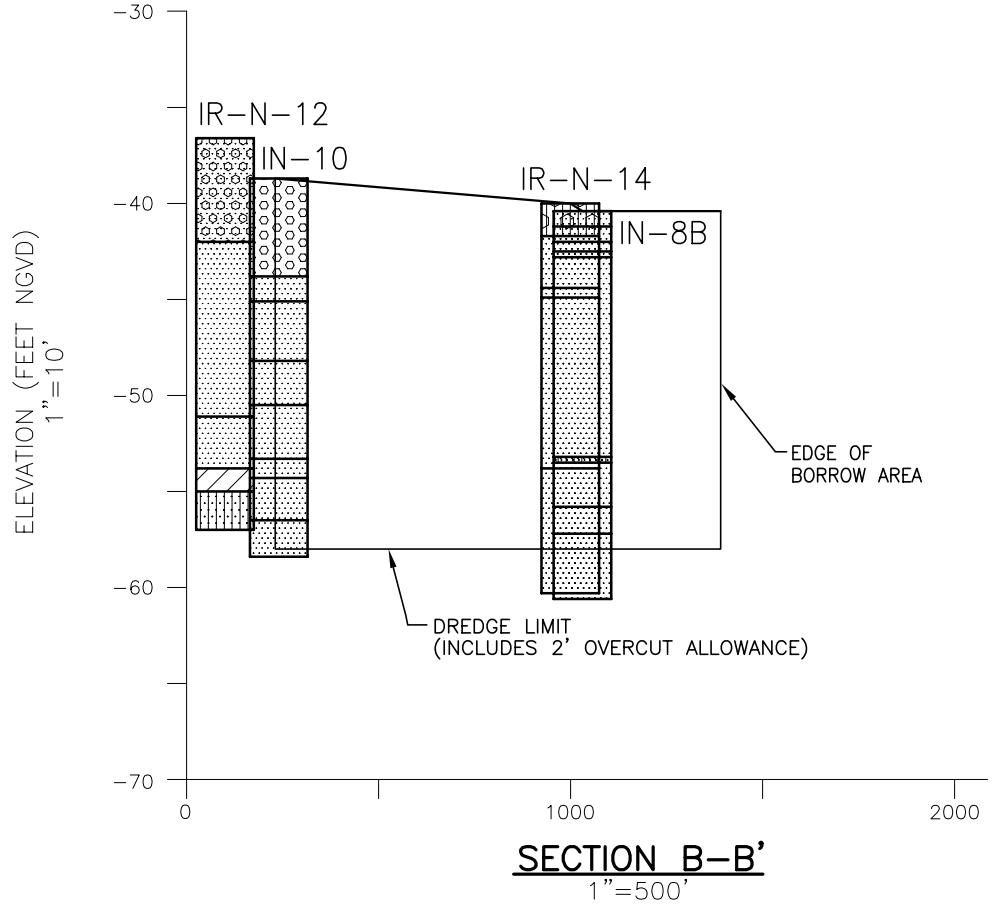
Figure B-8
Indian River County Geotechnical Investigation
North Borrow Area Option 4 - Vibracore Locations



SECTION A–A'

1"=500'





SECTION B–B'

1"=500'

99–219 North Borrow Option 4.dwg 11/07/01

TAT&T
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure B–9
Indian River County Geotechnical Investigation
North Borrow Area Option 4 – Cross Sections

ATLANTIC OCEAN

X= 728,472.18
Y=1,201,892.42

SIDE-SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

X= 727,521.17
Y=1,194,957.33

X= 725,500.00
Y=1,202,300.00

X= 724,548.99
Y=1,195,364.90

IR-C-1 25.8
IR-C-2 24.0
IR-C-3 30.2
IR-C-4 29.8
IR-C-5 24.7
IR-C-6 28.8
IR-C-7 25.7
IR-C-8 28.0
IR-C-9 24.8
IR-C-10 23.6
IR-C-11 27.2
IR-C-12 25.2
IR-C-13 27.4
IR-C-14 27.9
CERC38

LEGEND

PROPOSED BORROW AREA EXCAVATION LIMIT

IR-C-4 29.8 ATM JUNE-JULY 1999 VIBRACORE LOCATION & NGVD WATER DEPTH

CERC38 USACE VIBRACORE

N

0 600
Scale in Feet

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON DECEMBER 22, 1999.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE-SCAN SONAR SURVEY CONDUCTED APRIL 28, 2000.

ATM
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure B-10
Indian River County Geotechnical Investigation
Central Borrow Area Vibracore Locations

11/07/01 99-219 Geotech Appendix B Plan Views.dwg

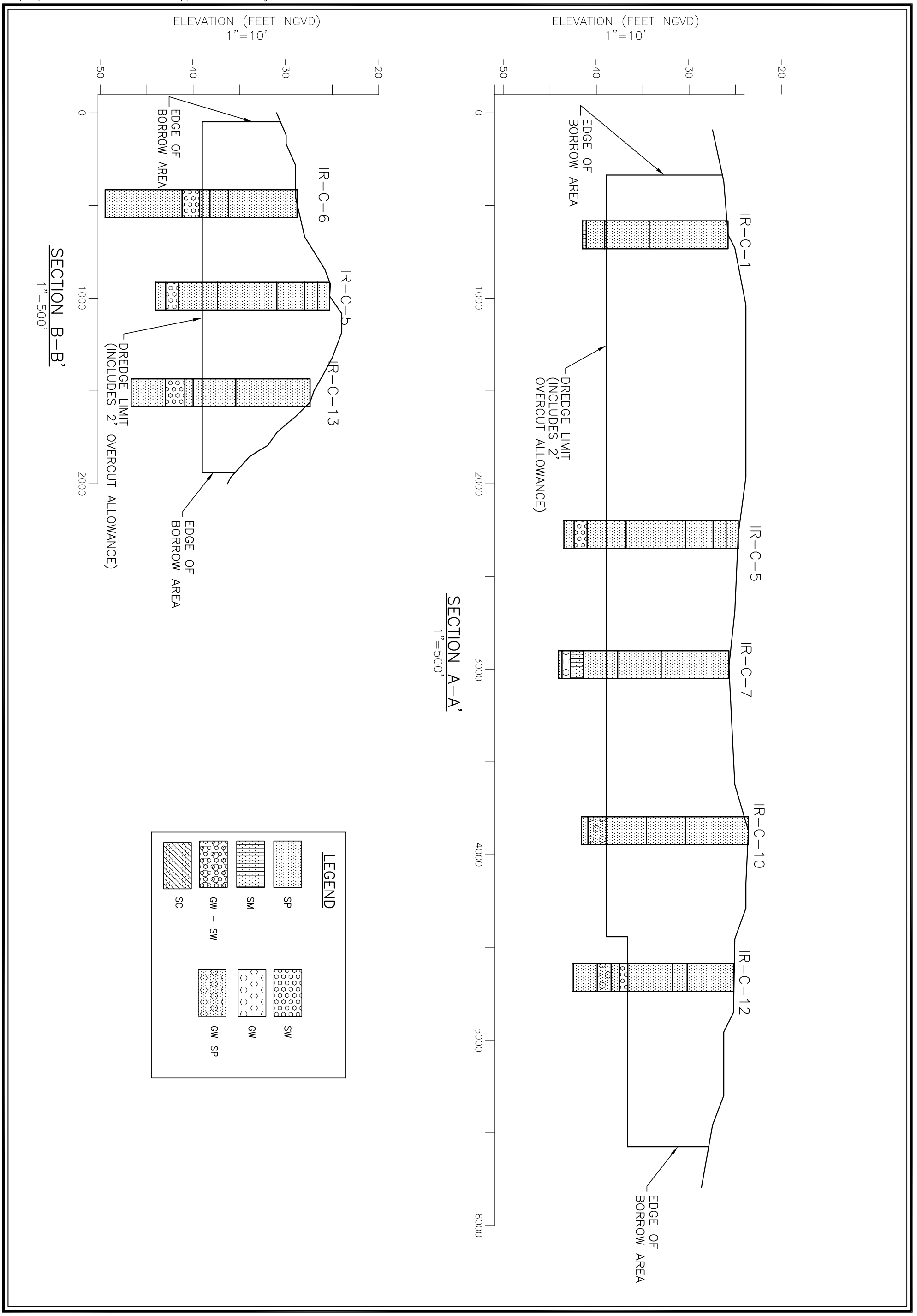


Figure B-11
Indian River County Geotechnical Investigation
Central Borrow Area Cross Sections

APPLIED TECHNOLOGY & MANAGEMENT, INC

ATLANTIC OCEAN

X= 729,020.42
Y=1,185,999.49

X= 728,759.41
Y=1,180,170.99

X= 727,100.38
Y=1,171,901.41

X= 726,522.92
Y=1,186,111.33

X= 726,270.50
Y=1,180,474.56

X= 724,649.22
Y=1,172,393.16

SUB–AREA 1

SUB–AREA 2

SUB–AREA 3

SIDE–SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

IR–S–1 25.8
IR–S–2 24.0
IR–S–3 28.3
IR–S–4 23.3
IR–S–5 22.6
IR–S–6 24.9
IR–S–7 24.5
IR–S–8 22.1
IR–S–9 18.7
IR–S–10 24.6
IR–S–11 25.3
IR–S–12 17.7
IR–S–13 24.5
IR–S–14 23.1
IR–S–15 17.1
IR–S–16 21.4
IR–S–17 18.2
IR–S–18 21.7
IR–S–19 18.1
IR–S–20 21.5
IR–S–21 20.9
IR–S–22 18.4
IR–S–23 23.8
IR–S–24 17.9
IR–S–25 17.3
IR–S–26 27.6

LEGEND

- SUB–AREA 1 – PROPOSED BORROW AREA LIMITS
- SUB–AREA 2 – PROPOSED BORROW AREA LIMITS
- SUB–AREA 3 – PROPOSED BORROW AREA LIMITS
- IR–S–13 24.5 — ATM JUNE–JULY 1999 VIBRACORE AS–BUILT LOCATION & WATER DEPTH
- CB–22 — USACE VIBRACORE

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED ON JANUARY 13, 2000 BY MORGAN & EKLUND, INC.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE–SCAN SONAR SURVEY CONDUCTED FEBRUARY 17, 2000.

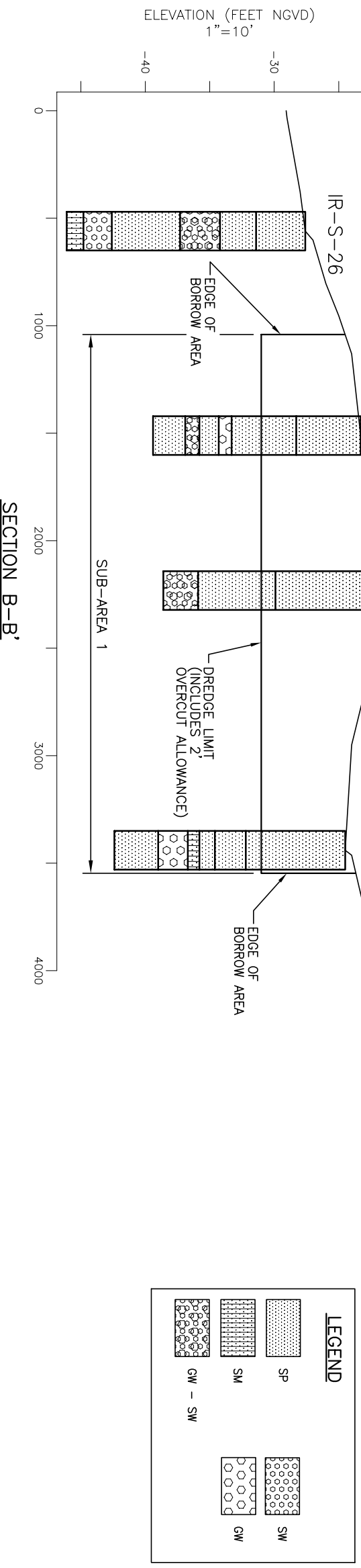
N

0 1000
Scale in Feet

APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure B–12
Indian River County Geotechnical Investigation
South Borrow Area Vibracore Locations

11/07/01 99–219 Geotech Appendix B Plan Views.dwg



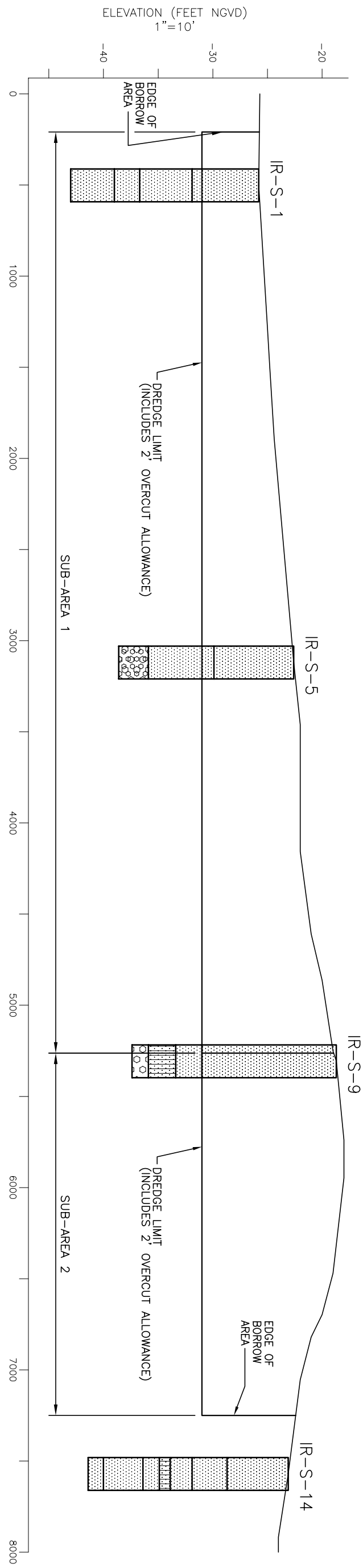
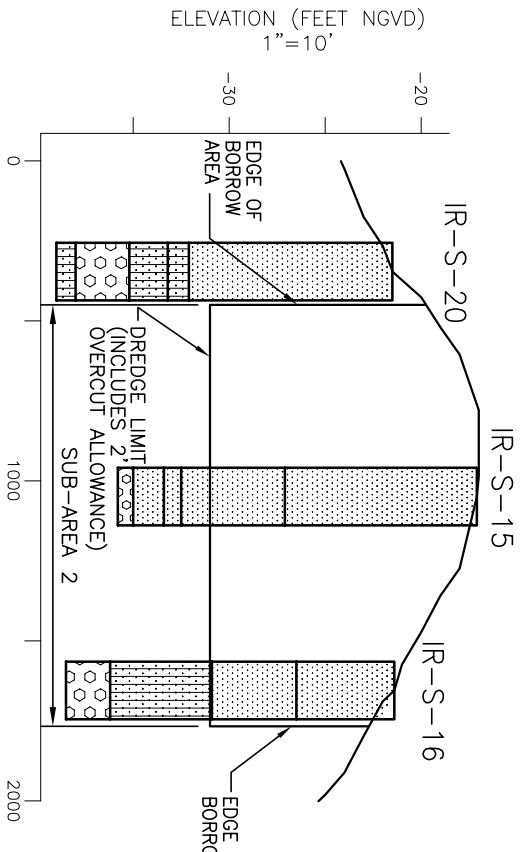
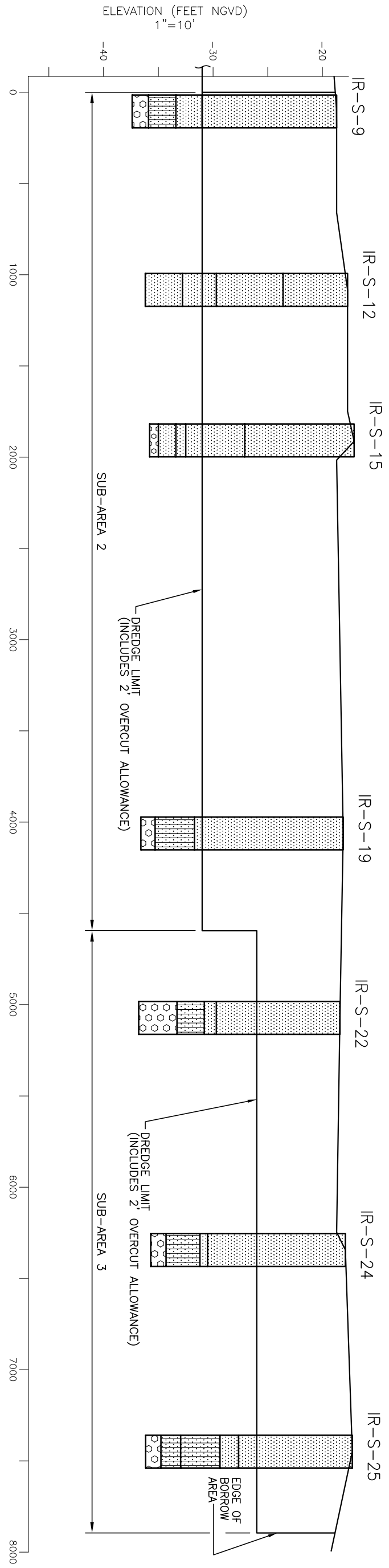


Figure B-13
Indian River County Geotechnical Investigation
South Borrow Area Cross Sections

APPLIED TECHNOLOGY & MANAGEMENT, INC



SECTION D-D'
1"=600'



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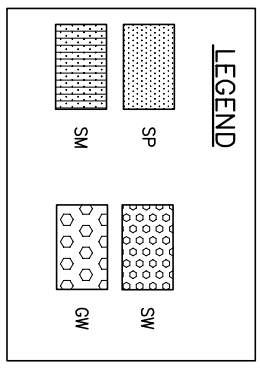

Figure B-14
Indian River County Geotechnical Investigation
South Borrow Area Cross Sections

APPLIED TECHNOLOGY & MANAGEMENT, INC

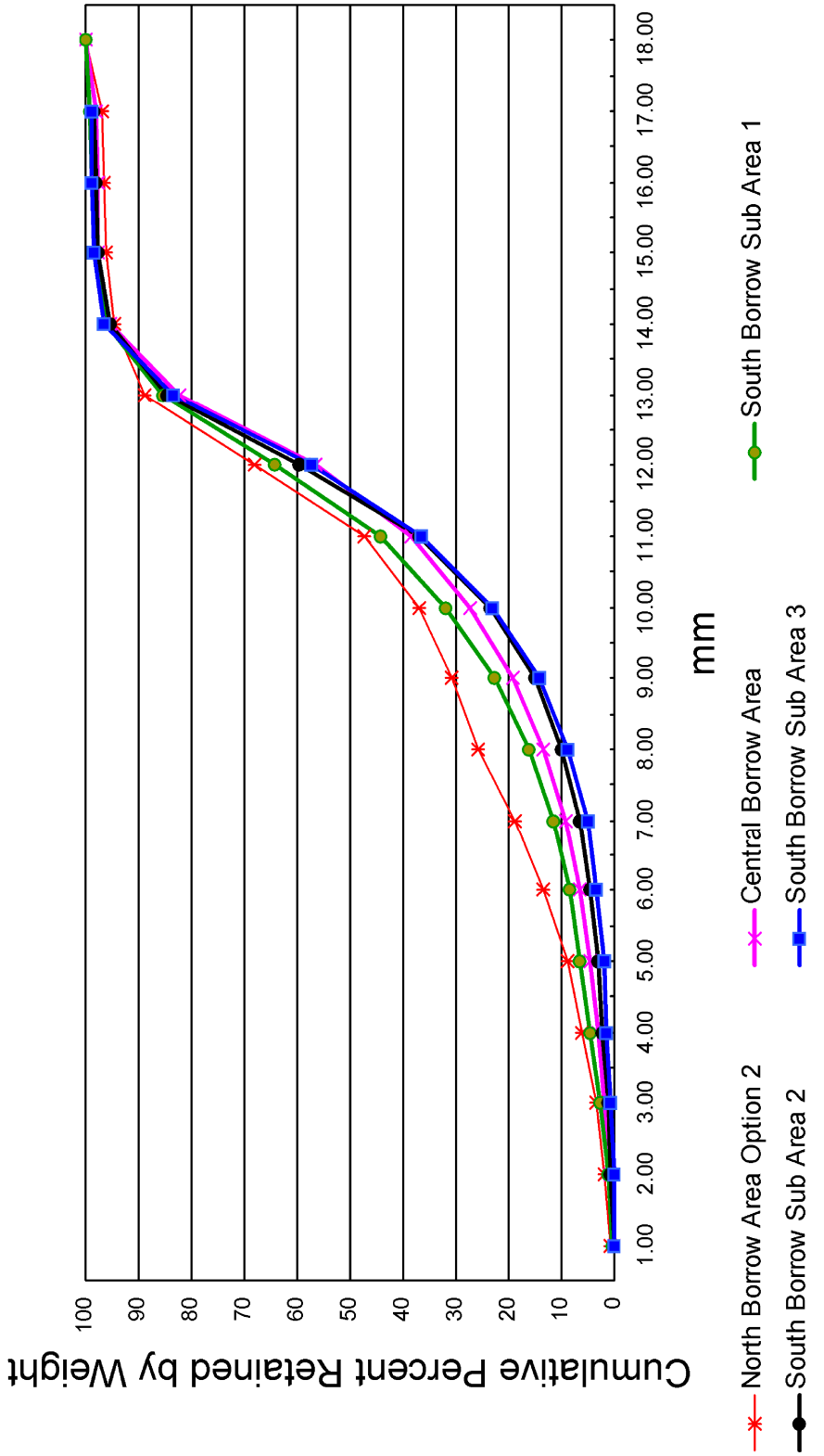

Figure B–15
Indian River County Geotechnical Investigation
Borrow Site Composite Grain Size Distributions

APPLIED TECHNOLOGY & MANAGEMENT, INC

Indian River County - October 2000 North Borrow Area Vibracore Results

SAMPLE	Silt/Clay %	Sand-Gravel %
IN-1R1-0.5	13.00%	87.00%
IN-1R1-2.0	7.54%	92.46%
IN-1R1-5.0	0.90%	99.10%
IN-1R1-8.0	0.72%	99.28%
IN-1R1-12.0	4.67%	95.33%
IN-1R1-15.0	0.58%	99.42%
IN-1R1-COMP	3.15%	96.85%
IN-1R2-11.0	0.56%	99.44%
IN-1R2-15.0	0.75%	99.25%
IN-1R2-18.0	1.12%	98.88%
IN-2-1.0	9.06%	90.94%
IN-2-3.0	1.55%	98.45%
IN-2-6.0	0.33%	99.67%
IN-2-9.0	0.06%	99.94%
IN-2-11.0	0.33%	99.67%
IN-2-14.0	1.21%	98.79%
IN-2-17.0	1.38%	98.62%
IN-2-COMP	0.62%	99.38%
IN-3-0.5	8.48%	91.52%
IN-3-3.0	9.56%	90.44%
IN-3-6.0	0.77%	99.23%
IN-3-9.0	2.12%	97.88%
IN-3-12.0	3.24%	96.76%
IN-3-15.0	0.73%	99.27%
IN-3-COMP	3.51%	96.49%
IN-4AR1-0.5	4.27%	95.73%
IN-4AR1-3.0	6.74%	93.26%
IN-4AR1-6.0	4.40%	95.60%
IN-4AR1-9.0	2.33%	97.67%
IN-4AR1-12.0	4.13%	95.87%
IN-4AR1-14.0	2.28%	97.72%
IN-4AR1-COMP	3.98%	96.02%
IN-4AR2-13.0	0.60%	99.40%
IN-4AR2-15.0	0.95%	99.05%
IN-4AR2-18.0	1.47%	98.53%
IN-4AR2-COMP	0.87%	99.13%
IN-5-0.5	7.04%	92.96%
IN-5-2.0	8.77%	91.23%
IN-5-5.0	4.20%	95.80%
IN-5-6.0	1.78%	98.22%
IN-5-8.0	1.03%	98.97%
IN-5-11.0	2.62%	97.38%
IN-5-13.0	1.83%	98.17%
IN-5-16.0	2.42%	97.58%
IN-5-COMP	3.05%	96.95%
IN-6-1.0	5.00%	95.00%
IN-6-3.0	3.99%	96.01%
IN-6-5.0	1.70%	98.30%
IN-6-7.0	0.96%	99.04%
IN-6-10.0	0.81%	99.19%
IN-6-13.0	1.41%	98.59%
IN-6-16.0	1.39%	98.61%
IN-6-COMP	1.82%	98.18%

Indian River County - October 2000 North Borrow Area Vibracore Results

SAMPLE	Silt/Clay %	Sand-Gravel %
IN-7-0.5	15.64%	84.36%
IN-7-3.0	2.65%	97.35%
IN-7-5.0	1.16%	98.84%
IN-7-8.0	1.49%	98.51%
IN-7-11.0	12.06%	87.94%
IN-7-14.0	1.45%	98.55%
IN-7-17.0	0.64%	99.36%
IN-7-COMP	1.16%	98.84%
IN-8B-0.5	21.62%	78.38%
IN-8B-2.0	10.89%	89.11%
IN-8B-4.0	1.90%	98.10%
IN-8B-7.0	11.33%	88.67%
IN-8B-9.0	0.52%	99.48%
IN-8B-12.0	4.27%	95.73%
IN-8B-16.0	1.18%	98.82%
IN-8B-19.0	0.97%	99.03%
IN-8B-COMP	3.18%	96.82%
IN-9B-1.0	4.16%	95.84%
IN-9B-3.0	0.99%	99.01%
IN-9B-6.0	0.53%	99.47%
IN-9B-9.0	0.33%	99.67%
IN-9B-12.0	0.76%	99.24%
IN-9B-14.0	0.55%	99.45%
IN-9B-COMP	1.07%	98.93%
IN-10-0.5	4.46%	95.54%
IN-10-2.0	6.52%	93.48%
IN-10-5.0	4.24%	95.76%
IN-10-8.0	0.80%	99.20%
IN-10-14.0	0.42%	99.58%
IN-10-11.0	3.01%	96.99%
IN-10-17.0	1.00%	99.00%
IN-10-COMP	2.17%	97.83%

Indian River County - Samples -
Carbonate Percentages North Borrow Area October 2000 cores

SAMPLE #	CaCO3%
IN-1R1-0.5	74.78%
IN-1R1-2.0	46.14%
IN-1R1-5.0	23.76%
IN-1R1-8.0	9.72%
IN-1R1-12.0	9.25%
IN-1R1-15.0	7.42%
IN-1R1-COMP	24.90%
IN-1R2-11.0	6.30%
IN-1R2-15.0	8.83%
IN-1R2-18.0	16.14%
IN-2-1.0	62.97%
IN-2-3.0	47.40%
IN-2-6.0	51.07%
IN-2-9.0	79.64%
IN-2-11.0	73.93%
IN-2-14.0	48.01%
IN-2-17.0	49.51%
IN-2-COMP	48.64%
IN-3-0.5	83.96%
IN-3-3.0	72.20%
IN-3-6.0	40.01%
IN-3-9.0	25.57%
IN-3-12.0	67.12%
IN-3-15.0	74.57%
IN-3-COMP	45.80%
IN-4AR1-0.5	85.81%
IN-4AR1-3.0	81.45%
IN-4AR1-6.0	69.70%
IN-4AR1-9.0	72.08%
IN-4AR1-12.0	64.53%
IN-4AR1-14.0	53.17%
IN-4AR1-COMP	75.90%
IN-4AR2-13.0	73.96%
IN-4AR2-15.0	52.33%
IN-4AR2-COMP	71.81%
IN-5-0.5	77.47%
IN-5-2.0	62.68%
IN-5-5.0	20.37%
IN-5-6.0	26.27%
IN-5-8.0	40.14%
IN-5-11.0	84.61%
IN-5-13.0	83.72%
IN-5-16.0	63.24%
IN-5-COMP	65.53%

Indian River County - Samples -
Carbonate Percentages North Borrow Area October 2000 cores

SAMPLE #	CaCO3%
IN-6-1.0	57.20%
IN-6-3.0	56.39%
IN-6-5.0	41.99%
IN-6-7.0	78.86%
IN-6-10.0	37.93%
IN-6-13.0	52.79%
IN-6-16.0	73.40%
IN-6-COMP	56.90%
IN-7-0.5	73.94%
IN-7-3.0	24.48%
IN-7-5.0	50.71%
IN-7-8.0	56.74%
IN-7-11.0	44.60%
IN-7-14.0	70.68%
IN-7-17.0	61.33%
IN-7-COMP	43.89%
IN-8B-0.5	68.73%
IN-8B-2.0	24.49%
IN-8B-4.0	13.71%
IN-8B-7.0	21.07%
IN-8B-9.0	16.05%
IN-8B-12.0	20.40%
IN-8B-16.0	41.09%
IN-8B-19.0	79.52%
IN-8B-COMP	28.30%
IN-9B-1.0	13.18%
IN-9B-3.0	13.71%
IN-9B-6.0	5.72%
IN-9B-9.0	17.50%
IN-9B-12.0	12.58%
IN-9B-14.0	9.14%
IN-9B-COMP	13.83%
IN-10-0.5	81.00%
IN-10-2.0	77.36%
IN-10-5.0	82.39%
IN-10-8.0	10.50%
IN-10-11.0	18.11%
IN-10-14.0	54.98%
IN-10-17.0	40.10%
IN-10-COMP	47.67%

Indian River County - Samples -
Carbonate Percentages North Borrow Area October 2000 cores

SAMPLE #	CaCO3%
IRC-1-COMP	70.96%
IRC-2-COMP	68.01%
IRC-3-COMP	78.67%
IRC-4-COMP	66.14%
IRC-5-COMP	70.62%
IRC-6-COMP	76.31%
IRC-7-COMP	71.31%
IRC-10-COMP	69.86%
IRC-11-COMP	64.28%
IRC-12-COMP	69.50%
IRC-13-COMP	70.74%
IRC-14-COMP	72.13%
IRS-1-COMP	77.54%
IRS-2-COMP	73.35%
IRS-5-COMP	79.28%
IRS-7-COMP	73.99%
IRS-9-COMP	70.96%
IRS-15-COMP	71.47%
IRS-18-COMP	74.50%
IRS-19-COMP	72.94%
IRS-21-COMP	74.12%
IRS-22-COMP	72.61%
IRS-23-COMP	59.38%
IRS-24-COMP	73.12%
IRS-25-COMP	75.14%
R-4 -COMP	21.76%
R-7 -COMP	14.88%
R-10 -COMP	16.21%
R-13 -COMP	19.48%
T-17 -COMP	31.14%

Indian River County
June-July 1999 North Borrow Area Vibracore Results

SAMPLE	% Silt/Clay	% Sand-Gravel
IR-N-1-0.5	6.63%	93.37%
IR-N-1-4.0	11.65%	88.35%
IR-N-1-8.0	1.70%	98.30%
IR-N-2-0.5	2.47%	97.53%
IR-N-2-5.0	4.69%	95.31%
IR-N-2-11.0	2.33%	97.67%
IR-N-3-0.5	12.53%	87.47%
IR-N-3-4.0	8.91%	91.09%
IR-N-3-8.0	1.70%	98.30%
IR-N-3-12.0	1.10%	98.90%
IR-N-3-17.0	3.39%	96.61%
IR-N-4-0.5	6.73%	93.27%
IR-N-4-4.0	8.75%	91.25%
IR-N-4-8.0	1.12%	98.88%
IR-N-4-12.0	1.51%	98.49%
IR-N-5-0.5	9.61%	90.39%
IR-N-5-4.0	7.75%	92.25%
IR-N-5-8.0	2.24%	97.76%
IR-N-6-0.5	9.22%	90.78%
IR-N-6-4.0	2.03%	97.97%
IR-N-6-8.0	1.04%	98.96%
IR-N-6-14.0	1.36%	98.64%
IR-N-7-0.5	11.62%	88.38%
IR-N-7-4.0	6.78%	93.22%
IR-N-7-8.0	2.72%	97.28%
IR-N-7-14.0	6.33%	93.67%
IR-N-9-0.5	11.48%	88.52%
IR-N-9-4.0	7.61%	92.39%
IR-N-9-8.0	1.41%	98.59%
IR-N-10-0.5	9.52%	90.48%
IR-N-10-4.0	9.88%	90.12%
IR-N-10-8.0	3.60%	96.40%
IR-N-10-13.0	1.67%	98.33%
IR-N-11-0.5	1.28%	98.72%
IR-N-11-5.0	20.20%	79.80%
IR-N-11-8.0	1.07%	98.93%
IR-N-11-13.0	2.13%	97.87%
IR-N-12-0.5	7.55%	92.45%
IR-N-12-4.0	20.77%	79.23%
IR-N-12-8.0	4.05%	95.95%
IR-N-12-14.0	2.33%	97.67%

SAMPLE	% Silt/Clay	% Sand-Gravel
IR-N-13-0.5	20.62%	79.38%
IR-N-13-4.0	6.29%	93.71%
IR-N-13-8.0	1.64%	98.36%
IR-N-13-12.0	1.28%	98.72%
IR-N-13-16.0	1.09%	98.91%
IR-N-14-0.5	14.07%	85.93%
IR-N-14-4.0	4.93%	95.07%
IR-N-14-8.0	1.20%	98.80%
IR-N-14-12.0	1.10%	98.90%
IR-N-14-16.0	2.52%	97.48%
IR-N-15-0.5	2.45%	97.55%
IR-N-15-4.0	19.34%	80.66%
IR-N-15-8.0	0.84%	99.16%
IR-N-16-0.5	5.84%	94.16%
IR-N-16-4.0	0.88%	99.12%
IR-N-16-8.0	3.72%	96.28%
IR-N-16-12.0	1.11%	98.89%
IR-N-16-16.0	0.32%	99.68%
IR-N-17-0.5	3.35%	96.65%
IR-N-17-4.0	7.64%	92.36%
IR-N-17-8.0	6.51%	93.49%
IR-N-18-0.5	3.75%	96.25%
IR-N-18-4.0	10.83%	89.17%
IR-N-18-8.0	4.49%	95.51%
IR-N-19-0.5	10.31%	89.69%
IR-N-19-4.0	2.30%	97.70%
IR-N-19-8.0	0.59%	99.41%
IR-N-19-12.0	0.48%	99.52%
IR-N-19-16.0	0.75%	99.25%
IR-N-20-0.5	2.96%	97.04%
IR-N-20-4.0	3.75%	96.25%
IR-N-20-8.0	1.03%	98.97%
IR-N-20-12.0	1.39%	98.61%
IR-N-20-16.0	1.32%	98.68%

Indian River County
Central Borrow Area Vibracore Results

SAMPLE	% Silt/Clay	% Sand-Gravel
IR-C-1-0.5	0.41%	99.59%
IR-C-1-3.0	1.55%	98.45%
IR-C-1-7.0	3.27%	96.73%
IR-C-1-12.0	2.11%	97.89%
IR-C-2-0.5	0.12%	99.88%
IR-C-2-4.0	1.32%	98.68%
IR-C-2-9.0	2.03%	97.97%
IR-C-2-15.0	2.06%	97.94%
IR-C-3-0.5	0.50%	99.50%
IR-C-3-3.0	1.12%	98.88%
IR-C-3-6.0	2.73%	97.27%
IR-C-3-10.0	6.41%	93.59%
IR-C-4-0.5	0.71%	99.29%
IR-C-4-3.0	1.80%	98.20%
IR-C-4-6.0	2.00%	98.00%
IR-C-4-11.0	1.68%	98.32%
IR-C-4-14.0	2.20%	97.80%
IR-C-5-0.5	0.05%	99.95%
IR-C-5-4.0	1.07%	98.93%
IR-C-5-8.0	0.46%	99.54%
IR-C-5-12.0	1.53%	98.47%
IR-C-5-16.0	3.16%	96.84%
IR-C-6-0.5	0.73%	99.27%
IR-C-6-3.0	1.28%	98.72%
IR-C-6-8.0	1.17%	98.83%
IR-C-6-12.0	2.54%	97.46%
IR-C-6-17.0	1.52%	98.48%
IR-C-7-0.5	0.97%	99.03%
IR-C-7-4.0	1.91%	98.09%
IR-C-7-8.0	1.45%	98.55%
IR-C-7-13.0	3.08%	96.92%
IR-C-7-17.0	18.99%	81.01%
IR-C-8-0.5	0.91%	99.09%
IR-C-8-4.0	2.46%	97.54%
IR-C-8-8.0	2.21%	97.79%
IR-C-8-12.0	2.83%	97.17%
IR-C-8-17.0	4.58%	95.42%
IR-C-9-0.5	0.91%	99.09%
IR-C-9-4.0	2.68%	97.32%
IR-C-9-8.0	1.57%	98.43%
IR-C-9-14.0	4.75%	95.25%
IR-C-9-17.0	1.92%	98.08%

Indian River County
Central Borrow Area Vibracore Results

SAMPLE	MUD %	SAND-GRAVEL%
IR-C-10-0.5	0.78%	99.22%
IR-C-10-4.0	1.12%	98.88%
IR-C-10-8.0	1.80%	98.20%
IR-C-10-14.0	4.16%	95.84%
IR-C-11-0.5	0.50%	99.50%
IR-C-11-4.0	1.29%	98.71%
IR-C-11-8.0	2.90%	97.10%
IR-C-11-14.0	5.01%	94.99%
IR-C-11-18.0	1.53%	98.47%
IR-C-12-0.5	1.45%	98.55%
IR-C-12-4.0	1.91%	98.09%
IR-C-12-8.0	2.73%	97.27%
IR-C-12-12.0	2.55%	97.45%
IR-C-13-0.5	1.19%	98.81%
IR-C-13-4.0	5.56%	94.44%
IR-C-13-8.0	2.62%	97.38%
IR-C-13-14.0	3.95%	96.05%
IR-C-14-0.5	0.51%	99.49%
IR-C-14-4.0	1.50%	98.50%
IR-C-14-8.0	2.22%	97.78%
IR-C-14-12.0	9.28%	90.72%
IR-C-14-16.0	5.18%	94.82%

Indian River County
South Borrow Area Vibracore Results

SAMPLE	% Silt/Clay	% Sand-Gravel
IR-S-1-0.5	0.29%	99.71%
IR-S-1-4.0	0.94%	99.06%
IR-S-1-8.0	2.26%	97.74%
IR-S-1-13.0	1.06%	98.94%
IR-S-2-0.5	0.45%	99.55%
IR-S-2-4.0	0.23%	99.77%
IR-S-2-8.0	1.27%	98.73%
IR-S-2-16.0	8.54%	91.46%
IR-S-3-0.5	0.20%	99.80%
IR-S-3-4.0	1.42%	98.58%
IR-S-3-8.0	8.48%	91.52%
IR-S-3-14.0	2.09%	97.91%
IR-S-4-0.5	0.22%	99.78%
IR-S-4-4.0	1.24%	98.76%
IR-S-4-8.0	1.66%	98.34%
IR-S-4-15.0	11.79%	88.21%
IR-S-5-0.5	0.25%	99.75%
IR-S-5-4.0	1.82%	98.18%
IR-S-5-8.0	1.96%	98.04%
IR-S-5-12.0	7.32%	92.68%
IR-S-6-0.5	0.02%	99.98%
IR-S-6-4.0	1.11%	98.89%
IR-S-6-8.0	2.12%	97.88%
IR-S-6-14.0	1.29%	98.71%
IR-S-7-0.5	0.39%	99.61%
IR-S-7-4.0	1.03%	98.97%
IR-S-7-8.0	1.28%	98.72%
IR-S-8-0.5	0.72%	99.28%
IR-S-8-4.0	0.86%	99.14%
IR-S-8-8.0	1.53%	98.47%
IR-S-8-15.0	3.64%	96.36%
IR-S-9-0.5	0.07%	99.93%
IR-S-9-4.0	0.43%	99.57%
IR-S-9-8.0	0.44%	99.56%
IR-S-9-13.0	3.34%	96.66%
IR-S-10-0.5	0.53%	99.47%
IR-S-10-4.0	2.59%	97.41%
IR-S-10-8.0	12.81%	87.19%
IR-S-11-0.5	0.68%	99.32%
IR-S-11-4.0	1.17%	98.83%
IR-S-11-8.0	1.91%	98.09%
IR-S-12-0.5	0.20%	99.80%
IR-S-12-4.0	0.63%	99.37%
IR-S-12-8.0	0.68%	99.32%
IR-S-12-12.0	1.50%	98.50%
IR-S-13-0.5	0.13%	99.87%
IR-S-13-4.0	0.72%	99.28%
IR-S-13-8.0	10.45%	89.55%
IR-S-13-13.0	7.34%	92.66%

Indian River County
South Borrow Area Vibracore Results

IR-S-14-0.5	0.57%	99.43%
IR-S-14-4.0	0.64%	99.36%
IR-S-14-8.0	2.41%	97.59%
IR-S-15-0.5	0.73%	99.27%
IR-S-15-4.0	0.40%	99.60%
IR-S-15-8.0	1.67%	98.33%
IR-S-15-14.0	2.71%	97.29%
IR-S-16-0.5	0.79%	99.21%
IR-S-16-4.0	1.64%	98.36%
IR-S-16-8.0	3.60%	96.40%
IR-S-17-0.5	0.38%	99.62%
IR-S-17-4.0	3.46%	96.54%
IR-S-17-8.0	1.48%	98.52%
IR-S-17-14.0	3.13%	96.87%
IR-S-18-0.5	0.71%	99.29%
IR-S-18-4.0	0.78%	99.22%
IR-S-18-8.0	2.33%	97.67%
IR-S-18-13.0	2.57%	97.43%
IR-S-19-0.5	0.43%	99.57%
IR-S-19-4.0	0.30%	99.70%
IR-S-19-8.0	1.11%	98.89%
IR-S-19-13.0	6.06%	93.94%
IR-S-20-0.5	0.84%	99.16%
IR-S-20-4.0	1.12%	98.88%
IR-S-20-8.0	0.93%	99.07%
IR-S-21-0.5	0.99%	99.01%
IR-S-21-4.0	0.79%	99.21%
IR-S-21-8.0	2.21%	97.79%
IR-S-22-0.5	0.36%	99.64%
IR-S-22-4.0	1.44%	98.56%
IR-S-22-8.0	2.42%	97.58%
IR-S-22-11.0	4.67%	95.33%
IR-S-23-0.5	1.28%	98.72%
IR-S-23-4.0	2.78%	97.22%
IR-S-23-8.0	27.44%	72.56%
IR-S-23-13.0	5.98%	94.02%
IR-S-24-0.5	0.57%	99.43%
IR-S-24-4.0	0.62%	99.38%
IR-S-24-8.0	1.68%	98.32%
IR-S-24-12.0	1.92%	98.08%
IR-S-25-0.5	0.07%	99.93%
IR-S-25-4.0	0.75%	99.25%
IR-S-25-8.0	1.35%	98.65%
IR-S-25-11.0	3.31%	96.69%
IR-S-26-0.5	0.52%	99.48%
IR-S-26-4.0	2.92%	97.08%
IR-S-26-8.0	3.25%	96.75%
IR-S-26-13.0	2.81%	97.19%

N 1269000 N 1268000 N 1267000 N 1266000 N 1265000 N 1264000 N 1263000 N 1262000 N 1261000 N 1260000

E 693000 E 692000 E 691000 E 690000 E 689000 E 688000

ATLANTIC OCEAN

X= 692,053.49
Y=1,262,645.07

SIDE–SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

A01

X= 690,343.38
Y=1,267,977.57

SS9

SS12

SS11

SS10

X= 689,672.91
Y=1,261,881.63

X= 687,962.81
Y=1,267,214.13

R–27 R–26 R–25 R–24 R–23 R–22 R–21 R–20 R–19 R–18

N

0 800
Scale in Feet

LEGEND

- APPROXIMATE SHORELINE
- R–20 ∘ DEP MONUMENT
- PROPOSED BORROW AREA EXCAVATION LIMIT
- SS12 SIDE SCAN SONAR TARGET
- A01 MAGNETIC ANOMALIES

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE–SCAN SONAR SURVEY CONDUCTED APRIL 29, 2000.
5. MAGNETOMETER SURVEY CONDUCTED MAY 10–12, 2000.

TAMS
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure C–1
Indian River County Geotechnical Investigation
North Borrow Area Option 1 – Geophysical Investigation

11/07/01 99–219 Geotech Appendix C Plan Views.dwg

N 1269000 N 1268000 N 1267000 N 1266000 N 1265000 N 1264000 N 1263000 N 1262000 N 1261000 N 1260000

E 693000 E 692000 E 691000 E 690000 E 689000 E 688000

ATLANTIC OCEAN

X= 692,053.49
Y=1,262,645.07

SIDE–SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

A01

X= 690,343.38
Y=1,267,977.57

SS9

SS12

SS11

SS10

X= 689,672.91
Y=1,261,881.63

X= 687,962.81
Y=1,267,214.13

R–27 R–26 R–25 R–24 R–23 R–22 R–21 R–20 R–19 R–18

N

0 800
Scale in Feet

LEGEND

- APPROXIMATE SHORELINE
- R–20 ∘ DEP MONUMENT
- PROPOSED BORROW AREA EXCAVATION LIMIT
- SS12 SIDE SCAN SONAR TARGET
- A01 MAGNETIC ANOMALIES

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE–SCAN SONAR SURVEY CONDUCTED APRIL 29, 2000.
5. MAGNETOMETER SURVEY CONDUCTED MAY 10–12, 2000.

TAMS
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure C–2
Indian River County Geotechnical Investigation
North Borrow Area Option 2 – Geophysical Investigation

11/07/01 99–219 Geotech Appendix C Plan Views.dwg

N 1269000 N 1268000 N 1267000 N 1266000 N 1265000 N 1264000 N 1263000 N 1262000 N 1261000 N 1260000

E 693000 E 692000 E 691000 E 690000 E 689000 E 688000

ATLANTIC OCEAN

X= 692,053.49
Y=1,262,645.07

SIDE–SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

A01

X= 690,343.38
Y=1,267,977.57

SS9

SS12

SS11

SS10

X= 689,672.91
Y=1,261,881.63

X= 687,962.81
Y=1,267,214.13

R–27 R–26 R–25 R–24 R–23 R–22 R–21 R–20 R–19 R–18

N

0 800
Scale in Feet

LEGEND

- APPROXIMATE SHORELINE
- R–20 ∘ DEP MONUMENT
- PROPOSED BORROW AREA EXCAVATION LIMIT
- SS12 SIDE SCAN SONAR TARGET
- A01 MAGNETIC ANOMALIES

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE–SCAN SONAR SURVEY CONDUCTED APRIL 29, 2000.
5. MAGNETOMETER SURVEY CONDUCTED MAY 10–12, 2000.

APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure C–3
Indian River County Geotechnical Investigation
North Borrow Area Option 3 – Geophysical Investigation

11/07/01 99–219 Geotech Appendix C Plan Views.dwg

N 1269000 N 1268000 N 1267000 N 1266000 N 1265000 N 1264000 N 1263000 N 1262000 N 1261000 N 1260000

E 693000 E 692000 E 691000 E 690000 E 689000 E 688000

ATLANTIC OCEAN

X= 692,053.49
Y=1,262,645.07

SIDE-SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

A01

X= 690,343.38
Y=1,267,977.57

SS9

SS12

SS11

SS10

X= 689,672.91
Y=1,261,881.63

X= 687,962.81
Y=1,267,214.13

R-18 R-19 R-20 R-21 R-22 R-23 R-24 R-25 R-26 R-27

N

0 800
Scale in Feet

LEGEND

- APPROXIMATE SHORELINE
- R-20 ∘ DEP MONUMENT
- PROPOSED BORROW AREA EXCAVATION LIMIT
- SS12 SIDE SCAN SONAR TARGET
- A01 MAGNETIC ANOMALIES

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON FEBRUARY 7, 2000.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE-SCAN SONAR SURVEY CONDUCTED APRIL 29, 2000.
5. MAGNETOMETER SURVEY CONDUCTED MAY 10-12, 2000.

TAIT
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure C-4
Indian River County Geotechnical Investigation
North Borrow Area Option 4 - Geophysical Investigation

11/07/01 99-219 Geotech Appendix C Plan Views.dwg

ATLANTIC OCEAN

X= 728,472.18
Y=1,201,892.42

SIDE-SCAN SONAR AND BATHYMETRIC SURVEY LIMITS

X= 727,521.17
Y=1,194,957.33

X= 725,500.00
Y=1,202,300.00

X= 724,548.99
Y=1,195,364.90

SS1 SS2 SS3 SS4 SS5 SS6 SS7 SS8

E 729000 E 728000 E 727000 E 726000 E 725000 E 724000

N 1203000 N 1202000 N 1201000 N 1200000 N 1199000 N 1198000 N 1197000 N 1196000 N 1195000

LEGEND

- PROPOSED BORROW AREA EXCAVATION LIMIT
- SS1 SIDE SCAN SONAR TARGET
- B02 MAGNETIC ANOMALIES

N

0 600
Scale in Feet

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED BY MORGAN & EKLUND, INC ON DECEMBER 22, 1999.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE-SCAN SONAR SURVEY CONDUCTED APRIL 28, 2000.
5. MAGNETOMETER SURVEY CONDUCTED MAY 10-12, 2000.

TAMS
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure C-5
Indian River County Geotechnical Investigation
Central Borrow Area Geophysical Investigation

11/07/01 99-219 Geotech Appendix C Plan Views.dwg

ATLANTIC OCEAN

X= 729,020.42
Y=1,185,999.49

X= 728,759.41
Y=1,180,170.99

X= 727,100.38
Y=1,171,901.41

X= 726,522.92
Y=1,186,111.33

X= 726,270.50
Y=1,180,474.56

X= 724,649.22
Y=1,172,393.16

SUB–AREA 1

SUB–AREA 2

SUB–AREA 3

SIDE–SCAN SONAR AND
BATHYMETRIC SURVEY LIMITS

C01 C02 C03 C04 C05 C06 C07 C08 C09 C10 C11 C12

N 1186000 N 1185000 N 1184000 N 1183000 N 1182000 N 1181000 N 1180000 N 1179000 N 1178000 N 1177000 N 1176000 N 1175000 N 1174000 N 1173000 N 1172000

E 731000 E 730000 E 729000 E 728000 E 727000 E 726000 E 725000 E 724000 E 723000

N 1184000 N 1173000

LEGEND

- SUB–AREA 1 – PROPOSED BORROW AREA LIMITS
- SUB–AREA 2 – PROPOSED BORROW AREA LIMITS
- SUB–AREA 3 – PROPOSED BORROW AREA LIMITS
- ⊠C01 MAGNETIC ANOMALIES

NOTES:

1. ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. CONTOURS GENERATED FROM BATHYMETRIC DATA COLLECTED ON JANUARY 13, 2000 BY MORGAN & EKLUND, INC.
3. ALL HORIZONTAL VALUES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1927, FLORIDA STATE PLANE, EAST ZONE.
4. SIDE–SCAN SONAR SURVEY CONDUCTED FEBRUARY 17, 2000.
5. MAGNETOMETER SURVEY CONDUCTED MAY 10–12, 2000.

N

0 1000

Scale in Feet

TAIT
APPLIED TECHNOLOGY & MANAGEMENT, INC

Figure C–6
Indian River County Geotechnical Investigation
South Borrow Area Geophysical Investigation

11/07/01 99–219 Geotech Appendix C Plan Views.dwg

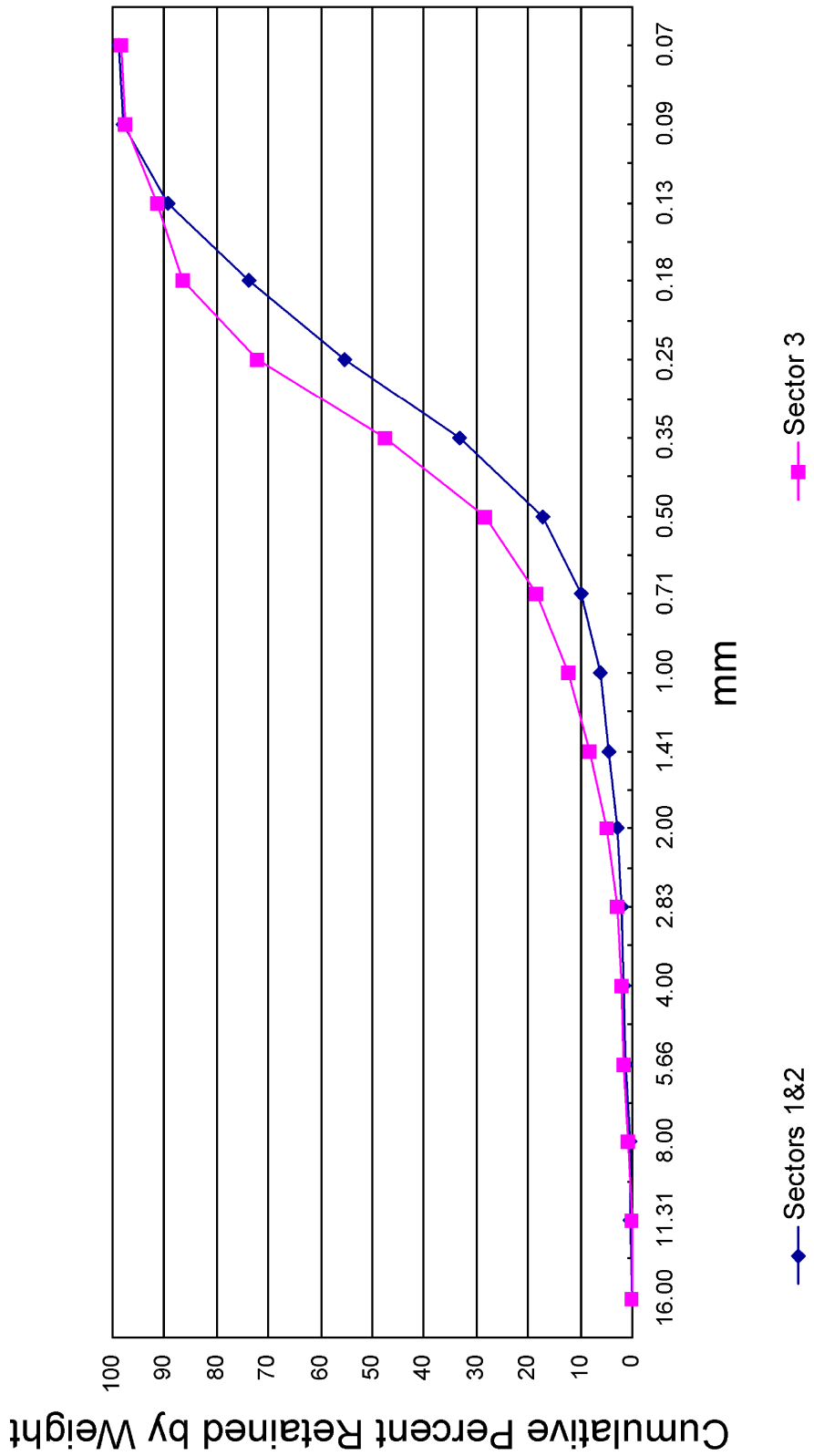

Figure D–1
Indian River County Geotechnical Investigation
Native Beach Composite Grain Size Distributions

APPLIED TECHNOLOGY & MANAGEMENT, INC

Indian River County Native Beach Samples June 2000

SAMPLE	% Silt/Clay	% Sand-Gravel
R 4, -6	2.36%	97.64%
R 4, -3	1.17%	98.83%
R 4, 0	1.25%	98.75%
R 4, +3	1.12%	98.88%
R 4, +6	0.27%	99.73%
R 4, +9	0.41%	99.59%
R 4, +12	0.07%	99.93%
R 4 COMP	0.84%	99.16%
R 7, -15	8.21%	91.79%
R 7, -9	1.97%	98.03%
R 7, -6	1.36%	98.64%
R 7, -3	1.46%	98.54%
R 7, 0	0.62%	99.38%
R 7, +3	0.44%	99.56%
R 7, +6	0.31%	99.69%
R 7, +9	0.03%	99.97%
R 7, +12	0.05%	99.95%
R 7 COMP	0.73%	99.27%
R 10, -15	9.75%	90.25%
R 10, -6	1.00%	99.00%
R 10, -3	0.65%	99.35%
R 10, 0	1.06%	98.94%
R 10, +3	0.98%	99.02%
R 10, +6	0.02%	99.98%
R 10, +9	0.71%	99.29%
R 10, +12	0.14%	99.86%
R10 COMP	0.80%	99.20%
R 13, -15	5.58%	94.42%
R 13, -12	6.28%	93.72%
R 13, -3	1.76%	98.24%
R 13, 0	0.46%	99.54%
R 13, +3	0.31%	99.69%
R 13, +6	0.22%	99.78%
R 13, +9	0.14%	99.86%
R 13, +12	0.26%	99.74%
R 13 COMP	1.18%	98.82%
R 37, -6	4.48%	95.52%
R 37, -3	0.77%	99.23%
R 37, 0	0.54%	99.46%
R 37, +3	0.51%	99.49%
R 37, +6	0.30%	99.70%
R 37, +9	0.33%	99.67%
R 37, +12	0.09%	99.91%
R 37 COMP	0.79%	99.21%

Indian River County Native Beach Samples June 2000

SAMPLE	% Silt/Clay	% Sand-Gravel
R 40, -15	0.73%	99.27%
R 40, -12	4.55%	95.45%
R 40, -9	3.01%	96.99%
R 40, -6	1.74%	98.26%
R 40, -3	0.62%	99.38%
R 40, 0	0.73%	99.27%
R 40, +3	0.32%	99.68%
R 40, +6	0.21%	99.79%
R 40, +9	0.06%	99.94%
R 40, +12	0.04%	99.96%
R 40 COMP	0.64%	99.36%
R-43, -9	7.83%	92.17%
R 43, -6	9.29%	90.71%
R 43, -3	0.95%	99.05%
R 43, 0	0.70%	99.30%
R 43, +3	0.45%	99.55%
R 43, +6	0.14%	99.86%
R 43, +9	0.06%	99.94%
R 43, +12	0.02%	99.98%
R 43 COMP	1.72%	98.28%
R 46, -12	3.61%	96.39%
R 46, -9	10.10%	89.90%
R 46, -6	4.44%	95.56%
R 46, -3	0.17%	99.83%
R 46, 0	0.75%	99.25%
R 46, +3	0.88%	99.12%
R 46, +6	0.36%	99.64%
R 46, +9	1.01%	98.99%
R 46, +12	0.44%	99.56%
R 46 COMP	1.75%	98.25%
T 17, -15	15.72%	84.28%
T 17, -12	3.47%	96.53%
T 17, -9	4.28%	95.72%
T 17, -6	3.08%	96.92%
T 17, -3	1.32%	98.68%
T 17, 0	0.41%	99.59%
T 17, +3	0.50%	99.50%
T 17, +6	0.38%	99.62%
T 17, +9	0.02%	99.98%
T 17, +12	0.09%	99.91%
T 17 COMP	0.92%	99.08%