DEP Contract No. BS028
Task Assignment
Technical Review of the Southeast Florida SAND Study Report Memorandum

Purpose and Objectives

Coastal Planning & Engineering, Inc. (CPE) was contracted to provide a technical review of the Southeast Florida Sediment Assessment and Needs Determination (SAND) Study Report developed by the US Army Corps of Engineers Jacksonville District (USACE). The SAND Study analyzed areas offshore of St. Lucie, Martin, and Palm Beach Counties in order to better characterize and quantify sediment resources that could potentially be used for beach nourishment. The work conducted included a reconnaissance level vibracore investigation, which was used to supplement data that had been previously collected. The historic data that was used is currently housed in the Reconnaissance Offshore Sand Search (ROSS) database.

The USACE provided an industrious effort and produced a great amount of work in a very short amount of time. If additional time had been available, many of the recommendations provided in this memorandum may already have been addressed. Additional time for additional analysis and the incorporation of additional data would be beneficial to the report.

The USACE investigation expanded on the Southeast Atlantic Regional Sediment Management Plan for Florida (Taylor, 2009). The Regional Sediment Management (RSM) Plan assessed and categorized offshore sediment deposits. The vibracores that were collected during the SAND Study were primarily collected in areas that were characterized as "Potential" and "Unverified" in the RSM Plan. The USACE collected 199 vibracores offshore of St. Lucie, Martin, and Palm Beach Counties. A total of 619 samples extracted from the vibracores were analyzed to determine grain size distribution, Munsell color and carbonate content.

The technical review conducted by CPE is broken into three sections 1) a review of the SAND report, 2) a review of the methods employed to delimit deposit areas; area classifications; and volume estimates and 3) a review of the Site Investigation Report. In the first section the SAND report was examined in detail for both its technical content and its composition. The second section reviewed contingencies associated with refining deposits and determining the volume of dredgable material within deposits. The volume of material that can be placed on the beach from a deposit is typically less than the amount of sand identified within the borrow area. This is due to several factors including dredge loss, dredge inefficiencies and overfill. Therefore a discussion of the typical percentage of material impacted by these issues is also included in the evaluation. The third section reviewed the Site Investigation Report.

Section 1 - Technical Report Review

The SAND Report review provided below addresses both specific editorial items as well as conceptual issues identified with the technical soundness and clarity of expression of the report. This review section follows the pagination and headings of the SAND report for ease of use. A summary is provided at the end of this section.

Abstract - Page 2

Beginning in the abstract, and continuing throughout the report, regardless of the level of investigation or design that has been conducted, potential sediment resources are identified as borrow areas. This nomenclature is confusing as the term "borrow area" is typically reserved for fully developed deposits that have been sufficiently investigated and designed in accordance with industry standards. It is suggested that

unless specifically describing an area that meets this criteria, the areas identified should be referred to as either "potential sand resources" or "deposits."

Response: All pertinent references to "borrow areas" have been changed to sand or sediment source as appropriate.

The stakeholders for the SAND assessment have expressed concerns that the categories applied to the identified deposits should be further refined. Those categories are introduced here, however they are fully explained later in the document. Suggestions to modify the categories are provided in the review of the detailed section.

Response: This is addressed in the discussion of categories below.

The sand rule should be referenced throughout the report as 62B-41.007(2)(j) F.A.C.

Response: All occurrences of "sand rule" were changed to 62B-41.007(2)(j) F.A.C. with the exception of one in the needs determination.

Forward - Page 3
"…data from 198 vibracores collected on the continental shelf…." A total of 199 vibracores were collected.

Response: The typo has been corrected to reflect 199 cores.

1.0 Introduction
1.2 Scope - Page 5
The last sentence on the page may need to be modified/reworded. It sounds as if it refers to the results from the SAND study.

Response: The last sentence has been reworded because it did refer to the results from the SAND study but caused confusion.

Figure 1 is difficult to read and may need to be reproduced.

Response: Figure 1 was reproduced to improve visual quality.

1.3 Geologic Setting
1.3.1 Stratigraphy – Page 6

Page 6
Table 1 is a stratigraphic column for St. Lucie to Palm Beach County. This column is based on a 1971 paper by Meisburger and Duane. Stratigraphic columns are constantly evolving as technology improves and newer information is obtained. It should be possible to locate a more recent stratigraphic column than 1971. The Florida Geologic Survey should have more recent information.

The following are specific comments on the formations shown in the stratigraphic column:

- **Fort Thompson Formation**- Miami and Key Largo limestones and the Anastasia Formation interfinger with the Ft. Thompson Formation.
- **Anastasia Formation-**see comment above.

- **Bermont Formation-** In southeastern Florida the Caloosahatchee Marl is overlain by the Bermont Formation, which is primarily fossiliferous siliciclastics and carbonates.
- **Tamiami Formation**- This formation stretches from the late Miocene into the Pliocene. So it should be shown in the Pliocene. The Tamiami Formation is found on the southwest coast of Florida (Miami-Dade, Collier, Hendry, Lee and Charlotte Counties). Therefore, it shouldn't be included in a stratigraphic column for St. Lucie, Martin and Palm Beach Counties.
- **Hawthorn formation**-This is actually a "Group" not a "Formation." This group includes the Arcadia, Coosawhatchie, Peace River, Statenville and Torreya formations. The Arcadia and Peace River formations are found in central and southern Florida. The others are found in either north Florida or along the west central coast of Florida. Therefore, they should not be included in this stratigraphic column.
- **Oldsmar formation-** This formation consists of micritic limestone and dolomite
- **Cedar Key formation**-This should be the "Cedar Keys" formation.

With the comments above in mind, the simplest solution might be to show a generalized column for south Florida, rather than trying to identify which formations appear in St. Lucie, Martin and Palm Beach Counties.

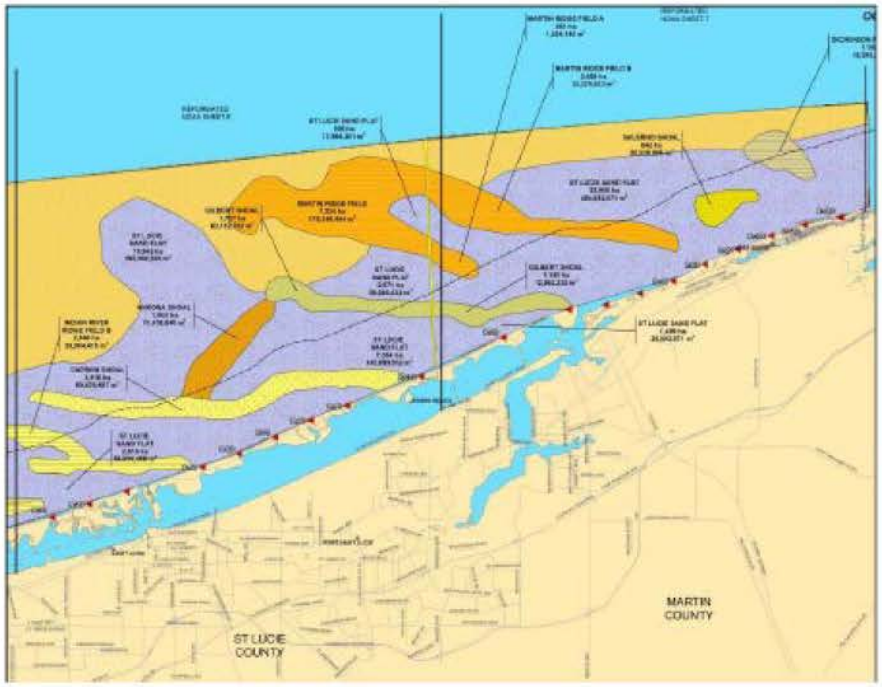
Response: Citation of the Bermont Formation according to the USGS is actually an informal classification and is inappropriate to incorporate in this report. See: http://tin.er.usgs.gov/geology/state/fips-unit.php?code=f12011. The Miami Limestone is younger than the Fort Thompson and is not interfingered. The citation of Meisburger and Duane (1971) was used because the SAND study replicated the table headings and structure, not specifically the stratigraphy presented within.

To resolve the comment, the stratigraphic column was reduced to units observed no later than the Miocene and captioned to generally represent southeast Florida as oppose to St. Lucie, Martin and Palm Beach Counties. The Hawthorn was left in the stratigraphic section and was annotated as a group as the Hawthorn does exist in the stratigraphy of southeast Florida. The appropriate grading of the Miami Limestone unit with the Anastasia Formation was annotated. Additional references were added.

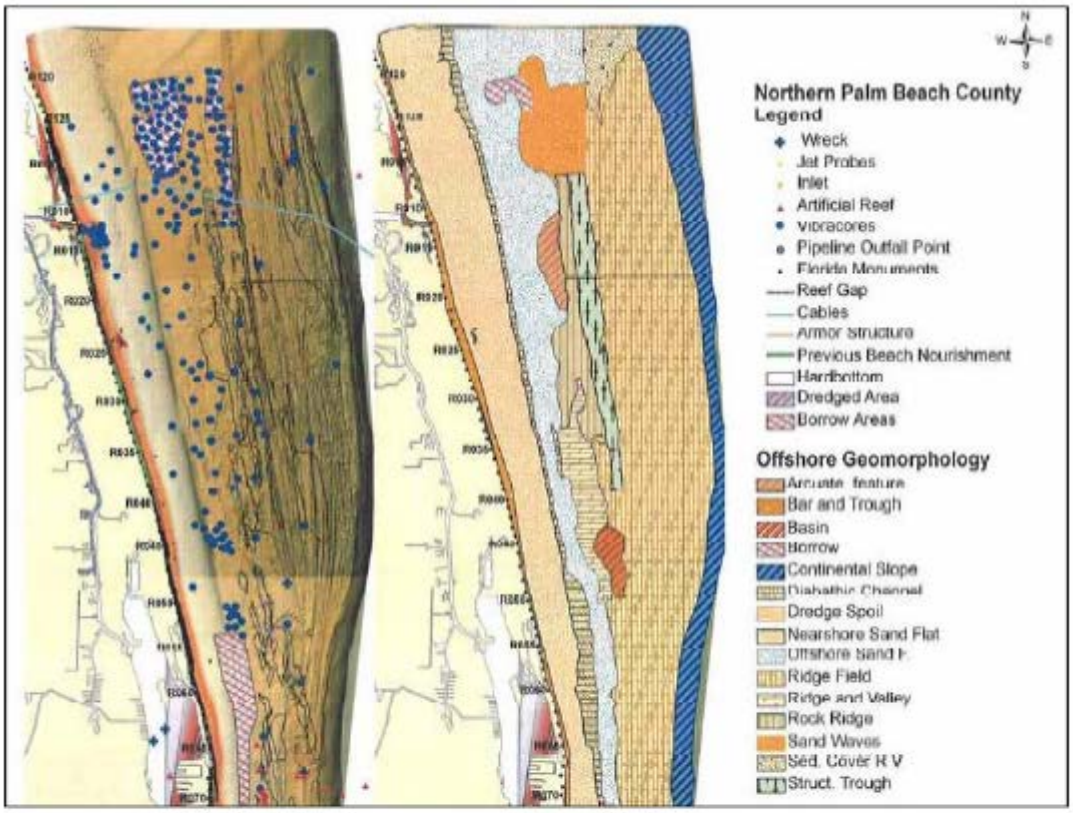
1.3.2 Stratigraphy – Page 7

Most of this discussion is based on work that was done in the 1970s. Although the Central Atlantic ROSS report is referenced (URS, 2007), the geomorphology described in the ROSS report is not discussed or incorporated into the analysis. Highly detailed maps were developed for the ROSS project. The overall purpose of the ROSS project was to determine the sand resource potential on the continental shelf along the Florida coast. NOAA bathymetry was used to map seafloor topography, determine geomorphologic units and establish a submarine land topology that could be related to morphosedimentary bodies (see figures below).

Screen capture showing reformatted NOAA bathymetry from the ROSS Central Atlantic Project (URS 2007).



Screen capture showing the geomorphologic features identified and mapped off Martin and St. Lucie Counties during the Central Atlantic ROSS project (URS, 2007).



Screen capture showing the geomorphic units that were identified and mapped on the continental shelf off northern Palm Beach County during the Southeast Atlantic ROSS project (URS, 2007).

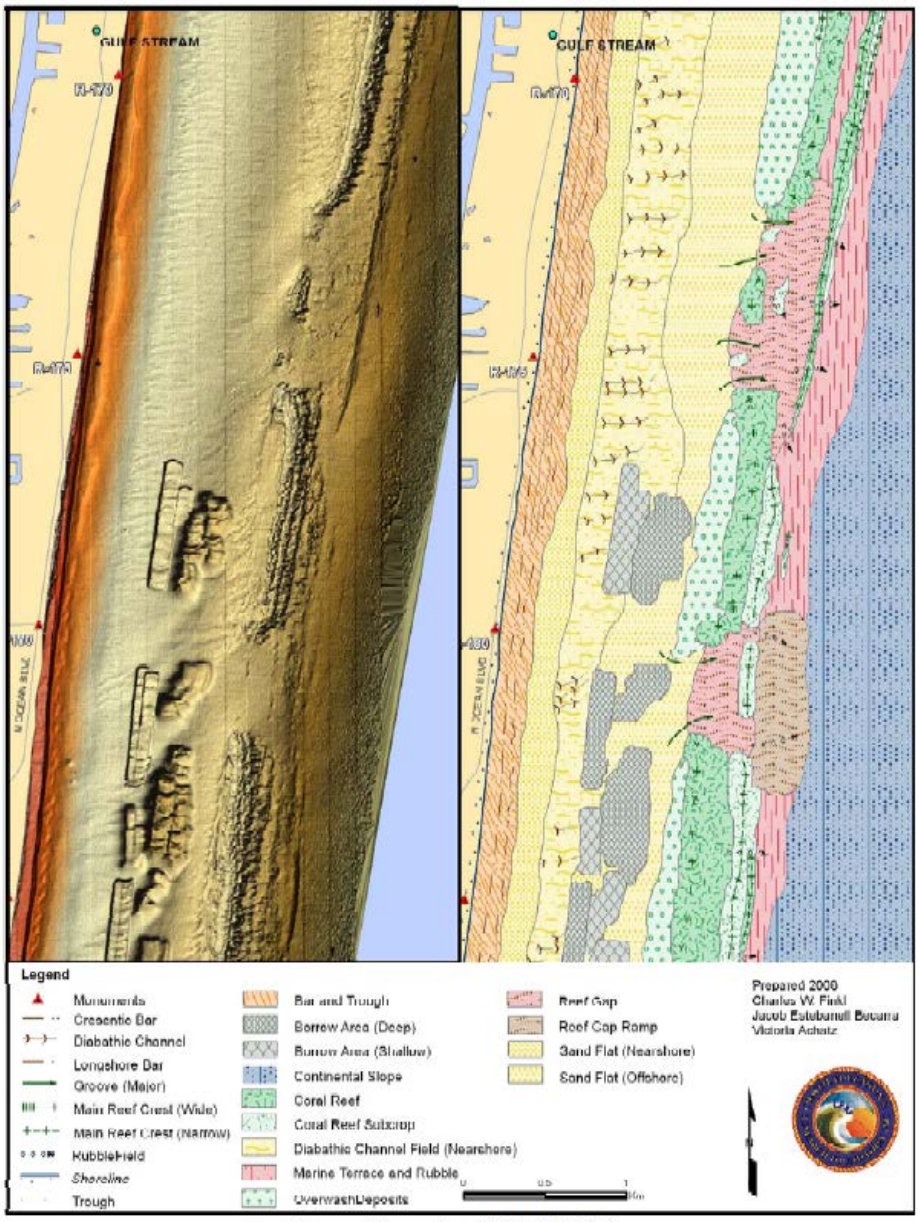
These maps have been peer reviewed and published in the Journal of Coastal Research (Finkl et al, 2008). These maps were based on data available through the ROSS database as well as supplemental bathymetric, environmental, cultural resource and infrastructure data. The information should be included in the analysis for the SAND study. A lot of relatively recent work has been conducted within St. Lucie, Martin and Palm Beach Counties (see image below from Finkl et al, 2008). Much of this work provides very detailed descriptions of the local geomorphology. Below is a list of examples of recent studies that have been conducted. The information provided in these recent studies should be included in the discussion of the regional geomorphology.

Khalil, S.M. and Finkl, C.W., 2010. Coastal process zones interpreted from acoustic remote sensing of submarine geomorphology: Southeast Florida Atlantic continental shelf. International Journal of Imaging, 3(S10), 84-99.

Finkl, C.W.; Estebanell-Becerra, J.; Achatz, V., and Andrews, J.L., 2008. Geomorphological mapping along the upper southeast Florida Atlantic continental platform; I: Mapping units, symbolization and

geographic information system presentation and interpreted seafloor topography. Journal of Coastal Research, 24(6), 1388-1417.

Finkl, C.W. and Andrews, J.L., 2008. Shelf geomorphology along the southeast Florida Atlantic continental platform: barrier coral reefs, nearshore bedrock, and morphosedimentary features. Journal of Coastal Research, 24(4), 823–849. (for information on Palm Beach County).



Geomorphic map from Finkl et al. (2008).

URS and CPE, 2007. Florida Central Atlantic Coast Reconnaissance Offshore Sand Search (ROSS). Prepared for Florida Department of Environmental Protection, 278p. Available at http://ross.urs-tally.com/Reports.aspx.

Finkl, C.W., Benedet, L. and Andrews, J.L., 2005. Submarine geomorphology of the continental shelf off southeast Florida based on interpretation of airborne laser bathymetry. Journal of Coastal Research, 21(6), 1178-1190. (for information on Palm Beach County).

Finkl, C.W., Benedet, L. and Andrews, J.L., 2005. Interpretation of seabed geomorphology based on spatial analysis of high density airborne laser bathymetry. Journal of Coastal Research, 21(3), 501-514.

Because an understanding of the local and regional geomorphology plans such an important role in the identification and delineation of potential sand resources, the discussion provided in this report should be expanded.

Response: Section 1.3.2 is Geomorphology, not Stratigraphy. This section is still a large scale view to understand the context of study area, specifically the upper unconsolidated Holocene sediments. The comments made regarding section 1.3.2 are more applicable to section 2.0 Sediment Distribution. The CP&E review states that the SAND Study was primarily based on work done in the 1970's. However, the text in the SAND Study is actually a review citing sources from 1971, 1997, 2001, 2002, 2007, 2009, and 2011. It includes concepts from the 2007 URS reports noted in CP&E's review, in addition to information provided in the Geology of Florida and several reports produced by the Florida Geological Survey and the US Army Corps of Engineers.

Following that, Figure R1 below is the manner in which the referenced documents rectify the SEFL geomorphology. This and similar inconsistencies must be considered and taken into account when being incorporated into the SAND Study.

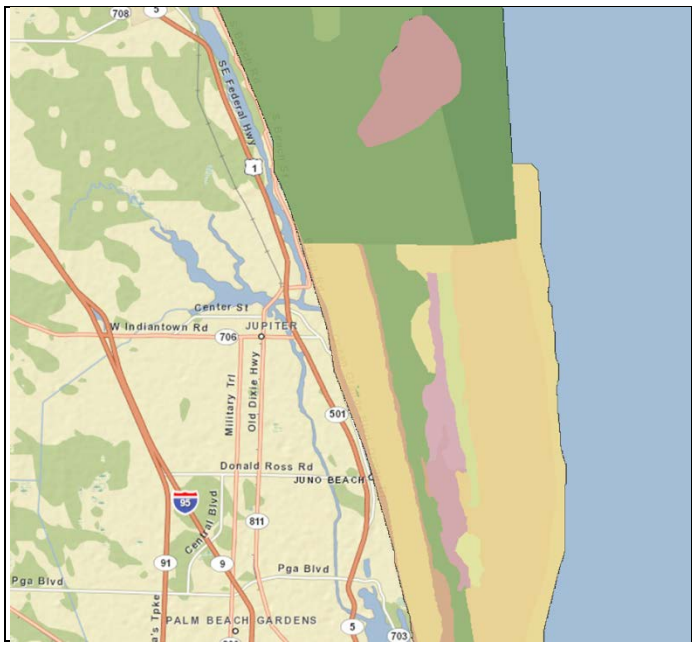


Figure R1: Screen shot from the ROSS database showing the adjacent geomorphology plates.

Reference page from URS and CPE, 2007, Florida Central Atlantic Coast Reconnaissance Offshore Sand Search (ROSS) prepared for Florida Department of Environmental Protection, 278p, shows that the general geomorphology used in the SAND Study and recommended by CP&E are one in the same, going so far as using the same references.

3.2.3 Features of the Continental Shelf

The study area occurs on the southern extension of the major physiographic unit identified by Uchupi (1968) as the East Coast Shelf. The Florida Hatteras Slope occurs seaward. The East Coast shelf is a gently seaward-sloping submarine plain bordering the Atlantic coast from near Cape Cod to the Florida Keys. The south-central Florida Atlantic shelf area is part of the southeastern shelf. Following Price's (1954) geomorphologic terminology, Meisburger and Duane (1971) subdivide the Florida shelf into three main units: shoreface (low water line to about -39.37 ft), inner shelf plain (-39.37 to -75.46 ft MLW), and outer shelf that is transitional from the 'flat' inner shelf to the top of the Florida-Hatteras Slope lying at -78.74 to -229.67 ft LMW (Low Mean Water). The slope break generally falls between the -65.62 and -78.74 ft depth contour. These units are shown in Figure 3-2.

Sub bottom features of the inner shelf were interpreted from zigzag reconnaissance seismic surveys (Meisburger and Duane, 1971). The shallowest reflector, light gray or white calcarenite or sediment containing calcarenite fragments, lies just below the shelf surface and outcrops at -59.06 to -68.9 ft MLW. The calcarenite layer dips seaward at about 1 on 1300 slope and is parallel to the general dip of the surface of the inner-shelf zone.

Shoreface Zone

The shoreface zone between North Palm Beach and Cape Canaveral is a relatively narrow terrace-like feature that extends from mean low water to depths of -29.53 to -39.37 ft. This 2,952.8 to 459.32 ft wide zone dips seaward on a slope of 1 on 80. Shoals that occur in the segment between Hobe Sound and Vero Beach often extend into the shoreface (Figure 3-2). Coquina outcrops alongshore and on the inner shelf suggests that the shoreface may be partly composed of consolidated or semi-consolidated coquina rock of the Anastasia Formation. There is often 4.92 to 9.84 ft of sediment over the coquina rock in the shoreface zone (Meisburger and Duane, 1971).

Inner Shelf Plain

According to Meisburger and Duane (1971), the inner shelf plain (Figure 3-2) is characterized by an extremely gentle seaward slope, narrow depth range (between -39.37 to -75.46 ft), and its general alignment is parallel to the shoreline. Morphologically, the inner-shelf plain consists of a series of platforms or step-like flats (areas of reduced gradient), gentle slopes leading from one level to the next, and shoals. The features are bathymetrically subdued, not topographically prominent. Shoal ridges and hills are most extensively developed south of Sebastian Inlet. These shoals are linear and most are aligned in a northeasterly direction. In profile, inner-shelf shoals show a smooth regular surface with both symmetrical and asymmetrical cross-sectional forms. Where asymmetrical, the steeper flanks face east or southeast (seaward). Analyses of seismic reflection profiles indicate that the shoals are superposed on the surface of the flat.

Outer-Shelf Zone

This is dominantly a zone (Figure 3-2) of discontinuous broken topography of generally low relief (9.84 to 22.97 ft). The seafloor is characterized by rocky or coral reef patches, ridges, ledges, cliffs, and depressions. Linear trends of ridges or abruptly steepening slopes are typical

To resolve the comment the SAND Study used 2010 NOAA NOS maps, historical seismic data and 199 additional borings when creating the geomorphology plate. It is believed that the geomorphology depicted in the SAND Study for the areas offshore of St. Lucie and Martin Counties are more accurate than the 2007 URS reports. However, as requested, the maps from the URS 2007 report have been brought in to ensure consistency where pertinent and the SAND study geomorphology map has been

reworked to better correlate to the available seismicity. The reports cited by CP&E contain a greater level of geomorphic detail for Palm Beach County and are incorporated into the geomorphology for the SAND Study.

2.0 Sediment Distribution – Page 9

Plate B1 shows the general distribution of geomorphologic units in the study area based on recent boring elevations and compositions, 2010 NOS contours and seismic data. A brief discussion of how core borings and seismic data were used to improve upon existing morphologic maps (including those produced during the ROSS project) to produce the one shown in Plate B1 should be included in this report.

Response: The discussion on how recent boring elevations and compositions, 2010 NOS contours and seismic data were used has been revised. A brief discussion of how core borings and seismic data were used to improve upon existing morphologic maps (including those produced during the ROSS project) is included in the section on sediment distribution.

The description of sediments in the second paragraph appears to be redundant. Re-wording the paragraph may be appropriate.

Response: The paragraph has been reworded for clarity.

North-south trending shoals are discussed. However, shoals trending Northeast-Southwest have also been significantly used and should be mentioned as well.

Response: The discussion of north-south trending shoals has been expanded to include northeast-southwest trending shoals also.

It should be stated that the carbonate content in the shoals and flats is approximate. The source of this information should be provided.

Response: Stated carbonate content ranges are not approximate. Reported carbonate content range is taken from the 619 carbonate content samples processed during the SAND vibracore effort. Also, the carbonate content range is reflective of carbonate ranges cited in previous studies (2009 RSM, URS 2007, Meisburger and Duane 1971).

All references to "topographical" should be changed to "bathymetric" if they are describing submerged lands.

Response: all references to "topographical" were changed to "bathymetric."

The term "reef-like ridges" should be clarified. These features are actually relict Holocene reefs and lithified sand ridges that formed during backstepping of the reefs in response to changes in sea level. References discussing these features include Banks et al (2007) and Walker (2012).

Banks, K.W., Riegl, B.M, Shinn, E.A., Piller, W.E. and Dodge, R.E., 2007. Geomorphology of the Southeast Florida continental reef tract (Miami-Dade, Broward and Palm Beach Counties, USA). Coral Reefs, 26, 617-633

Walker B.K., 2012. Spatial Analyses of Benthic Habitats to Define Coral Reef Ecosystem Regions and Potential Biogeographic Boundaries along a Latitudinal Gradient. PLoS ONE 7(1): e30466. doi:10.1371/journal.pone.0030466

Response: Statements in the SAND Study of "reef-like ridges" have been modified and reflect the concepts presented in the recommended references above.

3.0 Sediment Requirements – Page 9
The Results section on page 16 states:

"Renewable" sand sources such as ebb shoals used for sustaining specific projects like inlet sand bypassing are incorporated by reducing the needs determination.

This information should be discussed before the results section.

Response: The structure of the report was modified and this statement was relocated to Sediment Needs Determination discussion.

A full discussion of the methodology used to determine the sediment needs should be included in section 3 (Sediment Requirements). The existing discussion in this section should be expanded to better describe how the sediment needs of each region were determined (i.e. which types of projects were used to calculate the required volumes). It should also include a description of how borrow areas that are permitted, but have not yet been used for construction, were factored into the needs determination.

Response: The detailed methodology used for determining the sediment needs was not done by the authors of this sand study. It was done, as stated in the SAND report, by the county representatives and/or project engineers with institutional project knowledge. A table has been added to the needs determination showing each project that was considered by county and the sediment needs determinations for each county have been added the study as an appendix. No borrow areas, permitted or otherwise were factored into the needs determination.

Page 10
The report describes three separate contingencies that were applied to the volume needs determination. The volumes for each county were increased by 30% to account for borrow area waste, 15% for dredging losses and 10% for future project performance.

There are multiple types of inefficiencies possible for any given borrow area. Some are discussed below:

a. Borrow material left behind after passage of the dredge. After the pass of a cutterhead, a small portion of material will not be entrained by the dredge and will be left behind. This may be significant if a cutterhead dredge attempts to excavate a thin sand deposit.
b. Borrow area corners are difficult to dredge with either a hopper dredge or a cutterhead dredge. The efficiency of the operation (cy/unit time) goes down if the contractor is chasing the sediment in the corner. As the operational time goes up, the operational cost increases; therefore, it is disadvantageous to dredge the corners.
c. Borrow area vertical steps are difficult to dredge with a hopper dredge as a result of a contractor having to vertically adjust the drag head on every passage of the vessel over the cut. This leaves sediment within the borrow area.
d. The allowance of overflow on a hopper dredge results in silts and clays being washed overboard. The sediment lost in the overflow is not transported to the beach.
e. In rare cases discharge pipelines have unintentionally leaked sediments. While this quantity is usually negligible and at worst case small, the sediment does not reach the beach and can be considered a loss.

Once the sand is discharged on the beach, there are several other types of "loss" that may occur. First, the silts and clays may be washed out into the ocean with deposition far from the construction template. Second there is sand that may be deposited above or seaward of the pay template (with tolerance). While this sand is not lost, it is not paid for.

There are no guidelines for estimating these losses without a specific borrow area design. Conservative borrow area designs in Florida have historically attempted to provide 50% more sand in the borrow area than required on the beach. Projects have been successfully constructed with less. Therefore the combined contingencies presented in this section of the SAND report are reasonable at 55%.

Response: No changes were made to the SAND Study report as a result of CPE's "Page 10" comments.

4.0 Sediment Suitability – Page 10

It should be noted somewhere in this section, that although mean grain size is discussed, borrow areas were not delimited based on a specific project's needs or location, but rather on a deposit's regional potential. If this is not the case for certain areas, a discussion of this should be included in the report.

Response: A comment was added to the SAND Study stating that sediment sources are identified for regional potential as opposed to being based on a specific project's needs or location.

It is stated "*If the material is too fine, a greater volume of sand is needed to construct the project….*" This should be revised to more specifically state that if the fill material is finer than the existing/native beach, a greater volume of sand is needed.

Response: This comment by CPE and half accurate. It is true that more fill will be needed, but that is only in the case of maintaining the same dry beach width. From a shore protection perspective material, even when nourishment material is finer it will still provide upland protection.

To resolve the comment the discussion in the section on sediment suitability has been expanded to capture the impacts of disparate grain size on the equilibrium beach profile.

It is stated *"However, if the beach is too coarse, recreational value will be decreased."* This should be revised to state that the recreational value *may* be decreased. This statement should be accompanied by a brief description of how the recreational value may be impacted.

Response: The referenced statement was expounded to describe how the recreational value of a beach can be impacted by fill material that is too coarse.

Odor should be removed from the sediment properties considered for beach nourishment. This is not a property that is not typically recorded during the logging process and is not evaluated by the FDEP.

Response: Proper field logging of sediment records all of the properties of materials encountered, this includes odor. The discussion of odor will not be removed from the sediment properties considered for the SAND Study.

Page 11

It is stated *"Constructing a beach nourishment project with identical properties between the offshore sediment and existing/native beach sediment is often difficult…."* The term identical should be changed, or replaced by nearly identical. It is an impossibility to find identical fill material.

Response: This statement was re-worded.

"*Explicit beaches*" should be changed to "specific beaches."

Response: This sentence was reworded.

The information in Table 3 does not properly reflect the ranges of sediment parameters for beach placement as specified by the Florida Administrative Code. The rule states:

(j) To protect the environmental functions of Florida's beaches only beach compatible fill shall be placed on the beach or in any associated dune system. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. Such material shall be predominately of carbonate, quartz or similar material with a particle size distribution ranging between 0.062mm (4.0φ) and 4.76mm (-2.25φ) (classified as sand by either the Unified Soils or the Wentworth classification), shall be similar in color and grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the material in the existing coastal system at the disposal site and shall not contain:

1. *Greater than 5 percent, by weight, silt, clay or colloids passing the #230 sieve (4.0φ);*
2. *Greater than 5 percent, by weight, fine gravel retained on the #4 sieve (-2.25φ);*
3. *Coarse gravel, cobbles or material retained on the ¾ inch sieve in a percentage or size greater than found on the native beach;*
4. *Construction debris, toxic material or other foreign matter; and*
5. *Not result in cementation of the beach.*

If rocks or other non-specified materials appear on the surface of the filled beach in excess of 50% of background in any 10,000 square foot area, then surface rock should be removed from those areas. These areas shall be tested for subsurface rock percentage and remediated as required. If the natural beach exceeds any of the limiting parameters listed above, then the fill material shall not exceed the naturally occurring level for that parameter.

Response: Table 4 (actually Table 3) is labeled "Acceptable Ranges of Sediment Parameters for Beach Placement used for the SAND Study" not parameters of the Florida Administrative Code. The table is for the reader to see what criteria were used for sediment constraints in the SAND Study.

There is no specific range of acceptable grain sizes [in the F.A.C.].

Response: Per F.A.C. material with a particle size distribution ranging between 0.062 mm and 4.76 mm can be considered for fill compatibility.

Coarse gravel, cobbles or material retained on the ¾ inch sieve is allowed within samples.

Response: Table 3 was modified and material retained on the ¾ inch sieve was removed from the SAND Study parameters. As the delineated borrow areas were re-visited, no borings were found to have been previously discounted as a result of material retained on the ¾ inch sieve.

There is no discussion of cementation in the rule, and it is not something that the industry has a test to determine if sediment is likely to cement. Please provide information on beaches within the study area that have cemented due to the placement of fill material.

Response: The F.A.C. states that beach fill material must not result in cementation of the beach. Occasionally, the State requests that the Corps do pre- and post carbonate digestion sieve analysis on collected core samples. The non-destructive carbonate analysis method is used to determine what sediment fraction is carbonate. So, while it is correct that there is no direct test to determine if sediment is likely to cement on a beach, ensuring that the carbonate content in samples are not in the fines fraction, suggests that the beach is less likely to cement. Regarding beach cementation, there was a reported instance of cementation issues from a truck haul project in Indian River County and of beach cementation at Ft. Zachary Beach, Key West, Monroe County FL.

There is also no specified range of composite Munsell Color in the Sand Rule.

Response: It is correct that the FAC does not specify a Munsell color range. In the study area, no native or existing beaches have a Munsell color value darker than 4. Therefore, a Munsell color value of 4 was used to constrain the parameters for the SAND Study.

Table 3, and the associated discussion, should be revised to indicate that the parameters shown in the table were actually the criteria used during the analysis of the data.

Response: The referenced table and the associated discussion were improved for clarity.

The report states that *"surficial unconsolidated sediments on the continental shelf have mean grain sizes ranging from 0.09 to 2.17 mm."* Surficial sediment characteristics are not an indicator of what the subsurface sediment will be like. The purpose of the surficial sediment analysis should be clarified. Why is it limited to surficial material when vibracore data that represents material at depth is available? Borrow area design is typically based on the subsurface sediment characteristics shown by vibracores.

Response: This comment is a misunderstanding of what constitutes "surficial unconsolidated sediments." It is clear that CPE took the statement to mean surficial grab samples. The intent was to describe Holocene unconsolidated sediments above older consolidated materials. The authors do not consider a 20 foot vibracore to represent any substantial "depth." To resolve the issue, the word "surficial" was removed from the paragraph.

Page 12

The labels on the histogram are confusing. Should they be "Original Distribution" and "Post Digestion Distribution"? There should be a label for "Means" above what is now called "Original Means".

Response: Labels and label locations were changed as requested.

Data collected in very shallow water depths (-8ft NAVD88) was reviewed during this investigation. As described later in the report, ebb shoals are excluded from the analysis as they are considered renewable resources. Therefore, the analysis includes areas that are within the Depth of Closure (DoC) and would most

likely not be permitted for use by the FDEP. Specific examples are provided in Section 2 of this memorandum.

Response: Per the SAND Study team, Depth of Closure (DoC) considerations were included in the SAND Study. In St. Lucie and Martin Counties, the DoC was taken to be 28 ft, in Palm Beach County, a 25 ft DoC was used. Ebb shoals, though shallower than the DoC were included in the SAND Study.

The areas identified as either Depleted or Unusable are reported to be presented in Plate B-2. It appears that these areas have been combined into a single category labeled "Cannot Extract Beach Quality Sand". Depleted or Unusable areas are not defined on the referenced map, therefore either the text or the map needs to be adjusted. Additionally, Table 4 (Page 13), uses the expanded terminology "Depleted Unusable or Currently Economically Unfeasible". The terminology should be consistent throughout the report and the terms should be described prior to their use in the document text.

The Depleted areas should be discussed separately from Unusable areas. Depleted areas are known to be void of sand resources, while the areas identified as Unusable are not necessarily verified to be void of dredgable beach quality sand. This distinction may warrant a separation in the classification system, accompanied by well-defined guidelines. The possibility of sediment resources existing within the Unusable areas (as it appears they are currently defined) should be acknowledged, as many of these areas are rather large. However, based on the information currently available, these areas should not contribute to the volume of available sand resources.

Response: In the final sand report, Plate B-2 has been removed. Also, depleted, unusable, currently economically unfeasible, and avoidance areas have been separated in the report.

Plate B-2

This plate should be revised and possibly divided into a series of plates. In addition to the classification items described above it is difficult to see the boring locations at this scale. It appears as if no core borings were collected within Palm Beach County, however this is not the case. The items listed under the "Cannot Extract Beach Quality Sand" heading should be notes. The way that they are currently presented makes them look as if they are part of the legend and objects that appear on the map.

Response: The original Plate B-2 and associated discussion have been removed from the SAND Study final report.

Page 13

Table 4 describes the various categories that were used to describe the deposit classification scheme. The consensus from the stakeholders of this project is that these categories be further refined and potentially expanded to include additional classes. There are currently 4 defined categories:

1) Proven
2) Potential
3) Unverified
4) Depleted, Unusable or Currently Economically Unfeasible

The descriptions of all of the classes need to be better defined.

Response: Descriptions of the sediment source categories have been refined in conjunction with FDEP and CPE.

Additionally seismic data is briefly touched upon throughout the document; however there is no description on how it is used to refine deposits.

Response: A discussion of how seismic was used to refine sediment source boundaries has been added to the final SAND study report.

The description for Proven sediment resources states that there is *"Sufficient vibracore data to prove quality and quantity of sand"*. There is no indication of what level of vibracore data was considered sufficient. This description also requires "laboratory testing of the full three dimensional geometry of the borrow area". The amount of laboratory testing should be tied to the vibracores. Perhaps it would be better to state that laboratory testing of the vibracores within the area extends vertically to the base of beach compatible sand. Geomorphic data should also be included for the proven category. Remote sensing data should also be used where available.

Response: The criteria for the proven category have been refined and all sediment sources have been reassessed.

As discussed earlier in this review, it is suggested that the Depleted, Unusable or Currently Economically Unfeasible category should be broken into two separate classes. The Depleted areas should be discussed separately from Unusable areas. Depleted areas are known to be void of sand resources, while the areas identified as Unusable or Currently Economically Unfeasible are not necessarily verified to be void of dredgable beach quality sand. New descriptions should be developed for these categories

The description of the Depleted, Unusable or Currently Economically Unfeasible category states "*Cannot extract any beach quality sand from the area because the material occurs in small quantities (less than 4' thickness), is of poor beach quality material per Table 3, or is in close proximity to (less than 200') hardbottom, historical artifacts, or submerged utility. Fish havens and offshore dredge material disposal areas also fit into this category."* Most of this references exclusion zones that would be used to refine areas. These are typically not delimited as their own areas. The areas that do not appear to contain beach quality sand, and the depleted areas should be the only areas that are delimited. A separate discussion of how areas are refined should be developed. This should include information about how the horizontal and vertical buffers were applied.

Response: The avoidance areas were separated from depleted, unusable or currently economically unfeasible categories.

Are areas that are permitted but not yet used for construction included in the Depleted category, or are they included in the Proven category?

Response: Permitted areas not yet used for construction are included in the Proven category.

Page 14

It appears that in nested areas, the volume for the internal areas are not subtracted from the larger area. Instead these areas are simply reported independently. This should be restated. There are occasional issues that were found with the volume calculations of nested areas that will be described in Section 2 of this memorandum.

Response: All areas were revisited and any issues with nested areas have been resolved.

A 200' buffer was used for hardbottom. Several deposits are within 200' of hardbottom/reef, as discussed is Section 2 of this memorandum. Although in the future a 200' buffer may be applied under some circumstances, the industry standard is 400'. The offsets should be adjusted to a minimum of 400', which would reduce the estimated volume in some areas. It should be explicitly stated that the 400' buffer applies to hardbottom, reef, artificial reef and other environmentally sensitive areas.

Response: Application of a 400' buffer is not an industry standard, it is a regulatory practice. It was the consensus of the SAND Study team to apply 400' buffers around hardbottom habitats in the SAND Study. The application of additional 200' buffers resulted in a loss of approximately 30 mcy from the total available sediment volume.

The volume calculations are based on the average thickness of beach compatible material within each area. Once the average thickness was calculated, it was reduced by 2' to account for the industry accepted vertical sediment buffer above non-compatible material. Then the area was assessed to determine if the average thickness was sufficient to dredge (2' or greater). Areas that did not have an average thickness of at least 2' were excluded from volume calculations.

The method to determine thickness inadvertently includes areas that are too thin to dredge based on the order of the calculations performed in some of the deposits. For example, in area SL3-R33 (*Revised name SL1-R23) four vibracores were included in the delimitation subsequent volume estimate of the borrow area. These cores had the following thickness of beach compatible sand: 3.5', 10', 5.7' and 6.1'. The core having a 3.5' thickness would only have 1.5' of beach compatible material remaining after the 2' vertical buffer is applied. This area, by definition, is too thin to dredge. Therefore, the borrow area should be reduced to exclude the area of influence of this core. The method that is used in the report should be modified to exclude areas with insufficient thickness prior to calculating the average thickness and area which are used for the volume calculations.

Response: Borings with less than 4' of thickness have been removed from the SAND study and sediment sources have been adjusted to remove the influence of the borings. To capture the deposit geometry, where applicable, a 4' deposit edge thickness was included in the thickness average for volume calculation.

**The name cited in the technical review is stated incorrect; the borings listed in the comments are located in area SL3-R33.*

It is unclear why areas that do not have geotechnical data were delimited and given an arbitrary thickness of 2 ft. These areas should not be delimited since there is no information that can be used to determine the quality of sediment within these areas. This would discourage future sand search investigations in these areas. These areas should not be delimited as there is not sufficient evidence to do so.

Response: Some unverified areas were given a thickness of 2' so the contributing volume to the SAND study would be zero. All areas that are included as unverified with a zero volume were either delineated in studies prior to the SAND Study, capture a geomorphic feature or have some indicator that a sand source may be present. Areas were not arbitrarily delineated void of a justifiable cause. This issue was resolved by creating two categories for "Unverified" deposits; volume contributing and non-volume contributing. The SAND Study reflects revised and more detailed descriptions of each of these categories.

The nomenclature presented in Table 5 was not applied correctly to many of the areas in St Lucie County. The table presented below shows the area name provided in the report, and the revised name based on following the methodology provided on Page 13. Additionally, the table should be moved to page 14.

Revised borrow area names.

County	Revised Borrow Area Name	Original Borrow Area Name	Category	Centroid (State Plane FL East)	
				Easting	Northing
St. Lucie County	SL3-R33	SL2-R9	Proven	906305	1141375
	SL2-R9	SL3-R10		892746	1164179
	SL3-R10	SL1-R23		898897	1162948
	SL1-R23	SL3-R33		892238	1151173
	unchanged	SL6-R78		934159	1100439
	SL7-R104	SL4-R100A		949341	1076713
	SL4-R100A	SL7-R104		931626	1080448
	unchanged	SL3-R107		930682	1073611
	SL7-R12	SL3-R12	Potential	919587	1160941
	SL10-R16	SL7-R12		935044	1157324
	SL9-R23	SL10-R16		934018	1151620
	SL10-R27	SL9-R23		938431	1147747
	SL10-R38	SL10-R27		940469	1136414
	SL1-R87	SL1-R32		912920	1091823
	SL1-R92	SL10-R38		914364	1087558
	SL0-R99	SL0-T41		915092	1080630
	unchanged	SL2-R60		905682	1116775
	SL3-R12	SL1-R87		896983	1161819
	SL1-R32	SL1-R92		892290	1143007
	SL0-T41	SL0-R99		891308	1134093
	SL4-R24	SL11-R16	Unverified	907877	1150406
	SL8-R39	SL4-R24		932942	1135617
	SL1-R81	SL8-R39		913215	1097487
	SL11-R16	SL6-R69		941623	1158086
	unchanged	SL2-R72		913425	1105454
	SL6-R69	SL10-R75		929808	1108499
	SL10-R75	SL1-R81		954077	1102968
	unchanged	SL7-R90		946121	1089221

Response: The nomenclature is correct; the centroid points were not correctly aligned in the draft report. The error has been corrected for the final report.

6.0 Results – Page 16

Much of the information in the results section really belongs in a methodology section. Methods employed during this investigation are spread throughout the report making it difficult for the reader to understand what was done in the study.

Response: The structure of the document has been revised to consolidate study methods.

Broward County was found to be void of any beach quality sand. An investigation that was carried out in 2009 identified 3.4 mcy of material offshore of Broward County (Forrest et al, 2011), using a minimum 400 ft offset from environmental resources. If a 200 ft hardbottom buffer had been used, the resulting volume

would likely have been larger. There is sufficient evidence to suggest that some amount of beach compatible material is available in Broward County.

Page 17
The need for a contingency for reef talus is unclear. A 25% contingency in Palm Beach County to account for reef talus seems at odds with the material that was deemed to be beach compatible. The material that is considered to be beach compatible should have considerably less since the maximum amount of fine gravel is 5% and the amount of material exceeding ¾" is not allowed to exceed the amount found on the existing beach. If only material that meets the sand rule is used, than this additional 25% contingency provides a very conservative volume estimate for Palm Beach County. The report should include a discussion of how the need for a 25% contingency was determined (i.e. was it based on project history? etc). The impact of increasing the hardbottom buffers to the 400 ft industry standard should also be investigated as the buffer is increased, the distance between a deposit and the reef increases and reef talus becomes less of an issue. The impacts of future improvements in dredging technology on this contingency should also be discussed.

Response: It is noted that the F.A.C. technically regulates the material placed on the beach, not the material that exists in the borrow area. Previous project constructions (i.e. 2009/2010 Juno) and knowledge of the processes of sediment deposition show that it is not unreasonable to assume a 25% talus content in sediment sources in Palm Beach County regardless of talus content observed in borings. While the resulting volume estimate is conservative, the authors believe inclusion of the 25% contingency for talus is reasonable. The dredging industry can currently place screens on the drag head of a dredge while removing sediment from a borrow area and can place a screen on the discharge pipe in the fill area to avoid talus.

For each of the deposit/borrow area categories, a confidence level (%) was assigned. The consensus of the SAND study stakeholders was that the categories should be refined and the percentages applied should be modified. The existing categories rely heavily on vibracore data. However, an understanding of the geology of the region, geomorphology of deposits and the interpretation of seismic data are integral to the process of delineating deposits. Below are suggested revisions to the deposit/borrow area categories:

Category	Description	Confidence Level
Borrow Area	Areas that are permitted or are in the final stage of development. There is an understanding of the geology of the region and knowledge of the geomorphology of the deposit. These areas must include vibracore analysis meeting state standards, seismic interpretation and a cultural resource investigation. The borrow area must incorporate acceptable offsets for environmental and cultural resources as well as infrastructure (current industry standard is 400 ft). Appropriate vertical buffers above non-beach compatible material should also be incorporated into the design. Minimum thickness of beach compatible material should be 4.0 ft* as indicated by laboratory testing.	95%
Proven Sand Deposit	Vibracores collected within the deposit have a minimum thickness of 4.0 ft* of beach compatible material as indicated by laboratory testing. There must be at least 4 vibracores in the area with a maximum spacing of 2000 ft. Geomorphic evidence and seismic data should be used to determine if the deposit is continuous, even at reconnaissance level spacing (greater than 60m). The deposit must incorporate acceptable offsets for environmental and cultural resources as well as infrastructure (current industry standard is 400 ft).	90%
Potential Sand Deposit	Strong evidence of the presence of beach compatible material based on the geology of the region, knowledge of the local geomorphology and geotechnical and geophysical data. All vibracores within the area must contain a minimum of 4.0 ft* of beach compatible material as indicated by laboratory testing. The vibracore spacing may be variable but should average a maximum of approximately 3000 ft. If seismic data is available it should be incorporated. Geomorphologic analysis must be included in the delineation as well as the area of influence of the vibracores. The deposit must incorporate acceptable offsets for environmental and cultural resources as well as infrastructure (current industry standard is 400 ft).	70%
Unverified Sand Deposit	Some evidence to suggest a beach quality sand source (i.e. a single vibracore with laboratory testing). Geomorphic evidence and seismic data (even at regional spacing) should be taken into consideration, if available. The deposit must incorporate acceptable offsets for environmental and cultural resources as well as infrastructure (current industry standard is 400 ft).	30%
Unusable Sediment	Vibracores collected within the deposit show no beach compatible material or have beach compatible material less than 4 ft* thick based on laboratory testing. There must be at least 4 vibracores in the area with a maximum spacing of 2000 ft. Environmental and cultural resources as well as infrastructure have less than 400 ft buffers incorporated.	0%
Depleted Resource	Areas that are permitted and have been used for a beach restoration project or multiple projects. There is no dredgeable material remaining in the borrow area.	0%

* The 4.0 ft minimum thickness used throughout the guideline descriptions was carried over from the SAND study and is based on the concept that a 2 ft vertical buffer will be applied, leaving a thickness of 2ft to be dredged. Currently 2 ft is being used as the minimum thickness that can be extracted; therefore 4 ft of material must be identified to account for the buffer. If dredge technologies improve in the future, the minimum thickness of material may be decreased, allowing more areas to be considered for use as sand resources.

Response: The criteria have been revised and the confidence for potential increased.

Summary

Based on a review of the SAND report's technical content and composition, several recommendations have been made. In addition to the technical recommendations discussed above, the composition of the report should be revisited to improve reader clarity. There are several areas within the report and several statements that should be referenced. Every effort should be made to include the most up to date references available. The methods and results sections are not well defined. Methodology and results are discussed throughout the report, but should be compiled into two distinct sections. A section that discusses conclusions should also be added.

Response: The report has been rewritten and restructured.

Section 2 – Analysis Review

This section discusses the technical findings that are presented in the borrow area calculation sheets provided at the end of the SAND report. These sheets show individual maps for each delimited area, the data used to calculate the volumes, key characteristics, the assigned category and additional notes. The individual sheets and associated data were evaluated to determine if the methods presented in the report were applied consistently. Additionally, they were reviewed to determine if the volume estimates are reasonable and follow geologic principals, industry standards and Florida Administrative Code. Volumes were not recalculated as a part of this review. Issues identified with the methodology that were addressed in Section 1 are not readdressed here.

Borrow Area Delineation and Volume Calculations

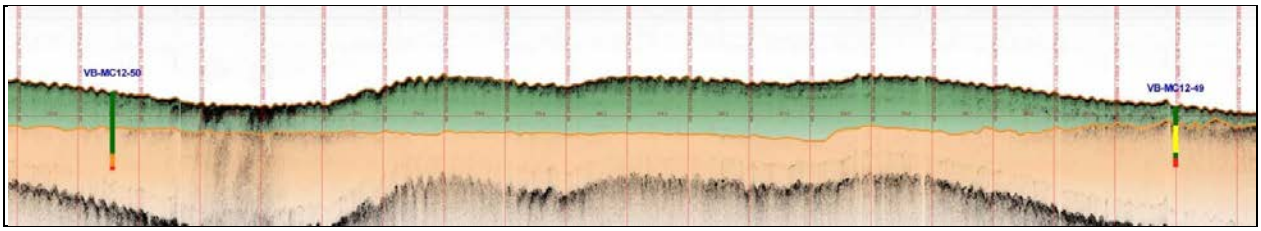
The Borrow Area volume calculation pages from Section 8.0 of the report had several inconsistencies. Historic data for the vibracores and previous design of borrow areas should be provided. The "Number of Cores" reported versus the actual number used for the volume calculations did not match in many cases. Vibracore spacing was variable. The Borrow Area boundaries were not delineated consistently based on the vibracores or geomorphology. The Avoidance Areas were not always excluded from the volume calculations, missing buffers, or located less than one hundred feet away from the borrow area edges and need larger buffers. The reference maps included for the borrow areas were unclear and missing data to correctly interpret the maps. There were also inconsistencies in some of the "Area" calculations.

Response: Sediment source data sheets have been revised; maps improved, numbers made consistent and more thorough narratives have been added.

Historic grain size data and logs need to be provided and reviewed in order to understand volume calculations (i.e. SL6-R78). In situations where it has been indicated that plans and specs level investigations were conducted, designed Sub-Areas and cuts, along with construction plans/specs and borrow area reports should be included (i.e. SL6-R78, SL7-R104, SL3-R12). The Borrow Area outline, vibracores, and volume calculations for PB3-R8 need to be obtained from Palm Beach County ERM for example.

Response: The SAND Study is not intended to be a secondary repository of data. While historical references are used, they will not be reproduced in this report. References that will not be reproduced include seismic lines, specific borings and laboratory data, borrow area reports, and other similar type reference material. Most referenced data can be found in the FDEP ROSS database.

Seismic html's should also be provided and incorporated into the borrow area design. The interpretation of geophysical data plays an integral role in deposit delineation. Seismic data is used to identify the stratigraphic layers located between the vibracores and indicate the extent and thickness of a potential deposit. In many cases, the vibracores collected during this study were collected on the edges of a deposit. The image below is an example of 2 vibracores that were collected during this study plotted on an existing seismic line that was collected in 2007. In 2007, over 650 miles of seismic data was collected along the northeast and central Atlantic coast of Florida as part of the East Coast ROSS High-Resolution Seismic Survey. The vibracores were color-coded based on the quality of sediment within the cores. Green represents material that is potentially beach compatible. The figure below shows that both cores were collected at the edges of a deposit. If any volume calculations had been based on those two cores, they would have underestimated the actual volume.



Vibracores VB-MC12-50 and VB-MC12-49 plotted on a seismic line collected during the East Coast ROSS High-Resolution Seismic Survey.

Response: Seismic data were incorporated in the sediment source delineations to establish the deposit geometry. It was noted that the vast majority of deposits have a triangular shape. Also, the criteria of the study restricted the deposit to a minimum of 4 feet on the edge. So, for volume calculations, a thickness of 4' was averaged with the boring thicknesses to better capture geometry.

The "Number of Cores" listed did not consistently represent the number of vibracores that were used for volume calculations. Some Borrow Areas were missing the listed number of vibracores (i.e. SL6-R78). Vibracores were included in this number listed that had "unknown" thicknesses and were excluded from the volume calculations.

Response: Cores with "unknown" thicknesses were listed because they were taken in the deposit boundary, but the logs were unable to be located before the completion of the draft report. Many additional boring logs were located in the time between the draft and final SAND reports. Borings that were unable to be located were removed from the data sheets for the final report.

This number would also include jet probes, even though the jet probes were not used for volumes (i.e. SL1-R92).

Response: The number of cores has been reviewed as data sheets were updated.

Vibracores that had zero thicknesses were included when calculating the "Average Thickness" for the Borrow Area. These vibracores, with their areas of influence, should be removed from the Borrow Area (i.e. SL0-T41).

Response: Sediment source areas were revised to remove the area of influence of cores with less than 4 feet thickness of material meeting the criteria of the study.

Vibracore spacing ranged from hundreds to thousands of feet apart, with multiple outliers that could not be included for an average value of spacing, and was not consistent for each Borrow Area (i.e. SL6-R78). The industry standard for vibracore spacing is a maximum of 1000 feet apart.

Response: Obtaining and average value of boring spacing for each deposit was not an objective of the SAND Study.

The method of borrow area delineation was not consistent. Boundaries were not consistently based on vibracore area of influence or local geomorphology (i.e. SL7-R12). Some of the Borrow Areas were delineated based on very limited vibracore data. SL9-R23 was delineated based on 1 vibracore and PB2-R2 was delineated despite having no vibracores. This extension of borrow area boundaries without vibracore coverage would lead to an overestimation of the volume of beach compatible sand.

Response: Each sediment deposit was delineated for some reason or combination of reasons. These include but are not limited to: delineation from a previous study, geomorphic evidence, isopachous thickness from Meisburger and Duane which used seismic data, borings, jet probes, or historical data.

Avoidance Areas obtained from the USACE microstation files were not consistently excluded from the Borrow Area's "Area" total and were applied to the total volume calculation. A 1000 ft diameter hardbottom buffer was located within Borrow Area SL1-R32. This area was not excluded from the volume calculation.

Response: SL1-R32 was the only case in the draft report where the avoidance area subtraction was missed. This was corrected for the final report.

The Avoidance Areas were unable to be located in the ROSS database and need to have a source provided. CPE's enterprise database contained shipwrecks that were not included in the Avoidance Areas, and Borrow Area SL6-R78 contained the wreck "Halsey" inside its northern edge that needs to be buffered.

Response: As stated in the draft report, most of the avoidance areas on the SAND study plates were obtained from NOAA NOS maps 11466 and 11474. All cultural resources were verified by USACE archeologists using the SEARCH database, the AWOIS database and other cultural resource investigations. It is correct that most avoidance areas are not in the ROSS database. Additionally, the "Halsey" is incorrectly located in CPE's enterprise database and is actually located just less than five miles to the southwest as shown with a 400' on the plates from the draft SAND Study report.

Borrow Area PB3-R8 has the northern end within an avoidance area. Several borrow areas were also located less than 100 ft from environmental, cultural resource and infrastructure avoidance areas. Buffers around these areas need to be increased. For example, PB0-R212 was located 64 ft from the nearest hardbottom.

Response: All buffers have been reexamined when increasing the hardbottom buffer from 200' to 400' from the draft to the final report.

The Borrow Area reference maps included with Section 8.0 for the Borrow Area volume calculations were difficult to interpret. The maps lacked basic map elements such as a scale, north arrow, legend, and hardbottom/cultural resources. The Avoidance Areas were color coded a blue that was very similar to the background and, therefore, hard to distinguish. Some maps did not have the vibracores labeled. Geomorphic features should be included on these maps, as well as seismic tracklines, where available.

Response: Sediment source reference maps were improved from the draft to the final report to include proper scales, north arrows, legends, avoidance area, borings and other relevant features.

The "Area" reported for SL1-R23 was carried over from SL2-R9, and should be approximately 6,467,679 square feet. The "Area" reported for SL6-R78 could not be determined from the information provided. The total "Area" should be approximately 87,740,062 square feet. Some of the "Area" calculations performed in GIS were tens to hundreds of square feet larger than the reported areas (i.e. PB0-R85).

Response: Both the USACE microstation and CPE's GIS are spatially referenced to State Plane FL East, NAD83, with units of survey feet. I am not certain why, the two programs show a volume and slight location offset between them. Neither CP&E nor USACE could figure out why the minor discrepancy occurred.

Vibracore Spacing

Vibracore spacing and density was inconsistent and overlapped between the 3 main borrow area categories (Proven, Potential and Unverified) (see the table provided below). As previously discussed, the categories need to be better defined.

Vibracore spacing analysis.

County	Vibracore Spacing (ft)		
	Proven Category	Potential Category	Unverified Category
St. Lucie	600-2400	500-6000	600-5500
Martin	1000-6000	1000-4000	2000-6000
Palm Beach	250-8000	2000-4000	1000-1200

The Proven category is defined as having "*sufficient vibracore data to prove quality and quantity of sand. Laboratory testing throughout full three-dimensional geometry of the borrow area.*" However, despite having little data, several borrow areas within each county were classified as Proven. In St. Lucie County, SL2-R9 and SL3-R10 are classified as Proven based on 2 historic cores with spacing ranging from 1,300 ft. to 2,300 ft. In Martin County, M2-R83 has been classified as Proven based on 2 historic cores collected over 3000 ft apart. In Palm Beach County, PB2-R2 is considered Proven despite having no vibracores within the borrow area. PB3-R8 is also considered Proven based on only 2 historic cores spaced 8000 ft apart. This data density doesn't match the definition of the category.

Response: Response: Category criteria and all sediment sources have been reevaluated with USACE, FDEP and CPE. The two areas, SL2-R9 and SL3-R10 have been accepted as proven borrow sources since the 1997 Ft. Pierce SPP General Reevaluation Report and came into the SAND Study from the 2009 RSM as proven polygons. Martin County, M2-R83 came into the SAND Study as a proven polygon also. It is the former Site A identified by the ROSS Sand Search in 1989 for Jupiter Island. PB2-R2 and PB3-R8 are permitted Jupiter/Carlin borrow areas. As stated in the draft report, the borings were unavailable for the draft report and volumes were taken from permits. However, between the draft and final SAND reports, the borings have been obtained and volumes have been calculated for the sites.

The Potential category is defined as having *"strong evidence to suggest a beach quality sand source, including laboratory testing of samples from vibracores."* However, as was the case with the Proven category, several borrow areas within each county fall under this category despite having little data. SL9-R23 is classified as Potential based on 1 vibracore while SL10-R16 is classified as Potential based on 2 cores spaced over 3000 ft apart. In Martin County, 8 borrow areas have been classified as Potential. All but 2 of these borrow areas, have fewer than 7 vibracores. In Palm Beach County PB0-R49 and PB0-T215 are classified as Potential based on 1 vibracore in each area. In Palm Beach County there were also several Potential borrow areas that had a higher density of vibracores than those classified as Proven. For example PB0-R17, PB0-R44 and PB0-R179 had between 25

and 27 vibracores, including recent ones collected during this study. Only 4 of the 15 areas classified as Proven in Palm Beach County had more than 27 vibracores.

Response: Category criteria and all sediment sources have been reevaluated with USACE, FDEP and CPE.

The Unverified category is defined as having *"some evidence to suggest a beach-quality sand source, such as a single vibracores (with or without laboratory testing)……".* Many of the borrow areas that have been placed in this category have the same data density and spacing as those that fall into the Proven and Potential categories.

Response: Category criteria and all sediment sources have been reevaluated with USACE, FDEP and CPE.

Environmental Offsets

As indicated on page 14 of the SAND Study Report, "*known hardbottom areas were given a minimum approximate 200 ft buffer".* There are exceptions to this, primarily in Palm Beach County where hardbottom is more abundant. In several cases, the borrow areas are closer than 200 ft from the nearest hardbottom and in other situations, there is hardbottom located within the borrow areas. Exceptions to the 200 ft buffer are summarized below.

Summary of Environmental Concerns.

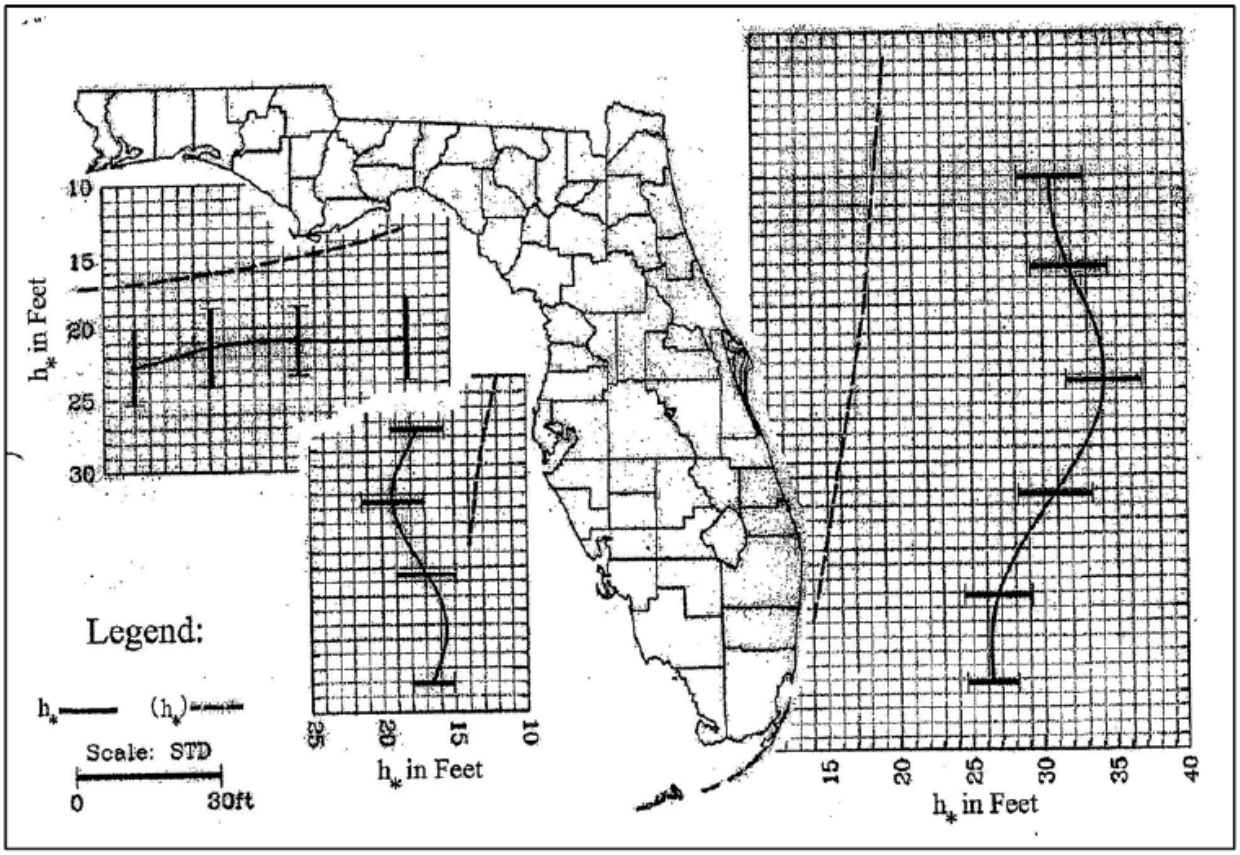
County	Borrow Area	Environmental Offset Issue
St. Lucie	SL1-R23	150 ft. east of the Ft. Pierce Fish Haven (artificial reef)
	SL4-R100A	Hardbottom/cultural resource avoidance area within the borrow area
	SL7-R104	Hardbottom/cultural resource avoidance area within the borrow area
	SL3-R107	Hardbottom/cultural resource avoidance area within the borrow area
	SL1-R32	Hardbottom/cultural resource avoidance area within the borrow area (not excluded from the volume calculations)
Palm Beach	PB3-R8	northeastern most part of the borrow area cuts into the hardbottom
	PB0-R128	100 ft. from nearest hardbottom
	PB0-212	64 ft. from nearest hardbottom
	PB0-223	60 ft. from nearest hardbottom
	PB1-R21	100 ft. from nearest hardbottom
	PB0-R49	100 ft. from nearest hardbottom
	PB0-T215	90 ft. from nearest hardbottom
	PB0-R94	150 ft. from nearest hardbottom
	PB0-R97	50 ft. from nearest hardbottom
	PB0-R201	Patch of hardbottom within the borrow area

Response: The SAND team determined that a 400' buffer was preferred for the SAND Study. Therefore 400' buffers were applied resulting in approximately 30 mcy reduction in sediment volume.

Potential Nearshore Impacts

When sediment is removed from areas that are close to shore, the resulting dredge pit may cause a negative impact on the adjacent shoreline. The depth of closure (DoC) is an important consideration in coastal engineering and coastal management activities. It represents the depth beyond which there is no significant change in bottom elevation and no significant net sediment transport between the nearshore and the offshore. It is determined either through profile surveys done over several years at fixed survey lines or

through an estimation procedure. DoC provides an inshore limit for the siting of borrow pits. Borrow areas that are located inshore of the DoC become sinks that accumulate sediment that would otherwise be part of the longshore/onshore and offshore transport system. They prevent sediment from reaching the shore. They also impact the wave environment by providing a greater potential for wave modification what may lead to erosional hotspots (Dean and Malakar, 2002). Estimates of closure depths around the beaches of Florida have been developed by Dean and Malakar (2002) under contract to the Bureau of Beaches and Wetland Resources, Department of Environmental Protection and are shown in the figure below.



Closure depths determined by Dean and Malakar (2002).

The approximate minimum depth of closures for St. Lucie, Martin and Palm Beach Counties were obtained from the figure above. The figure above provides generalized information on the depth of closure, and was therefore used as a guideline. The data in each project area should be reviewed to estimate the depth of closure associated with specific areas. Each borrow area within the 3 counties was assessed to determine if it fell within the county's minimum depth of closure. The assessment included a review of the minimum water depth and the distance from the shore at the borrow areas closest point. Offshore shoal complexes may have water depths shallower than the depth of closure, however due to their distance offshore, these features lay beyond the active beach sediment transport zone. Therefore, dredging these features is unlikely to produce

nearshore impacts. The table below provides a summary of the borrow areas that have been identified as being within the depth of closure.

County	Depth of Closure from Figure X.	Borrow Area	Minimum Water Depth (ft)	Distance from shore (ft)[1]
St. Lucie	-28 ft.	SL0-T41	-16	1800
Palm Beach	-25 ft.	PB0-R71	-8.8	898
		PB0-R85	-15.1	840
		PB0-R160	-22.9	1700
		PB0-R170	-18	1300
		PB0-R17	-18	2217
		PB0-R44	-18	2217
		PB0-R142	-18	900
		PB0-R197	-18	1300
		PB0-R94	-20	1700
		PB0-R95	-20	1700
		PB0-R97	-20	1700
		PB0-R201	-18	1000
		RB0-T211	-18	600

[1]Distance from shore was measured from the borrow areas closest point to the shore.

To avoid potential adverse interaction with the shoreline, the landward most boundaries of these borrow areas should be moved further seaward. This will reduce the size of each borrow area and volumes will need to be reduced accordingly.

Response: The original proposed scope presented for the SAND study was to use the -16' contour. Changing the assumption from the -16' contour to the depth of closure (-28 for St. Lucie and Martin and -25' for Palm Beach) resulted in a decrease of approximately 20 mcy of sediment.

Summary

Based on the amount of inconsistencies present with the delineation of the borrow areas, the volume estimates seem to be overestimated. Historic and previously designed data should have been provided for the review. Vibracore spacing and density, geomorphology, avoidance areas, and area calculations were not consistent with the designed boundaries. The definition of borrow areas as Proven, Potential or Unverified often did not match with their descriptions based on the data available within each area. Several environmental concerns in St. Lucie and Palm Beach counties are present due to a reduced buffer applied to the hardbottom and/or cultural resources. These buffers should be expanded to provide an appropriate offset from sensitive areas. There are also borrow areas located within the depth of closure that would disrupt the sediment transport and wave environment. These boundaries should be adjusted seaward of the depth of closure to reduce adverse impacts. The reduction of borrow area boundaries based on the above considerations should result in a reduction of the total volume of beach compatible sand. The estimation of borrow area volumes could be improved through the incorporation of bathymetric and seismic data, along with thorough vibracore data.

Response: Total changes in volume from the draft to the final report are approximately 100 mcy. Approximately 50 mcy of this was lost due to changing the study assumptions regarding hard bottom buffers and the depth of closure. The remaining volume reduction came from a sum of many other things: tightening the deposits, trying to better constrain the deposits cross-sectional geometries, professional opinion filter regarding the classification of the areas, increasing the minimum

acceptable mean grain size from 0.12 to 0.13, re-evaluating Munsell color values and % retained on the #4 sieve etc. The volume change from the draft to the final report is a loss of about 25%.

References Cited:
Dean, Robert, G. and Malakar, Subarna, B., 2002. *Closure Depth Considerations Along the Florida Shoreline.* Gainesville, Florida: University of Florida, 14p. (prepared for Bureau of Beaches and Wetland Resources, Department of Environmental Protection).

Forrest, B.M.; Larenas, M. and Andrews, J.L., 2011. *Broward County Shore Protection Project: Segment II Sand Search Investigation.* Boca Raton, FL: Coastal Planning & Engineering, Inc. 55p. (Prepared for Broward County).

Section 3 – Site Investigation Report Review

Response: Given time constraints, the Site Investigation Report comments are acknowledged but will not be addressed at this time.

3.2.1, 3.2.2 and 3.2.3.
There is a reference to "URS, 2007". However there is no (URS, 2007) reference included in the reference list. There is, however a (URS, 2009) reference.

5.0 Pertinent Project Details- Page 6
This section should include a discussion of how vibracore locations were selected.

7.0 References- Page 7
The following reference is included in the reference list, but has not been referenced in the report.

> Davis, R.A. Jr., 1997, Geology of the Florida Coast, in Randazzo, A.F., and Jones, D.S., eds., The Geology of Florida: Gainesville, University Press of Florida, 155-168 p.

8.2.2 Laboratory Testing and Methods- Page 9
In Table 2 the grain size sieve analysis method is listed as ASTM D422-63. This is true, however, this table should also include a reference to ASTM D1140-54, which is the method that CPE used for the fines (sediment passing the #230 sieve).

8.2.4 Definitions- Page 10
The following is listed under "Component Percentages":

Trace – Particles are present but estimated to be less than 5%
Few – Particles constitute 5-12% of material
Little – Particles constitute 12-25% of material
Some – Particles constitute 25-50% of material
Mostly – Particles constitute 50-100% of material

However, the standard descriptive terms, which have been adopted by the FDEP from the USACE Engineering and Design Geotechnical Manual for Surface and Subsurface Investigations (reference: Department of the Army, 1985. Engineering and Design Geotechnical Manual for Surface and Subsurface Investigations (DM 1110-1-1). Atlanta, Georgia: South Atlantic Division, Corps of Engineers.) should be:

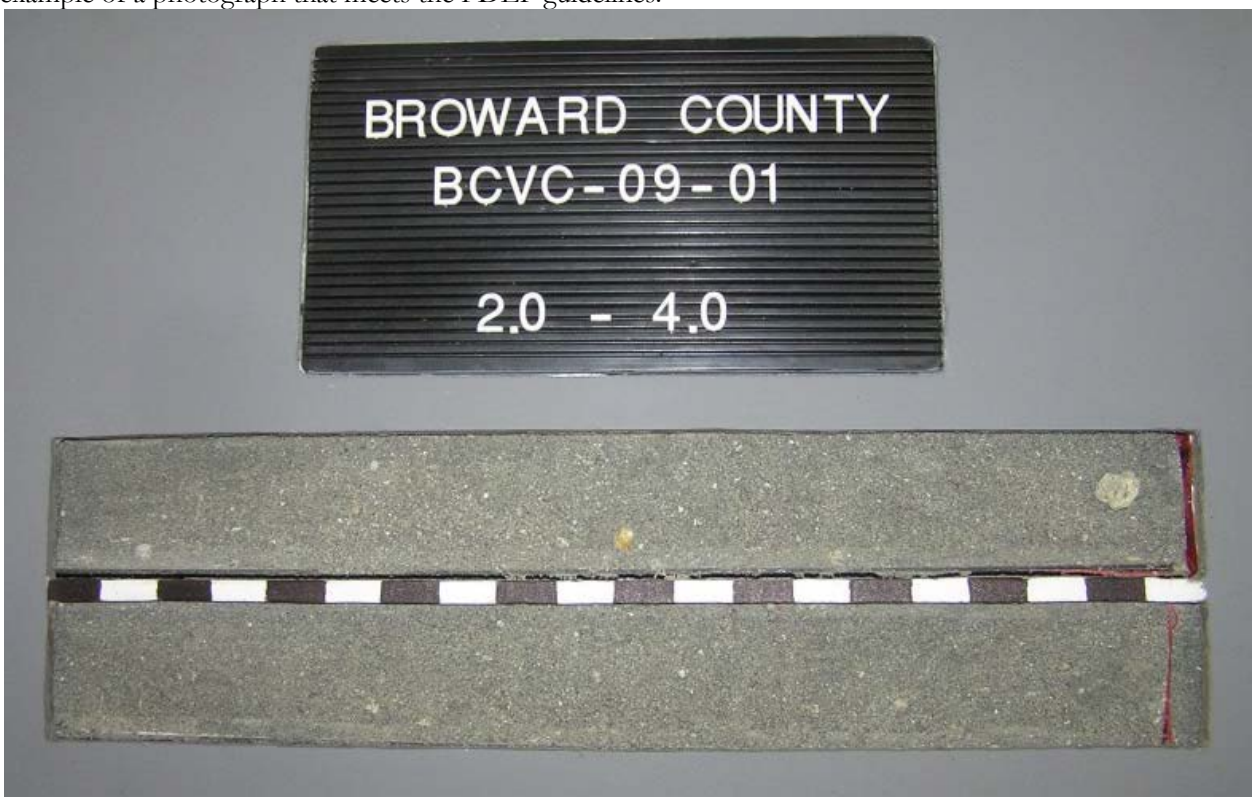
Trace-particles constitute less than 10% of material
Little-particles constitute 10-20% of material

Some-particles constitute 20-35% of material
Shelly/gravelly/silty-particles constitute 35-50% of material

Table 3- Pages 12-15
This table should include a column for "Date Collected"

Table 4- Pages 17-27
There are 190 cores included in this table. However, on page 3 (1st paragraph) of the report it states that 199 vibracores were collected. Were there 9 vibracores that were collected but not analyzed (or were logged but not sampled)?

Vibracore Photographs
According to the DEP's sand search guidelines document (reference: FDEP, 2010. Offshore Sand Search Guidelines. Tallahassee, Florida: Bureau of Beaches and Coastal Systems, 29p.), vibracore photographs should be taken with an 18% gray background. It doesn't appear that this was done. The image below is an example of a photograph that meets the FDEP guidelines.



Sample vibracore photograph that meets FDEP standards.

Several of the photographs are blurry (i.e. 0-5 ft VB-MC12-31).

Several of the photographs are not complete. For example, the first couple of inches are missing from the 0-5 ft section of VB-MC12-42.

Boring Location Maps (B-2, B-3, B-4, B-5, B-6)

The color gray has been used to denote avoidance areas, 2009 RMS report borrow areas and hardbottom/cultural resources. This color is difficult to see and these legend items are the same color, they are difficult to differentiate.

Conclusion

Although a significant amount of work was accomplished within a very short timeframe, this report would benefit from some additional time. The report would benefit from the inclusion of geomorphic (including recent geomorphic maps created for Palm Beach County) and seismic data to better refine volumes, improve confidence levels etc. Some areas within the study area would also benefit from the collection of additional seismic data. Additional data would help to further refine the sand deposits and their volume estimates.

Response: Additional time has been taken and the review comments have been incorporated.