VALUE ENGINEERING REPORT

US Army Corps
of Engineers

JACKSONVILLE DISTRICT

North Jetty Sand-Tightening and Jetty Extension
Canaveral Harbor, Florida
March 2002

Valparaiso University
Value Engineering College Initiative

VALUE ENGINEERING STUDY

NORTH JETTY SAND-TIGHTENING AND JETTY EXTENSION; CANAVERAL HARBOR, FL

Preliminary
Value Engineering Report

North Jetty Sand-Tightening and Jetty Extension
Canaveral Harbor, Florida
March 2002

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Introduction to the Problem

Canaveral Harbor in Florida has had a series of various harbor features constructed in the past 48 years. In 1954 two jetties were constructed for protection of the entrance channel. Over time those jetties and the channel itself have been modified. Currently, the Army Corps of Engineers is investigating the sand tightening and extension of the north jetty. This is being done because too much sand is passing over, through and around the jetty and entering the harbor. Dredging of the sand in the harbor is very expensive and time consuming to traffic through the channel. Interim sand tightening of the existing north jetty occurred in 1998 and consisted of using geotextile tubes. The Army Corps Jacksonville office is now looking for a more permanent solution since the geotextile tubes are at their maximum capacity of sand stoppage.

A Value Engineering team from Valparaiso University has been assembled to investigate the current plans of sand tightening for the north jetty. Value Engineering consists of brainstorming new ideas to solve the problem and researching those new solutions to see if they can be cost effective without sacrificing value. This report contains the research efforts and recommendations of the Value Engineering study done to Canaveral Harbor.

VALUE ENGINEERING STUDY

NORTH JETTY SAND-TIGHTENING AND JETTY EXTENSION; CANAVERAL HARBOR, FL

SUMMARY OF RECOMMENDATIONS:

OPTIONS	ANNUAL COST SAVINGS
SEA OATS (1 MILE)	$7,500
GEOTUBES (300')	$92,800
VINYL SHEET PILE IN EXTENSION	$2,250
PRESSURE GROUTING	$13,000

POSSIBLE COMBINATIONS:

COMBINATION 1	ANNUAL COST SAVINGS
SEA OATS (1 MILE)	$7,500
GEOTUBES (300')	$92,800
PRESSURE GROUTING	$13,000
TOTAL	**$113,300**

COMBINATION 2	ANNUAL COST SAVINGS
SEA OATS (1 MILE)	$7,500
VINYL SHEET PILE IN EXTENSION	$2,250
PRESSURE GROUTING	$13,000
TOTAL	**$22,750**

CONCLUSION: Combination 1 is more cost effective but may not be as reliable as combination 2.

OTHER OPTIONS FOR FURTHER RESEARCH:

- Jetty orientation
- Other uses of geotubes within project
- Alternate dredge method
- Core-loc armor stone
- Multiple jetties
- Wave breakers (seawalls, vertical poles, etc.)

RECOMMENDATIONS

DESCRIPTION: Sea Oats

ORIGINAL CONCEPT:

No vegetation is to be used.

PROPOSED CONCEPT:

Plant a 20 foot wide strip of sea oats on the north side of the jetty as far north as is possible in order to create long-lasting natural sand dune which will trap sand and stabilize the beach.

ADVANTAGES:

- Sea oats are relatively inexpensive, roughly $40,000 per mile (given a 20' wide strip)
- Natural and environmentally friendly solution
- Sea oats are native to the area
- Long term beach stabilization
- Trap a good amount of sand, approximately 5 cu. Yards per year per lineal foot

DISADVANTAGES:

- Need to acquire or have the permission to plant on a significant amount of beach for visible and economical effect (at least a half mile)
- Difficult to model exact trapping ability of the artificial dunes, especially long term (greater then 10 years)

DISCUSSION:

The use of sea oats in the stabilization and revitalization of beaches has been increasing in recent years. Hope Town, Florida planted 200,000 sea oats in order to rebuild the beaches and dunes destroyed by Hurricane Floyd. In Sarasota County, Don Fleming is using a sea oat program he developed in Lee County to revitalize the beachfront property. The sea oat (Uniola paniculate) is a coastal plant, one of a handful that can withstand the harsh conditions of salt, wind, and waves that the beach provides. Its long roots hold the sand in place while the plant continues to catch more sand thereby increasing the size of the dune. According to the 1977 version of the Shoreline Protection Manuel, published by the US Army Coastal Engineering Research Center, sand dunes created by sea oats grow on the average of 1 to 5 cu. yd. per lineal foot per year. In Padre Island, Texas, sea oats trapped around 29 cu. yd. per lineal foot over an eight-year period. If planted over a long stretch of beach, this could mean a substantial amount of sand trapped, sand that will not have to be dredged. After a conversation with Kevin Bodge of Olson Associates, it was determined that sand dunes built north of the jetty would not be very effective. This is for two main reasons. First, the sand north of the jetty is primarily coarse, which does not aid the creation of sand dunes. Second, the majority of the sand that enters the jetty is from wave action not by the wind. From this it was decided to estimate a low accumulation rate of 0.5 cu yd. per year per lineal foot. It was also found that the Port Air Force Base owns the land north of the jetty. Coordination and permission would need to be obtained in order to make this option a success. If the Port is required to purchase the land or rights to the land in order to plant, then this would most likely not be a cost effective alternative. If one mile of beach is planted with a 20' wide strip of sea oats, the cost of planting would be around $40,000 according to Dr. Michael Kane of University of Florida. This mile of sea oats would trap an average of 2,640 cu yards of sand. This could mean savings of approximately $7,500 per year. The table below shows the cost and benefits of a variety of planted lengths. The models used to approximate the volume trapped by these dunes are not extremely accurate. Many variables affect the effectiveness of the dunes such as the amount of available sand, the direction and strength of the winds, and soil conditions. A study should be done using the specific regional characteristics to determine the effectiveness of the sand dunes. Additionally some maintenance is involved in the creation of dunes. This is estimated at about 5% of the original cost. See figure below for cost and savings estimates based on length of beach planted. Due to the lack of long term projections, the cost estimates below are based on a 10 yr. design life and an interest rate of 6.375%.

Length of Beach Planted	Initial Cost of Installation	Cost	Benefit	B/C	Excess Benefits	10 yr Savings
ft				Ratio		
75	$568.18	$106.98	$213.75	2.0	$106.77	$1,067.66
300	$2,272.73	$427.94	$855.00	2.0	$427.06	$4,270.63
600	$4,545.45	$855.87	$1,710.00	2.0	$854.13	$8,541.27
1000	$7,575.76	$1,426.46	$2,850.00	2.0	$1,423.54	$14,235.45
2000	$15,151.52	$2,852.91	$5,700.00	2.0	$2,847.09	$28,470.89
3000	$22,727.27	$4,279.37	$8,550.00	2.0	$4,270.63	$42,706.34
5280	$40,000.00	$7,531.68	$15,048.00	2.0	$7,516.32	$75,163.16
10560	$80,000.00	$15,063.37	$30,096.00	2.0	$15,032.63	$150,326.31

SEA OATS – REFERENCES:

TITLE: RE: Sea Oats

EMAIL ADDRESS: Mkane@mail.ifas.ufl.edu

REFERENCE: Dr. Michael Kane, University of Florida

EMAIL CONTACT: 03/12/02

READ BY: BJG

RELEVANT INFORMATION:

With respect to planting sea-oats, a 20 foot-wide planting at 22,000 plants per linear mile will cost an estimated $40,000 installed (information provide by commercial source).

TITLE: Sea Oats Keep Sand on Beaches

REFERENCE: Sarasota Herald Tribune

DATE OF PUBLICATION: 02/08/99

READ BY: BJG

RELEVANT INFORMATION:

Sea Oats are being used in Sarasota County to restore beaches.

TITLE: Hope Town Dunes – sea oats and ecology

WEB ADDRESS: http://www.go-abacos.com/news/conian/new12-00/abaco_dunes.html

REFERENCE: The Abaconian

DATE ACCESSED: 03/15/02

READ BY: BJG

RELEVANT INFORMATION:

Hope Town plants 200,000 sea oats in order to restore and stabilize beaches and dunes destroyed by Hurricane Floyd.

TITLE: Shoreline Protection Manual, Volume II

REFERENCE: US Army Coastal Engineering Research Center

DATE OF PUBLICATION: 1977

READ BY: BJG

RELEVANT INFORMATION:

See Pages 6-36 through 6-54 for types, effectiveness, and instillation of different types of sand dune producing vegetation.

REFERENCE: Olson Associates

PHONE CONTACT: Kevin Bodge (800) 247-6760

CALLED BY: BJG

CALLED: 03/25/02, 10:00 AM

RELEVANT INFORMATION:
Kevin Bodge is the coastal engineer for the Port Authority at Cape Canaveral. Information based on the effectiveness of sea oats in that area was obtained.

DESCRIPTION: Geotube jetty

ORIGINAL CONCEPT:

Geotubes are already in place in the current jetty design. By altering the setup of the Geotubes or creating some sort of new design with them, it was thought that the jetty would not need to be sand tightened or possibly extended.

PROPOSED CONCEPT:

The Geotube that is in place could be kept there. Instead of adding a jetty, a pyramid of Geotubes made of two Geotubes on the bottom and one on the top could be added to act as a jetty. The pyramid shape would give extra height, which would solve the problem previously encountered of the sand was drifting over the existing Geotube.

ADVANTAGES:

- Durable
- Affordable
- Appears to be working in the current setup, except for the fact that it is too short
- Indefinite underwater lifespan
- Not too many detrimental storms in the area

DISADVANTAGES:

- Tropical storms could very easily damage the Geotube, causing damage that is unplanned for in the initial or maintenance costs
- There is not really a taller Geotube- just a wider one
- Relatively new technology, so not all aspects of the Geotube are understood

DISCUSSION:

Geotubes appear to be a rather new technique of coastal engineering. They have not been used too often for jetties yet, although the times they have been used have been a success. The Geotube has an indefinite underwater life. The only problem is the indeterminate facts on tropical storms. While a Geotube can be repaired, it could be impossible if it is damaged enough due to that storm. Fortunately, there are not too many storms in the area of the proposed jetty, in comparison with the rest of Florida. It would still be cost-effective to replace it once or twice during the life of the project.

COST ANALYSIS FOR 100 FOOT GEOTUBE JETTY:

COST BENEFIT ANALYSIS OF THE GEOTUBE JETTY

Jetty Length	Initial Cost	Per year Avg. Cost	Per year Avg. Benefit	B/C Ratio	Per year Excess Benefits
100	$7,340	$490	$187,600	382.7	$187,110
150	$11,011	$735	$271,700	369.5	$270,965
200	$14,681	$981	$349,400	356.3	$348,419
250	$18,351	$1,226	$420,600	343.2	$419,374
300	$22,021	$1,471	$478,800	325.5	$477,329
350	$25,691	$1,716	$504,700	294.1	$502,984

	Unit Cost	Volume	Feet	# of Tubes	Total
Geotubes	$12/ft		100	3	$3,600.00
Dredging	$6/cy*	2.078cy/ft**	100	3	$3,740.40
				Total	$7,340.40

Compare to original 300' Jetty extension	$1,411,363
Per year cost of original 300' Jetty	$94,263
Per year cost of new Geotube jetty	$490
Benefits Lost b/c of more dredging	$291,200
TOTAL SAVINGS	**-$197,427**

The total savings for this option compared to the original idea is negative.
Therefore, go back to the 300-foot distance for the Geotube, to maintain the dredging benefits.
This will be better since safety will increase and time spent dredging will decrease.
The cost/benefit ratio is still very high for this situation.

	Unit Cost	Volume	Feet	# of Tubes	Total
Geotubes	$12/ft		300	3	$10,800
Dredging	$6/cy*	2.078cy/ft**	300	3	$11,221
				Total	$22,021

Compare to original 300' Jetty extension	$1,411,363
Per year cost of original 300' Jetty	$94,263
Per year cost of new Geotube jetty	$1,471
Benefits Lost b/c of more dredging	$0
TOTAL SAVINGS	**$92,793**

*$6.00/cy unit cost based on Sand References section

**2.078cy/ft based on email references with Jack Fowler

It is assumed that the proposed pyramid Geotube configuration will stop as much sand as the original sheet-pile jetty extension. Therefore, the annual benefits of reduced dredging costs were assumed to be the same for both concepts. This may not be true and may require further investigation.

GEOTUBE JETTY – REFERENCES:

TITLE: Flip Chart Notes on Consideration for Policies on Geotextile Tubes on Gulf Beaches

WEB ADDRESS:
http://www.glo.state.tx.us/coastal/cccpkts/ec010503/agenda04attachment2.txt

REFERENCE: Texas General Land Office

DATE ACCESSED: 03/11/02

READ BY: DRS

RELEVANT INFORMATION:
Geotubes can be durable and affordable, but there can be hidden costs, and they have limited durability and are susceptible to wave action. Some argue that they are a

temporary solution, but they can be permanent if they are properly monitored. This also means that they would have to undergo no detrimental effects to be permanent. Natural vegetation also enhances the ability of the Geotube to properly perform its job.

To properly monitor the performance of a Geotube, the stability is observed in photographs and field reports are conducted. It is also necessary to accurately track the cost of the Geotubes.

TITLE: Geotubes prove themselves in storm

WEB ADDRESS: http://www.galvnews.com/print,lasso?wcd=3139

REFERENCE: Galveston County Daily News

DATE ACCESSED: 03/11/02

READ BY: DRS

RELEVANT INFORMATION:
After Tropical Storm Frances, Geotubes were laid along the beach for miles. Frances destroyed over 100 homes and up to 100 feet of beach. It is speculated that without the Geotubes in place, the 50 to 75 homes would have been on the beach after Tropical Storm Allison. Also, the damage from the tropical storm on the Geotubes was limited to about $25000. The success of the Geotubes comforted many people about their abilities. The Geotubes should be used in conjunction with other beach reconstruction projects.

TITLE: Using Geotubes for Engineering and Environmental Projects

WEB ADDRESS: http://bigfoot.wes.army.mil/5924.html

REFERENCE: U.S. Army Engineer District, Baltimore

DATE ACCESSED: 03/11/02

READ BY: DRS

RELEVANT INFORMATION:

Three tubes were placed along a site in the shape of an "L" to help protect the plants from damaging wave energies at Twitch Cove. The weight of these tubes prevents rolling and moving. Aquatic plants are then planted around the tubes. The tubes were successful in keeping the aquatic grass stabilized.

This district also used the geotextile tubes for offshore breakwaters for erosion control. They have proven useful thus far in this project.

TITLE: Shoreline Erosion- Sundown Island

WEB ADDRESS: http://www.tcmirafi.com/markets/marine/marine_index.html

REFERENCE: Mirafi Engineered Solutions for an Innovative World

DATE ACCESSED: 03/17/02

READ BY: DRS

RELEVANT INFORMATION:
Sundown Island Sanctuary is an island constructed of dredged material. Shoreline erosion was occurring due to waves and tides. This was decreasing the size of the island, which was critical for the bird population. Geotubes were then laid on the beach, extending out into the bay, and they were spaced approximately 300 feet from each other to reduce the loss of island size. The project has been a huge success, and more tubes are being planned for the northeast side of the island.

TITLE: Shores to install Geotubes next week- weather permitting

WEB ADDRESS: http://www.crcwater.org/issues6/19981203geotubes.html

REFERENCE: The Aberdeen Daily World

DATE ACCESSED: 03/17/02

READ BY: DRS

RELEVANT INFORMATION:

One portion of the job that needs to be considered is always the weather. In the construction in this article, the winds and rain have been a recent problem. This would not make installing the Geotubes in the dunes very easy. Although planning for tides has to be done, the weather doesn't always seem to be one of the things that is taken into consideration. The Geotubes need to be inserted at this location so the dune doesn't breach any more during the winter months.

TITLE: Proposed ASTM Standard Method

WEB ADDRESS:
http://www.geotecassociates.com/publications/newpubs/Proposed%20ASTM%20Standard%20Method.pdf

REFERENCE: Geotech

DATE ACCESSED: 03/18/02

READ BY: DRS

RELEVANT INFORMATION:
Testing of geotextile material is vital to determining its maintenance needs. This test determines the percent of suspended solids passing through the Geotubes at a specific time. This gives some evidence as to how the material is performing and how it will continue to perform. The test involves setting up an apparatus with the material stretched over the top and a drip pan on the bottom. A sample of dredged material and water is placed on the material at the top, and it is timed while allowed to fall into the drip pan. Samples are collected at set times, and the data can then be analyzed properly.

This process seems to be rather long and drawn out. Unfortunately, it is the only testing procedure for any type of geotextile material that I came across, and it would require that samples be taken from the Geotubes that were in place in the water.

TITLE: Proposed Alternative for Raising Mississippi Levees Using Geotube™ Technology Developed Under the Corps of Engineers' Construction Productivity Research Program

WEB ADDRESS: http://www.geotecassociates.com/publications/MSGEOTUB.pdf

REFERENCE: Geotech

DATE ACCESSED: 03/18/02

READ BY: DRS

RELEVANT INFORMATION:
For this project, the levees on the Mississippi River needed to be raised. The corps decided to use Geotubes for this. In 1996, the costs for the tubes were \$25.00/foot, or \$12.50/yd^3 for tubes with about 2 cubic yards per foot. Dredging costs to placed dredged material in the Geotubes and between the Geotube and the levee (or jetty, in our case) was \$5.00/yd^3. The cost of filling the Geotubes is \$5.00/yd^3. An erosion blanket is available for \$5.00/foot.

EMAIL CONTACT: Dr. Jack Fowler, PhD, P.E. jfowler@vicksburg.com

EMAILED: March 17, 2002

RELEVANT INFORMATION:
While the Geotubes that Dr. Fowler's company provides come in a variety of circumferences, the height cannot be altered from six feet. The Geotubes only become wider when filled with sand. The different sieve sizes of material cost the same amount. The 30' circumference Geotube costs about \$12 per foot, and the 45' circumference costs about \$20 per foot.

EMAIL CONTACT: Dr. Jack Fowler, PhD, P.E. jfowler@vicksburg.com

EMAILED: March 19, 2002

RELEVANT INFORMATION:
The life of the Geotubes, if exposed to sunlight, is usually around 15-20 years. If algae and other sorts of vegetation cover them, they will last longer, since they are not exposed to sunlight. Under water the Geotube life is very long, if not indefinite. UV is the worst culprit. Dr. Fowler's company does not usually do anything to maintain the Geotubes. If they are vandalized or damaged in another way, they can be fixed with epoxy patches.

EMAIL CONTACT:

EMAILED:

RELEVANT INFORMATION:
The price of the Geotube quoted by Dr. Fowler includes installation prices.

TITLE: Florida Hurricane History

WEB ADDRESS: http://www.usatoday.com/weather/huricane/history/whfla.htm

REFERENCE: USA Today

DATE ACCESSED: 03/20/02

READ BY: DRS

RELEVANT INFORMATION:
There have been no Category 3,4, or 5 landfalling hurricanes in the Cape Canaveral area in the last 100 years.

TITLE: Florida Hurricanes

WEB ADDRESS: http://www.owlnet.rice.edu/~coolnel/

REFERENCE: Rice University

DATE ACCESSED: 03/20/02

READ BY: DRS

RELEVANT INFORMATION:
None of the major hurricanes to hit Florida have hit in the Cape Canaveral area. Many of the hurricanes have hit in the southern Florida area or the Florida Keys.

TITLE: *Hurricanes*

AUTHOR: Ivan Ray Tannehill

PUBLISHER: Princeton University Press

COPYWRIGHT: 1952

RELEVANT INFORMATION:
When comparing the Gulf coast of Florida and the Atlantic coast, the Gulf coast has more hurricanes per year. From 1879-1943, the Gulf coast had 35 storms of hurricane intensity, while the Atlantic coast had 14. The cities that are located in the southern area have a much larger chance of experiencing hurricane winds. For example, in Jacksonville, the chance in any given year of winds of a hurricane force hitting are 1 in 50, while in Pensacola and Key West the chances are 1 in 10. For West Palm Beach, Miami, and Fort Myers, the chances are 1 in 30. Therefore, the area of interest does not seem to be as in danger of tropical storms as other parts of Florida.

DESCRIPTION: Use of vinyl sheet piles instead of steel sheet piles

ORIGINAL CONCEPT:

Placement of steel sheet piles in the existing jetty and the 300-foot jetty extension as the proposed sand-tightening mechanism.

PROPOSED CONCEPT:

Use vinyl sheet piles in the place of the proposed steel sheet piles.

ADVANTAGES:

- Cheaper cost per square foot
- Cheaper cost for hauling due to lighter weight
- No extra seal coating or tar epoxy needed
- No change in tools on drive barge for installation

DISADVANTAGES:

- Hauling distance from Georgia

DISCUSSION:

The use of vinyl sheet piles would be a valid alternative to the recommended steel sheet piles. The raw material cost for this type sheet pile is approximately half of that of the steel with no change to the installation process. Although the savings on material cost may be minimal in comparison with the total cost of the project, there is also a decrease in the cost of hauling the materials due to the lighter weight of the vinyl sheet piles that cannot be quantified at this time.

COST ANALYSIS:

Existing Jetty

		Unit Cost ($)		Total Cost ($)	
Length (ft)	Avg. Depth (ft)	Steel (ft^2)	Vinyl (ft^2)	Steel	Vinyl
530	15	8.25	4.50	65,588	35,775

Total Cost Savings: $29,813

Cost Savings per Year: $2,000

The cost of the steel sheet pile came from the Means book (1996 ed.)

The depth of the sheet pile was determined by evaluating the height of the jetty using the given schematics and assuming a drive depth into the sand.

Jetty Extension

		Unit Cost ($)		Total Cost ($)	
Length (ft)	Avg. Depth (ft)	Steel (ft^2)	Vinyl (ft^2)	Steel	Vinyl
300	20	10.10	4.50	60,600	27,000

Total Cost Savings: $33,600

Cost Savings per Year: $2,250

The cost of the steel sheet pile came from the Means book (1996 ed.)

The depth of the sheet pile was determined by evaluating the height of the jetty using the given schematics and assuming a drive depth into the sand.

VINYL SHEET PILES - REFERENCES:

WEB ADDRESS: http://www.vinylseawalls.com/pub3_quality_story.cfm

REFERENCE: Northstar Vinyl Products, LLC

DATE ACCESSED: 03/11/02
READ BY: JCP

PHONE CONTACT: Jeff Armstrong, Regional Sales Manager (800) 558-6702

CALLED: 03/11/02, 2:30 PM

RELEVANT INFORMATION:
The use of vinyl sheet piles in place of the steel sheet piles will reduce the material costs considerably without any additional installation costs. The raw material cost for this type of project was estimated at $4.50/sq.ft. (This estimate was based only on the information received over the phone so in no way should this price be thought of as final or published as an official estimate) The installation of the vinyl sheet piles is no different than that of the steel sheet piles. The same tools are used on the drive barge for both. Another advantage to using vinyl is that it is ready to be installed upon delivery. There is no extra seal coating or tar epoxy that needs to be done and it will not rust like steel. Also the transporting cost would be sufficiently reduced due to the weight difference between the vinyl and the steel.

DESCRIPTION: Pressure grouting the existing jetty

ORIGINAL CONCEPT:

Placement of geogrid/geotextile material within the existing jetty to act as the sand tightening mechanism.

PROPOSED CONCEPT:

Pressure grout the existing jetty with a chemical grout, which will fill the voids in the armor stone preventing the passage of sand through the jetty.

ADVANTAGES:

- Availability of data from previous application in Florida by the Army Corps of Engineers
- Potential for large amount of savings

DISADVANTAGES:

- Uncertainty that chemical composition of the grout will work for entire jetty
- Tests to show accuracy of results are costly
- Machinery used depends on accessibility to top of jetty

DISCUSSION:

The concept of pressure chemical grouting is a valid alternative to the placement of geogrid/geotextile. Studies have shown that with the right amount of research, this application can be done, and has been done in the past. Depending on the complexity of the specifications, a savings of $100,000 to $330,000 can be obtained. The cost savings is a rough estimate due to the need for the studying of the wave action and foundation materials by an expert to determine the exact chemical composition of the grout needed to withstand the conditions that it is exposed to.

PRESSURE GROUTING – REFERENCES:

REFERENCE: W.G. Jaques Company

PHONE CONTACT: Darrell Farmer (800) 247-6760

CALLED BY: JCP

CALLED: 03/15/02, 10:00 AM
03/22/02, 9:46 AM

RELEVANT INFORMATION:
W.G. Jaques Co. was the subcontractor for the pressure grouting of the south jetty at Palm Beach Harbor, Florida discussed above. Based on the information provided to him over the telephone, an estimate could not be given because there are many factors that will greatly effect the cost. In order to determine what type of mixture to use, the wave action data must be studied along with preliminary inspections of what type of materials exist below the jetty. If the top of the jetty is jagged, a dual strength system would be needed, making the cost rise. Also, there are different types of technology that is used to determine how accurate and effective the job is being done. The greater the degree of accuracy that is wanted, the higher the cost will be.

Given more information, Darrell was able to give a rough cost estimate based on the soil data and wave action data given in the report. For a span of 530' at the provided depths, the work could possibly be done at a cost between $600,000 and $800,000. If the entire existing jetty needs to be sand tightened this price would be adjusted accordingly. The wide range is due to the lack of a site inspection and how detailed the specs for the project are.

TITLE: Case History of Breakwater/Jetty Repair
Chemical grout sealing of Palm Beach Harbor South Jetty, Florida

WEB ADDRESS: http://www.wes.army.mil/REMR/pdf/co/rr-8-1.pdf

REFERENCE: U.S. Army Repair Evaluation Maintenance Rehabilitation Technical Information

DATE ACCESSED: 03/6/02

READ BY: JCP

RELEVANT INFORMATION:

In 1985, the Jacksonville District of the Army Corps of Engineers sealed the voids in a portion of the south jetty at Palm Beach Harbor, Florida, by using various mixtures of cement, sodium silicate, bentonite, and calcium chloride. The process by this was performed is called pressure chemical grouting. Pressure grouting involves the injection under pressure of a liquid or suspension into the voids of a soil or rock mass or into voids between these materials and an existing structure.

The project specifications stated that a 6-foot wide impermeable zone through the jetty would be made using a chemical grout to depths down as far as –10-feet MLW. The process by which this was performed was to drill 3-1/2 inch diameter holes, at 5-foot centers, until sand was encountered. An injection pipe was then lowered and a cement-sand grout was pumped in. In order to achieve the 6-foot curtain 18 cubic feet of grout was pumped in for every rise of the pipe by 1-foot.

For the 1300-foot jetty, the estimated cost was between $1.8 and $1.9 million, dependant on the type of grout used. This price grew to almost $2.2 million due to changes in the chemical composition of the grout because of different wave activity at different sections of the jetty.

OTHER RESEARCH IDEAS

VALUE ENGINEERING STUDY

NORTH JETTY SAND-TIGHTENING AND JETTY EXTENSION; CANAVERAL HARBOR, FL

DESCRIPTION: Use of concrete sheet piles instead of steel sheet piles

ORIGINAL CONCEPT:

Placement of steel sheet piles in the 300-foot jetty extension as the proposed sand-tightening mechanism.

PROPOSED CONCEPT:

Use concrete sheet piles in the place of the proposed steel sheet piles.

ADVANTAGES:

- Durability

DISADVANTAGES:

- Unit cost for materials
- High cost of shipping due to heaviness of materials

DISCUSSION:

The use of pre-cast concrete sheet piles in place of the steel sheet piles would not be a very cost-effective approach. The raw material cost is more than that of the steel sheet piles and the cost of hauling the materials will be high due to the weight of the concrete.

CONCRETE SHEET PILES – REFERENCES:

WEB ADDRESS: http://www.gcprestress.com/

REFERENCE: Gulf Coast Pre-stress, Inc.

DATE ACCESSED: 03/11/02

READ BY: JCP

PHONE CONTACT: Pete Shoemaker (228) 452-9495

CALLED: 03/11/02, 2:45 PM

RELEVANT INFORMATION:
After explaining the project to Mr. Shoemaker, it seemed that using pre-cast concrete sheet piles would not be a very cost-effective approach. The raw material cost was roughly estimated to be $12.00/sq.ft. Also, the shipping charge would be very expensive due to the weight of the piles.

TITLE: Port Construction and Repair

WEB ADDRESS: http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/5-480/5ch.pdf

REFERENCE: U.S. Army Training & Doctrine Digital Library

DATE ACCESSED: 03/6/02

READ BY: JCP

RELEVANT INFORMATION:
Jetties are designed to control movement and shoaling in channels. They are usually made of stone, concrete, steel or timber. Asphalt is sometimes used as a binder.

Timber, steel, and concrete sheet piles have been used for jetty construction where wave action is not severe. Cellular sheet pile structures require little maintenance. They are suitable for construction in depths to 40 feet on all types of foundations.

TITLE: Enhanced Sediment Forcing – Littoral Drift

WEB ADDRESS: http://taylorengineering.com/DMShome/DMSManual/littoral.htm

REFERENCE: Taylor Engineering, Inc.

DATE ACCESSED: 03/6/02

READ BY: JCP

RELEVANT INFORMATION:
At the Santa Cruz Harbor in California, jetties were built in 1962-1965 to stabilize the mouth of the lagoon at the mouth of the Santa Cruz River. At the time, the Corps of Engineers estimated drift to be between 30,000 and 300,000 cu yd/year. Within two years, the updrift fillet had filled with 600,000 cu yd of sand and the channel was blocked. Initially, sand was observed to be passing through the structures, but the Corps of Engineers grouted the jetties to make them sand tight and now, most of the sediment entering the channel comes from the littoral drift passing around the tips of the jetties.

DESCRIPTION: Change angle of the existing jetty

ORIGINAL CONCEPT:

The jetty designed for this project extends due east from the shore into the ocean.

PROPOSED CONCEPT:

A proposed idea was to change the angle of the jetty either more north or more south. It was thought that another type of orientation could make the jetty more effective in stopping sand entering the harbor.

ADVANTAGES:

- None are verified

DISADVANTAGES:

- Not as easy to construct
- Provides no less sand migration

DISCUSSION:

Jetty orientation is normally as shown for this project, however angle jetties and doglegs or spurs at the end of the up-wave jetty are not uncommon. There are many factors that go into deciding the orientation of the jetty. The first one would be associated with the peak waves. As stated in point 7, reducing the net rate of littoral drift toward the inlet can be done by reorienting the beach to a more perpendicular angle to the predominant wave direction. Therefore, a jetty that extends directly into the peak wave direction would accomplish this better than any other orientation. The occurrence of peak waves occurs most often perpendicular to the beach (90 degrees), as shown in Table 1. Therefore, the design fairs well in this regard.

Another considerations included making sure that the boats entering and exiting the harbor hit the predominant waves straight on. Any big waves from the sides would be dangerous for the boats. Therefore an eastern jetty as shown or one oriented more south would work in this case.

The last consideration done for reorientation of the jetty was a re-analysis using the GENESIS software. That is, seeking quantitative values of sand migration. In this software, results are insensitive to structure orientation. So therefore, this model cannot predict the results of a differently oriented jetty with significant confidence.

Qualitatively the eastern bound jetty works the best out of any other solution with our situation. In addition, no quantitative analysis is available to make the solution seem less cost effective. A reanalysis of the software incorporating jetty orientation would only be worthwhile if the wave direction was different.

JETTY ANGLE – REFERENCES:

REFERENCE: Nicholas Kraus (Nicholas.C.Kraus@erdc.usace.army.mil)

CONTACTED BY: TVW

CONTACTED: 3/17/02

RELEVANT INFORMATION:
A lot could be written about jetty design. There are three design considerations: (1) navigation safety -- in particular, vessels are afforded wave protection in crossing through the surf zone or zone of waves breaking on the entrance "bar" or ebb shoal; (2) the inlet position is locally stabilized; and (3) maintenance dredging is minimal or controllable (predictable). The modern approach to inlet or entrance navigation projects (a navigation project is the channel and any protective structures -- jetties) is to treat the channel and beaches as a system.

That is, we expect to dredge some sand to bypass it to the down-drift beach, aiding the natural sand bypassing if it exists.

Concerning jetty orientation, the default orientation but one that is often modified, is to align the inlet or entrance channel (jetties) such that vessels exiting to the ocean or sea meet the incident waves straight on. If a vessel receives waves from the side, then there is potential for it to be in a dangerous situation. However, on many coasts there is a predominant direction or a direction from which the larger waves originate. In this case, the jetties might be aligned obliquely so that waves tend to strike the up-wave structure with more normal incidence -- in this sense the jetty functions more as a breakwater. In summary, there are variations to the straight-out design, including angle jetties, dogleg or spur at the ends of the up-wave jetty, a breakwater offshore to shadow the entrance, and so on.

In the area of navigation safety, the wave-current interaction enters, besides water depth (depth of the channel and stage of tide), desire to eliminate wave breaking, and desire to avoid oblique wave incidence in breaking waves. At ebb tide, waves encounter an opposing current and both increase in height and decrease in wavelength, thereby greatly increasing in steepness. On a flood current, the waves lay down -- increasing in length and decreasing in height. Mariners know this phenomenon well.

Best wishes in your studies. You might also look at pictures of jetties as found on the Corps' Inlets Online, which is on our Coastal Inlets Research Program web site --

http://cirp.wes.army.mil/cirp/cirp.html

REFERENCE: Michael Wolz (Michael.W.Wolz@usace.army.mil)

CONTACTED BY: TVW

CONTACTED: 3/18/02

RELEVANT INFORMATION:
I spoke with ED Hodgens, the lead engineer for this job. The easement used in the geotube installation was 75 feet. We can obtain increased temporary construction easement as required (i.e. several hundred feet), but the permanent easement is probably around 75 feet. Apparently, genesis, the software used for the modeling, assumes the

structure is basically perpendicular to the shoreline, and analysis results are insensitive to structure orientation. So, even if the a more northerly alignment was better, the modeling cannot capture that benefit with significant confidence. Feel free to suggest re-analysis. But, results will not be available in order to establish cost differences in your report.

DESCRIPTION: Used tires, Recycled plastic, Use old submarine / sunken ship to act as reef / barrier.

ORIGINAL CONCEPT:

Use the traditional armor arrangement for the jetty.

PROPOSED CONCEPT:

Use alternative materials to construct the jetty.

ADVANTAGES:

- None are verified

DISADVANTAGES:

- Not as easy to construct
- Aesthetically displeasing
- Possible environmental hazards

DISCUSSION:

These ideas were briefly explored with no major information to report. After contemplating the ideas a little more, it was decided to scrap the ideas all together.

DESCRIPTION: Alternative Sand Uses

ORIGINAL CONCEPT:

Sand that is dredged from the harbor is replaced on the south side of the harbor.

PROPOSED CONCEPT:

Sell the dredged sand to material companies for various other purposes.

ADVANTAGES:

- Decreased annual cost, material companies could pay for the dredging.
- Decreased use Ocean Dredged Material Disposal Sites.

DISADVANTAGES:

- Beach sand is not physically and/or chemically compatible for many of the uses of non-beach sand including recreational, structural, industrial and agricultural applications.
- Harbor is still inhibited by use of periodic dredging equipment.

DISCUSSION:

This option is not valid, however, within the research, a larger statewide coastal problem became evident, which leads to the following alternative sand option. It would be more beneficial to keep the sand within Florida's coasts than to transport it elsewhere. Please see the following REFERENCES.

ALTERNATIVE SAND USES – REFERENCES:

TITLE: U.S. Silica – Sands of Time

WEB ADDRESS: www.u-s-silica.com

REFERENCE: U.S. Silica of Berkley Springs, WV

DATE ACCESSED: 03/12/02

READ BY: DEP

RELEVANT INFORMATION:
There are many uses for sand, which are listed on the home page and have further explanation through links. Some of these uses are:
Structural – Glass, Ceramics, Face Brick, Concrete, Shingles, Fiber Cement Panels
Recreational – Golf Bunkers, Baseball Diamond Toppings, Tennis Court Toppings, Racetracks, Walking/Hiking Trails, Sand Boxes
Industrial – Pool Filters, Water Filters, Wastewater Filters, Landfills, Railroads
Agricultural – Landscaping, Farming

PHONE CONTACT: Doug Washkowiak (800) 243 - 7500

CALLED: 03/14/02, 11:30 AM

RELEVANT INFORMATION:
The sand used by this site is mined from the ground. Testing is done to determine quality, such as the size distribution, color and iron content. For most applications this sand must be pure white. Even for non-altered sand uses, requirements still exist such as in golf course bunkers. This sand should be round for absorption purposes, as opposed to the jagged nature of natural sand from beaches. Mr. Washkowiak was not optimistic that beach sand could be used for any of U. S. Silica's purposes. When asked what types of applications would beach sand be appropriate, the reply was gardening, castings or pipe bedding.

TITLE: Sand selection & your game

WEB ADDRESS: http://www.gcsaa.org/resource/golfer/sand.html

REFERENCE: Golf Course Superintendent Association of America

DATE ACCESSED: 03/14/02

READ BY: DEP

RELEVANT INFORMATION: The United States Golf Association specifies particle-size criteria for selecting bunker sand. A golf course subject to high winds should stay away from selecting sand that is too fine. The predominant particle shape of sand comes into play. A desired bunker sand shape is angular with a low degree of roundness. A hard silica sand will resist weathering and retain its original shape longer. Testing includes the sand's particle-size, distribution, shape, color, crusting potential, hydraulic and its resistance to buried lies. Bunker sand selection affects the condition of play as well as bunker maintenance.

TITLE: Sand Channel Greens, Sports Turf Drainage System

WEB ADDRESS: http://www.dryturf.com/

REFERENCE: Sand Channel Greens, Sports Turf Drainage System

DATE ACCESSED: 03/14/02

READ BY: DEP

RELEVANT INFORMATION: Sand Channel Greens designs and installs high intensity sand channel drainage systems for golf courses, sports fields, and other sports turf venues. Sand channel systems consist of a matrix of closely spaced, interconnected, sub-surface drainage channels. This network of channels provides highly efficient vertical bypass drainage for large turf areas.

PHONE CONTACT: Wendy Griffith

CALLED: 03/14/02, 2:00 PM

RELEVANT INFORMATION:
The sand used by this company is from a mine and is fairly coarse, passing through the 20 – 30 sieve (0.6 mm to 0.85 mm). They do not use beach sand because of the many

fines and high salt content. Sand use in playgrounds and landscaping requires an intense washing and screening process.

TITLE: Corps digs into Florida sand shortage

WEB ADDRESS: http://www.hq.usace.army.mil/cepa/pubs/oldpubs/july97/story7.htm

REFERENCE: By Christina Plunkett - Jacksonville District

DATE ACCESSED: 03/15/02

READ BY: DEP

RELEVANT INFORMATION:
Florida is running out of sand. Jacksonville District sponsored has discussed using non-domestic sand for hurricane and beach protection projects in South Florida. Miami Beach is a prime example where sand is needed.

The generic sand specification will encompass grain size, composition, color, and anticipated performance for all sand REFERENCES including aragonite, calcium, and quartz sands.

DESCRIPTION: Alternative Beach Disposal

ORIGINAL CONCEPT:

Sand that is dredged from the harbor is replaced on the south side of the harbor.

PROPOSED CONCEPT:

Sell the sand to hotels and other beach owners for beach renourishment projects.

ADVANTAGES:

- Decreased annual cost for project, hotels could pay for the dredging.
- Decreased use Ocean Dredged Material Disposal Sites.
- Helps solve statewide problem of beach erosion.

DISADVANTAGES:

- Not all beach sand is compatible for placement at another beach.
- Harbor is still inhibited by use of periodic dredging equipment.
- Foresee large amount of legal paperwork.
- Even though the cost to hotels is less for dredged sand compared to new sand, the cost to transport by truck is expensive.

DISCUSSION:

This option is also not substantial because of the above listed disadvantages, but the references for this option lead to a brief analysis of the dredging method. Please see the following references.

ALTERNATIVE BEACH DISPOSAL – REFERENCES:

TITLE: Panama City Beach, Florida
Renourishment Project

WEB ADDRESS: www.panamacitybeachmall.com/web/beach

REFERENCE: Panama City Beach Mall (Tourist Company)

DATE ACCESSED: 03/12/02

READ BY: DEP

RELEVANT INFORMATION:
Two hurricanes in 1998 (Earl and Georges), and Hurricane Opal in 1995, caused millions of cubic yards of beach to be eroded from our shores. Great Lakes Dredge and Dock Co., Oakbrook, IL, contracted the project to place 7.3 Million Cubic Yards back on the beach for about 16 million dollars, paid for by the Federal, and State Government, as well as a raised tax by the Tourist Development Council in 1997.

The sand pumped up and onto the beach-contained silt and sediments. Natural rain will cleanse the sand and wash the silt and sediment away. Within a short period of time, most of the sand and beach should be back to its "sugar white" color. Weather and traffic will allow the beach, over a period of time, to again appear in its natural state. Sea Oats will also be planted to help protect the beach from further erosion.

TITLE: The right time for geotextile tube technology

WEB ADDRESS: www.dredge.com/casestudies/geotube.htm

REFERENCE: Ellicott International
(Designer and Builder of Cutter Suction Dredges)

DATE ACCESSED: 03/12/02

READ BY: DEP

RELEVANT INFORMATION: Between January 1993 and January 1994, Atlantic City lost more than 100 feet (30 m) of beach in some areas, a rate of eight-plus feet per month. During past storms and over time, sand dunes, which protect the city's boardwalk, as well as the homes, businesses, hotels and casinos along it, deteriorated, and in some cases, completely washed away. The problem was most severe when extreme high tides driven by offshore storms in the Atlantic Ocean slashed away the beach and sand dunes.

TITLE: Volume of Ocean Dredged Material Disposed of Off Florida's Coast

WEB ADDRESS: http://www.pepps.fsu.edu/FACT/sec_B/vol.html

REFERENCE: Florida State University

DATE ACCESSED: 03/14/02

READ BY: DEP

RELEVANT INFORMATION: Currently, there are fifteen Ocean Dredged Material Disposal Sites (ODMDS) off the Florida coast. These sites are areas that have been set aside as receptor sites for dredge material. These fill materials are considered a state resource that has the potential to be used for renourishment of Florida's beaches. The volume of ODMDS material is already monitored by the U.S. Army Corps of Engineers. The volume of material that is disposed of in designated sites is monitored during the dredging operation, and data are available upon completion of each project.

TITLE: Determining Site Suitability for Ocean Dredged Material Disposal Sites in North Carolina

WEB ADDRESS: http://www.csc.noaa.gov/opis/html/csdrdg.htm

REFERENCE: National Oceanic and Atmospheric Administration

DATE ACCESSED: 03/14/02

READ BY: DEP

RELEVANT INFORMATION: Millions of cubic yards of sediment are dredged each year from U.S. channels and ports in order to maintain navigation for national defense, commerce, and recreational use. The U.S. Army Corps of Engineers makes use of approved Ocean Dredged Material Disposal Sites (ODMDS) when other beneficial use or upland disposal options for this dredged material are not feasible.

As mandated by the Marine Protection, Research, and Sanctuaries Act of 1972, the ocean disposal of dredged material must take place at sites designated by the Environmental Protection Agency (EPA). The site designation process requires that the Corps prepare an Environmental Impact Statement (EIS) to evaluate the site based on environmental impacts, user conflicts, and economic issues.

With the use of Ocean Planning Information System (OPIS) data sets, the Corps can complete a quick initial screening of large areas without prior fieldwork or an extensive literature search. In this way, more time and resources can be devoted to the examination of areas with a higher probability of success.

TITLE: Beach Restoration Projects

WEB ADDRESS: http://www.olsen-associates.com

REFERENCE: Olsen Associates, Inc.,
4438 Herschel Street, Jacksonville, Florida 32210

DATE ACCESSED: 03/15/02

READ BY: DEP

RELEVANT INFORMATION: This website has detailed descriptions of Florida beaches that have been restored by this company, including Amelia Island Plantation, Brevard County, Broward County, Bonita Beach, Canaveral Harbor, Cocoa Beach, Fisher Island, Ft. Clinch, Lighthouse Point, Ocean Ridge, Patrick Air Force Beach, Pensacola Beach, and South Seas Plantation.

TITLE: Pensacola Beach, FL Feasibility Study for Beach Restoration

WEB ADDRESS: http://bcs.dep.state.fl.us/jcp/pen-bch/grain-sz.pdf

REFERENCE: Olsen Associates, Inc. (Coastal Engineering Company)

DATE ACCESSED: 03/15/02

READ BY: DEP

RELEVANT INFORMATION: The distribution of sand from Pensacola Beach is distributed between about 0.2 mm and 1.0 mm. Also, the beach sand, relative to the ocean sand is slightly larger. See the attached graph in the Appendix.

REFERENCE: Olsen Associates, Inc., http://www.olsen-associates.com/

CALLED BY: DEP

CALLED: 03/19/02, 10:10 AM

PHONE CONTACT: Steve Howard (904) 387 – 6114

RELEVANT INFORMATION: This is the design review firm for the Canaveral Harbor projects. They have engineered the projects in 1989, 1995 and 1998. The dredged sand is placed at a near shore disposal site, which enters back into the sand movement process. See the attached diagram in the Appendix.

REFERENCE: Fountains & Falls 2365 US Highway 92 E Lakeland, FL

CALLED BY: DEP

CALLED: 03/15/02, 11:05 AM

PHONE CONTACT: Chuck Cold (863) 667-1114

RELEVANT INFORMATION: This company has not taken in any beach sand and refuses to do so. They have not had any offers to supply sand to a beach, however they have supplied sand for lakefront restoration. The unit price of their sand is $15.00 for one cubic yard.

REFERENCE: Larry Larson's Topsoil 4700 Ulmerton Rd Clearwater, FL

CALLED BY: DEP

CALLED: 03/15/02, 11:10 AM

PHONE CONTACT: Bill, the dispatcher, (727) 573-1712

RELEVANT INFORMATION: This company supplies some sand to hotels and motels in the area. The quality of this sand is pure and white and comes from the Florida Rock Industry. The sand cost is $24 per cubic yard, with a $10 delivery charge per truck. Approximately 18 yards of sand will fill up one of their trucks.

REFERENCE: Taylor Engineering, Inc., 9000 Cypress Green Dr. Jacksonville, FL, www.taylorengineering.com

CALLED BY: DEP

CALLED: 03/19/02, 12:20 PM

PHONE CONTACT: Joe Wagner, (904) 731 – 7040

RELEVANT INFORMATION: The website tells about a couple of other beach restoration projects, including 500,000 cubic yards moved from a disposal site near St. Lucie to Juniper Island and 1.3 miles of beach replaced on Ft. Pierce Beach.

The phone call with Mr. Wagner pointed out the state law that requires dredged material from inlets to be placed down shore from the inlet to where the sand would naturally flow if it wasn't held up by the inlet. This required maintenance of the far shore keeps the sand placement near by to the dredging operations, because alternative methods of transporting is costly. However, in the past, temporary easements have been obtained to transport this dredged material further along. First, the sand materials must be tested, especially the size of the sand particles, both on the beach and the dredged material to make sure they are compatible. As a rule of thumb, if the silt content is higher than 5%, it is rarely placed on a beach other than the far shore of the inlet it is dredged from.

REFERENCE: Woods Hole Group, Marine Environmental Solutions, http://www.whgrp.com/ 81 Technology Park Drive, East Falmouth, MA 02536

CALLED BY: DEP

CALLED: 03/19/02, 12:30 PM

PHONE CONTACT: Leslie Fields, (508) 540 – 8080

RELEVANT INFORMATION: Most of the dredging projects that this company oversees uses disposal sites as opposed to other distant beaches. The sand is hydraulically pumped from the harbors through a pipe to the new location. This pipe is typically less than 10,000 feet, which would keep the disposal site relatively close to the dredging site. If transportation by road would be used, it would be more costly because it includes the draining of the sand and water mixture that is dredged and the use of trucks. The sand physical and chemical compatibility was another issue, using the same size or coarser material to place on an existing beach. Fine-grained sand is more susceptible to collecting contaminants. There are many design parameters to consider when placing sand, including the length, width and elevations, as well as how the sand would be contained and for what design life.

DESCRIPTION: Dredging Method Analysis

ORIGINAL CONCEPT:

Sand is now transported to the disposal site using barges.

PROPOSED CONCEPT:

Use a piping method to transport the sand to the disposal site.

ADVANTAGES:

- Prices of the two methods are comparable. More research is necessary to confirm that pipe transportation is less costly than barge transportation.
- Even though the same space is required in the harbor, the time to pump rather than transport by barge is considerably less.

DISADVANTAGES:

- More easements may required.

DISCUSSION:

Without specific price quotes that a comparable to the dredging prices given, the cost analysis can not be completed. The price cost is slightly lower, but in the same general range. Because the use of barges or pipes is so situational, more research is necessary for pipeline discharge for maintenance dredging in Canaveral Harbor.

DREDGING METHOD ANALYSIS – REFERENCES:

REFERENCE: Taylor Engineering, Inc., 9000 Cypress Green Dr. Jacksonville, FL, www.taylorengineering.com

CALLED BY: DEP

CALLED: 03/21/02, 10:20 AM. 03/22/02, 9:30 AM.

PHONE CONTACT: Joe Wagner, (904) 731 – 7040

RELEVANT INFORMATION:
This second phone call with Mr. Wagner was to compare the dredging process. The ball park unit price for dredging and transporting via pipes is around 3 to 8 dollars per cubic yard, including the mobilization and demobilization of the dredging equipment The price cost is slightly lower, but in the same general range. Because the use of barges or pipes is so situational, more research is necessary for pipeline discharge for maintenance dredging in Canaveral Harbor. The only time that barge transportation is used is when toxicity and contamination is a concern. The space requirement within the harbor is about the same when comparing barge and pipe transportation. However, the time requirement and approximate costs are lower when using pipe transportation. The pipe used is made of cast iron, usually 18" or 24" in diameter, unless the contractor is facilitated with a 36" pipe. The maximum length that this pipe can be used is about 5 or 6 miles because of pumping restraints.

REFERENCE: Olsen Associates, Inc., http://www.olsen-associates.com/

CALLED BY: DEP

CALLED: 03/23/02, 9:40 AM

PHONE CONTACT: Steve Howard, (904) 387 – 6114

RELEVANT INFORMATION:
Barge transportation was used in Canaveral Harbor for the last two maintenance dredges. No reasons were found for why pipes weren't used and if there was any valid cost comparison.

REFERENCE: Coastal Engineering Consultants, Inc.

E-MAILED BY: DEP

E-MAILED: 03/20/02

CONTACT: mtp@cecifl.com (Michael Poff)

RELEVANT INFORMATION:
Some information was confirmed, other questions were answered. Florida law requires sand to be tested for size and contamination before it is transported. The transportation of sand using trucks is only cost effective in small quantities. The difference between sand bypassing and maintenance dredging has something to do with the source and transportation of material. Sand bypassing is removing sand from a beach or harbor and transporting it to the downdrift beach.

The pipes and booster pumps can carry materials a maximum of 8 miles downshore with the proper equipment. For this purpose, temporary easements are required. Barges and pipes are frequently used and the choice typically depends on the type of material, where the material comes from and where it is going. A cost analysis of the two methods depends on these items as well. Unit prices for bypassing and dredging range from 2 to 20 dollars per cubic yard and on the east coast of Florida for about 6 to 8 dollars per cubic yard.

TITLE: Tools & Terms / Doing Business Abroad

WEB ADDRESS: http://www.cmsenergy.com/Tools&Terms/T07.asp

REFERENCE: CMS Energy Co.

DATE ACCESSED: 03/21/02

READ BY: DEP

RELEVANT INFORMATION:
5 Nautical Miles equals about 5.75 Statute Miles.

SPECULATION PHASE – 02/21/02:

1. Sheet piling or fabric along entire jetty (use single material for barrier).
2. Leave geotubes in place.
3. Add geotubes. Stack 2 with bracing. Stack 3 in a pyramid.
4. Use double layer of geotextile fabric.
5. Move the base, or move the port. (Do Nothing.)
6. Use insertion methods for fabric rather than sand excavation.
7. Build a second (or multiple) jetties north of port.
8. Minimize the entrance size by constructing a tunnel-like barrier.
9. Use different sheet pile material, such as fiberglass or vinyl.
10. Steepen the side slopes on the jetty.
11. Widen the top of the jetty for construction purposes, eliminates barge use.
12. Sand compaction to the North.
13. Equipment substitute from barge to long armed apparatus.
14. Substitute alternate armor stone (recycled concrete, limestone.)
15. Recycle dredging material for armor stone.
16. Use crushed recycled concrete as liner material or fill material.
17. Use vegetation to stabilize the beach to the north (sea oats).
18. Sell sand for commercial use (pipe bedding).
19. Remove sand by under water pumps / sand bypassing.
20. Sea walls / wave breaker wall.
21. Put liner on harbor side with lower sea state (dimensional analysis required).
22. Recycle geotubes within project.
23. Cut geotubes and remove sand before removal.
24. Remove sheet pile.
25. Evaluate the length of the extension.
26. Reuse geotube material, cut into usable lengths for geotextile material.
27. Roll geotextile material from bottom of jetty, rather than starting at the top.

28. Use vertical poles (3' dia.) to slow down waves.
29. Use horizontal poles on the beach to stabilize the shoreline.
30. Concrete retaining wall.
31. Use old submarine / sunken ship to act as reef / barrier.
32. Use large stones/concrete mix/grouting in anchor wall instead of sheet-piling/fabric.
33. Reinforced concrete wall for jetty.
34. Used tires.
35. Recycled plastic.
36. Use space station material for wall (launch pad).
37. Use empty kegs for wall.
38. Expand harbor using slurry wall, profile will shift, creating wider port.
39. Change the angle of existing jetty to the extension.
40. Consider periodic truck removal of sand on beach.

DEVELOPMENT PHASE – 02/25/02
DISCARDED IDEAS:

4. Use double layer of geotextile fabric.
REASON: Small amount of available research material.

5. Move the base, or move the port. (Do Nothing.)
REASON: probably not realistic, not a cost savings

6. Use insertion methods for fabric rather than sand excavation.
REASON: Small amount of available research material.

7. Build a second (or multiple) jetties north of port.
REASON: Sand volume analysis required, site is only 100' north of existing jetty.

8. Minimize the entrance size by constructing a tunnel-like barrier.
REASON: massive construction, difficult to dredge small opening

10. Steepen the side slopes on the jetty.
REASON: detailed analysis required

11. Widen the top of the jetty for construction purposes, eliminates barge use.
REASON: detailed analysis required

12. Sand compaction to the North.
REASON: sand compaction is minimal, not effective in reducing sand movement

13. Equipment substitute from barge to long armed apparatus.
REASON: not needed based on chosen alternatives

14. Substitute alternate armor stone (recycled concrete, limestone.)
REASON: After some research, found material properties are too variable.

15. Recycle dredging material for armor stone.
REASON: After some research, found material properties are too variable.

16. Use crushed recycled concrete as liner material or fill material.
REASON: After some research, found material properties are too variable.

20. Sea walls / wave breaker wall.
REASON: detailed analysis required

21. Put liner on harbor side with lower sea state (dimensional analysis required).
REASON: would collect more sand, resulting in higher pressures, wall instability

27. Roll geotextile material from bottom of jetty, rather than starting at the top.
REASON: Small amount of available research material.

28. Use vertical poles (3' dia.) to slow down waves.
REASON: may require analysis from scale model

29. Use horizontal poles on the beach to stabilize the shoreline.
REASON: may require analysis from scale model

30. Concrete retaining wall.
REASON: assume already been considered, prefer research of recycled concrete

33. Reinforced concrete wall for jetty.
REASON: assume already been considered, prefer research of recycled concrete

36. Use space station material for wall (launch pad).
REASON: may be unappealing to look at

37. Use empty kegs for wall.
REASON: unrealistic, expensive

38. Expand harbor using slurry wall, profile will shift, creating wider port.
REASON: very complicated

40. Consider periodic truck removal of sand on beach.
REASON: limited access, foreseen transportation costs.

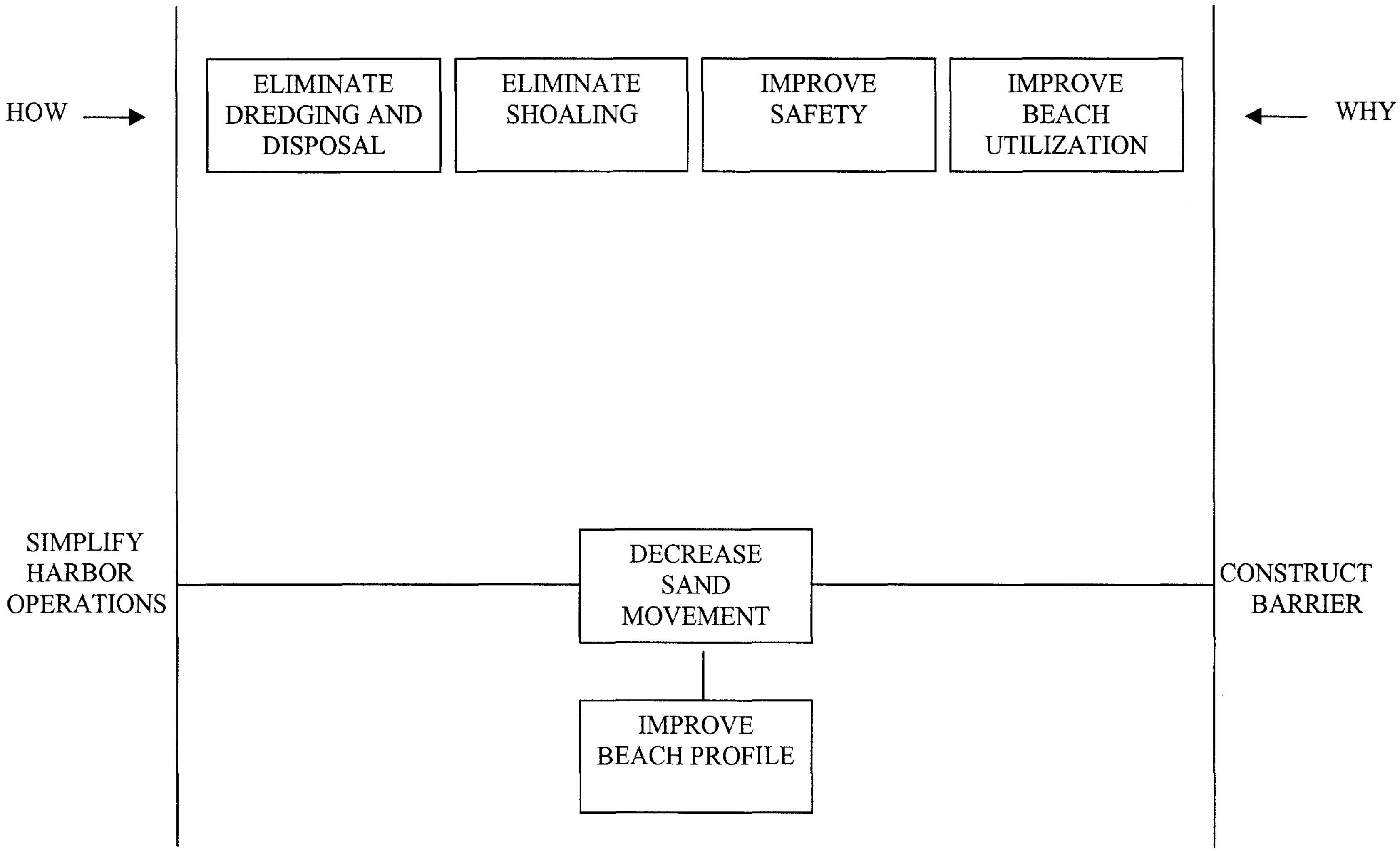
DEVELOPMENT PHASE - 02/25/02

RESEARCH IDEAS:

34. Used tires. TW
35. Recycled plastic. TW
31. Use old submarine / sunken ship to act as reef / barrier. TW
25. Evaluate the length of the extension. TW
39. Change the angle of existing jetty to the extension. TW

18.	Sell sand for commercial use (pipe bedding).	DP
19.	Remove sand by under water pumps / sand bypassing.	DP
1.	Sheet piling or fabric along entire jetty (use single material for barrier).	JP
24.	Remove sheet pile.	JP
32.	Use large stones/concrete mix/grouting in anchor wall instead of sheet-piling/fabric.	JP
9.	Use different sheet pile material, such as fiberglass or vinyl.	JP
17.	Use vegetation to stabilize the beach to the north (sea oats).	BG
2.	Leave geotubes in place.	DS
3.	Add geotubes. Stack 2 with bracing. Stack 3 in a pyramid.	DS
22.	Recycle geotubes within project.	DS
23.	Cut geotubes and remove sand before removal.	DS
26.	Reuse geotube material, cut into usable lengths for geotextile material.	DS

FAST DIAGRAM



VALUE ENGINEERING STUDY

NORTH JETTY SAND-TIGHTENING AND JETTY EXTENSION; CANAVERAL HARBOR, FL

Preliminary
Value Engineering Report

North Jetty Sand-Tightening and Jetty Extension
Canaveral Harbor, Florida
March 2002

Prepared For:
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Prepared By:
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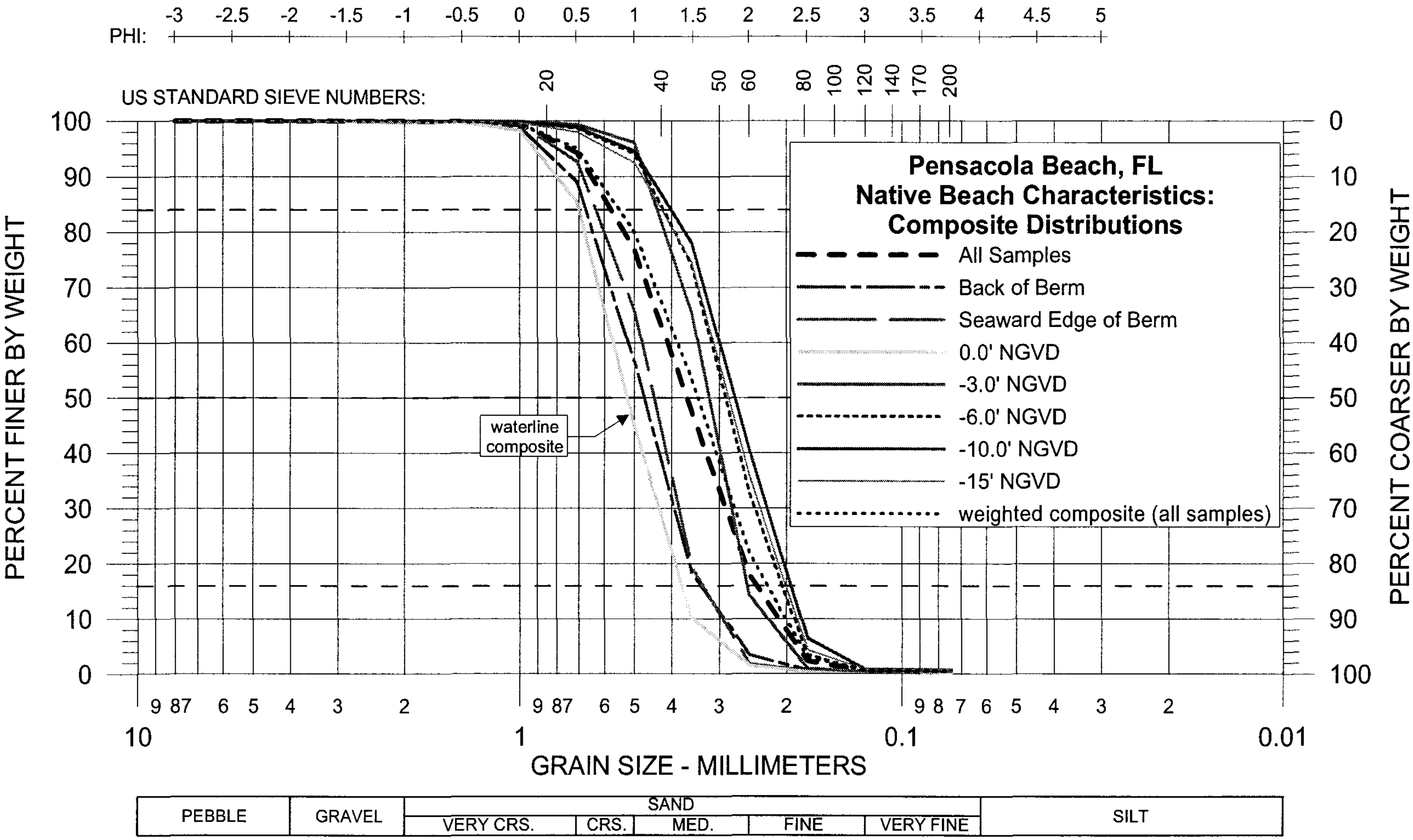

olsen
associates, inc.
coastal engineering
4438 herschel street
jacksonville, fl 32210

Pensacola Beach, FL
Feasibility Study for Beach Restoration

Sand Search Investigation
Native Beach Composites

April 2001

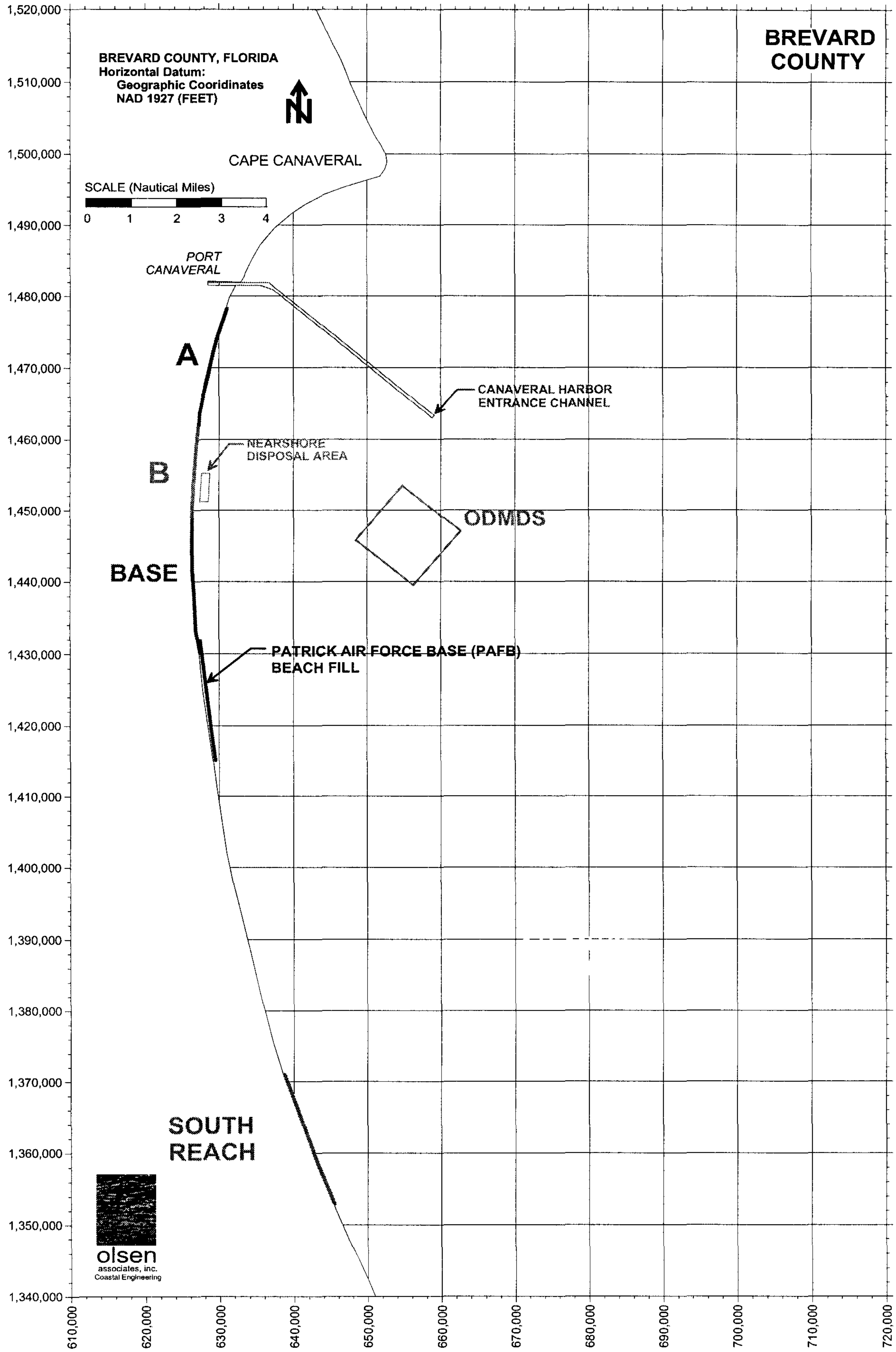
BREVARD COUNTY, FLORIDA
Horizontal Datum:
Geographic Cooridinates
NAD 1927 (FEET)
N
CAPE CANAVERAL
SCALE (Nautical Miles)
0 1 2 3 4
PORT CANAVERAL
A
CANAVERAL HARBOR ENTRANCE CHANNEL
NEARSHORE DISPOSAL AREA
B
ODMDS
BASE
PATRICK AIR FORCE BASE (PAFB) BEACH FILL
SOUTH REACH
BREVARD COUNTY
olsen
associates, inc.
Coastal Engineering
1,520,000
1,510,000
1,500,000
1,490,000
1,480,000
1,470,000
1,460,000
1,450,000
1,440,000
1,430,000
1,420,000
1,410,000
1,400,000
1,390,000
1,380,000
1,370,000
1,360,000
1,350,000
1,340,000
610,000
620,000
630,000
640,000
650,000
660,000
670,000
680,000
690,000
700,000
710,000
720,000

Figure A