Attachment C

Comparison of Sediments in Martin County Florida

Response to RAI #1

Comparison of Sediments in Martin County

Martin County, Florida

December 2008

Comparison of Sediments in Martin County
Martin County, Florida

Prepared for

Martin County, Florida

by

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1.0 INTRODUCTION

Existing data show that the width of Bathtub Beach has fluctuated dramatically over the past 30 years, periodically eroding and accreting rapidly with sand from adjacent (primarily updrift) beaches. However, the width of the beach has shown a net decrease over that period, and it does not currently provide adequate erosion defense for local park structures and residential roadways. In summer 2008 conditions necessitated an emergency fill effort, using sand from an upland source: the Stewart mine. To provide a mechanism to protect the remaining Park structures and local residential roadways from further erosion, Martin County has proposed a fill project for Bathtub Beach that would protect the Park and roadways but would not provide an expansive beach as might have been found in previous decades.

This report evaluates appropriate sand quality for Bathtub Beach in the absence of known and native beach sand characteristics. Comparison of the qualities of the Martin County Shore Protection Project (SPP) sand, St. Lucie inlet sand trap sand (used to nourish Jupiter Island beaches), and sand from the proposed borrow area for the Bathtub Beach fill project provides a means to determine the suitability of the borrow area sand. Sand from adjacent beaches, particularly the Martin County SPP area to the north, nourished periodically since the mid-1990's, likely contributes significantly to Bathtub Beach sand quality. The SPP beaches and the Jupiter Island beaches have performed as predicted by physical models and the sand qualities of those beaches have provided appropriate marine turtle nesting conditions; The SPP and Jupiter Island beaches have shown no long-term negative change in nesting.

Figure 1.1 presents a map of the project area. The Martin County SPP ranges between FDEP reference monuments R-1 and R-25, and used a borrow area in Gilbert Shoal, approximately one mile offshore Martin County. The proposed borrow area for Bathtub Beach lies in the flood shoal inside St. Lucie Inlet. The St. Lucie Inlet sand trap lies just south of the jetty. Bathtub Beach lies between these locations, near R-35 in Martin County.

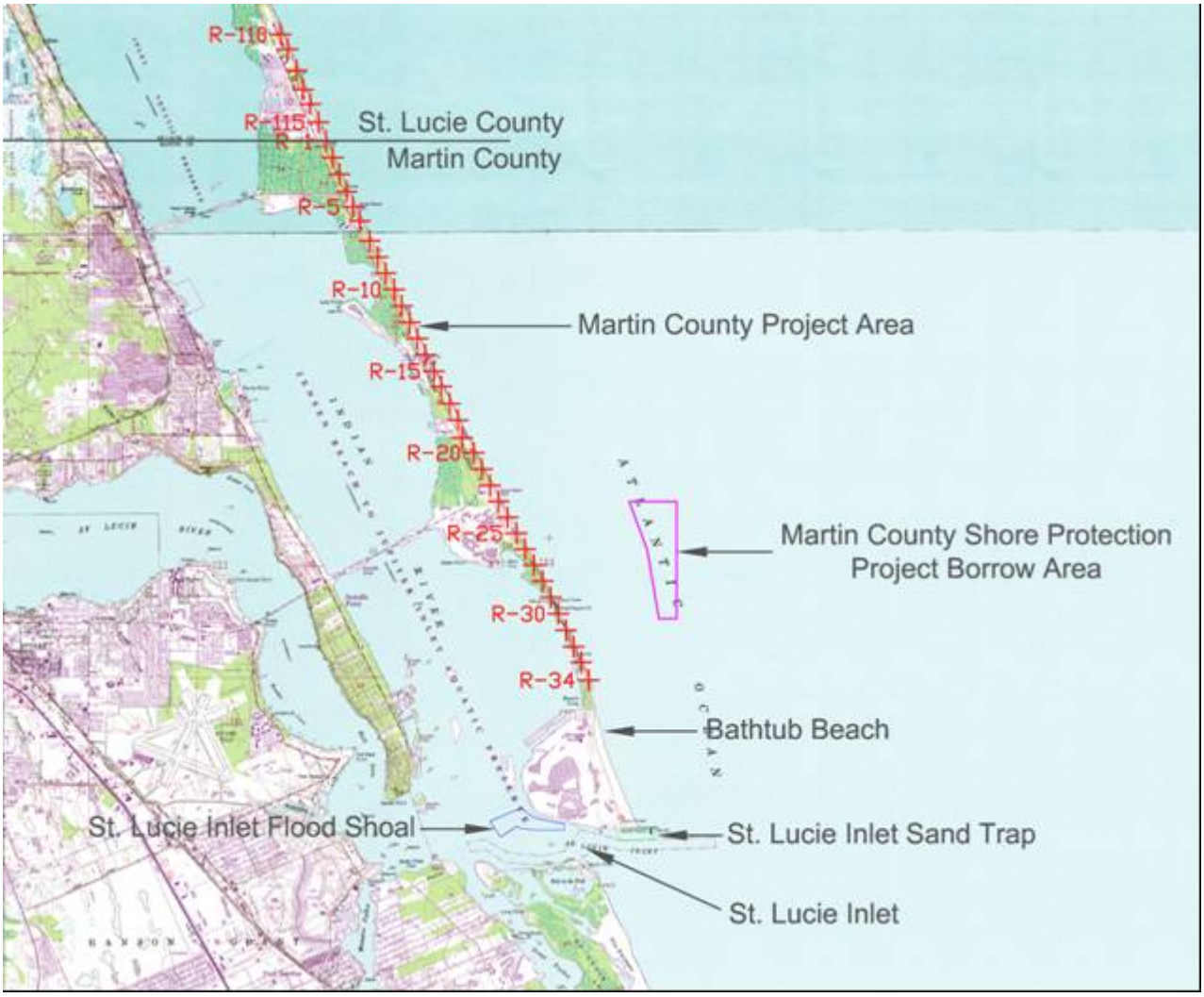


Figure 1.1 Location Map

2.0 SITE DESCRIPTIONS AND SOURCE DATA

2.1 Martin County Native Beach

As part of its SPP, Martin County has nourished the portion of native beach between R-1 and R-25 three times since 1995. Projects in 1995, 2001/2002, and 2005 nourished the beach with material from a borrow area in Gilbert Shoal, approximately one mile offshore Martin County (Figure 1.1). As part of the SPP, geologists sampled the native sand in 2005, 2006, and 2007 and sieved it to ascertain grain size distributions, fines percentages, and carbonate percentages. Figure 2.1 presents the composite grain size distributions from these three geological studies. Because the figure indicates little change in the grain size distributions over the three years, this report hereafter considers only the 2007 data. Appendix A contains a full set of results from the 2007 geological study.

The three geological studies do not contain Munsell color data. Taylor Engineering collected

additional native beach samples in November 2008 to characterize the color of the native beach sediment.

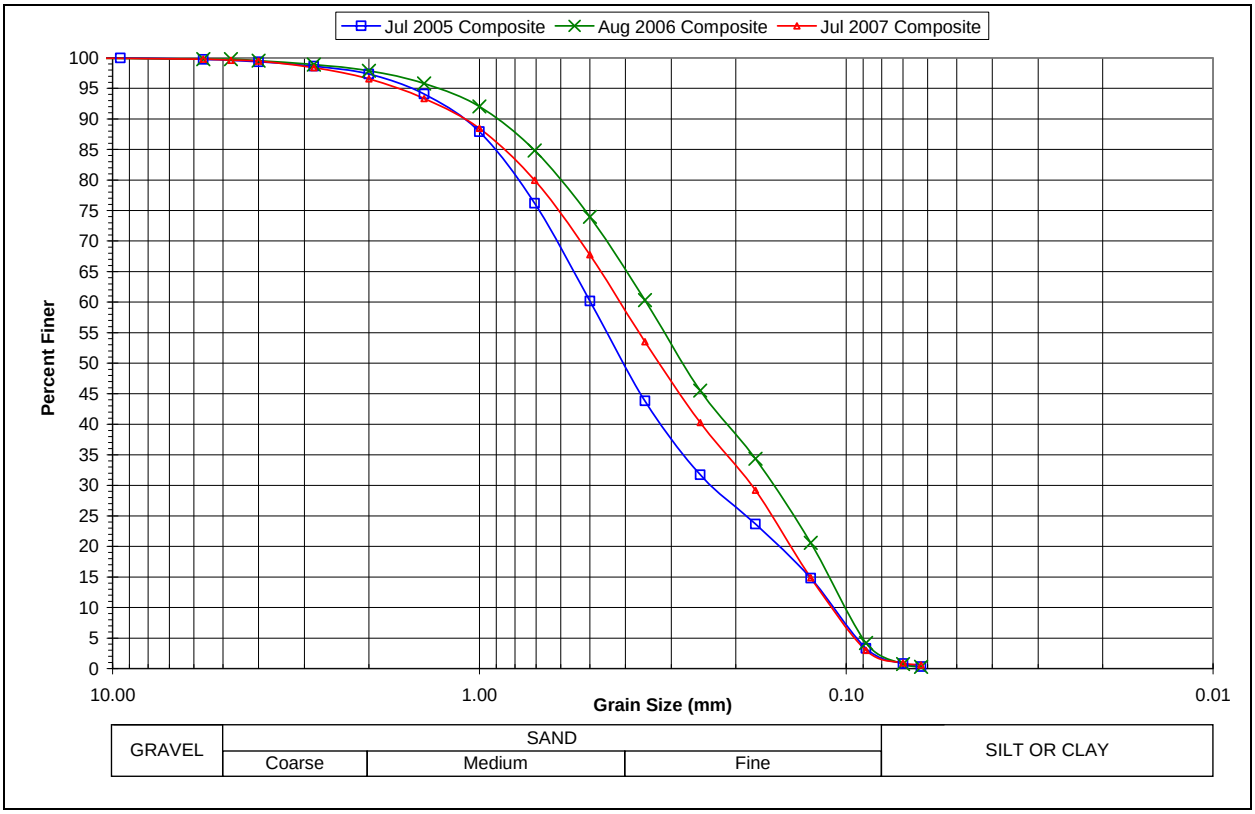


Figure 2.1 Comparison of Composite Grain Size Distributions from Three Geological Studies

2.2 Sand Trap South of St. Lucie Inlet Jetty

The St. Lucie Inlet Management Plan provides for the maintenance of St. Lucie Inlet by dredging sand from the inlet and placing it on Jupiter Island beaches south of it. As part of this management plan, the U.S. Army Corps of Engineers created an impoundment basin in the mouth of the inlet in 2002 by cutting a rectangular depression out of the rock of the seabed south of the jetty. This impoundment basin serves as a sand trap (Figure 1.1), designed to fill up over the course of two years. Gahagan & Bryant Associates, Inc. (GBA) collected six vibracores from this sand trap in March 2003 (Figure 2.2) in order to confirm the suitability of its contents for placement on Jupiter Island. GBA sieved samples from these vibracores to determine grain size distributions and fines percentages. This effort provides a useful comparison to the current study, and Appendix B contains GBA's report. However, no carbonate or color data exists for these samples.

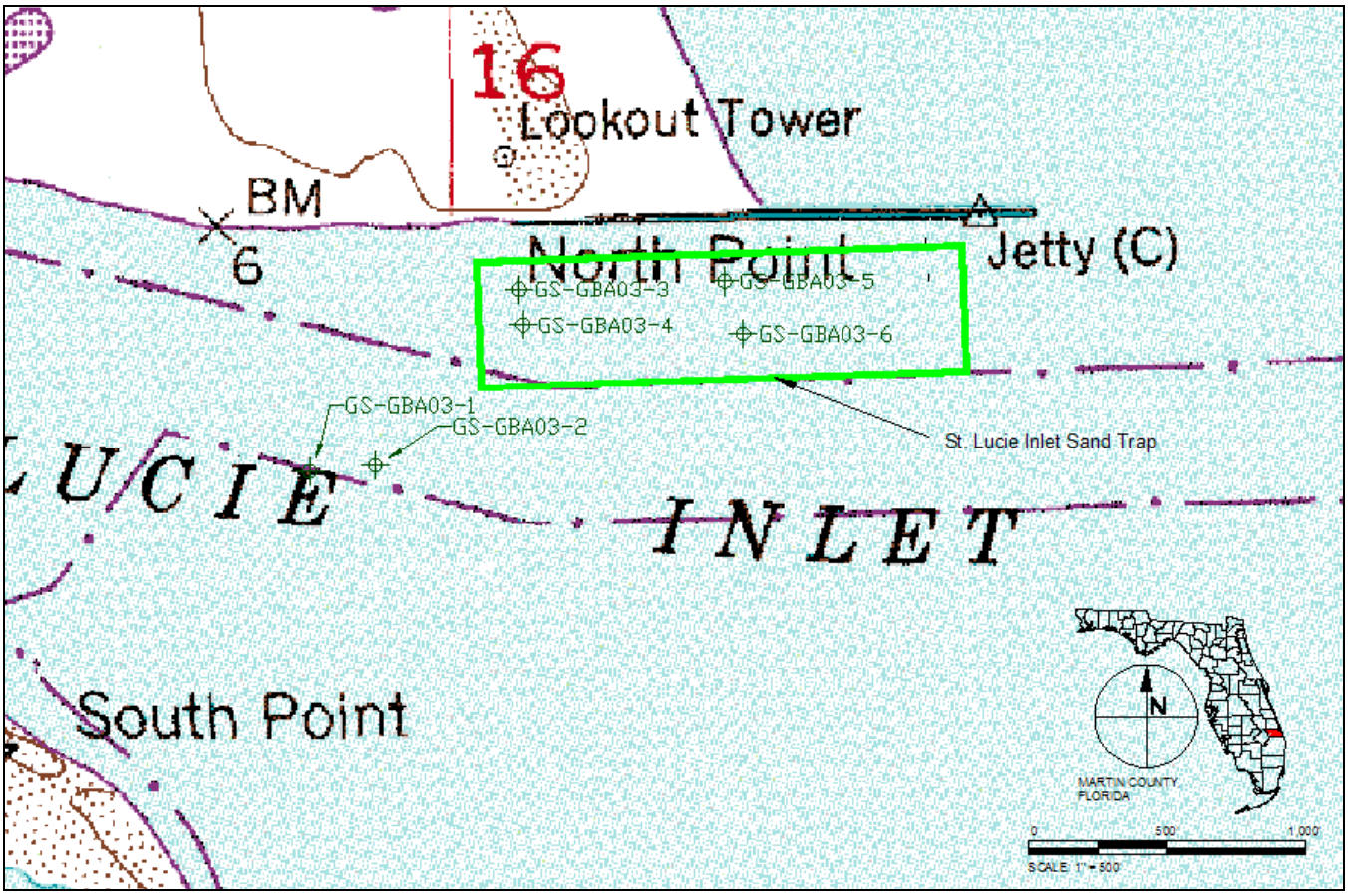


Figure 2.2 St. Lucie Inlet Sand Trap with March 2003 Vibracore Locations

2.3 Flood Shoal Inside St. Lucie Inlet

The proposed borrow area lies in the flood shoal inside St. Lucie Inlet (Figure 1.1). Martin County and the state dredged sand from this flood shoal in 1999 and placed it on beaches south of the inlet. In May 2008, GBA collected 23 vibracores from the flood shoal in order to characterize the sand it contains. Figure 2.3 shows the vibracore locations. GBA sieved samples from the vibracores, chemically tested them, and inspected them to determine grain size distributions, fines percentages, carbonate percentages, organic content, and Munsell color. Appendix C contains GBA's report from this effort.

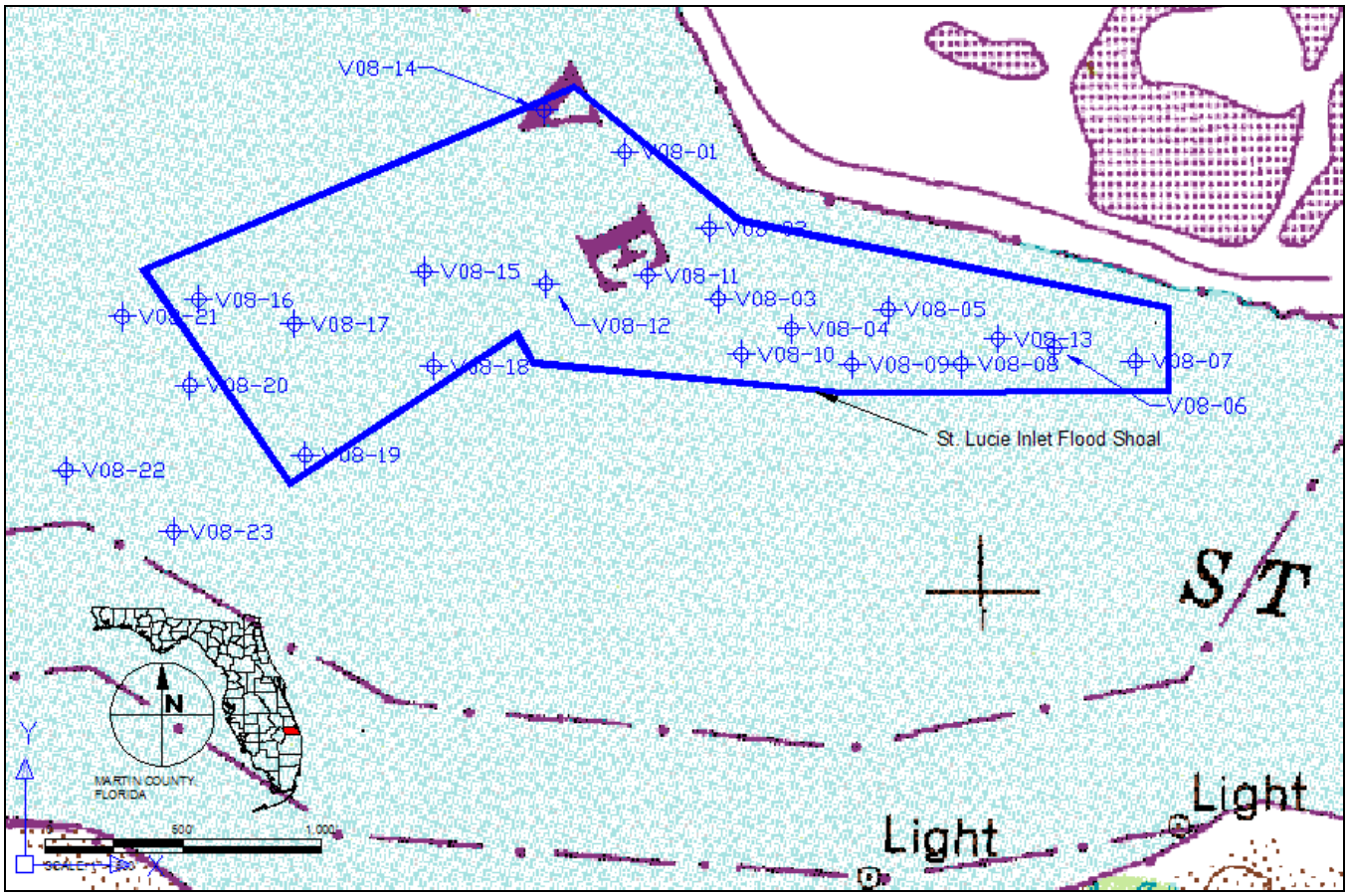


Figure 2.3 St. Lucie Inlet Flood Shoal with May 2008 Vibracore Locations

3.0 METHODOLOGY

In order to compare the sand in the three locations described in Section 2, this study calculated composite statistics at each location. Characteristics for comparison included grain size distribution, mean grain size, sorting, median grain size, percent fines, percent carbonates, and moist Munsell color distribution. The first five of these summarize the sediment sieve test. Computation of composite characteristics in these categories involved summing the weight percent retained at each sieve size for all samples and dividing by the number of samples. The Moments method then provided mean and sorting (in phi units) for the resulting distribution, and linear interpolation of the sieve sizes (in millimeters) provided D_{16}, D_{50}, and D_{84}. Computation of composite carbonate percentage and Munsell color distribution involved simply summing the values for each sample and dividing by the number of samples. Thus, the composite statistics presented in the following sections weight all samples equally and do not account for differing volume contributions.

4.0 RESULTS

Figure 4.1 shows the grain size distributions of the composite samples from each location. Table 4.1 contains summary data for the three composites. Figure 4.2 displays the moist Munsell color distributions for the two composites for which color data exists.

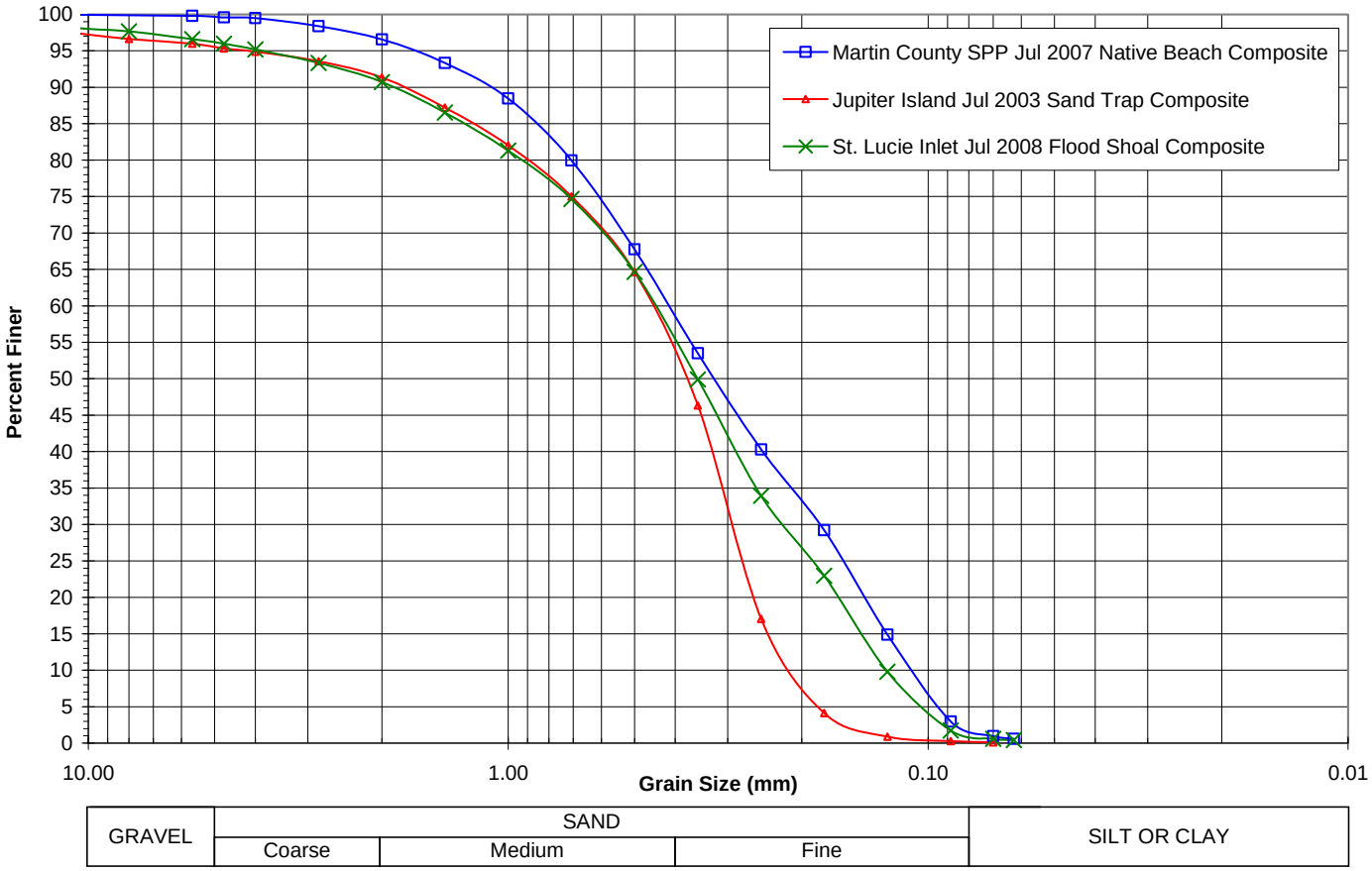
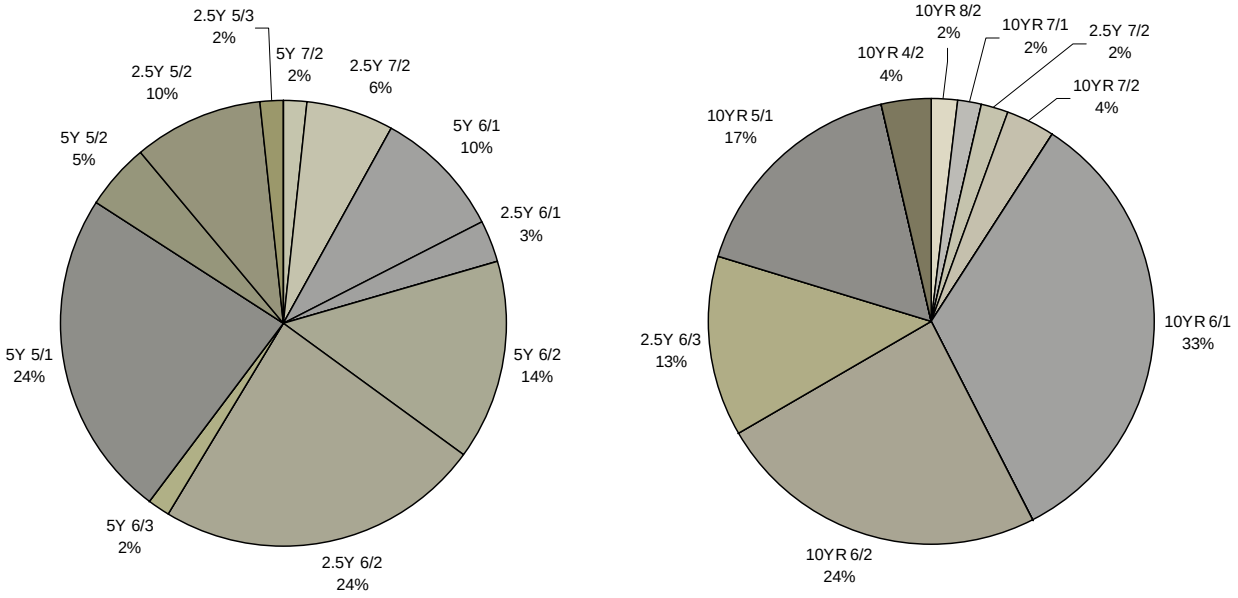


Figure 4.1 Grain Size Distributions of the Composite Samples from the Three Locations

Table 4.1 Characteristics of the Three Sediment Composites

		Martin County SPP Jul 2007 Native Beach Composite	Jupiter Island Jul 2003 Sand Trap Composite	St. Lucie Inlet Jul 2008 Flood Shoal Composite
Mean Grain Size (phi)		1.55	0.98	1.22
Mean Grain Size (mm)		0.34	0.51	0.43
Sorting (phi)		1.28	1.39	1.57
Sorting (mm)		0.34	0.57	0.57
D_{16} (mm)		0.85	1.16	1.21
D_{50} (mm)		0.33	0.38	0.35
D_{84} (mm)		0.13	0.24	0.15
Percent Fines	**Mean**	0.6%	0.3%	0.4%
	Max	3.0%	0.1%	4.8%
	Min	0.0%	0.0%	0.0%
Carbonate Content	**Mean**	54.7%	-	48.6%
	Max	96.0%	-	76.0%
	Min	17.0%	-	2.9%
Organic Content	**Mean**	-	-	1.2%
	Max	-	-	8.0%
	Min	-	-	0.6%
Moist Munsell Color Percentages	**2.5Y 7/2**	6.3%	-	1.9%
	2.5Y 6/1	3.2%	-	0.0%
	2.5Y 6/2	23.8%	-	0.0%
	2.5Y 6/3	0.0%	-	13.0%
	2.5Y 5/2	9.5%	-	0.0%
	2.5Y 5/3	1.6%	-	0.0%
	5Y 7/2	1.6%	-	0.0%
	5Y 6/1	9.5%	-	0.0%
	5Y 6/2	14.3%	-	0.0%
	5Y 6/3	1.6%	-	0.0%
	5Y 5/1	23.8%	-	0.0%
	5Y 5/2	4.8%	-	0.0%
	10YR 8/2	0.0%	-	1.9%
	10YR 7/1	0.0%	-	1.9%
	10YR 7/2	0.0%	-	3.7%
	10YR 6/1	0.0%	-	33.3%
	10YR 6/2	0.0%	-	24.1%
	10YR 5/1	0.0%	-	16.7%
	10YR 4/2	0.0%	-	3.7%



Martin County Native Beach Composite **St. Lucie Inlet Flood Shoal Composite**

Figure 4.2 Munsell Color Distributions

5.0 DISCUSSION

Table 4.1 shows that the three composites have very similar median grain sizes (D_{50}). Figure 4.1 shows that for grain sizes larger than D_{50}, the flood shoal composite has a distribution similar to the sand trap composite, but for smaller grain sizes it more closely resembles the SPP native beach composite. The following discussion considers only the flood shoal and SPP native beach composites, as the sand trap composite lacks carbonate and color data.

5.1 Grain Size Distributions

Table 4.1 shows that the flood shoal composite has median grain size similar to the SPP native beach composite. The two composites have similar distributions of smaller grains and both have fines percentages under 1%. However, the flood shoal composite contains greater proportions of the larger grain sizes, with a mean grain size 26% higher than the SPP native beach composite. This coarse mean grain size should result in greater longevity of the placed beach fill and a low overfill ratio.

5.2 Carbonate Percentages

Both the flood shoal and native beach composites have high average carbonate contents — approximately 50%. The maximum and minimum carbonate statistics reveal a very wide range in both cases; however, the flood shoal contains less carbonate. The Martin County SPP three-year monitoring report (Taylor Engineering, 2008) concludes with the following statement.

Since the most recent nourishment in 2005, the project beach between R-1 to R-25 has continued to accrete volumetrically at a rather consistent annual rate… The percent of volume of placed material and planform have all increased during the most recent monitored period (June 2007 to August 2008). Even with a reduction in major hurricanes and tropical storms affecting the region since the 2004 and 2005 seasons, this volumetric stability within the project is noteworthy.

This project performance in Martin County suggests that high carbonate content does not reduce volumetric stability or project longevity.

Sediment samples containing large amounts of carbonate can produce grain size distribution curves with two peaks. The Martin County 2007 native beach composite exemplifies this condition, as indicated in Figure 5.1. The double peak in the overall composite arises because it contains significant quantities of both carbonates and silicates, and these have grain size distribution peaks in different places. Both the James and the Dean methods for calculating overfill ratios take inputs of mean and sorting. Thus, a double-peaked distribution potentially jeopardizes the reliability of these calculations. However, both theories predict that increasing the mean grain size of the fill relative to the native sand (given otherwise similar distribution) increases the stability of the constructed beach. The sediment from the St. Lucie Inlet Flood Shoal should provide stable fill material for Bathtub Beach because of its large mean grain size. Taylor Engineering's Martin County SPP three-year monitoring report suggests that sediment with a double-peaked composite grain size distribution can perform well when used as beach fill.

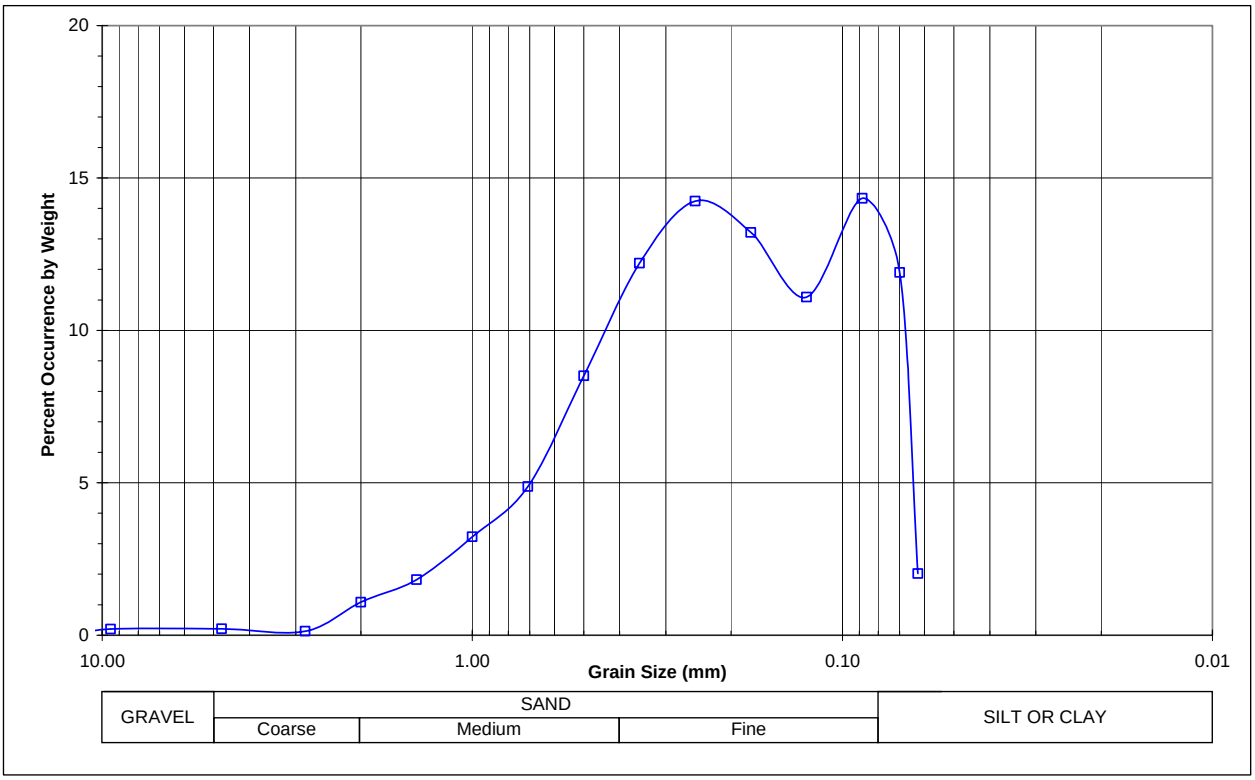


Figure 5.1 Martin County Native Beach 2007 Composite Grain Size Distribution

5.3 Sand Color

Figure 4.2 indicates that the flood shoal composite contains lighter sand than the native beach in northern Martin County. However, the darkest sand observed in the flood shoal is darker than anything observed on the native beach. Overall, the two sites have very similar color characteristics.

6.0 CONCLUSION

The sand in the St. Lucie Inlet flood shoal has similar characteristics to that on the native beach of northern Martin County. Where differences between the two occur, they make the flood shoal sand appear more suitable for use as beach fill on Bathtub Beach. The recent nourishment projects in Martin County have performed well and shown good stability. This study suggests that the flood shoal sand could behave similarly if placed on Bathtub Beach.

REFERENCES

Taylor Engineering, Inc. 2008. *Martin County Shore Protection Project, Martin County, Florida, 2008 Physical Monitoring Report.* Report prepared for Martin County, Florida.