Biennial Report of Sand Beaches; Hancock County, 1999

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Executive Summary

The Hancock County Beach from the boat launch in Bay St. Louis to the southwestern end in Waveland remained stable from the period of 1997 to 1999, including the passage of Hurricane Georges. Since its construction in 1994, the beach has retreated over 33 feet along much of its length. A notable exception is the region northeast of Ladner Pier, which has changed little. Sand volume change along the beach appears to mimic shoreline change; both have an overall negative trend since construction. Again, though, the Ladner Pier area has received more sand than it has lost. In the case of most beach locations, sediment is being moved from the dry beach (above 0 elevation) to the submerged portion (below sea level). Total sand loss from the beach (seawall to about 4 feet below sea level) from 1994 to 1999 is roughly 55,000 cubic yards (11,000 cubic yards/year); sand loss from 1997 to 1999 is roughly 18,000 cubic yards (9,000 cubic yards/year).

The Bay St. Louis Beach shows a higher shoreline retreat signal than the Hancock County Beach. Possible reasons for this are its shorter length and more recent construction.

Introduction

The Mississippi Office of Geology continues to monitor the evolution of the renourished and natural beaches in the three coastal counties. This report is meant to update coastal governments on the state of their beaches from a coastal geology perspective and highlight areas that may require more resource allocation. The data presented here include Global Positioning System (GPS) shoreline surveys and beach profiles along the beach from the boat launch in Bay St. Louis to the terminus in Waveland and encompasses the years of 1994 to 1999. Additionally, a section on the more recently completed Bay St. Louis City beach spans the years from 1996 to 1999 and is limited to GPS shoreline surveys. Changes in the past one to two years have been highlighted, mainly for analysis of trends associated with Hurricane Georges. Beaches are as important in limiting infrastructure damage as they are in offering recreational space and attracting visitors. With an increase in development along the Mississippi Gulf Coast, the beaches are becoming an even more valuable asset. For this reason, the Mississippi Office of Geology will continue to update local communities on the state of their sand beaches.

Methods

Two methods were used to map and describe the beach, both above and below sea level. Shoreline surveys of the normal high tide line were carried out using backpack style GPS receivers with an accuracy, after being corrected for government scrambling, of 1-2 meters (3-6 ft.). The normal high tide line has been chosen as a repeatable datum for these shoreline surveys, which were done in the summer and spring months. The error in determining the high tide line is, based on comparison of multiple surveys of the same beach area, on the order of 1-3 meters (3-10 ft.). Thus, the overall accuracy of the method is generally about 2-5 meters (6-16 ft.). These surveys do not show the extent of storm-related or astronomical high tides. In many locations even a strong-wind tide will advance the shoreline several tens of meters (50+ ft.) beyond the mapped shoreline. In addition, beach maintenance and storm water runoff from the coastal roads are sporadic events that can obscure local trends. Therefore, this method, though largely representative of erosion and accretion, should be augmented by higher accuracy site surveys such as beach profiles.

Beach profiles are performed using survey grade instruments giving accuracies on the order of one inch. Unfortunately, beach profiles are time consuming and therefore only performed at set locations along the shore. Spacing between beach profiles is determined by the degree of change along the beach. Hancock and Jackson counties have a higher degree of change along the shore and, thus, have more beach profiles/beach length than Harrison County. Beach profiles are aligned at right angles to the shoreline, beginning at the seawall, and ending at depths around –4 feet (up to chin of survey personnel), which typically corresponds to the sand/mud boundary. Elevations are based on benchmarks along the seawalls. This technique encompasses nearly the whole beach system, from seawall to the mudline, and is, thus, more accurate in describing any changes that take place. Beach profiles, while representing changes caused by beach maintenance, wind loss, storm runoff, and high tides are not compromised because of them. In this report beach profiles are used to calculate sand volume change from date to date, highlight areas of erosion and accretion, and document the evolution of sediment transport features.

Hancock County Beach

High Tide Shoreline Surveys

GPS surveys of the high tide were carried out during April-May, 1999; previously shorelines were surveyed using GPS in 1993, 1994, and 1997. Comparison of the 1997 and 1999 data for the shoreline from the boat launch just southwest of Bay St. Louis to the southwestern end of the renourished beach in Waveland (Figure 1) showed little difference, despite the passage of Hurricane Georges. To highlight areas of the shoreline with more than 2.5 meters/year (8 feet/year) of erosion, a 5-meter (16-foot) setback from the 1997 shoreline was computed along the length of the beach (Figure 1). A 5-meter (16-foot) interval was chosen to account for inaccuracies of the technique while still highlighting a moderate degree of change. Any portion of the 1999 shoreline that is beyond the 5-meter (16 feet) setback has been highlighted in red. These areas are experiencing higher shoreline retreat than other parts of the beach from 1997 to 1999, and are generally clustered at the ends of the beach. Using a similar approach, areas with greater than 5-meters (2.5 meters/year; 8 feet/year) of shoreline advancement are shown in green. It appears that the area of shoreline advancement is higher than retreat along the beach. While areas of retreat (erosion) are grouped on the ends of the renourished beach, shoreline advancement (accretion) is dominant in the central regions of the beach (from Bay Oaks Dr. to Ladner Pier).

Looking at the slightly longer range, from 1994 to 1999, and encompassing the life of the present renourished beach it is clear that most of the shoreline is retreating (Figure 2). A 10-meter (33-feet) setback from the 1994 shoreline was computed along the length of the beach. Any portion of the 1999 shoreline that is beyond this setback is highlighted in red and represents more than 2 meters of retreat per year (6 feet/year). Again, areas in the middle stretch of the beach, especially east of Ladner Pier, were less prone to shoreline retreat than those on the ends. The slight embayment in Waveland and Ladner Pier appear to be efficiently trapping sand.

Beach Profile Surveys: Volumes

A total of 25 beach profiles was surveyed in 1999; of these 23 were done along the beach from the boat launch in Bay St. Louis to the southwestern end in Waveland. The remaining two were newly created along the beach in front of Bay St. Louis and will be used for future analysis of this newly renourished stretch. The profiles from Bay St. Louis to Waveland have been surveyed since 1991.

An approach similar to the GPS surveys has been adopted such that short term trends, including Hurricane Georges, have been analyzed using 1997 and 1999 data. Longer-term changes are reflected in the period of 1994 to 1999. Volume change is represented in cubic yards per linear foot of beach width, such that a volume change of –1.0 cubic yards over a 700-foot stretch is equal to a deficit of 700 cubic yards of sand. Sand volumes include the dry beach (above 0.0 elevation) and the beach below sea level to about –3.0 to –4.0 feet. In the earlier report by the Mississippi Office of Geology (October 1997), volumes were only computed for the dry beach change (above 0.0 elevation). This should be noted if comparing the relative sand volumes/trends from each report.

1997-1999 Hancock County Beach Change

Figure 1. To simplify the view only the 1999 shoreline is shown, with areas of more than 5 m of retreat and advance superimposed.

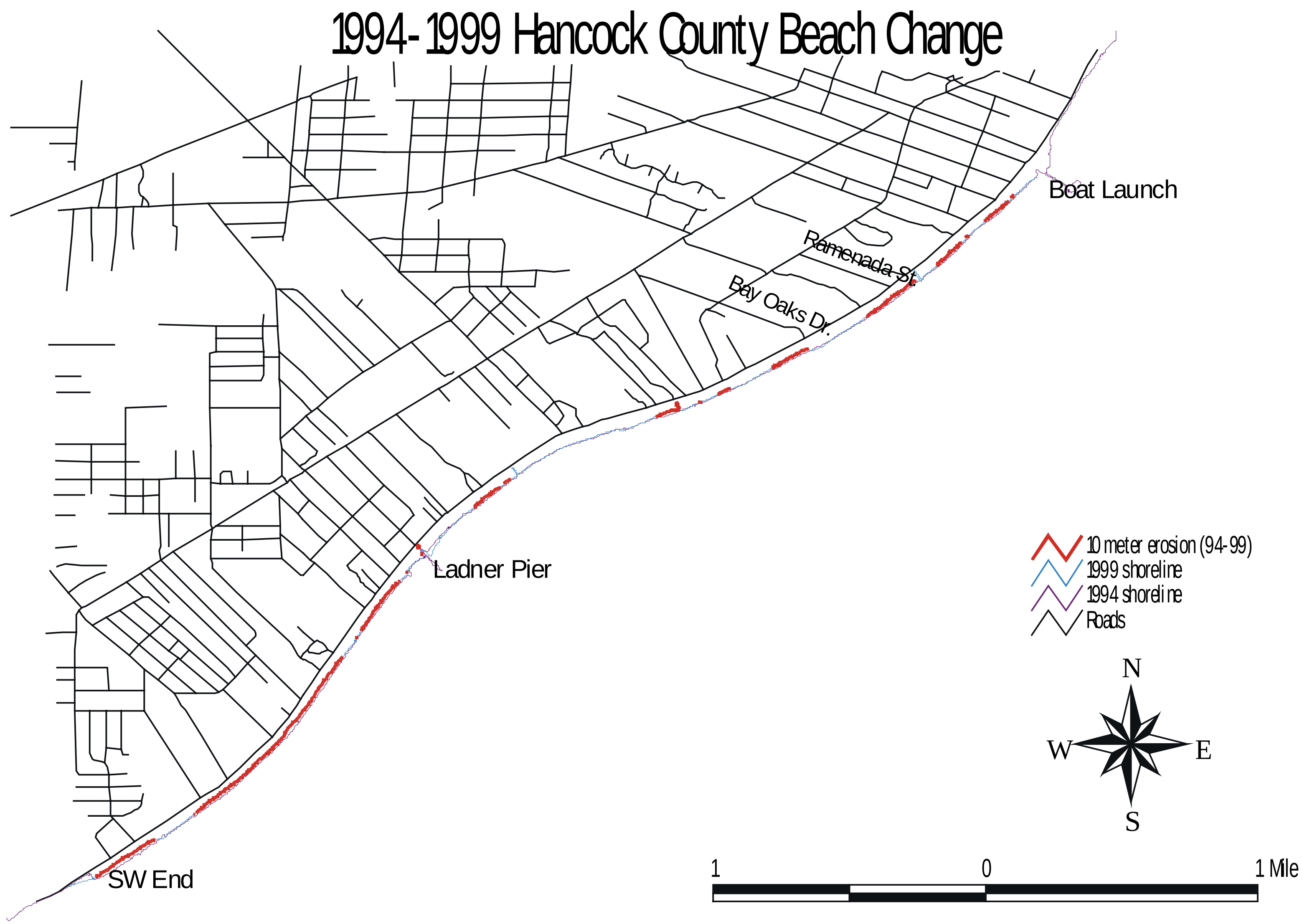

Figure 2. 1994 and 1999 shorelines with areas with more than 10 m of erosion superimposed. Notice the only area with significant accretion is next to Ladner Pier.

Comparison of 1997 with 1999 profile data shows a negative budget at both ends of the beach (Figure 3). Profiles southwest of Ramenada St. to Ladner Pier generally have a positive budget, although there are three short segments that have negative values. This stretch of beach is also typified by shoreline advance. Southwest of Ladner Pier there is a general deficit, except for one profile location. It is clear that both the embayment (beginning between Bay Oaks Dr. and Ramenada St.) and Ladner Pier in Waveland have strong influences on the sediment movement and budget along the coast. The negative budgets at the ends of the renourished beach are not surprising, since these areas can receive sand only from one longshore direction (only sand moving northeast on the Bay St. Louis end; only sand moving southwest on the Waveland end).

Similar comparison using 1994 and 1999 profile data shows the same strong influence of the Pier and embayment in Waveland and the negative budget at the beach ends (Figure 4). The stretch of beach from the beginning of the embayment (near Bay Oaks Dr.) to the Ladner Pier is generally gaining sand volume. Notice also that this stretch is typified by fewer setbacks of more than 10 meters (33 feet). Areas to both the northeast and southwest of this stretch generally have a negative sand budget.

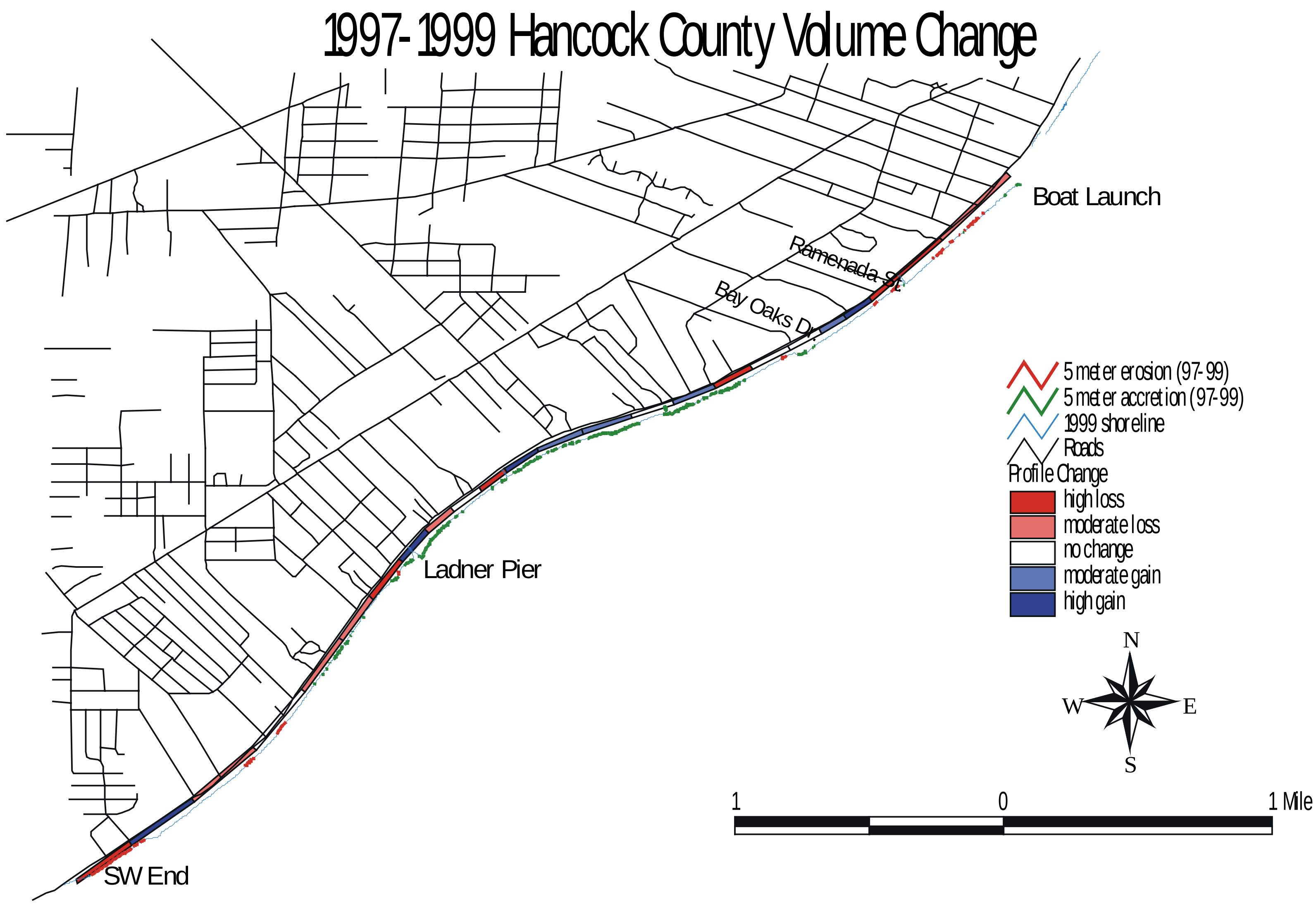

Figure 3. Shoreline volume change with 1999 shoreline, erosion and accretion overlays

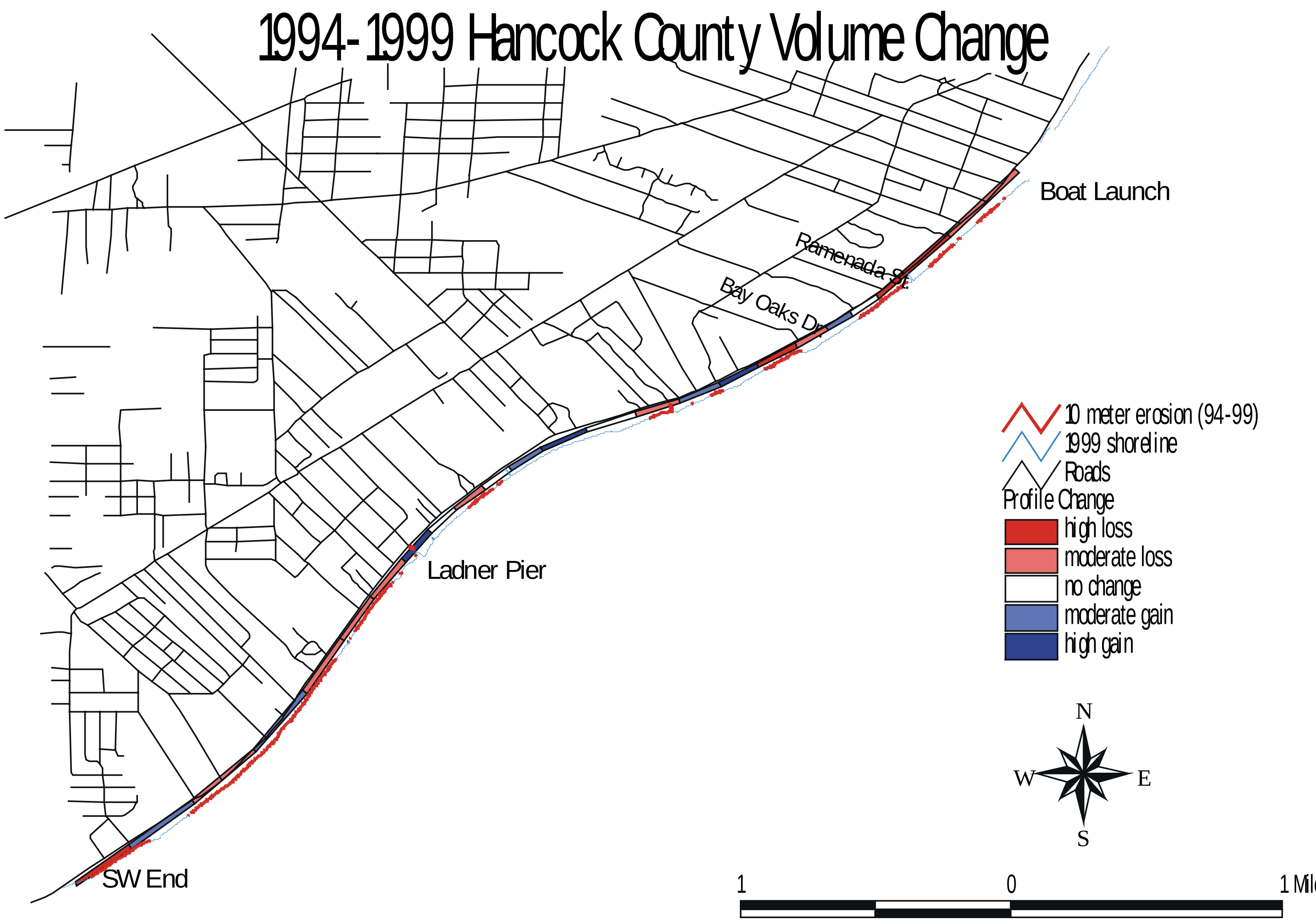

Figure 4. Shoreline volume change from 1994 to 1999 with 1999 shoreline and greater than 10 m of erosion overlayed.

Beach Profile Surveys: Beach Geometry

As mentioned, beach profiles also describe the shape of the beach and how it is evolving. The most striking features of the beaches are the large megaripples or sand waves that typically stretch from the shoreline to the mudline. These features are stable, and unique given their repeatability in a relatively low energy setting. More work needs to be done to fully understand how they are being maintained. The evolution of the beach as shown by profiles has a consistent trend both in the long and short term. In nearly all profiles there is a loss of beach volume above 0 elevation (above sea level) and in general the underwater portion of the beach is gaining volume.

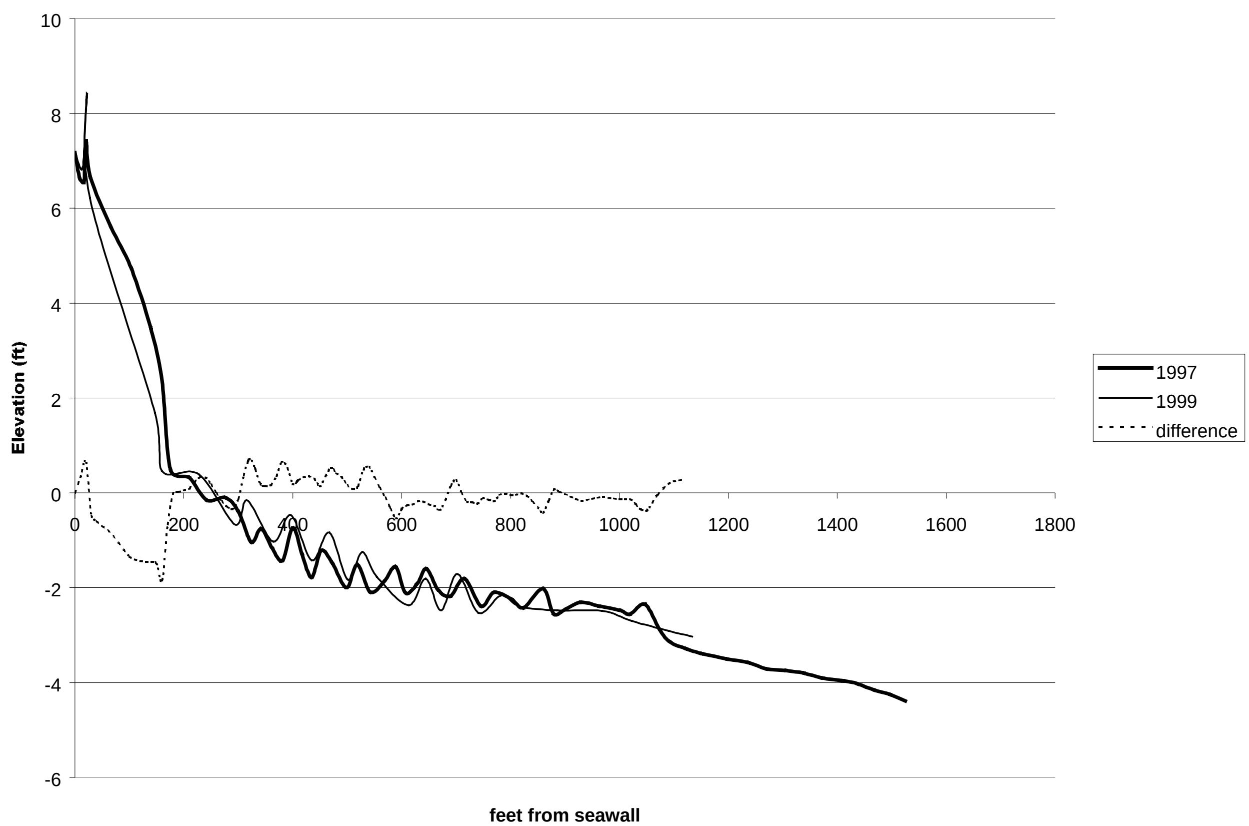

Figure 5. Beach profile at HK 21, near the eastern end of beach. Dark line is 1997 data, light line is 1999 data and dashed line is the difference in feet. Notice the prevalent megaripples and that much of the underwater portion of the beach (starting near 225 ft from the seawall) is gaining volume or has little change, but the dry portion of the beach shows a negative volume.

Bay St. Louis Beach

Introduction

This section covers the Bay St. Louis beach from the terminal groin near Union St. to the Highway 90 bridge. The data presented here are limited to GPS shoreline surveys. Two beach profile locations were added this year for future analysis, Bay St. Louis North (BSLN) and Bay St. Louis South (BSLS). Changes in the past one to two years have been highlighted, mainly for analysis of trends associated with Hurricane Georges.

High Tide Shoreline Surveys

A quick overview of the beach from 1996 to 1999 shows that it has retreated along much of its length (Figure 6). The exception to this appears to be in the areas south of Main St., north of Bayview St., and at the area near Ulman St. The structures at Main St. (Train Bridge) and at Ulman St. (pier) are trapping sand as it moves north. The area north of Bayview is at the terminus of the renourished beach and is receiving sand from longshore drift. The general rate of retreat appears to be significantly more than on the county beach to the south of this stretch.

To compare the change in the past years (1997 to 1999) a 10-meter (33 feet) buffer was chosen, such that any shoreline segment highlighted in red (Figure 7) has retreated more than the buffer (10 meters, 33 feet). A 10-meter buffer (33 feet) was chosen based on the apparently high rate of change seen in Figure 1 and corresponds to an average of 5 meters/year (16 feet/year). The areas of retreat beyond this level are typically found on the downdrift side of large structures and to some degree near the southern end of the beach. This is characteristic of a beach system with a significant degree of longshore sediment movement. Sand is piled up on the updrift side and ‘robbed’ from the downdrift side. This is an inescapable problem, creating erosion ‘hot spots’ that in some cases can cause local infrastructure flooding problems. However, this is generally not a concern in Bay St. Louis given the large seawall and considerable elevation of the town.

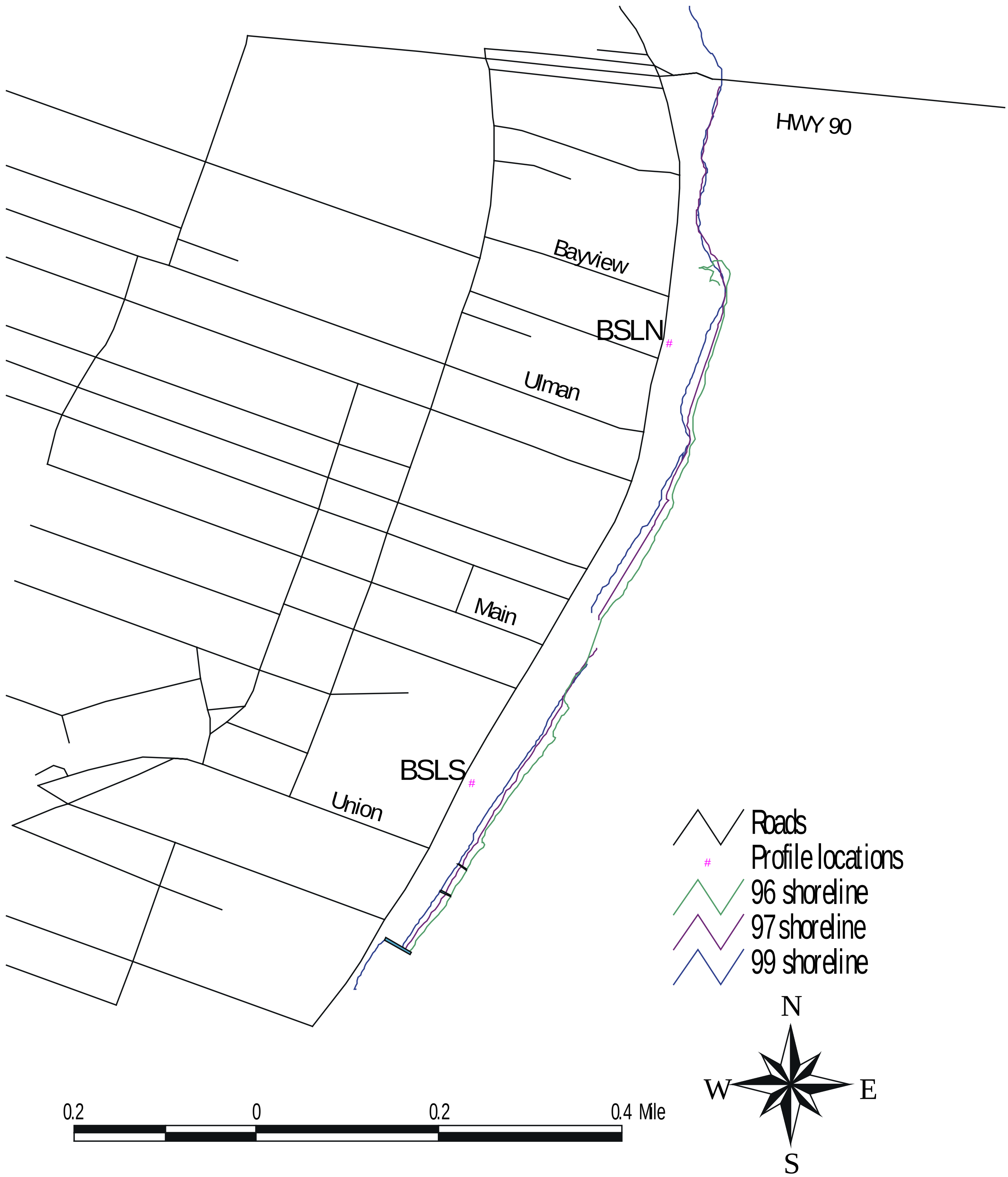

Figure 6. Shorelines from 1996 to 1999.

Looking at the life of the beach from 1996 to present by using a 15-meter buffer (the same 5 meter/year buffer scheme as above) (Figure 8) it is clear that most of the beach has exceeded 5 meters/year (16 feet/year) of retreat since being constructed. Comparison of Figures 7 and 8 shows that, for the most part, beach retreat has slowed since 1997; the initial loss of beach following construction is to be expected. The areas that do not follow this trend are once again on the downdrift sides of the train bridge and the pier at the end of Ulman St. This indicates that erosion will become a problem at these locations in the future if not attended to, such that the beach may become a series of disconnected stretches with the water up to the seawall behind the structures. Once the seawall is in the surf zone erosion typically increases. However, this problem is limited in scope and, thus, should be easily addressable.

It should be noted that north of the Highway 90 bridge the longshore component switches from northerly to southerly such that sediment is moved from the north to the bridge. In addition an initial investigation of the borrow pit north of the Highway 90 bridge indicates that sand has filled in the hole and may again be a source in future renourishments.

Beach Profile Surveys: Volumes

No volume comparisons can be made at this point; future reports will address volume changes.

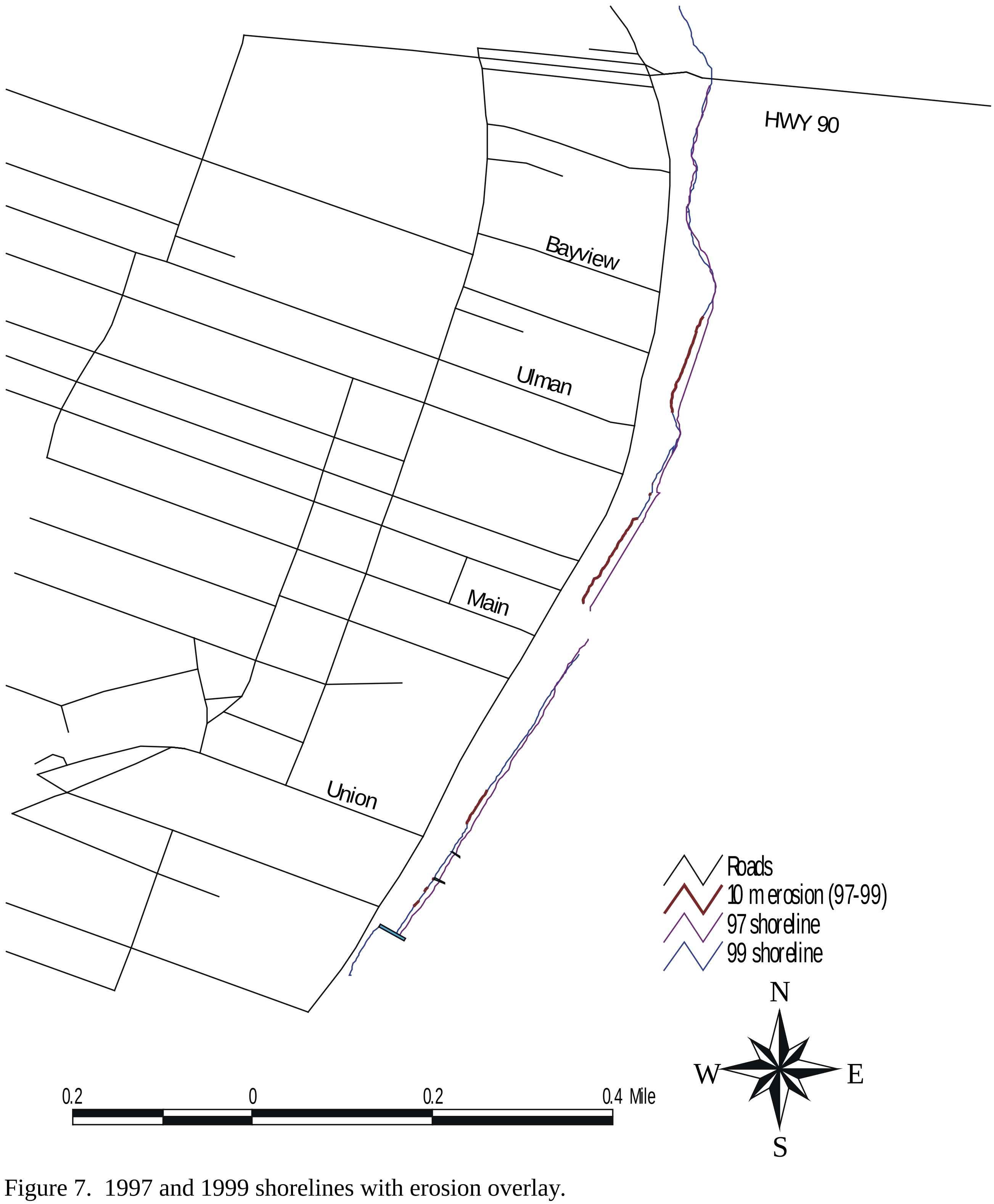

Figure 7. 1997 and 1999 shorelines with erosion overlay.

Figure 8. 1996 and 1999 shorelines with erosion overlay.

Beach Profile Surveys: Beach Geometry

Beach profiles taken at the two locations shown in Figure 6 are consistent with each other. The entire sand-dominated beach system (from seawall) has a width of approximately 900 feet (Figure 9), beyond which the sediment becomes muddy. No large-scale megaripples are evident along the profile, possibly due to the higher longshore component of the currents. Sediments in the northern portion of the beach (BSLN, Figure 6) had a considerable amount of shell material, possibly from dredging, that will probably act to 'armor' the beach and slow erosion.

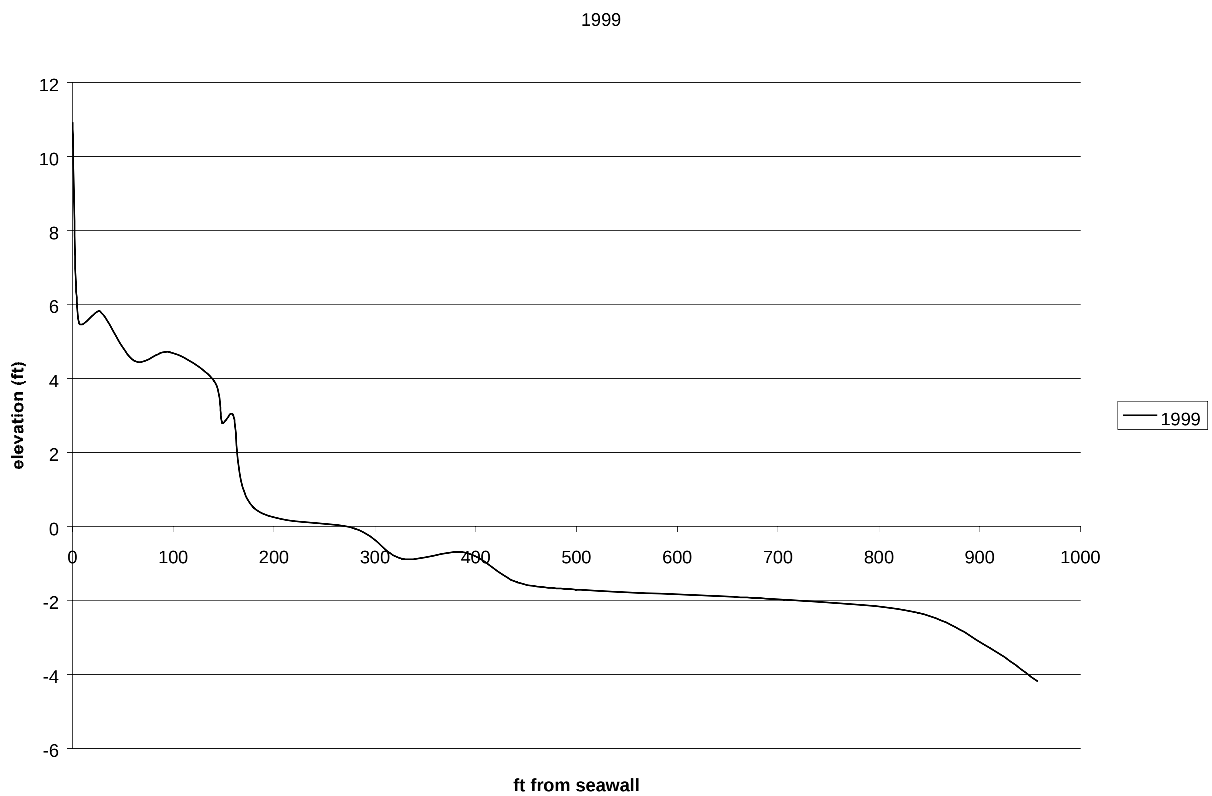

Figure 9. Beach profile at BSLS, near Union St.

Discussion

Hancock County Beach

Shoreline retreat is only noticeable (>2.5 meters/year; 8 feet/year) on the ends of the renourished beach from 1997 to 1999 (Figure 1), while nearly the entire stretch of beach has retreated more than 10 meters (33 feet) over the past five years (>2.0 meters/year; 6 feet/year) (Figure 2). The one exception is the central region near the Ladner Pier. This area is possibly more protected or favorably aligned to the dominant southeast wind direction (among a list of other possibilities) and acts like a sediment sink (deposition center). This trend is also evident in the beach profile volume change, both in the short and long terms (Figures 3 and 4). Using shoreline lengths and volume changes, the beach as a whole (from seawall to mudline) has lost about 55,000 cubic yards (11,000 cubic yards/year) since 1994; from 1997 to 1999 beach loss totaled 18,000 cubic yards (9,000 cubic yards/year). Shoreline surveys and beach profiles show similar patterns, such that stretches of the beach with negative sand budgets typically coincide with areas of shoreline retreat. As such, future renourishment or supplemental maintenance should concentrate on these highlighted locations to maximize resources and reduce costs.

When comparing beach profile data, the location of volume change is also important. In the case of almost all profiles, whether having a positive or negative budget, the offshore (underwater portion) is typically gaining or only slightly losing sand (Figure 5). The dry beach has a negative sand budget for almost all of the profiles. As mentioned in the earlier report (October 1997), this is to be expected over the immediate period following beach renourishment. The fact that it is occurring well into the fifth year of the beach suggests that the beach remains out of equilibrium with the natural conditions (a fact that may be inescapable on renourished beaches). Sand blown into the street, storm run-off and, to some degree, beach maintenance may be contributing factors. Given that these processes will continue, grading should be directed in opposition to the normal longshore drift. For example, on the northeast stretch of beach sand should be moved from Ladner Pier and the embayment towards Bay St. Louis. To the southwest of Ladner Pier it is slightly more difficult; the areas with positive budgets should be targeted as sources for the adjacent sections. In addition, sand collected on Beach Blvd. should be placed in areas with negative budgets. Sand should not be graded into the water. These suggestions might help equalize the beach and reduce the formation of erosion hot spots.

Hurricane Georges did not appear to have a major lasting effect on the Hancock County Beach. There were no large changes in sedimentation patterns or beach volume. Hancock County was on the western side of the hurricane and was therefore spared from the worst of the storm; beach change also reflects this. Had the eye passed to the west of the beach, results may have been quite different.

Bay St. Louis Beach

Using shoreline surveys to map shoreline position, it is clear that most of the beach in front of downtown Bay St. Louis has eroded more than 15 meters (50 feet) since it was constructed. Of this setback, a significant portion occurred during the first year, which is to be expected following renourishment. A pervasive northward longshore drift controls the present erosion patterns over much of the Bay St. Louis Beach (south of Highway 90). Hurricane Georges' impact was minimal over much of the beach, except possibly exacerbating erosion on the downdrift sides of the train bridge and at the pier at Ulman St. These two areas should be monitored. A short-term solution for the erosion problems here would be to even the erosion rates along these stretches by mechanically moving sand from the south side to the north side of the structures. In comparison to the Hancock County Beach, the Bay St. Louis Beach is retreating faster and may require renourishment at problem areas in the near future.   The limited size of the beach, localized erosion spots, and available maintenance equipment should allow for cost-effective solutions.

Conclusion

In summary, the renourished beach from the boat launch in Bay St. Louis to the southwestern end in Waveland is fairly stable. Only areas on the ends of the beach show significant signs of erosion. In contrast, the Bay St. Louis Beach appears to be further out of equilibrium and shows areas that may require additional renourishment in the near future. If rating the Hancock County Beach on a grade scale (A for no net erosion, F for widespread erosion and sand loss) it would receive a B; the Bay St. Louis Beach would receive a C.

The observed volume changes on the Hancock County Beach are almost balanced along the length, suggesting that much of the sand is staying within the system. This is encouraging and will surely reduce the cost of future renourishments. It is difficult to predict the actual remaining life span of the beach, as sporadic storms can hasten the process significantly. Given this, beach renourishment should be planned when 50% of the original renourished beach volume (above sea level) has been lost. This looks to be more than five years in the future given the present rates of change.

The following conclusions can be made based on the data presented:

1) The Hancock County Beach shows retreat of less than 2.5 meters/year (8 feet/year) over much of the area in the short term; but in the long-term, the majority of the beach has retreated more than 10 meters (33 feet) since 1994.

2) The Bay St. Louis Beach shows similar short-term retreat and higher long-term retreat compared to the Hancock County Beach.

3) The Hancock County Beach is losing sand at a rate of between 9,000 to 11,000 cubic yards/year.

4) The Hancock County Beach's ends have the highest rate of sand loss.

5) The embayment near Ladner Pier is acting like a sediment sink and the beach is gaining volume.

6) Sand is being moved from the dry beach to the submerged beach (towards the offshore) throughout the study area.