

**Preliminary Site Survey: Bay-Waveland Yacht Club Harbor,  
Bay St Louis, Mississippi**

Mississippi Office of Geology

Coastal Division

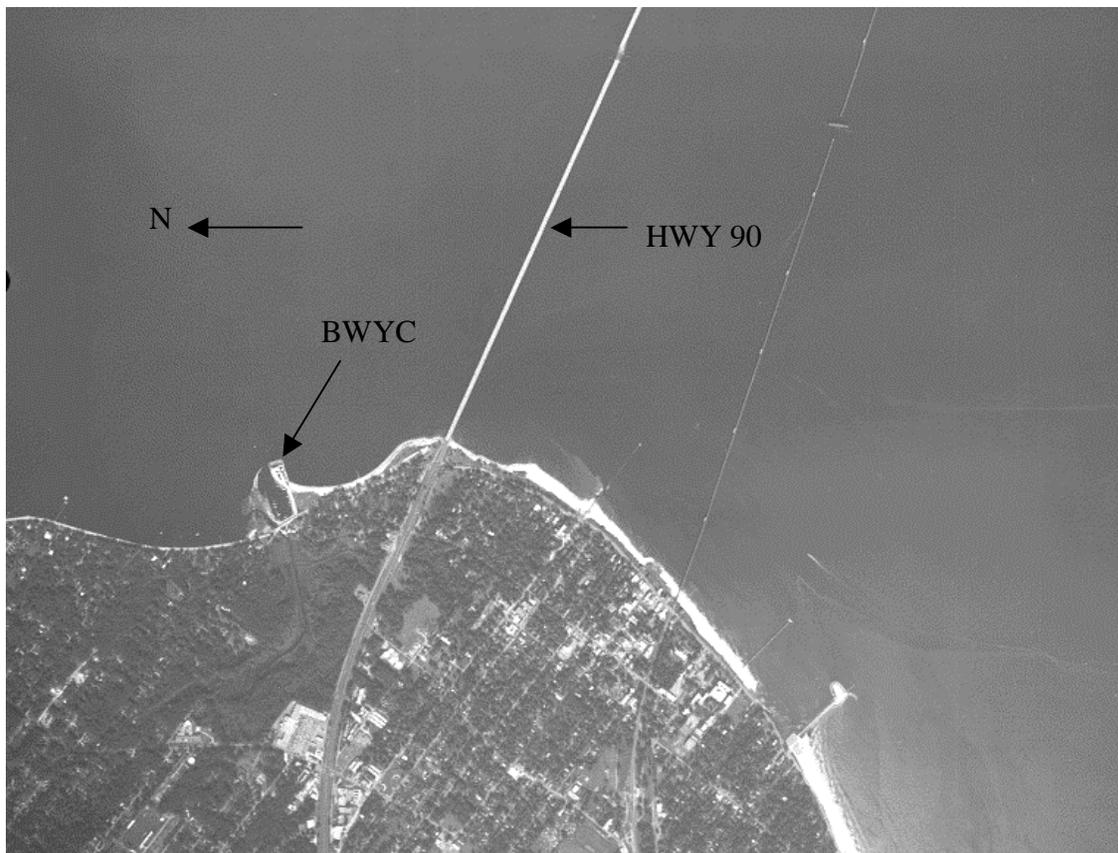
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### ***Introduction***

The Mississippi Office of Geology Coastal Division undertook a preliminary investigation at the site on September 14 and 16, 1999. An apparent increase in the sedimentation rate has caused navigation and docking problems. Within the harbor working depths had been reduced; at the harbor entrance shoaling has impacted the navigation channel. In addition, rough conditions in the harbor have caused damage to several vessels. These three concerns have prompted a study on the appropriate engineering solutions, if any.

The Bay-Waveland YC is located on the western shore of Bay St Louis about 700 meters north of the HWY 90 bridge (Figure 1). It had formerly operated as a commercial oyster facility and is seaward of the seawall. The harbor forms a promontory that deviates from the natural shoreline configuration. To the north the shoreline is dominated by seawall up to the northern corner of the harbor, where a small fringing marsh has developed. A small outflow creek that drains an upland marsh exits through the fringing marsh. To the south of the harbor a stable beach has formed.



*Figure 1. Location of the Bay-Waveland YC. Bay St Louis is the town in the bottom right of the picture*

## ***Methods***

Sediment thicknesses and samples were described in the field from the Mississippi Office of Geology's 22-ft Boston Whaler. Sample locations were GPS'ed and later post processed. An open-ended sampler was used to penetrate the sediment and a small corer was used to describe the upper 2-ft of sediment. In addition, coarse surface sediment description was performed by hand samples south and east of the harbor.

Aerial photographs from 1986, 1992, and 1998 were digitized and then aligned and scaled to the existing shoreline to document shoreline evolution. Sediment transport features and subaqueous (submerged) sediment deposits could be discerned on the large scale.

Shoreline evolution was examined using historic shorelines digitized from 1850, 1917, 1950, and 1986 maps. The shorelines and sample data were analyzed using several Geographic Information System (GIS) programs.

## ***Shoreline Evolution***

The shoreline at the yacht club evolved from a straight and unprotected shoreline in 1850 to a highly modified and protected harbor sometime before 1950 (Figure 2). In the middle of the 100-year stretch the harbor had only the southern point (before 1917). It is probable that the southern portion of the harbor is constructed mainly of oyster shells, a byproduct of the prolific industry in the late 1800's and early 1900's. From 1950 to 1986 the interior of the harbor was widened (Figure 3); following 1986, the entrance of the harbor was protected with an additional groin. During the period of 1950 to present the shoreline near the creek mouth has grown steadily indicating a deposition center.

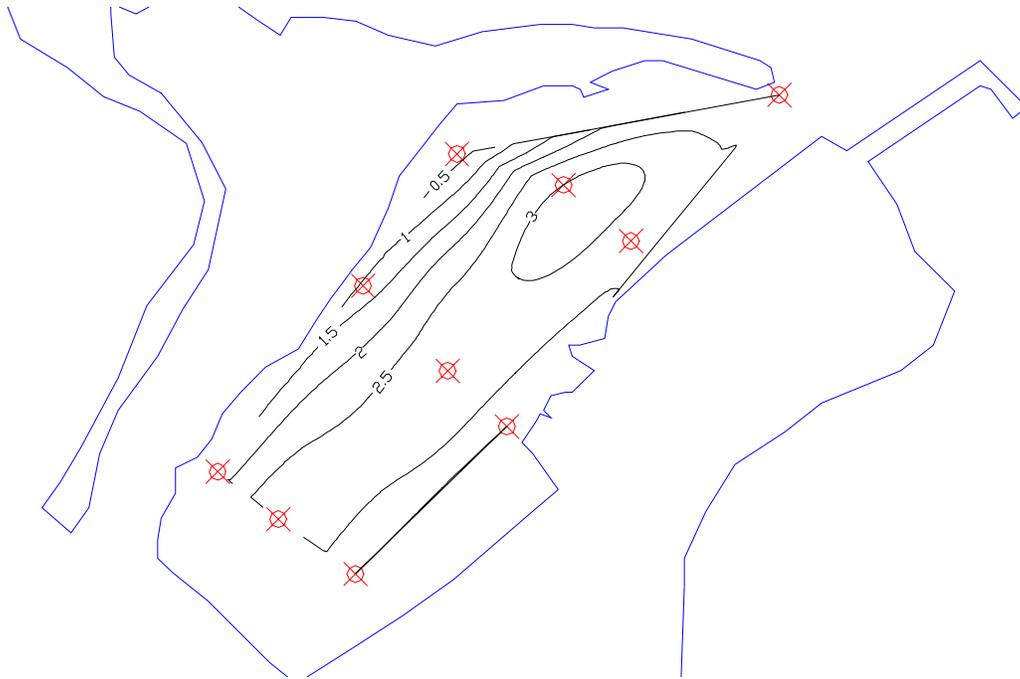
## Sediment Character



*Figure 4. Red crosses are sample locations, purple hatched areas represent mud bottom, and green hatched areas represent sandy bottom. Note that the sand shoal can be seen in the 1992 color infrared aerial photo.*

### Harbor Interior

The sediment inside the harbor and away from the immediate shoreline was generally mud or sandy mud (mostly mud with some sand) with the exception of one location on the northeast portion of the inner harbor where there was muddy sand (mostly sand with some mud) and a live oyster reef. Sediment thicknesses ranged from 1 ft near the oyster reef (muddy sand) to 9 ft (mud) in the central portion of the harbor. Sandy sediments are dominant along the northern shoreline out to about 1-ft of depth, at which point the depth increases rapidly (dredged area) and the sediments become muddy. The sampling technique limited the description of the entire sediment column, but in samples near the southern bulkheads and near the harbor entrance there is significantly more shell material throughout. It is not clear whether this is an indication of runoff from the parking lot (which may be built over oyster shell fill) or a submerged source. The bulkheads appeared to have areas that were prone to sediments washing out. Similarly, the northwestern end the harbor shows some signs of runoff from the adjacent creek. These two sources are, or, appear to be relatively minor. The mud filling the central harbor is loose and consistently soft indicating recent and continuous deposition. Taken in total the harbor contains approximately 25,000 cubic meters of soft mud, which, when de-watered, will probably be on the order of 5,000-10,000 cubic meters. This is a fairly substantial quantity that would be very noticeable if coming only from small sources (parking lot, adjacent creek).



*Figure 5. Harbor sediment thickness (not depths) in meters, crosses are sample locations.*

### Navigation Channel

An 80 to 100 meter wide sand bar (Figure 4) has migrated across the front of the harbor entrance; it begins along the northern shore and pinches out offshore of the yacht club pier. Near the harbor entrance the sand overlies mud and sandy mud, just to the west the sand is underlain by an ancient oyster reef, further west the sand overlies a thick deposit of muddy sand. The sand body is 1 to 2 ft thick near the harbor entrance and increases to 5+ ft to the west, near the creek mouth. The change in deposition from muddy sediments to sand indicates a different depositional pattern and is probably responsible for the formation of the sand bar. The extensive sand platform at the head of the creek is the source of sediment feeding the migrating bar. It does not appear that the creek is contributing sediment, it is more likely that either the sediment has been slowly but continuously building up since the construction of the harbor and there is now enough sand above wave base to allow transport beyond the trapped area; or alternately, the sand is a result of a sporadic event (hurricane) that is migrating down drift. Offshore of the sand bar the sediment is shelly mud, similarly south of the bar the sediment is also shelly mud.

### **Airphoto Analysis**

Airphotos from 1986, 1992, and 1998 were used to track recent changes in shoreline morphology surrounding the Bay-Waveland Yacht Club. The only apparent change was in the marsh to northwest of the harbor. The marsh tended to increase in size with an associative increase in sand over the 12-year period. The subaqueous sand body in front of the marsh is clearly visible in the 1992 photo. Shoreline morphology also indicates

that sediment moves from north to south in the inner bay, north of the HWY 90 bridge; south of the HWY 90 bridge sediment appears to move from south to north. The only offshore sediment source in the bay seems to be the sand shoal south of the Bay-Waveland Yacht Club, which does not contribute sediment to the yacht club harbor.

## ***Discussion***

### **Inner Harbor**

Within the harbor proper the sediment is generally thick, soft mud. There were no noticeable sand layers in the main portion of the harbor, although along the northern shore there is a very narrow beach. The existence of a beach indicates that there is a small source of coarse (sandy) sediment; this sand along with fine suspended sediment is or has probably washed in from the adjacent parking and boat storage area. The bulk of the harbor is underlain by mud that appears to have settled out of the water column in the tranquil harbor environment. The low energy and relatively deep water within the harbor allows for continual settling of fine-grained sediment below wave influence. If, for example, this area were in an open setting waves would continually scour the bottom limiting deposition. As this is not the case, dredging is (and has been) the most effective way of dealing with this type sedimentation. It is not clear whether sediment deposition in the harbor has increased; shoring up bulkheads on the southern side and possible placing new ones on the north side would probably help the situation. Similarly, limiting overflow from the drainage creek entering the harbor over the parking lot should be investigated. Constructing a raised levee on the creek bank to divert the flow past this area may solve the problem. In general, however, siltation of the harbor is a process that is driven by the amount of suspended sediment in the bay, which may be increasing given the hardened shorelines that do not dissipate wave energy like a natural shoreline. With more wave energy in the bay more sediment is suspended. An example of heightened wave energy caused by reflection off a hardened shoreline can be seen on the rip rap jetty along the northern side of the harbor during periods of moderate wind conditions.

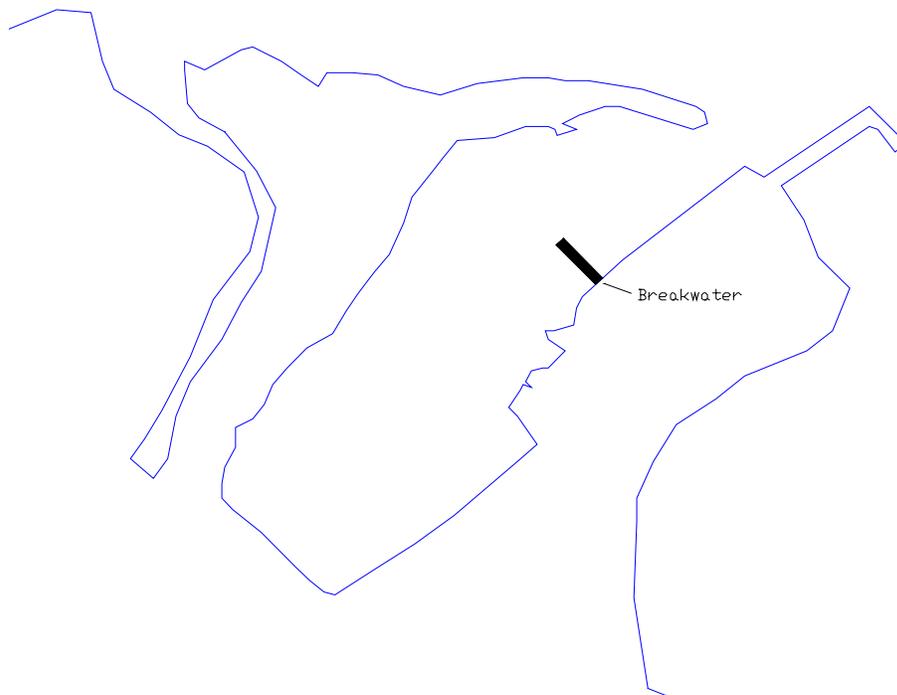
### **Navigation Channel**

Shoaling of the navigation channel is a separate problem that is driven by bedload sediment transport (sand rolled or bounced along the bottom by waves and currents). In this case there is a local source at the mouth of the creek that is migrating along the northern shoreline towards the channel. The source of sediment is not very large and has probably only recently reached a situation where it is starting to move around the northeastern point, as evidenced by the underlying mud. There is no other significant source of sandy sediment up drift of the harbor. The change from mud to sand is an import one, it signals a recent change in sedimentation that may be linked to a change in the shoreline morphology. In this case the construction of the northern harbor promontory (Figure 2; 1950 shoreline) created a situation where sediment was artificially trapped, leading to an increase in sand sedimentation out from the shoreline. One explanation for the development of the shoal in front of the harbor is that over the period when the northern point was constructed (1950) until the present a continual, but slow buildup of sediment has recently exceeded the storage capacity of the small cove and

created a source of sediment that is now shoaled enough to be moved along by waves. In essence, the harbor is acting like a groin that is now “full” of sediment and it is beginning to go around the end. The fact that this process took several decades is consistent with the very limited source of sand up-drift of the harbor. Samples taken to the south show no evidence that sand is coming from the south of the harbor. Given these observations, a simple solution would be to dredge the sand in the cove and in front of the northern spit and transport it down drift (to the south) to renourish the beaches south of site or in Bay St Louis. Removing the source sediment will reset the process and it may take another 40 years for the present situation to occur again. Construction of a jetty would also stop the sediment, but depending on its position it may also be bypassed at some point. Moreover, construction of a jetty must also be accompanied by dredging of the present sand bar. In general, we favor ‘soft’ engineering solutions, such as dredging, instead of increased shoreline hardening including jetties or groins.

### Inner Harbor Waves

Some mention of the rough conditions in the harbor was brought to our attention. Waves from the east-northeast do enter the harbor and are probably refracted along by the southern bulkhead. A 20-meter (65-ft) wooden breakwater, extending down several ft below the water surface, at the end of the docking space may stop the refracted waves from continuing into the harbor and allow for ample navigation room (assuming the harbor is dredged).



*Figure 6. Location of 20-meter breakwater to reduce wave propagation along southern bulkhead and allow for safe navigation in and out of harbor.*

## **Conclusions**

1. Siltation in the harbor appears to be mainly from fine suspended sediment; a natural process that probably can not be stopped. Dredging is the most attractive solution.
2. Shoring up the bulkheads on the south side of the harbor, constructing new bulkheads on the north side and keeping the creek from overflowing into the harbor may increase the period between dredging.
3. The sand shoal in front of the harbor is forming from a northwest sand source. Removing the source and moving it down drift (south of the harbor) should 'reset the clock' and solve the problem for the foreseeable future. This sediment is fairly high quality and would be useful in beach renourishment.
4. Rough conditions in the docking area will be reduced with the construction of a breakwater within the harbor.