

**BALD HEAD ISLAND, NC
SAND SHARING SYSTEM
OVERVIEW AND ASSESSMENT**

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BACKGROUND

Both the Village of Bald Head Island (VBHI) and the Bald Head Island Limited, LLC. (Ltd.) have proposed various improvements at/or adjacent to the entrance to the island's marina facility. More specifically, modifications to the south entrance structure have been considered for purposes of improving navigability and reducing chronic shoaling throughout portions of the channel. In addition, consideration has been given to the reconstruction of the four (4) timber groins northward of the marina entrance which serve to provide stabilization benefits to a series of adjacent upland residential structures located along what is termed Row Boat Row.

Presently, Ltd. operates the island's ferry system which is the sole means of passenger transportation to and from the island. Similarly, a work barge is operated for purposes of transporting commercial vehicles, building materials or equipment to the island. Both types of vessels have dedicated landings within the southernmost portion of the existing marina basin.

The current means of providing reliable navigational access through the two (2) marina entrance structures is by relatively frequent dredging of recurring shoal material. Without maintenance, ferrys can experience groundings during certain extreme low tide conditions. In addition, some level of advance dredging southward of the south jetty structure is performed as "advance maintenance" intended to add additional duration to each dredging cycle. All material excavated is routinely placed within a four (4) structure timber groinfield located along the Cape Fear River facing shoreline northward of the marina entrance. This "bypass" material, in combination with the timber groinfield has been successful in maintaining the relative stability of the Row Boat Row shorefront. Sediment transported by wind, waves, currents or boat wake from the groinfield moves either into the Cape Fear River channel or along the depositional shoreline leading to Bald Head Creek, as well as to the Creek itself.

SAND SHARING SYSTEM

The following discussion is a simplistic overview of the existing natural and man-induced sand sharing system which presently exists at Bald Head Island. Figure 1 is a photo-based schematic which provides an islandwide perspective and definition of the various shorefront features to be addressed herein.

East Beach – Net littoral transport along the East Beach side of Bald Head Island is strongly from North to South. Virtually all sediment transported southerly ultimately resides in the Cape Fear depositional feature or the expansive Cape Fear shoal system which extends to sea for several miles southward thereof.

South Beach (1) – Net littoral transport along South Beach is bi-directional. That is to say, there is an effective nodal point in the centermost one third of the island. To the east of the nodal point *net* transport is easterly to Cape Fear. Westward of the node, *net* transport is westerly toward the river. Along the westernmost segment of South Beach is a 16 sand tube groinfield (2) intended to reduce the rate of transport toward the Point and federal navigation channel. The principal benefit of the groinfield is to greatly reduce the landward migration (or extent) of the Mean High Water (*i.e.*, MHWL). The groinfield is most effective when there is a significant volume of sand within the sand sharing system of South Beach resulting from sand placement (*i.e.*, beach disposal or nourishment). Since 2001, some 3.9 Mcy of sand have been placed along South Beach as a direct result of beach disposal activities performed by the Wilmington District USACOE in accordance with the Wilmington Harbor Sand Management Plan. It is the intent of the VBHI to construct a separate and distinct beach fill project along South Beach in the winter of 09/10.

The Point (3) – Sediment that moves westward from either beach fill or beach disposal projects through the groinfield is transported either to the Point (in the form of temporary accretion) or to the inlet gorge (and navigation channel) as well as the nearshore portions of Bald Head Shoal. The Point itself is an accretional feature whose size and configuration are the result of an ever changing balance among factors which include: sediment removed by dredging, littoral sediment driven to the Point along South Beach and tidal/riverine currents which remove sediment by erosion (both to the offshore shoals and the Cape Fear River gorge). Any major changes in this “balance” of forces, including super elevated periods of wave energy resulting from major storms will reshape the footprint of Point. The VBHI beach monitoring program has relatively well documented adverse effects directly related to the dredging of the toe of the Point which extends into the defined limits of the federal navigation channel. Such dredging events typically occur on a 24-month basis.

West Beach – Between the Point and the marina entrance lies West Beach which is to a large degree represents the transition from oceanfront shoreline to riverine shoreline. Due to its proximity to the Cape Fear River Entrance, West Beach is subject to significant tidal and wave energy exposure. A small percentage of the overall littoral sand volume which reaches the Point is driven northward along West Beach. Due to the extremely deep river gorge which fronts West Beach, nearshore beach profile slopes are very steep at that location. As a result, the width of dry beach strand which is naturally maintained at the top of the profile is relatively narrow. As such, it is not a location where substantial beach fill width can be artificially constructed. The temporal width and condition of this beach is somewhat related to the configuration of the Point.

Marina Entrance (4) – In order to stabilize the entrance to the Bald Head Island marina, two (2) stabilizing structures extend from the upland basin into the Cape Fear River. On the West Beach updrift side of the entrance, the current low water shoreline is at the westward end of the south jetty structure. As a result, some percentage of the littoral sediment naturally transported to the jetty is easily driven around it and into the marina entrance channel. As a result, frequent maintenance dredging is performed by Ltd. By permit, Ltd. is allowed to not only dredge the marina entrance channel footprint but also to perform advance maintenance in a southerly direction so as to allow for a certain amount of advance shoaling to occur prior to its introduction into the channel per se. All material excavated by dredge is “bypassed” to the north shoreline so as to alleviate downdrift erosion on the Row Boat Row shorefront caused by the two (2) entrance channel jetties. Since, the south entrance jetty is currently overwhelmed by sand, it is now certain that all material transported to the jetty is either diverted to the Cape Fear River channel, or maintenance dredged during shoal removal operations. Such jetty structures are highly effective in directing sand seaward to the Cape Fear River channel due to the diversion of water and sand during high energy storm conditions. To break up or disrupt the “efficiencies” of this sand loss phenomenon, a spur is often added to the side of such a shore perpendicular structure.

Timber Groinfield (5) – On the downdrift (*i.e.*, north) side of the marina entrance there is a timber groinfield intended to improve the longevity of bypass sand placed at that location (see Figure 2). The groins are presently in a deteriorated condition and subject to major reconstruction. Regardless of the groins condition and the fact that their spacing is less than optimum, the groinfield has been successful in maintaining a beach/dune system seaward of the seawall which lies upland of this shorefront strand. The principal reason for the successful ongoing stabilized shorefront at this location is the high frequency sand bypass operation resulting from marina entrance channel maintenance. At present however, the MLW line extends to the end of the north entrance channel jetty, thereby facilitating the return of sand to the marina entrance. The location of bypass sand in relatively close proximity to the marina entrance likewise contributing to sand entrainment back into the marina channel.

Bald Head Creek (6) – Again, as a direct result of continued high frequency sand bypassing at the marina entrance, the sandy shorefront eastward of the northernmost timber groin, has been highly depositional and as a result has seen substantial growth over the last 20-30 years. Additionally, sand now migrates into the mouth of Bald Head Creek in the form of a depositional spit. Although approximately 45,000 cy of sand were removed from this shoal in 2005 (and back-passed to West Beach), the shoal rapidly reformed. Without a dredging protocol and a terminal structure at the mouth of Bald Head Creek, shoaling conditions will remain relatively unchanged into the future. As shown by Figures 1 and 2, the entrance to Bald Head Creek is the effective terminus of the sand sharing system of interest. Northward of the Creek, sand lost from the Creek shorefront or spit formation moves off to the submerged shoals located northward thereof. Portions of the shoals are exposed at low tide. Limited navigational access (small boats only) in or out of Bald Head Creek is therefore limited to high tide and fair weather conditions.

PROPOSED IMPROVEMENTS

A number of improvements or actions are currently under consideration which would have various effect(s) on the island's sand sharing system. A specific purpose of this discussion paper is to elaborate on the pros and cons of such activities as they relate to both existing and future shorefront conditions.

South Beach – As noted above, the VBHI is presently seeking State and Federal permits to construct a 1.5-2 Mcy beach fill along South Beach. This program is intended to both supplement sand losses during an impending 4-year hiatus between federal disposal projects and to provide a “base project” which will benefit South Beach in its entirety. Prior beach disposal projects at this location have failed to place sufficient volumes of sediment along the entirety of South Beach. The source of sand for the VBHI project would be a borrow area located within Jay Bird Shoals to the west. The net effect of the locally funded project is to keep the protective dimensions of South Beach shoreline in a robust condition by preventing any major disruptions (or deficits) in the island's sand sharing system.

West Beach – At the time of nourishment of South Beach, it is presently proposed that West Beach would receive a small scale fill placement project estimated at less than 150,000 cy. As noted above, the geometry of the West Beach profile is such that large scale beach fill construction at that location would not be successful.

Marina Entrance – Existing CAMA permits for the marina entrance channel presently allow for the extension of the south jetty structure by about 100-ft and the continuation of maintenance dredging/sand bypass operations on an as-needed basis. In 2005, Ltd. initiated design efforts intended to construct a 100-ft extension. At that time, a hydrographic survey performed for Olsen Associates, Inc. by the firm of McKimm and Creed indicated that a 100-ft extension would terminate in about 15-ft of water. There would be two major ramifications of such an extension: a.) it would be extremely expensive due to the forces (wave, current and scour) which would need to be addressed and 2.) it would potentially cut off *all* sediment supply such that no bypass/maintenance dredging would be warranted. Although some modest level of sediment buildup at the landward extent of the extended jetty may result, most sediment would be lost to the River gorge during storm events. Clearly the predictable reduction of bypass/maintenance sediment placement on Row Boat Row would be shoreline erosion and recession significantly landward of recently maintained locations – irrespective of the existing groinfield. Such a condition is deemed to be highly undesirable by both Ltd. and the VBHI.

In 2006, Olsen Associates, Inc. opined that advance dredging operations were in all probability a destabilizing factor in the long term stability of West Beach. To offset that effect, the future construction of a spur at the end of the south jetty was conceptually recommended. In addition, it was opined that *if* sediment bypassing was to be significantly reduced, the downdrift groinfield performance would need to be greatly enhanced. The proffered means of providing for that requirement would be a rationally designed T-head groinfield. It implemented however, sediment movement out of the groinfield toward the Bald Head Creek vicinity would be greatly reduced.

Timber Groinfield – The VBHI has recently received cost estimates for the major rehabilitation of the existing four (4) structure groinfield located northward of the marina entrance. Alternate quotes provide for the replacement of timber sheeting with vinyl sheet piling to reduce future maintenance. Similarly, each structure should have the rock replaced at its head *with* the addition of an appropriate geotextile composite type underlayment intended to reduce rapid subsidence of the stone. Groin rehabilitation is considered to be a high priority action item of significant public interest.

Bald Head Creek – The VBHI has recently (2008) initiated actions to review the probability of re-excavating the mouth of Bald Head Creek with the concurrent construction of a terminal structure design to reduce rapid reshaling of the Creek mouth.

RECOMMENDED ACTION ITEMS AND PRIORITIZATION – MARINA ENTRANCE

Timber Groinfield – It is presently recommended, that as structural measures go, the rehabilitation of the groinfield should be given highest priority. It is clearly necessary even if dredging and sand disposal frequencies remain unchanged. Minimal repairs to the groins will serve little useful purpose. Moreover, when the structures are reconstructed or replaced, it is very important that the stone armoring at the head of each groin is replaced with a suitable foundation to both reduce subsidence and enhance stability of the exposed terminus of each structure under storm conditions.

Marina Jetty Maintenance – At a minimum, the stone at the distal end of each jetty needs to be enhanced both vertically and horizontally (*i.e.*, its effective slope). Again, as with the timber groinfield, a suitable foundation should be employed. This would necessitate some rock removal and replacement. In this regard, a marine mattress should be placed below each rubble mound. It is anticipated that if the terminus of each structure were reinforced with a robust rubble mound, both wave reflection and sediment re-enhancement would be somewhat reduced. Both structures would likewise be better protected during major storm events.

South Jetty Extension – Any near term extension of this jetty should be modest, *i.e.*, 30-ft. mol. To do this it may be more prudent to consider an extension based upon a rubble mound, rather than a conventional concrete sheet pile structure with batter piles. If such a rubble extension were slightly recurved to the south, it would provide some of the functional benefits associated with a spur – although a spur would still be preferable. If placed on a marine mattress, the longevity of the rock extension would be greatly enhanced. Cost-wise, a 30-ft extension based upon a rubble mound type design may be as cost-effective as a concrete structural extension. A rubble mound structure would likewise be less impactful to sediment transport offshore from West Beach during storm conditions. A rubble mound structure would similarly reduce reflected wave energy (and boat wake) presently experienced by vessels transiting the entrance. If deemed advisable, the rubble mound could again be extended in the future.



Bald Head Island, North Carolina

Figure 1: Sediment Transport Trends.



Figure 2: Sediment transport bypass trends at the marina entrance (West Beach).