Shoreline Development BMP's

Best Management Practices for Shoreline Development Activities Which Encroach In, On, or Over Virginia's Tidal Wetlands, Coastal Primary Sand Dunes and Beaches, and Submerged Lands

Produced by the

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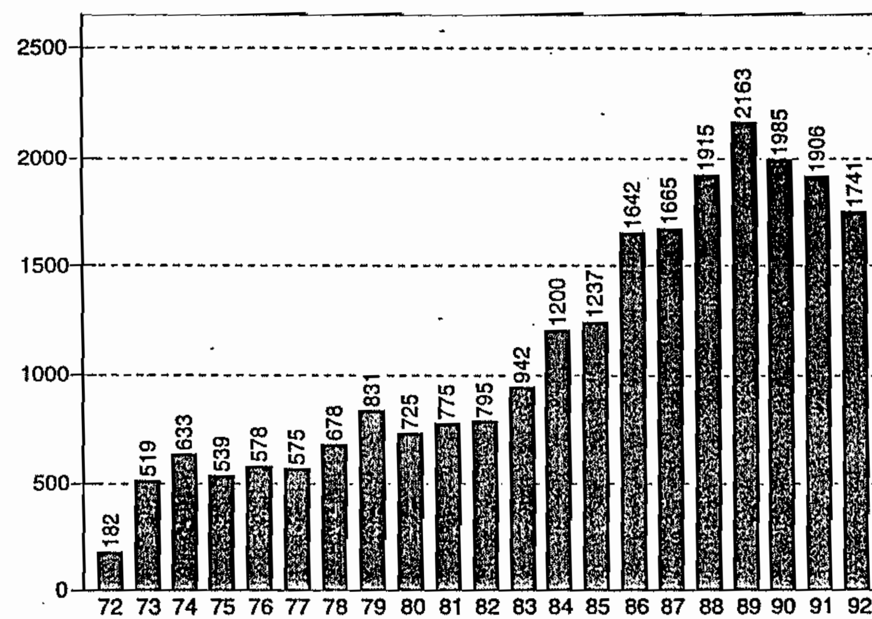
Section I

Introduction

The attractiveness of Virginia's coastal environs for residential, commercial, recreational and industrial uses frequently necessitates their physical alteration. Since the passage of Virginia's Tidal Wetlands Act in 1972, the Virginia Marine Resources Commission has processed over 21,000 applications for proposed shoreline construction. (Table 1) These applications have included projects located within Tidewater involving impacts to Virginia's tidal wetlands, coastal primary sand dunes, and throughout the State involving impacts to State-owned subaqueous lands. The responsibility for regulatory actions taken on these applications is shared among 34 local Wetland Boards and the Commission. Ensuring consistency, with regard to a unified approach to regulatory decision-making, can be

Table 1. Permit Applications.



difficult in this setting. While the basis for regulatory decisions can be found in the enabling Code Sections, the purpose behind a decentralized decision-making process is to provide for local input and site specific considerations that result in decisions that conform with stated policies and standards.

Over the years, the Marine Resources Commission has promulgated and adopted several guideline documents to assist regulators and the regulated community alike in understanding the many issues incorporated into the application review process. As recently as September 1991, the Virginia Institute of Marine Science prepared "The Virginia Wetlands Management Handbook," a compendium of these and other resource materials designed to provide a standardized, ready reference for Virginia Wetland Board members. In this document, we hope to combine some of the existing resource materials and further amplify them with practical and sound approaches to shoreline development activities.

The concept of incorporating cost-effective conservation measures into project design is not a new one. During the permit process, a variety of Best Management Practices (BMPs) are often recommended by the various regulatory and advisory agencies for specific projects. These measures have the combined effect of helping to ensure project integrity for the design life of the structure while minimizing the potential adverse impacts associated with construction. While many BMPs exist for various construction and land use projects, there has not been a concerted effort to compile and consolidate existing shoreline development activities in conjunction with the standard practices and conditions contained in our respective institutional memories. It is therefore the purpose of this document to provide a more comprehensive view of typical BMPs which can be readily applied to shoreline development projects thereby reducing both direct and indirect impacts to wetlands, water quality and marine resources.

Section II

Shoreline Protection

A. General

The coastal shoreline of Virginia, including its bays and tributaries, is experiencing continued erosion. While detrimental to property values and the structures it imperils, such erosion is a natural geologic process. Erosion stems from long term changes in sea level, waves, and local water level fluctuations that occur during storms. Upland soils become unstable when saturated and the interface between land and sea provides both the water and the energy to mobilize destabilized sediments. It is nature's relentless effort to strike an equilibrium in what can be and frequently is a zone of extremely high energy.

Along lower energy shorelines, it may be possible to counteract erosion by non-structual means through the proper planting and maintenance of a vegetated intertidal zone or marsh grass fringe. Such methods of controlling shoreline erosion are generally cost effective when properly applied and tend to preserve the shoreline equilibrium. Vegetated wetlands may erode but their ability to establish dense root systems, trap and accumulate sediments, and baffle wave energy allows them to act as buffers against erosive forces. Also used in combination with structural shoreline protection such as breakwaters, marsh plantings help stabilize these sediments and provide added protection against high energy natural forces.

The installation of structural shoreline protection generally tends to disrupt natural forces and drive shorelines away from the equilibrium state they seek. There are instances, however, where non-structural methods simply cannot mitigate the natural forces and physical characteristics of an eroding shoreline. In these situations, shoreline hardening is often viewed as a necessary alternative to retain upland property. And while the placement of these structures may reduce the sustained nutrient and sediment input into adjacent waters, it is necessary to understand that ground preparation, installation and maintenance of these structures can have equally damaging effects on adjacent living resources.

In reviewing shoreline hardening alternatives, it is helpful to understand the way in which each type of structure interacts with it's surroundings. This insight will help us determine which structure offers the most appropriate solution in a given situation. While it might prove convenient to attempt to identify every situation which might require an erosion control measure, it is not the intent of this document to provide a decision matrix which will yield only one possible solution or recommended structure for a given problem. Rather, with an understanding of structural design considerations and an appreciation of the impacts associated with construction, it may be possible to apply the most appropriate best management practices which minimize primary and secondary impacts associated with construction and maximize the design life of a given structure.

While the proper application of shoreline structures may reduce erosion, not all of the structures identified in this section treat erosive forces in the same manner. The construction of each of these structures involves varying degrees of primary and secondary impacts to the surrounding environment usually in the form of fill or unnecessary sedimentation due to uncontrolled upland runoff. It may be helpful to visualize a complete shoreline hardening project by examining three basic components: site preparation, construction, and post construction stabilization.

Site Preparation

Site preparation typically refers to land disturbing activities which occur prior to construction which facilitate access to a construction site or involve the preparation of proper earthen foundations for the erosion control measure. This can range from the removal of deadwood and debris to extensive grading and sloping of adjacent upland areas. The Shoreline Erosion Advisory Service (SEAS) of the Division of Soil and

Water Conservation is located in Gloucester Point and provides free analysis and planning assistance to private landowners seeking recommendations to address a shoreline erosion problem. Wholesale clearing and grading may not be warranted or necessary. Also it may be advisable to alter upland drainage patterns using berms or drains to help abate the negative effects of upland runoff on shoreline erosion.

Construction

Timing can be a critical factor when preparing for the construction phase of the operation. For large projects, with linear distances greater than 300 feet, it is preferable to gradually work along the shoreline doing the necessary grading, construction and post construction stabilization as you progress. Projects that do not lend themselves to this approach should not be allowed to grade too far in advance of the construction phase without applying the proper erosion control measures to reduce sedimentation in adjacent wetlands and over subaqueous land. Smaller projects, where wholesale clearing is not employed, should take advantage of the reduced disturbances and access points should be limited to only those necessary to import construction materials.

Post Construction

Once construction is complete, the denuded areas need to be stabilized as soon as possible. This can be accomplished through the proper application of silt barriers and the revegetation of denuded areas. The "Virginia Erosion and Sediment Control Manual," (available through your local government or directly from the Department of Conservation and Recreation, Division of Soil and Water Conservation) provides information pertaining to the installation and maintenance of soil conservation measures in accordance with State minimum standards and specifications. Applicants may also want to check with their local government to determine compliance standards under the local sediment and erosion control ordinance.

Chesapeake Bay Regulations

It is appropriate to mention that all proposed shoreline erosion control projects must satisfy the "Chesapeake Bay Preservation Area Designation and Management Regulations." Adopted by the State in September 1989, these regulations contain provisions designed to prevent a net increase in non-point source pollution. Key to achieving the design goals are performance standards intended to minimize erosion and sedimentation potential, reduce land application of nutrients, maximize rainwater infiltration, and ensure long-term performance of the measures employed.

Section 4.3(B)-1(d) of the regulation provides for the alteration of the mandated buffer for erosion control projects provided such alteration is accomplished utilizing the best available technical advice and applicable permit conditions or requirements. This section **does not** provide a categorical exclusion from the Chesapeake Bay Regulations. What it does is allow encroachment into the buffer area only to the extent necessary to establish the erosion control measures given the best available technical advice. This may involve clearing and grading of an entire reach of shoreline but it may also involve clearing only that which is necessary to access the site and install an erosion control structure.

In addition, if the land disturbance involves an area greater than 2,500 square feet, Sections 4.2-4 and 4.2-6 of the regulation state the applicant shall submit an erosion and sediment control plan and shall comply with the requirements of the local erosion and sediment control ordinance. Again, the attainment of a wetlands permit does not obviate the need to comply with this regulation. It is incumbent upon the property owner to find the local representative and ensure compliance with these regulations.

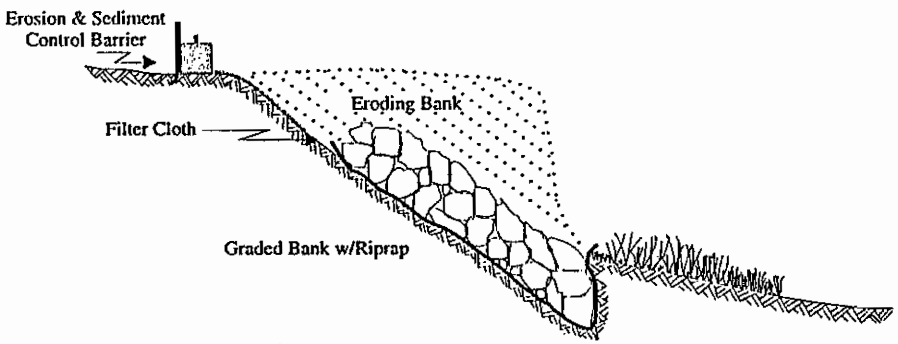
B. Revetments

From an environmental perspective, riprap revetments are generally preferred over bulkheads due in part to their ability to absorb and dissipate wave energy, thereby reducing the transfer of these erosive forces to adjoining properties. The sloped nature of a revetment also provides greater surface area within the intertidal zone than vertical structures. In addition, open spaces between armor units may provide suitable habitat for marine organisms and in some cases trap enough sediment to support wetland vegetation.

A revetment is usually composed of separate layers of stone. The size of the revetment is determined by the energy of the environment which will further dictate the composition of these materials. The construction of larger riprap revetments involves the placement of core material, generally smaller stone with random shapes and sizes, over filter fabric which prevents the loss of earth from behind the structure. The smaller stone acts to fill in gaps between larger armor units, shields the fabric from destabilizing ultraviolet light and also protects the filter fabric from being torn when laying the armor stone. This core layer is then covered with a layer of selected armor units. Armor units may be placed in an orderly manner to obtain good wedging or interlocking action between individual units or they may be randomly placed. The toe of the structure is usually buried below the MLW mark in high energy environs to prevent undercutting. Graded banks which are armored with smaller stone may not require the use of core material. In these instances, the armor stone is mixed with core stone and applied directly over the filter fabric. (Fig. 1, pg. 8) In general, the dumping of material down embankments with little or no attention to placement and the use of filter fabric is not viewed as a practical solution for shoreline erosion.

Designing riprap structures oftentimes requires using known variables to more accurately determine the necessary size of stone, height of structure, and depth of toe. These factors are influenced by the type of material used (unit weight and stability), site specific wave characteristics (wave height,

Figure 1. Riprap Revetment.



period, direction, storm duration and frequency), and design slope.

Recommended Best Management Practices

1. Construction materials employed typically vary in size and composition depending on the type of structure, the physical parameters at the project site and the availability of material. A publication by the U.S. Army Corps of Engineers entitled, "Low Cost Shore Protection... A Property Owner's Guide," recommends that no individual armor unit be longer than three times its minimum dimension. Therefore, if an individual chose to construct a revetment using slab concrete six inches thick, the material should be broken such that the average length of the armor material is no greater than eighteen (18) inches. The State Erosion and Sediment Control Field Manual, STD & SPEC 1.37 describes riprap such that "the stone shall be hard and angular and of such a quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all other respects for the purpose intended." Most if not all of the material used as riprap in coastal Virginia is either quarrystone granite, or broken concrete.

Riprap can therefore be defined as:

***Riprap:** Stone that is hard and angular and of such a quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all other respects for the purpose intended. No individual armor unit should be longer than three times its minimum dimension.*

a. Rubble concrete may be used as riprap provided it is broken into appropriately sized units and exposed rebar is cut flush with the unit. All asphalt material must be removed prior to installation.

2. Riprap is sized based on its weight. These weights, per VDOT specifications, are divided into the following classes/types (Fig. 2):

   a. Class AI - Stone in this class shall weigh between 25 and 75 pounds with no more than 10 percent of the stones weighing more than 75 pounds. Often referred to as "man-size."

   b. Class I - Stone in this class shall weigh between 50 and 150 pounds with approximately 60 percent of the stones weighing more than 100 pounds.

   c. Class II - Stone in this class shall weigh between 150 and 500 pounds with approximately 50 percent of the stones weighing more than 300 pounds.

Figure 2. Relative Stone Size.

d. Class III - Stone in this class shall weigh between 500 and 1,500 pounds with approximately 50 percent of the stones weighing more than 900 pounds.

e. Type I - Stone in this type shall weigh between 1,500 and 4,000 pounds with an average weight of 2,000 pounds.

f. Type II - Stone in this type shall weigh between 6,000 and 20,000 pounds and have an average weight of 8,000 pounds.

Note: In all classes/types of riprap, a maximum 10% of the stone in the mixture may weigh less than the lower end of the range.

Generally speaking, Classes AI and I stone are utilized in more tranquil creeks and protected shorelines while the remaining stone is typically used on lower tributaries, the Bay, and the ocean.

3. The slope of a revetment may vary somewhat depending on the physical setting and overall size of the proposed structure but, in general, slopes of 2:1 (2 Horizontal on 1 Vertical) or 3:1 are recommended.

4. All riprap revetments should be constructed using the proper application of filter cloth. As structures age and are exposed to erosive forces, filter cloth will tend to preserve the integrity of the structure by retaining underlying base material. Installing filter cloth initially will prolong the life of the structure, reduce maintenance costs, and reduce disturbances to adjacent wetlands caused by construction activities. Filter cloth may also reduce the frequency with which snakes and other undesirable pests utilize the revetment by providing a barrier against burrowing into sediments. Filter cloth should be a woven or nonwoven fabric consisting of continuous-chain polymeric filaments or yarns of polyester. The fabric should be inert

to commonly encountered chemicals and be mildew and rot resistant.

5. Proposed alignments for riprap revetments must be staked and flagged indicating the channelward limit of encroachment prior to or concurrent with the submission of Joint Permit Applications. Stakes should be located a maximum of 50 feet apart.

6. As in all shoreline hardening projects, access to a project site has a great influence on the overall impact of construction related activities. Direct and indirect impacts considered during project review generally do not take into account how materials and machinery will access a given reach of shoreline. The total impact of construction generally includes a variety of associated incremental impacts within various ecological zones around a project site. For this reason, care should be taken in transporting materials to a project site. In situations where armor material cannot be readily transported to it's ultimate destination, it is recommended that precautions be taken to minimize overall project impact.

   a. Projects which necessitate the dumping of stone down natural embankments to stock pile material should limit dump points to only those absolutely necessary. Given the core material and site preparation required, dump points should be limited to one every 75 to a 100 feet. The use of shoots to confine loose material may also be useful. Such practices will tend to reduce slope revegetation requirements and minimize erosion onto adjacent wetlands.

   b. Projects requiring the crossing of wetlands or which are in close proximity to wetlands, should make use of mats to minimize construction impacts. While potentially damaging to the standing crop vegetation, the purpose of using mats is to preserve existing circumstances, sand fills the groin cell to a point where it then bypasses the structure and continues movement along the downdrift shoreline. The sand remaining in the fillet is then available to function as a buffer against erosion. Yet even under ideal conditions, material tends to move more slowly through the filled groin cell thereby depriving downdrift shorelines of sand and increasing the rate of erosion on downdrift property.

Groins are generally only effective when adequate quantities of material are moving in the littoral transport system. Because of the potential to damage downdrift properties, it is often recommended to position groins away from property lines and to partially fill groin cells with appropriately sized material. Filling groin cells tends to reduce the time required for littoral material to start bypassing the groin thereby reducing erosion of downdrift property. Groin spurs may also be employed to help reduce downdrift erosion.

Recommended Best Management Practices

1. Construction materials/methods include the following:

    a. All wood should be pressure treated to a minimum of 1.5 lbs/ft^3 of CCA or a minimum creosote level of 12 lbs/ft^3.

    b. All hardware (bolts, nuts, washers, etc.) should be galvanized.

    c. If the structure is constructed of stone, the stone should be placed on a layer of filter cloth to help stabilize the structure. The size of the stone will be dictated by wave characteristics at the proposed location.

2. Because groins function to trap sediment moving along a shoreline, their effectiveness is somewhat related to the amount of material available in the system. For this reason it is prudent to space these structures such that the distance between groins is greater than, or equal to,

1.5 times the groins length from high water to it's channelward end. Groin length can be determined by examining the sand fillets in existing groins along the same shoreline reach or they can be based on the width of the local beach. Example: A 40-foot groins should be spaced a minimum of 60 feet apart.

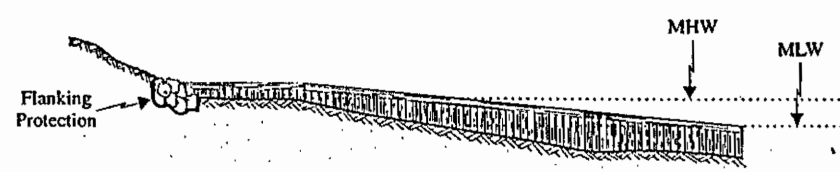
3. All groins should be constructed utilizing a low profile design. (Fig. 13) The low profile groin is designed to resemble the natural beach elevation and allows sand to by-pass and thus nourish downstream properties once the groin cell has filled. Groins which are too long may inhibit the longshore transport of sand to downdrift properties.

Low Profile Groin: *Low profile groins are structures with a terminal elevation at mean low water extending landward to an elevation of 1 foot above mean high water, at mean high water, with the landward terminus extending into upland to reduce flanking.*

4. In situations where groins are located in areas accessible to boaters, it is recommended that the channelward end of the structure be marked to aid navigation. This can be simply accomplished by using a longer pile at the terminus and leaving 12 - 24 inches remaining above mean high water.

5. Proposed alignments for groins should be staked and flagged indicating the channelward limit of encroachment

Figure 13. Low Profile Groin.



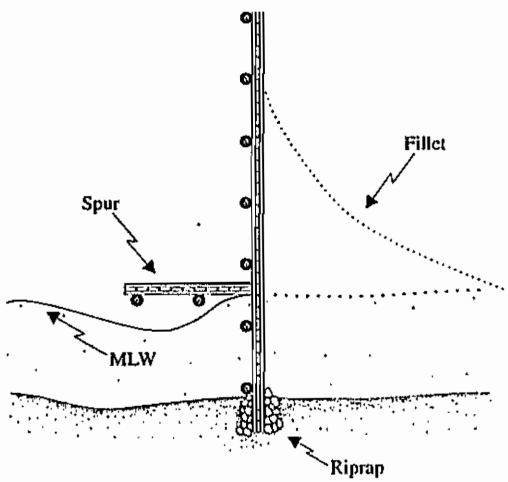
prior to or concurrent with the submission of a Joint Permit Application.

6. Groins should be located a minimum of 25 feet from property lines.

7. The application of groin spurs on the downdrift sides of groins may aid in reducing downdrift scour in the immediate vicinity of the groin. A spur should be located at approximately the mean low water mark. (Fig. 14)

8. At times, it may be desirable to artificially fill or nourish the groin cell to help reduce the amount of time necessary before sand begins bypassing the structure thereby minimizing the disruption in the supply of sand to downdrift properties. Nourishment material should be of a grain size equal to that of native beach sand and should be contoured to approximate the natural sand fillet which forms on the updrift side of the groin.

Figure 14. Groin Spur.

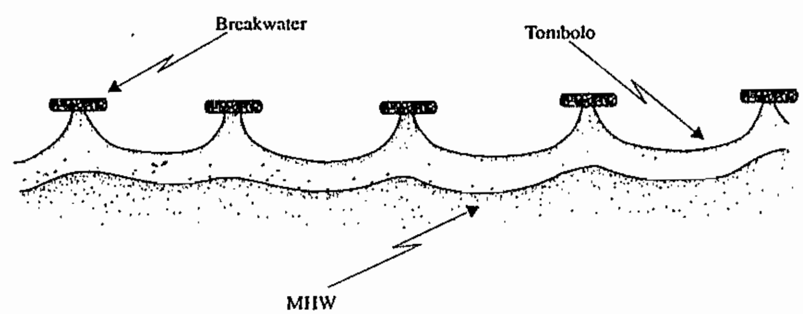


E. Breakwaters

Breakwaters are placed in the water parallel to shore and are designed to dissipate wave energy before it reaches adjoining shorelines. This decrease in wave energy reduces the ability of waves to transport sediment resulting in an area of sediment deposition behind these structures. A breakwater system usually addresses erosion over a large area and consists of a series of breakwaters along a reach of shoreline. (Fig. 15) Sand moving in the littoral transport system accumulates in the shadow of the breakwater until filled to its natural capacity. Once filled, sand can then move through the breakwater system to downdrift properties. As with groins, breakwaters can be partially nourished to create natural bays or tombolos and insure a minimal disruption in the supply of sand to downdrift properties.

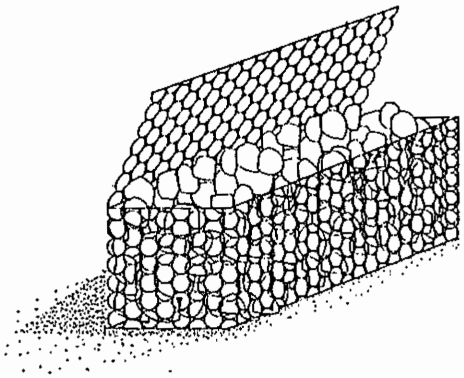
Offshore breakwaters must be constructed of materials capable of withstanding the high energy environment in which they are placed. Since the height of the breakwater determines how much wave energy is dissipated, an important design consideration rests in maintaining the design height for the life of the structure. While a variety of materials have been used in breakwater construction, some degree of success has been achieved in Virginia using quarrystone

Figure 15. Breakwater System.



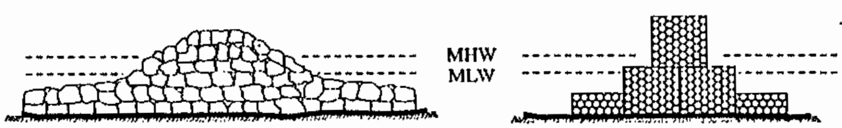
riprap. These structures are typically rubble mound or gabion systems and are able to withstand the differential settlement that may occur after placement. (Fig. 16a and 16b)

Figure 16a. Gabion Basket Filled with Quarrystone.



Breakwaters do not have universal application. The design of a breakwater system must take into account a variety of site specific considerations including wave characteristics, material composition, height requirements, distance from shore, length, spacing, and existing shoreline configuration. In addition, equipment and material access to the site as well as the potential environmental impact on sensitive submerged habitat must be taken into account. The Shoreline Erosion Advisory Service is available to assist in the design of breakwaters. It is strongly recommended that this type of work be undertaken by professionals experienced in breakwater construction.

Figure 16b. Rubble Mound and Gabion Basket Breakwaters (End View).



Recommended Best Management Practices

1. A plan of access to the proposed breakwater location should be developed. This should include precautions necessary to avoid or minimize impacts to adjoining resources.

2. A construction time table should be developed so that the staging and deployment of stone will not be unduly prolonged. Gabion baskets should be closed and sealed once filled. Partially filled structures should be secured until the remaining work can be completed.

3. At times, it may be desirable to artificially fill or nourish behind a breakwater to help reduce the amount of time necessary before sand begins bypassing the structure. Nourishment material should be of a grain size equal to that of native beach sand and should be contoured to approximate the cuspate shoreline which forms.