Shore Erosion Control

A Guide for Waterfront Property Owners in the Chesapeake Bay Area

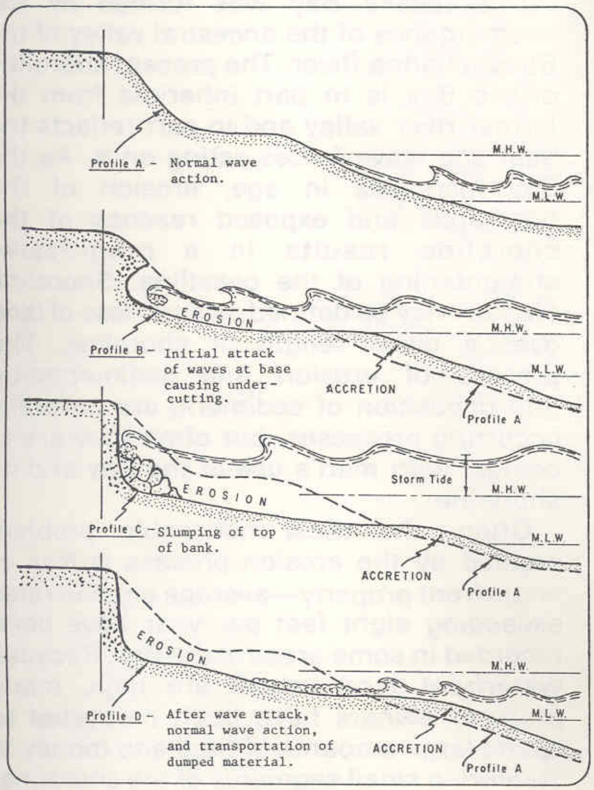
SHORE EROSION AND THE EDGES OF CHESAPEAKE BAY

Chesapeake Bay was formed by the submergence of the ancestral valley of the Susquehanna River. The present shoreline of the Bay is in part inherited from the former river valley and in part reflects the tidal and wave forces acting on it. As the Bay increases in age, erosion of the headlands and exposed reaches of the shoreline results in a progressive straightening of the coastline. Shoreline erosion may be defined as a net loss of land over a given length of shoreline. The process of erosion and sedimentation (the deposition of sediment) are naturally occurring processes, but often they are in conflict with man's use of the Bay and its shoreline.

Often, the most noticeable problem created by the erosion process is loss of waterfront property—average erosion rates exceeding eight feet per year have been recorded in some areas of the Bay. Because waterfront land values are high, many property owners have been motivated to spend large amounts of time and money in stabilizing small segments of the shoreline. These efforts are frequently successful, but in some cases the costly structures are either inadequate or improperly built.

A second problem of shoreline erosion is that of localized increases in sedimentation. Sediments derived from shoreline erosion are reworked by the waves and tides. Fine-grained sediments (silts-clays) are generally transported to the deeper portions of the Bay while coarser-grained sediments (sands) either remain at the shoreline or are transported along the shoreline to a site of depositon. Deposition in areas such as tidal creek inlets and shellfish beds interferes with man's use of the Bay and its resources. However, movement of such materials along the shoreline is essential to maintaining beaches and helps reduce shore erosion.

Figure 1 - Wave Activity On Beach And Bank



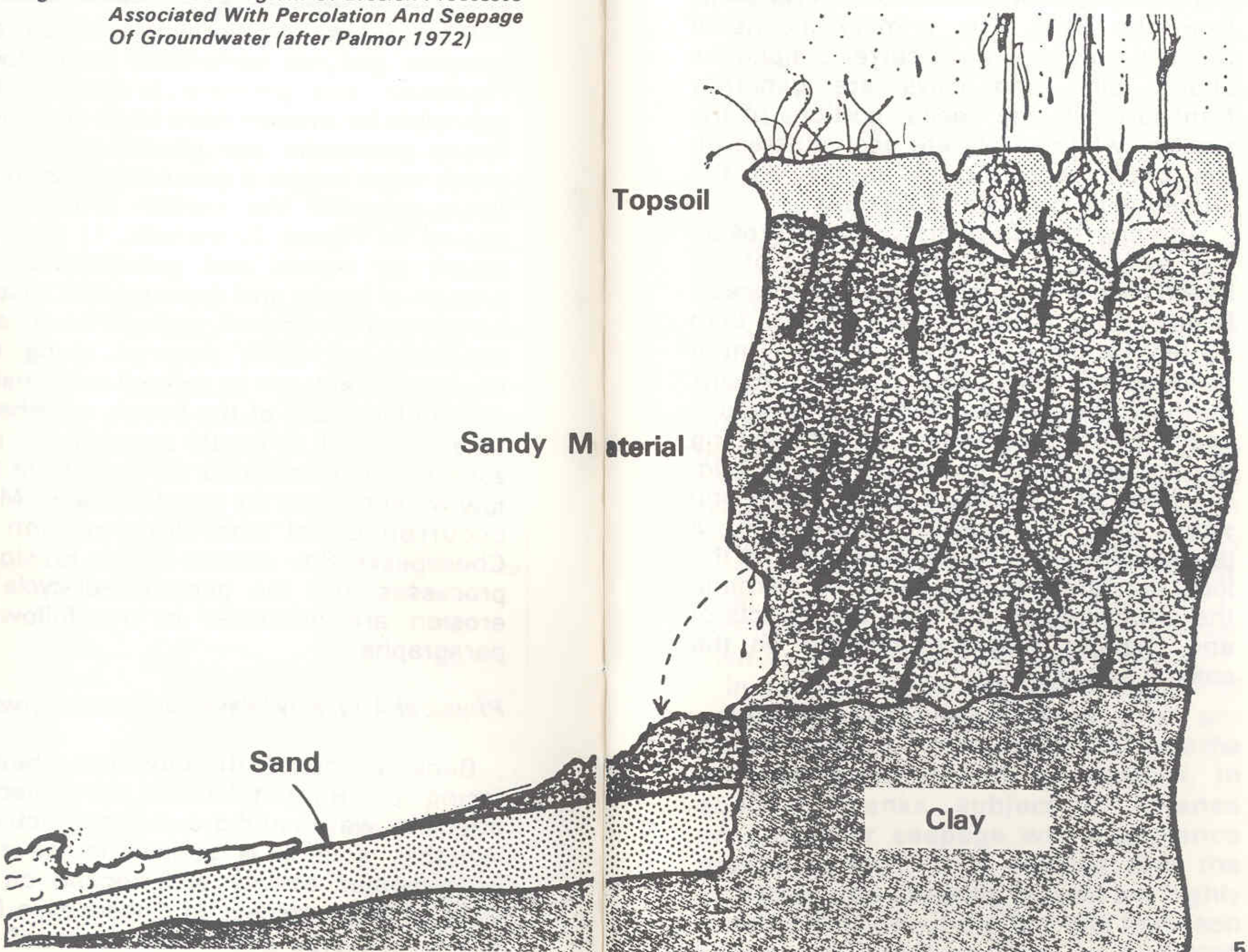
UNDERSTANDING SHORE EROSION

The causes of shoreline erosion are complex and not completely understood. However, the primary processes responsible for erosion have been identified. These processes are usually related to either wave action or groundwater activity. Basic steps of the erosion process, as shown in Figure 1, include: 1) physical attack by waves and groundwater, 2) erosion of banks and deposition at base of banks, and 3) removal, transportation, and deposition of bank material along the shoreline. Bank can be defined as the rising ground landward of the beach, whether it be a bluff, cliff, or gentle slope. Beach is a zone of unconsolidated material from the low water mark to the toe of the bank. Most occurrences of shoreline erosion in Chesapeake Bay involve banks. Erosional processes and the generalized cycle of erosion are described in the following paragraphs.

Physical Attack by Waves and Groundwater

Banks adjacent to the shoreline, whether facing open Bay or tidal river, are subject to attack by waves and groundwater activity. Whether a bank is subject to wave or groundwater activity will depend on its location with respect to Chesapeake Bay proper, the type and consolidation of the bank materials and height of the bank. Generally, physical attack by wave action is the more important of the two processes. However, groundwater can be equally important in localized areas. The latter process is illustrated diagramatically in Figure 2.

Figure 2 Schematic Diagram Of Erosion Processes Associated With Percolation And Seepage Of Groundwater (after Palmor 1972)



Erosion of Banks

Mechanisms of erosion vary depending on the dominant forces acting upon the shoreline. Where wave action is strong, material is eroded from the toe of the bank (Figure 1). This type of erosion, which is commonly called undercutting, causes the top of a bank to become unstable and results in sliding and slumping of the bank and a net loss of fastland. With erosion caused by groundwater activity, groundwater percolates through the porous sediments to an impervious clay layer and finally emerges from the face of the bank (Figure 2). The net effect is a breaking up at the base and slumping of the unstable bank.

Transportation of Bank Material

The final phase of the process is that of the transportation of eroded material away from the bank. The primary means of removal is by waves and currents along the shore. Silts and clays are generally transported to the deeper portions of the estuary while sands are accumulated on the beach and moved parallel to the shoreline by waves and currents.

Although the above discussion of erosion has focused on fastland, the role of the beach zone is very important in the process. Beach width, which is generally less than 15 feet on the Bay, affects the amount of wave energy that is able to reach the bank during storms. Preservation of an effective beach zone is dependent on maintaining the balance between sand supplied from the bank or movement along shore and sand lost to erosion. Therefore, a prerequisite for erosion control is that the local conditions be evaluated to determine the effectiveness and possible impacts of any changes that are imposed on the coastal system.

CHESAPEAKE BAY SHORELINE CHARACTERISTICS AND EROSION RATES

Chesapeake Bay lies entirely within the coastal plain. Bank heights range from 0 to 160 feet. The height of the bank is not necessarily indicative of the rate of erosion. More important factors are the composition and consolidation of the bank. Fine-grained consolidated sediments (silts-clays) erode more slowly than coarse-grained unconsolidated sediments (sands).

Determining factors in the generation of waves include wind velocity and wind duration. Wave generation is generally greater in areas that are exposed to the open Bay than in tidal tributaries. A shallow bottom nearshore will more effectively reduce wave energy than deep water nearshore. Consequently, less wave energy is received by a shoreline if there is a shoal, tidal flat, or vegetation immediately offshore. Similarly, a wide beach is better than a narrow beach for wave reduction.

In general, banks that are composed of easily erodable sediments and are subjected to high wave energy will have the greatest susceptibility to erosion. In addition, banks subject to intense groundwater seepage will experience greater erosion. It is obvious that the characteristics affecting erosion are highly variable throughout the Bay and that each segment of shoreline must be evaluated independently as to its physical environment.

Maps depicting historical shorelines and historical shoreline erosion rates for the entire Maryland portion of the Chesapeake Bay and tidewater tributaries at a scale of 1:24,000 have been prepared for the Maryland Coastal Zone Management Program by the Maryland Geological Survey. Individual shore erosion maps can be obtained for a nominal fee from the Maryland Department of Natural Resources, Tawes State Office Bldg., Annapolis, Md. 21401.

EROSION CONTROL

Shoreline erosion problems differ substantially from site to site around the edges of Chesapeake Bay. Similarly, considerable differences are found with respect to procedures and devices that can be employed to control erosion. Selection of the most appropriate control device requires a careful planning effort. Important steps in the planning activity are discussed below. Also, detailed information concerning specific control types is presented.

PLANNING CONSIDERATIONS

A Determination of Need

Erosion rates vary depending on location.

Usually, the rate can be directly linked to the strength of the agent(s) causing erosion (e.g., wave energy). Some erosion control mechanisms are effective only in areas where the agents of erosion are weak. Others, are designed to be effective under the most adverse conditions. If a structure type does not achieve the desired effectiveness, then other considerations such as cost become meaningless. Therefore, any planning effort should start with a determination of how severe the erosion problem is, and whether the structure is actually desired. If so, the next step is to identify those alternatives that would be adequate with respect to the erosional problems of a specific site.

In some instances improved vegetative measures used on land and at the waters edge may be sufficient.

Man's activities on the shoreline often contribute to shore erosion either by weakening the bank or by increasing the flow of water over and through the bank. Structures such as large patios, paved areas or drain fields which slope toward the bank should be avoided. Livestock, plowed fields, intensive recreation activities and construction projects should be separated from the bank by a vegetative buffer. New permanent structures should be built fifty feet from the bank for every one foot per year of erosion. For example, where a shoreline is experiencing an average erosion rate of three feet per year, a house should be built at least one hundred and fifty feet from the shoreline. The above described practices may reduce the requirements for erosion control structures. That is, these practices may allow your erosion problems to be effectively addressed with less elaborate and less costly structures.

An Assessment of Cost.

A careful review of erosion control types will usually result in the identification of several that are adequate to the specific problems of a given area. Frequently, costs will vary greatly among types. Therefore, costs related to the "adequate types" should be assessed early in the planning effort.

Agency Regulations

Both state and federal agencies require permits for shore erosion control structures. Generally, both state and federal agencies will issue permits if erosion can be demonstrated and if the design of the control structure indicates adequacy with respect to the problem of the area. However, regulatory agencies will assess the likely impact of the structure on the surrounding environment. If evidence is found to indicate that the structure will result in adverse impacts, then the agencies may require design modifications that would minimize adverse impacts. Familiarity with agency regulations during the planning stages may expedite the processing of your permit application.

Environmental Considerations

Major environmental considerations regarding structural abatements of shoreline erosion on Chesapeake Bay concern the placement of the structure and how it will affect the ability of the area to support aquatic plants, invertebrates, fish and wildlife.

The area typically affected by shoreline protection structures is the intertidal zone including nearshore shallow waters, associated marine soils, and marshes. The "intertidal zone," characteristically that area between low tide and high tide, has been documented as the most productive zone of the estuary. This area often supports coastal saltmarshes which continually produce detrital material (organic material, primarily fragments of marsh plants) which serves as a food base for many organisms in the estuarine food chain. The saltmarshes also provide habitat, food, and cover for many species of fish and wildlife. Furthermore, these marshes continually filter and purify upland runoff waters thereby aiding in improving water quality. The "intertidal zone" may also be characterized by mud or sand flats, which often appear lifeless to man. However, these areas also are vitally important to the Bay ecosystem since they provide habitat for crabs, clams, oysters, many species of invertebrates, algae, bacteria and other microorganisms, all of which play an integral role in the complex estuarine community and have adapted to live in a zone of temporary inundation either by vertical or horizontal movement with the tide.

Many times erosion control structures are proposed for the intertidal zone and the adjacent shallow water areas. In such cases, the installation of the structure and the subsequent fill often results in the loss of valuable shallow water habitat or prime saltmarshes which provide habitat, food, and cover for many species of estuarine fish and wildlife. Thus, shore erosion control structures, where deemed necessary, will have a reduced environmental impact if they are placed landward of all marsh vegetation and/or landward of the intertidal zone.

Even when placed as close as possible to the bank, an erosion control structure may cause environmental degradation. For example, scouring of marine soils and/or marsh vegetation located waterward of a structure may result from waves reflected from a vertical surface such as a bulkhead. Angled or irregular shoreline protective surfaces, such as rip rap, tend to disperse

wave energies thereby reducing the scouring effect and often enabling marsh to survive channelward of the structure. These latter surfaces are thus more environmentally acceptable. Marsh itself is often an excellent buffer against erosion and, where present, should be maintained. Under certain circumstances, it may be planted to aid in erosion control. Where a vertical structure is desired, the placement of rock immediately channelward of the structure reduces scouring at the toe of the structure and also provides habitat for aquatic organisms.

Groins are sometimes environmentally unacceptable because they alter the natural water transport of sand particles. Although groins may function to collect sand in one area, they often result in "starvation" or erosion in another area (See the section on "Groins" for further discussion).

Most timber bulkheads and groins today are chemically pressure-treated with a creosote (a petroleum product) or a cresote-coal tar process to retard most decomposing organisms from invading the wood. Although aged or weathered timber bulkheads do serve as habitat for some organisms (algae, barnacles), generally speaking, most cresote treated timber bulkheads provide minimal habitat for estuarine organisms. Likewise, steel or aluminum bulkheads provide minimal habitat for marine organisms. Conversely, irregular surfaces such as are associated with riprap or gabions provide substrate for both plant and animal life and provide many crevices for small aquatic organisms to dwell. They are often good fishing areas because sport fish tend to congregate in these areas to feed on the small invertebrates and other fish which seek shelter among the rocks.

Since both state and federal agencies entrusted to protect natural resources review permit applications for shoreline protective devices, careful consideration of adverse environmental impacts of erosion control structures during the planning stage may result in a more rapid processing of your permit application.

Professional Advice

Many shore erosion control problems are complex and technical expertise is required if they are to be effectively addressed. Technical assistance can be obtained from a number of engineering firms in the Bay region. These firms are listed in the yellow pages of the telephone directory. Agencies which will provide assistance or referral are listed at the end of this manual.

TYPES OF EROSION CONTROL: BANK STABILIZATION

The erosion control devices discussed here are divided according to their purpose. The first section describes structures which are designed to stabilize the bank or fastland. In the following section, devices which attempt to stabilize the beach or promote accretion are presented. Estimates of the cost of erosion control measures given below are based on 1975 figures and may vary considerably depending on the availability of labor and materials.

Bank stabilization structures used for shore protection fall into two general categories; those that form an impervious vertical wall to separate the earth materials from water and wave action, and those that utilize a more permeable structure to reduce the level of the wave's energy while acting as a filter to prevent the soil particles from passing through to the water. The success of both types depends on proper construction.

Structure height must be such that large waves will not regularly wash over the top and erode fill material. Adequate depth is important to prevent failure by scour or undercutting. If not compensated for in design, scouring will result in the undermining of wall and revetment type structures.

Increases in structure height and depth increases costs for materials and labor. Design for a twenty or thirty year storm is considered to be the best practice. A storm of this magnitude is one that would be expected to occur once every twenty to thirty years on the average. Designing to this level provides protection for most storm conditions encountered without imposing the undue costs of a more elaborate structure.

WALL TYPE STRUCTURES (Bulkheads)

Erosion control systems that generally form a wall to retain material on the upland side and separate erodable land from damaging wave action by an impermeable barrier are Timber Bulkheads.

DESCRIPTION. Timber bulkheads consist of treated wood sheets fastened to a framework of treated wood wall pilings and timbers. A tie back timber bulkhead (Figure 3) is kept from falling forward by the rods that run between the wall pilings and a row

Timber Bulkheads

of pilings driven behind the bulkhead. Some timber bulkheads are kept from falling forward by pilings that are driven into the ground in front of the bulkhead and bolted to the wall piles (Figure 4). In most cases these pilings are placed at every other wall pile.

ADVANTAGES. Materials are readily available in all areas of the Bay. The structure will usually provide adequate protection if properly constructed and maintained.

DISADVANTAGES. Timber bulkheads are susceptible to scouring because of their inability to absorb wave energy unless toe protection, such as riprap, is used. The creosote that is commonly used to prevent infestation by borers and rot can cause burns or stains. Structural members, being of wood, can splinter. The smooth face of the wall and the stresses caused by wave impact discourage habitation by wildlife or marine organisms.

COST. The cost of a timber bulkhead will vary according to construction conditions at the site and the sizes of timber used, but

Figure 3 - Tie Back Timber Bulkhead

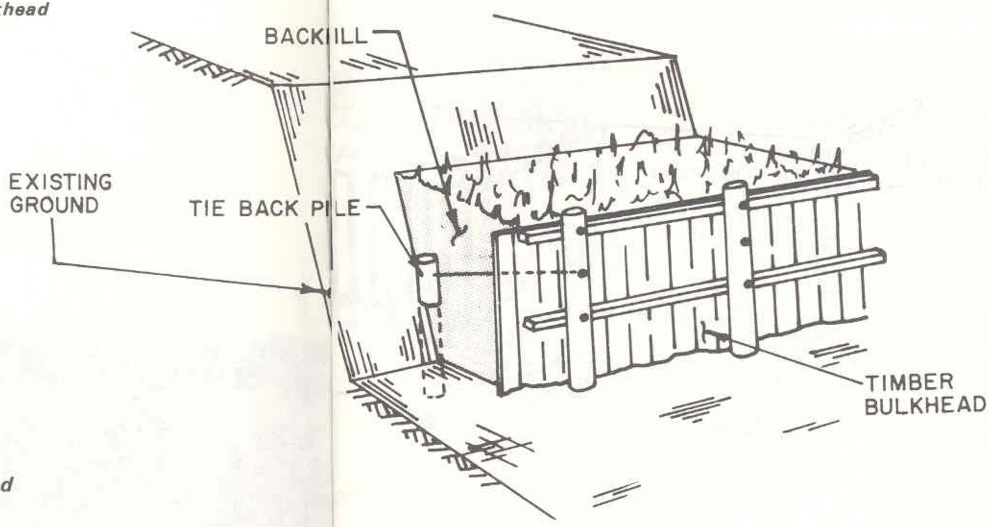
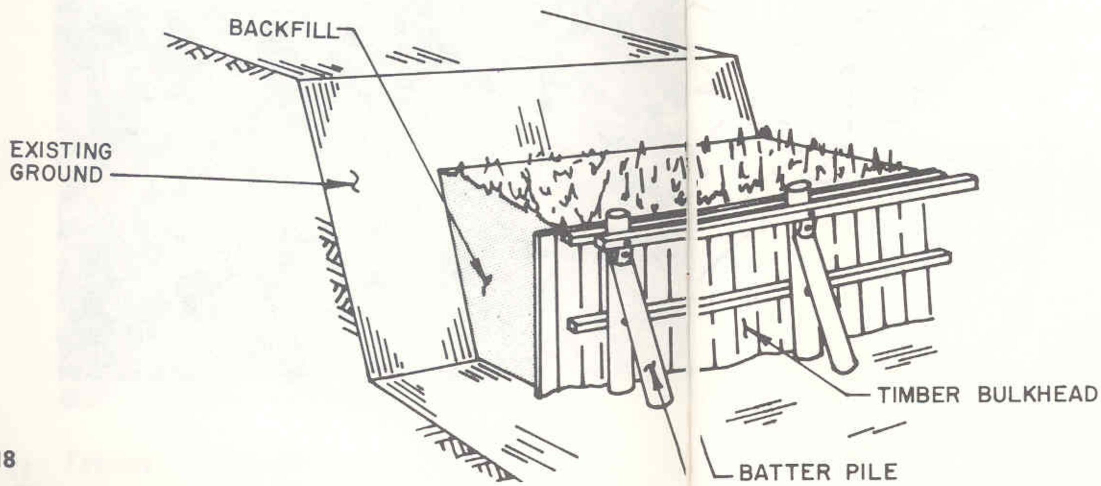


Figure 4 - Batter Pile Bulkhead



generally lies in the $90 to $120 range per linear foot. In rare cases the cost may exceed $200 per linear foot.

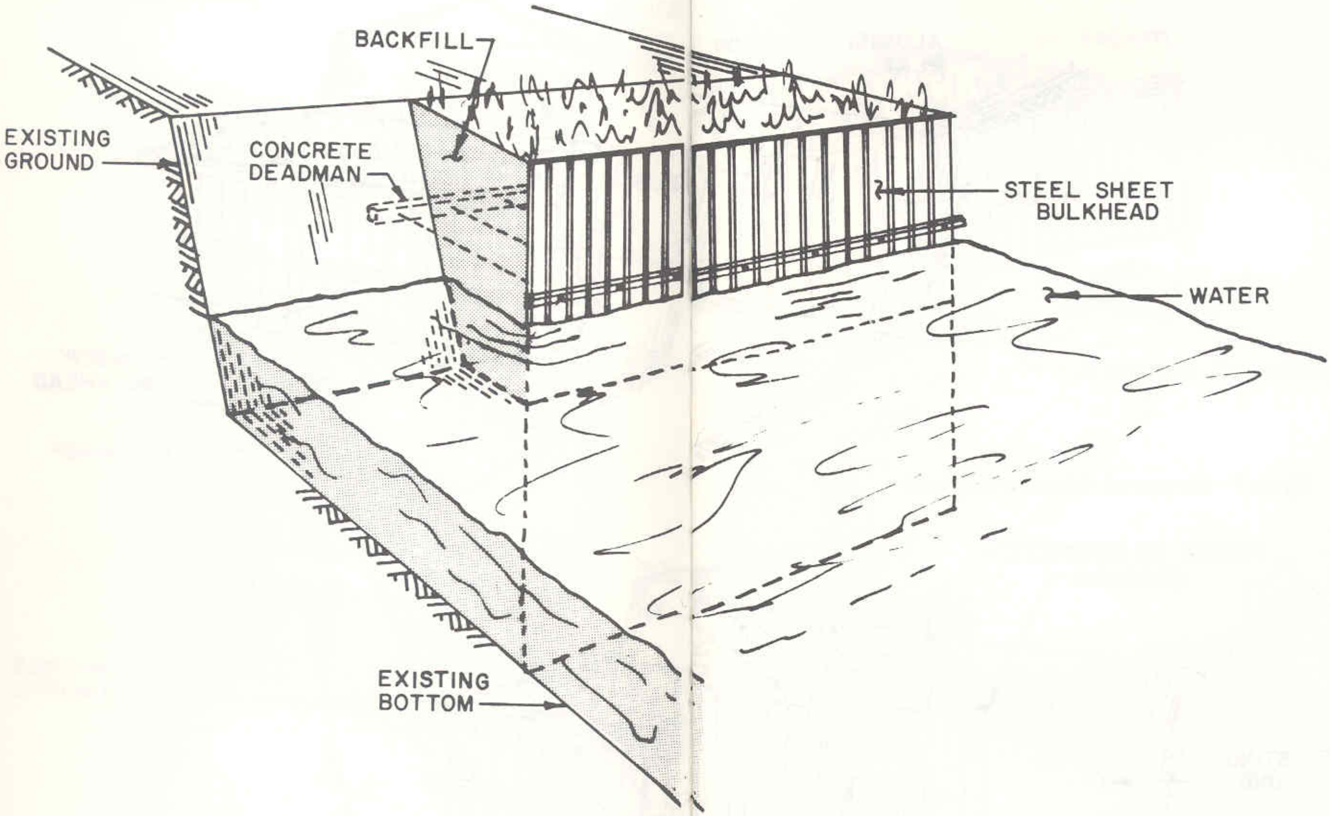
Steel Bulkheads

DESCRIPTION. Steel bulkheads (Figure 5) are constructed of steel sheet pilings with the steel usually being of a corrosion resistant grade. Each piling has a rolled shape with a system of grooves on each side that form interlocking joints between sheets. At the site, sheets are driven into the ground along the bulkhead line and braced by steel wales that are either tied to deadmen or are braced by buttresses.

ADVANTAGES. Properly designed and erected steel bulkheads are quite strong and are suitable where severe conditions are anticipated. Construction materials are available in a variety of sizes and shapes. Steel bulkheads have been in use for many years and design and engineering data are time tested and readily available.

DISADVANTAGES. Steel bulkheads are susceptible to corrosion and scouring at the

Figure 5 - Steel Bulkhead



base. Like the timber bulkhead, steel bulkheads have a low ability to absorb wave energy and are undesirable as habitats for marine organisms.

COST. Generally about $250 per linear foot but easily reaching $750 per linear foot at some sites.

Aluminum Bulkheads

DESCRIPTION. Aluminum bulkheads (Figure 6) are constructed of a special marine alloy sheeting 5 feet wide that is formulated to resist corrosion. The sheeting is corrugated and is available in standard lengths and thicknesses. Sheeting is driven into the ground with a vibrator pile driver. Adjacent sheets are joined together by a special interlocking joint. Ends of the sheeting that protrude above the bank are covered by an extruded aluminum cap that is bolted on along with aluminum tie rods that extend into the bank to aluminum anchor deadmen.

ADVANTAGES. The principal advantage of aluminum is that it can be installed

Figure 6 - Aluminum Bulkhead

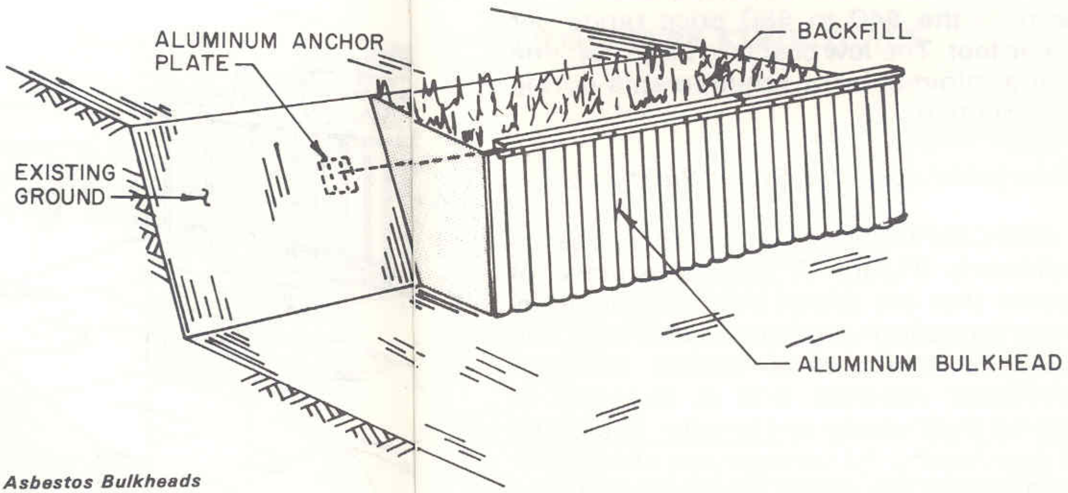
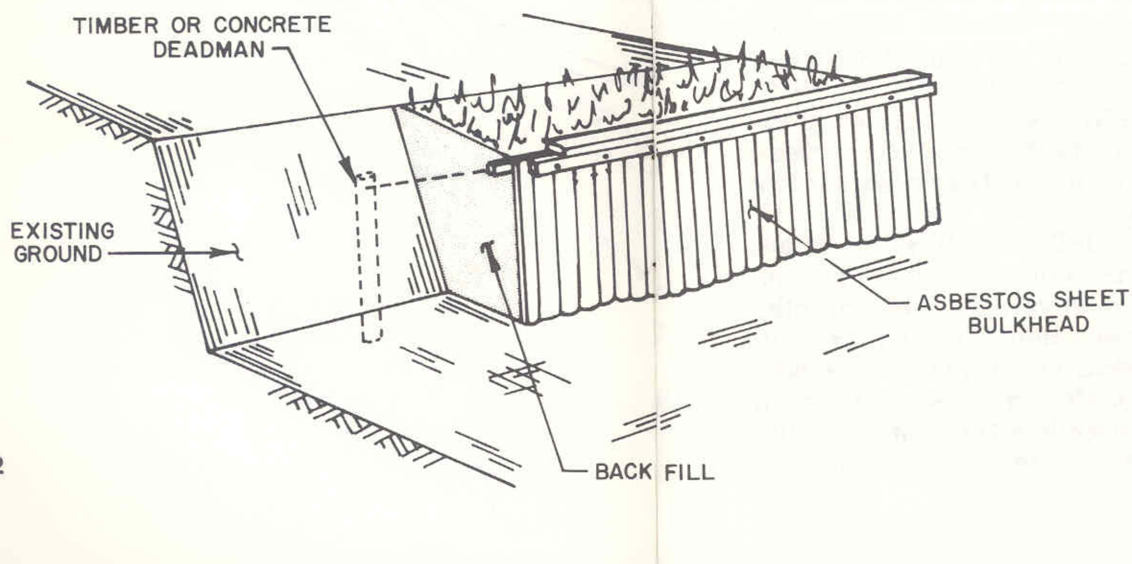


Figure 7 - Corrugated Asbestos Bulkheads



quickly and with a minimum of heavy equipment.

DISADVANTAGES. Aluminum bulkheading cannot be driven through logs, stones, etc., and cannot be used in areas in which these objects occur. Like all other forms of bulkheading, aluminum sheeting is susceptible to scouring. Because of its relatively recent appearance in Maryland, local experience is somewhat limited. At this particular time, aluminum is not recommended for use where extreme conditions — such as bay front sites — are common.

COST. Aluminum bulkhead costs have been in the $40 to $80 price range per linear foot. The low cost is in large part due to the minimal labor requirements during construction.

Corrugated Asbestos Sheet Bulkheads

DESCRIPTION. Corrugated asbestos bulkheads (Figure 7) are constructed of sheets that are driven into the ground by water jets to form an impermeable wall. The sheet is made of a special asbestos reinforced concrete and is available in varying thicknesses and lengths. It is joined by overlapping the corrugations of adjacent sheets. After the sheets have been installed forms are built along the top to receive poured concrete. Anchor rods are embedded and run to poured concrete deadmen.

ADVANTAGES. Asbestos sheet bulkheads can be installed quickly, are clean and require a minimum of heavy equipment for installation.

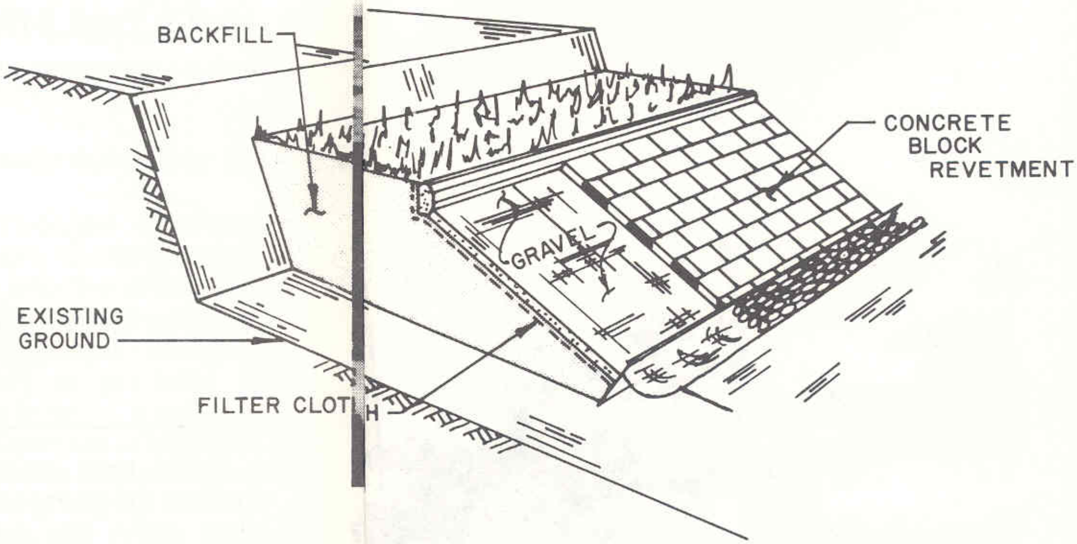
DISADVANTAGES. Asbestos sheets are not as strong as aluminum sheeting and thus require a relatively soft unobstructed bottom for construction. Limited strength for resisting wave action makes this type suitable for sheltered areas only. An important fact discovered in local use is that only sheets that are resistant to the absorption of water should be used; otherwise the concrete will absorb water and in freezing weather the expansion of this water as it freezes will destroy the sheeting.

COST. Because of the relatively low cost of the materials used, and the minimum of labor required, asbestos sheet bulkheading is relatively inexpensive — around $40 to $50 per linear foot.

FILTER TYPE STRUCTURES

Filter type structures are designed to reduce the energy of the incoming waves as they strike the surface of the structure, while at the same time acting as a filter, with each layer of the structure acting to hold in place the layer(s) beneath it. Reduction of the energy of incoming waves is accomplished by the sloping shape of the structure and by the relatively rough surface that it presents. Filtering qualities result from the use of layers of varying sized stone and other materials. In construction, the bank is first graded to achieve the shape required for the structure being installed. A filter cloth is placed and attached on the graded bank. This cloth is similar in weave and texture to tightly woven burlap but is made of a nondeteriorating plastic. The size of perforations should be selected to allow water to seep from the bank while keeping the soil particles in place. Seepage releases pressure from groundwater. On top of the layer of filter cloth is placed a six to eight inch layer of stone. This layer of stone holds the filter cloth in place and becomes the bottom layer of the actual structure. A variety of outer layers are then placed on top of the stone. This type of structure is preferred to bulkheads where groundwater contributes to bank erosion.

Figure 8 - Concrete Revetments



Interlocking Concrete Blocks (Revetment)

DESCRIPTION. Concrete revetments (Figure 8) are made of blocks of a patented design. The blocks are laid on a prepared base and when placed next to each other they will form a smooth relatively impervious surface. Blocks are held in place at the base by a "toe" of timber and large stone and at the top by a poured concrete cap piece. Filter cloth and small stone are used for the base.

ADVANTAGES. A concrete block revetment presents a very neat and clean appearance. The sloping surface helps dissipate wave energy and allows easy access to the water.

DISADVANTAGES. In order to construct a concrete block revetment, much hand labor is necessary to place the blocks properly. Because of the interlocking joints and the poured cap pieces, repair work is difficult. The smooth face does not provide good habitat for marine animals.

COST. Because of the expense of hand labor and the difficulties encountered when constructing the toe of an interlocking concrete block revetment, the cost per linear foot is approximately $200 for a typical structure.

Stone Revetment (Rip Rap)

DESCRIPTION. A stone revetment (Figure 9) is constructed by placing progressively larger blocks and pieces of stone on filter cloth or fine gravel. During construction, a layer of filter cloth or gravel is placed on a graded bank. Then a six to eight inch layer of quarry stone is added. On top of this is placed the large armor stone, the thickness of which varies according to site condition. In areas where large waves are expected, an overtopping apron is sometimes constructed. Generally, the overtopping is a layer of 10 to 12 inch stone about ten feet wide that extends landward from the top of the revetment.

Stone Revetment (Rip Rap)

Figure 9 - Stone Revetment

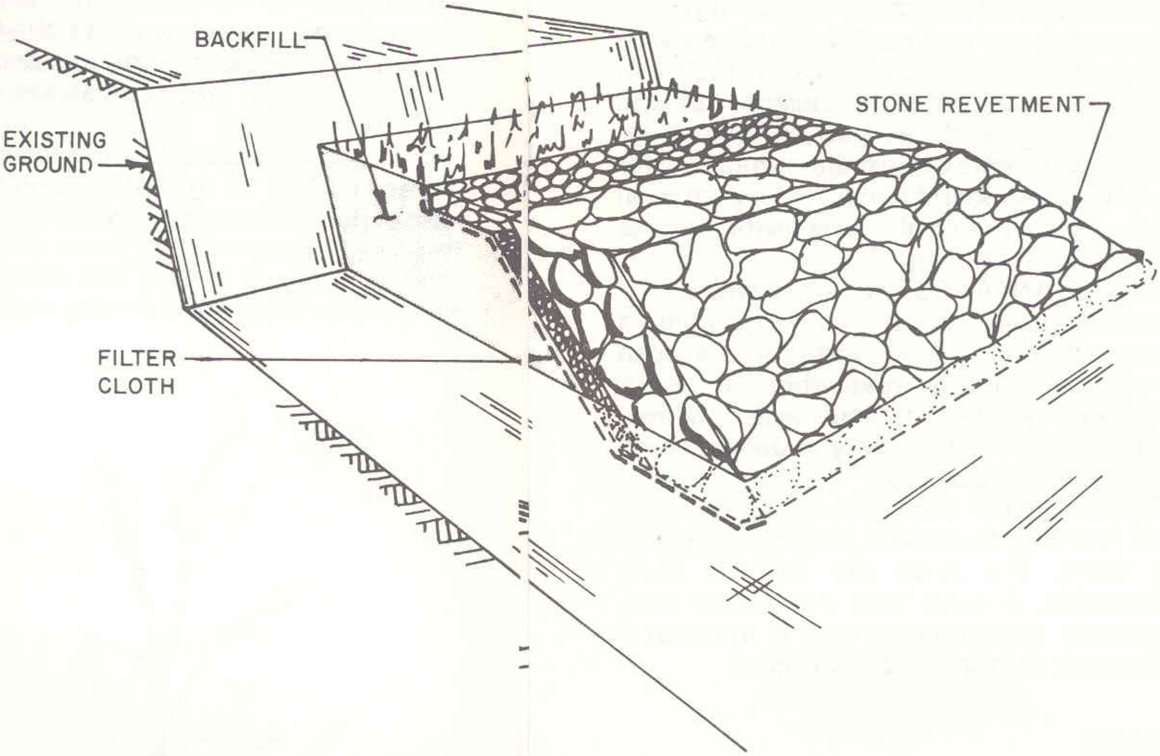
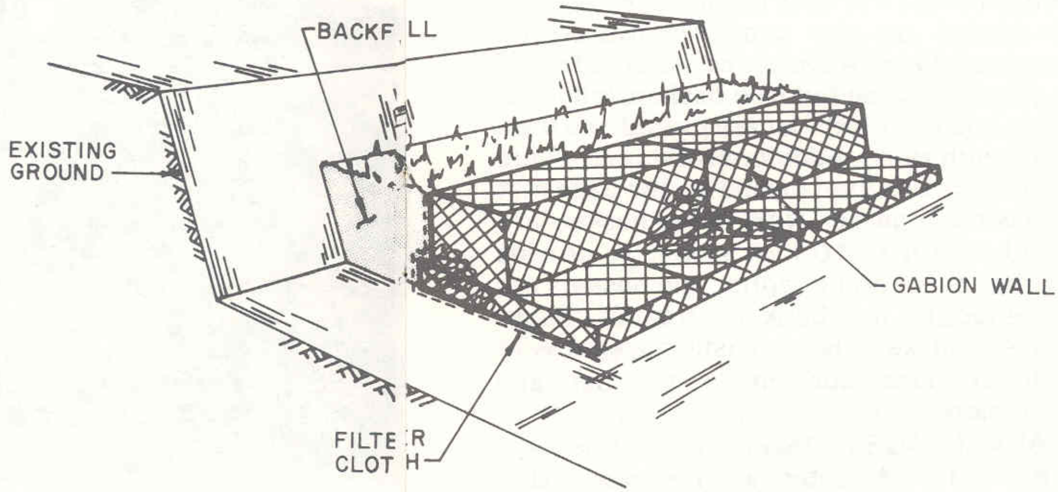


Figure 10 - Gabions



ADVANTAGES. The great advantage of stone revetments lies in its adaptability. It can be designed to fit the existing shape and height of the shoreline. The rough surface that it presents to waves is very effective in reducing wave energy. Because of the irregularities and greater surface area, stone revetments are excellent habitats for marine animals and allow for recreational fishing. Also, materials are reusable in case of structural damage.

DISADVANTAGES. A large amount of stone is needed to properly build a revetment. Hence, transportation costs can be considerable. In areas where access is limited by bridges or roads with low load limits, it may be necessary to design some other type of structure.

COST. For the durability and amount of work required to place the stone and grade the bank, the price per foot is fairly reasonable, around $90 per linear foot. Moreover, maintenance cost is minimal if revetment is properly constructed.

Gabions

DESCRIPTION. Gabions (Figure 10) are wire "baskets" that can be connected and filled with stone. At the start of construction, the bank is graded. Filter cloth is placed on the graded surface and fastened down. A base is constructed out of a generally wide but thin baskets (about 6' wide and 6" thick) that are placed and then filled with stone. Additional rows and layers of baskets are then placed on the base mat and wired together. Next, these baskets are filled with 4 to 10 inch stone. To provide further structural integrity, the baskets are fastened to the bank by treated timber stakes. Baskets using plastic covered wire will be less susceptible to rust and corrosion.

ADVANTAGES. Relatively small stones are used with gabions. This stone size allows individual property owners to undertake the construction work if they desire. As with a regular stone revetment, power equipment will speed the process. However, it is not a requirement.

DISADVANTAGES. The strength of a gabion revetment is dependent on the strength and condition of the wire baskets and ties. If they have not been fastened together properly, or if they are beginning to rust, structural integrity will suffer accordingly.

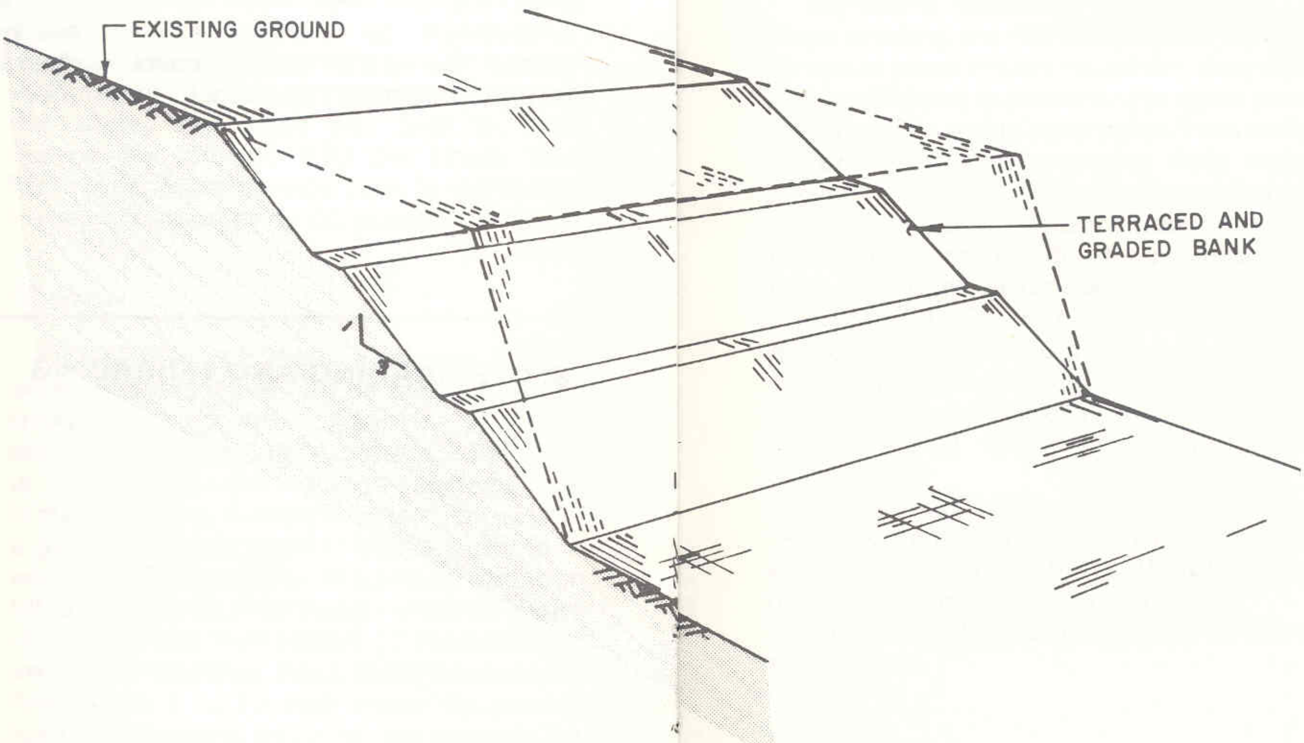
COST. The cost of transporting stone to the site must be considered when planning for a gabion revetment. Cost will vary considerably depending on the height of the bank and on how much of the work is undertaken by the individual property owner. Generally, gabion costs compare favorably with rip rap costs.

SLOPE GRADING AND TERRACING

Description

One determinant of bank stability is the steepness of the slope. The forces of gravity acting on the bank and upland runoff water may increase the rate of shore erosion by carrying soil material down to the region of wave attack. Grading or terracing (Figure 11) of the slope to reduce steepness will decrease the potential wave damage since wave energy is expended as it runs up the slope. A recommended slope gradient (average for terracing) is 5:1, although a slope of 3:1 is often satisfactory — especially if combined with other methods of shore protection. Control of surface and sub-surface water will generally be necessary, as with other control measures.

Figure 11 - Grading Or Terracing



ADVANTAGES. This practice can be combined with erosion control structures for increased effectiveness at low additional cost. The resulting land is more useful to the property owners and provides access to the waterfront.

DISADVANTAGES. Grading and terracing is generally not effective by itself against prolonged or intensive wave action. Also, permanent structures close to the top of the existing banks would prohibit this practice.

COST. Generally low but variable. The cost will increase greatly when hauling material off site is required.

VEGETATIVE PLANTING (BANK)

Vegetative plantings on the bank, like slope grading are not intended to resist the forces of wave action. However, they can be a very effective supplement to other control measures by reducing erosion from surface water runoff and retarding daily erosion processes. For planting, the slope should be no steeper than 3:1. Bermudagrass or tall fescue is recommended for plantings on a tidal river bank or landward of a structure.

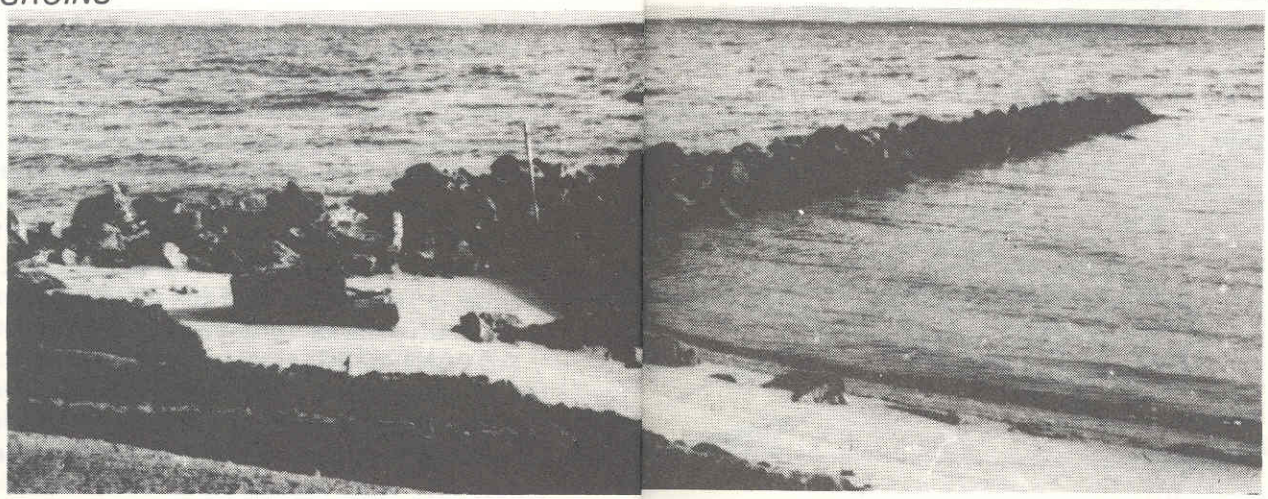
ADVANTAGES. For a minimum investment, vegetative plantings will help bind the soil against erosion and extend the life of a control structure. Where no structure exists it will retard the daily erosion processes.

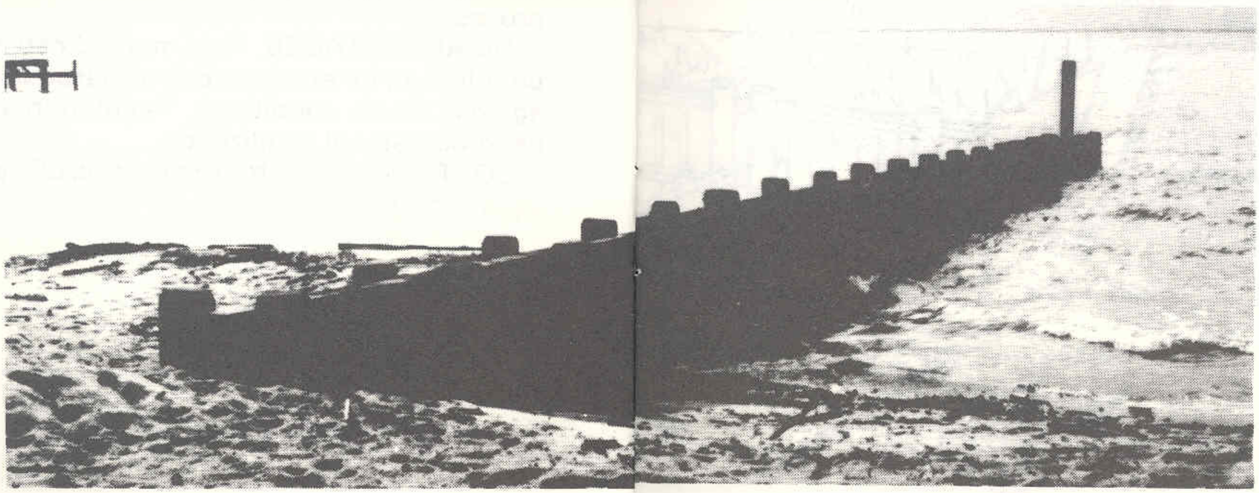
DISADVANTAGES. This method can not be relied on for erosion control, particularly against storm conditions. Vegetation will need occasional fertilization.

COST. Very low, often as little as 60c per square foot.

BEACH STABILIZATION AND TYPE OF EROSION CONTROL: ACCRETION

GROINS





Groins

Groins, usually constructed perpendicular to the shore, are employed to interrupt longshore sand movement for the purpose of accumulating sand on the shore, or to retard sand losses from the shore. Groins are generally classed by their length, height and permeability. These factors will determine the areal pattern of sand accumulation and the amount of sand or water that will be allowed to pass. Common types used in this area are stone (Figure 12) and timber groins (Figure 13). Agencies frequently discourage groin construction because of downdrift erosion (Figure 14).

ADVANTAGES. Stabilizing or increasing beach areas will reduce fastland loss from erosion since the beach absorbs wave energy. Recreational value of the shoreline is enhanced with beach stabilization.

DISADVANTAGES. Sand accumulation by groins occurs at the expense of downdrift areas. Also, groin placement does *not* guarantee sand accumulation and the movement of sand in suspension along a shoreline is often difficult to assess.

Figure 12- Stone Groin

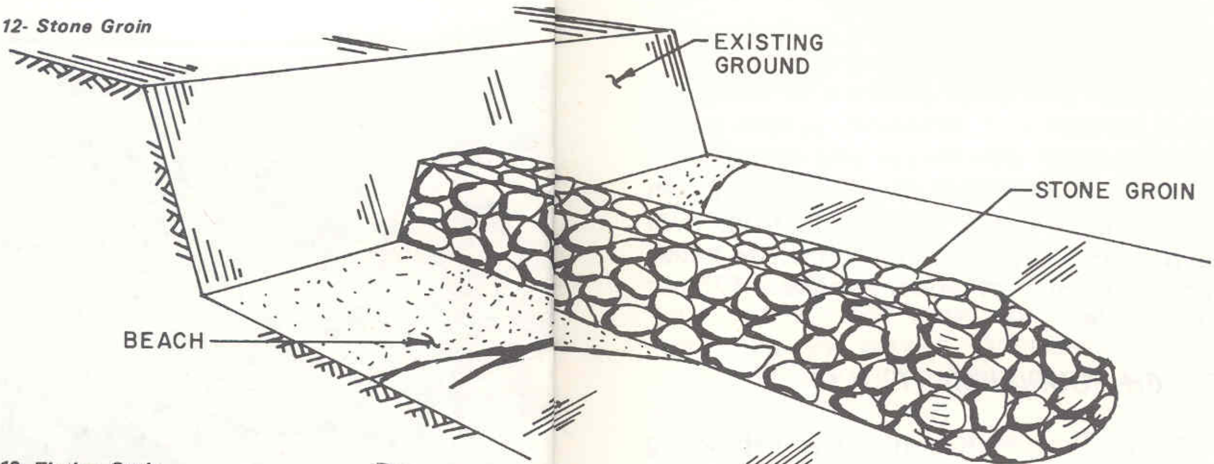


Figure 13- Timber Groin

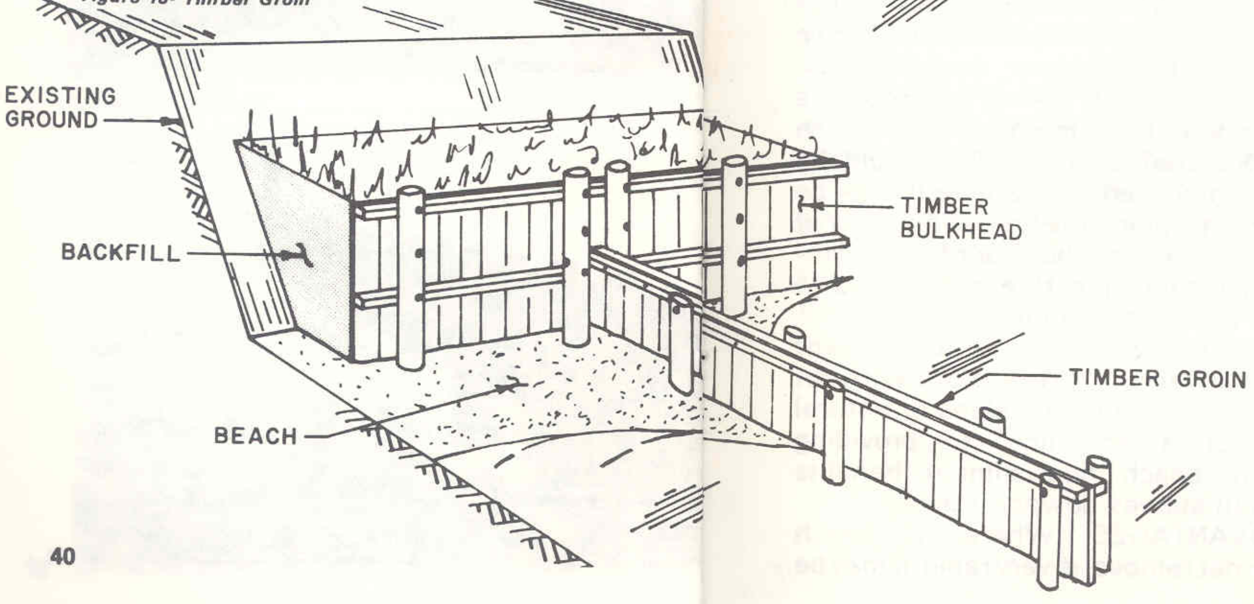
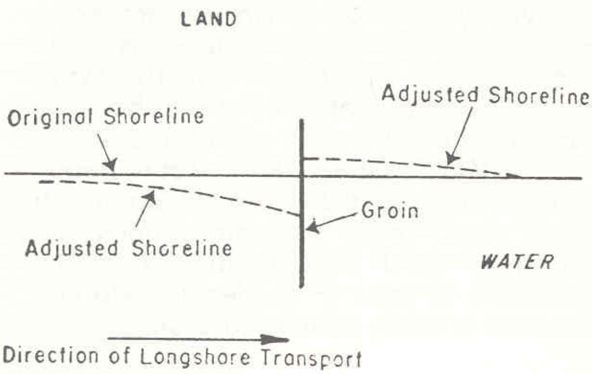


Figure 14- Downdrift Erosion



COST. Varies with length, water depth and material used. Groin constructed of stone generally cost about $50 per linear foot while those of timber run about $75 per linear foot.

BEACH NOURISHMENT

Beach nourishment, by replacing material lost to shore processes, takes advantage of the natural protection which a beach provides against wave attack. Periodic beach fill using appropriate materials will help maintain the beach profile. Material used for fill should be predominantly medium sand. Fill may be placed directly along the eroded sector or at the updrift reaches. The rate of replenishment must equal the rate of net loss to maintain the beach profile.

ADVANTAGES. Beach nourishment provides effective protection without altering the recreational values or natural integrity of a shoreline. In providing protection, beach nourishment benefits rather than starves downdrift areas.

DISADVANTAGES. Where no beach exists, or net removal is very rapid, it may be difficult to maintain a beach of adequate dimensions to protect the fastland. Even a well developed beach will not provide total protection against large storms. Where fill may cover existing aquatic organisms through sedimentation it is discouraged by regulating agencies.

COST. Varies greatly with frequency, amount of fill material used, and transport distances. Generally, the initial investment is low.

VEGETATIVE PLANTINGS (INTERTIDAL)

Vegetative plantings in the intertidal zone, under proper conditions, can be effective in trapping sand and dissipating wave energy. However, this method is not well tested and is probably most effective when used as a supplement to other measures. Planting in beach areas must be done during low tide and calm conditions in trenches parallel to shore. The plantings, particularly when new, are vulnerable to uprooting by waves. Appropriate grass types will vary with salinity, depth of water, and type of material.

ADVANTAGES. Planting is a low cost method of protection and will increase the effectiveness of other beach accretion devices.

DISADVANTAGES. Plantings, used alone, have a low probability of success in areas experiencing high wave energy.

COST. Low. Probably less than $5 per linear foot of shore front, depending on area covered. Professional design and construction is presently available in the Chesapeake Bay area.

PROBLEMS

Either inadequate planning or faulty construction efforts with respect to shoreline protective devices may result in undesirable problems. Adverse environmental impacts associated with protective structures was discussed previously in the section on planning considerations. Similarly, other specific problems such as downdrift erosion have been mentioned. Therefore, emphasis in this section is placed on the problem of structural failure. Selection of an inappropriate control device, or improper installation, may result in structural failure. Not only is the investment in the structure lost, but erosion of the property continues unabated. Examples of common structural failures for the Bay region are illustrated in the following photographs.

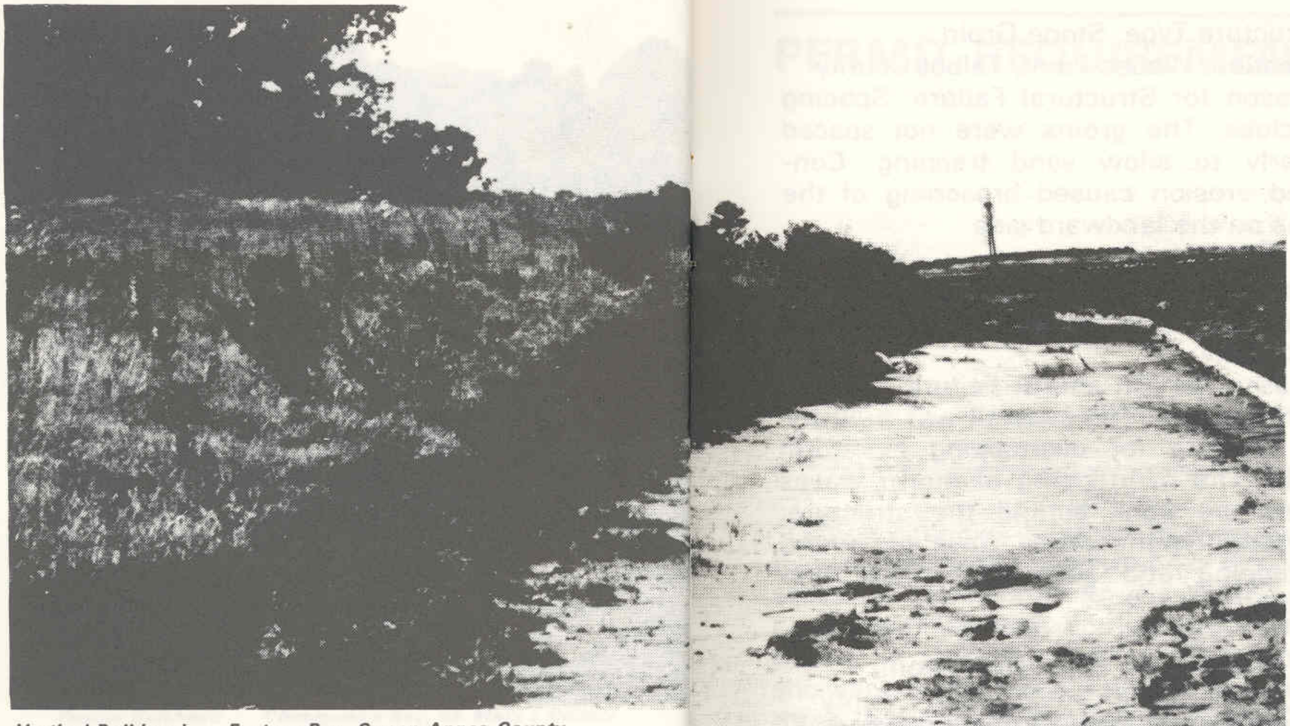
Structure Type: Timber Bulkhead
Location: Chesapeake Bay, St. Mary's County

Reason for Structure Failure: Improper fitting of tongue and groove joints. A small erosional hole developed between the area of the loose tongue and groove joints. By the process of surface runoff and wave action,

Timber Bulkhead *Chesapeake Bay, St. Mary s County*

 Timber Bulkhead *Ragged Island, Dorchester County*

Stone Groins *Wades Point, Talbot County*



Vertical Bulkhead   *Eastern Bay, Queen Annes County*

 Block Revetment   *Island Creek, Talbot County*

continue erosion behind the loose joint enlarged the hole and weakened the entire structure. Preventive maintenance by backfilling the small hole may have prevented total structural failure.

Structure Type: Timber Bulkhead
Location: Ragged Island, Dorchester County

Reason for Structural Failure: No tiebacks or batterpiles. The bulkhead was built without any tiebacks and was subsequently backfilled with material. The additional weight of the backfill exerted pressure on the bulkhead causing the structure to be bowed out and misaligned. This weakened the tongue and groove joints of the bulkhead, allowing erosion to continue between the joints.

Structure Type: Stone Groin

Location: Wades Point, Talbot County

Reason for Structural Failure: Spacing too close. The groins were not spaced properly to allow sand trapping. Continued erosion caused breaching of the groins on the landward side.

Structure Type: Vertical Bulkhead

Location: Eastern Bay, Queen Annes County

Reason for Structural Failure: Vertical height too low. The seawall was built too low allowing for overtopping by storm waves. The overtopping of storm waves eroded the bank behind the structure. Increased height would have prevented overtopping and save the banks from eroding.

Structure Type: Block Revetment

Location: Island Creek, Talbot County

Reason for Structural Failure: Chemical weathering of mortar. Saline water of the Bay chemically attacked the mortar, thus weakening the joints. Once weakened, physical wave attack removed the blocks allowing for erosion to continue.

PERMIT REQUIREMENTS

Many agencies have an interest in the development and conservation of the shore areas of the State. Permit systems to control and regulate such changes in these areas, including the installation of shoreline protective structures, exist at all three levels of government: Federal, State and Local.

Federal

The District Engineer, U.S. Army Corps of Engineers, has responsibility for the administration of Federal laws for the protection and preservation of the waters of the United States. His determination as to whether a permit will be issued will be based on an evaluation of the impact of the proposed work on the public interest. Public interest is described as including factors such as navigation, fish and wildlife, water quality, economics, conservation, aesthetics, recreation, water supply, flood damage prevention, ecosystems and, in general, the needs and welfare of the people. Authority is included to require that the structure will be so designed and built that it will resist wave and other destructive forces to avoid becoming a hazard to navigation.

Permit applications submitted to the Corps are regularly circulated for comment to the Environmental Protection Agency, the Department of Interior, the National Marine Fisheries Service, and appropriate state and local agencies.

The U.S. Environmental Protection Agency (EPA) is an independent Federal agency established in 1970 to maintain and improve our Nation's environmental quality. EPA, in accordance with the Environmental Policy Act of 1969, the Clean Air Act of 1970, the Federal Water Pollution Control Act Amendments of 1972, and various Executive Orders, advises the U.S. Army Corps of Engineers as to the water quality impacts of proposed projects to be constructed in navigable waters. The agency reviews the plans of all such projects, including shoreline protective structures, to insure that water quality degradation during and after construction are minimized.

When reviewing shoreline protection projects EPA considers the project's necessity, location, and design. In areas of severe, rapid erosion the permit application process can be expedited to cope with the immediate need.

Project location with respect to the adjacent waterway is considered to insure its compliance with EPA's role to "preserve wetland ecosystems and to protect them from destruction." In order to be consistent with this Policy, shoreline protective structures should, wherever possible, be constructed at or above the mean high waterline of a tidal waterway. Encroachment in shallow water areas of marshlands should be avoided as these are key systems of our marine environment.

Filling, often an integral part of shoreline protection, is reviewed by EPA in accordance with Section 404 of the Federal Water Pollution Control Act Amendments of 1972. Fill should also be confined to non-vegetated wetland areas as much as possible.

Project design is reviewed with

considerable attention to water quality consequences of the type of shoreline protection proposed. Generally, structures such as riprap or stone revetments which, while effectively controlling erosion provide habitat for beneficial marine organisms, are favored as erosion control alternatives.

After review of project plans and, if necessary, a site inspection, recommendations are made to the responsible District Office of the Corps of Engineers. One of four basic positions is taken by EPA on any project: (1) A project can be considered as no threat to water quality and thus EPA submits no objection. (2) A project can be viewed as necessary but potentially damaging. In this case EPA may respond by recommending the attachment of conditions to the Corps of Engineers' permit. These conditions are designed to minimize water quality degradation. (3) Many projects may present significant water quality impacts associated with their proposed design. Whenever possible, EPA will recommend such revisions that would make these projects acceptable. (4) A project may be considered detrimental to water quality and unacceptable as proposed. In this case EPA cites reasons for the project's unacceptability and recommends that the Corps of Engineers' permit application be denied.

The permit application review authority of the Department of Interior (DOI) derives from the Fish and Wildlife Coordination Act of 1950. This act requires that "wildlife conservation shall receive equal consideration" in any Federal decision, and that the Federal agency making a decision consult with the United States Fish and Wildlife Service of DOI. Review guidelines published in the December, 1975 Federal Register reflect Fish and Wildlife policy as follows:

"(1) Bulkheads and seawalls generally will be acceptable in areas having unstable shorelines, but their construction will be discouraged where marsh, man-

grove, or other naturally protective and productive areas would be disturbed. In the latter situations, any necessary bulkhead should not reflect wave energy so as to destroy productive wetlands. In rapidly eroding situations where natural protective vegetation or other controls are inadequate, bulkheads placed in navigable waters will be acceptable if properly designed to moderate but not aggravate natural forces and processes.
(2) In extensively developed areas, rip-rap and/or designs utilizing natural vegetation will be encouraged in lieu of bulkheads of wood, concrete, or metal. Bulkheads will be acceptable that aesthetically and/or ecologically enhance the aquatic environment.
(3) On barrier and sand islands and sand beaches, bulkheads which would adversely affect the littoral drift and natural deposition of sand materials will not be acceptable."

Several State agencies may comment on Corps permit applications. These comments are consolidated by the Wetlands Permit Section of the Water Resources Administration. Agency comments are evaluated and recommendations for necessary mitigating measures are incorporated in the Water Quality Certificate issued pursuant to PL 92-500, Sec. 401.

Upon receipt of the recommendations from EPA, DOI (F & WLS), the approvals or denials from the State and local governments and other comments from private organizations and individuals on the proposed work, the District Engineer writes an Environmental Assessment on the proposal, holds public hearings (if necessary), and prepares his recommendations for final disposition on the case. If the application is within his purview to issue or deny, the District Engineer will make the final decision, if not, he will forward his report and recommendation to the next

higher Corps authority for final disposition.

State

Title 9 of the Natural Resources Article entitles owners of land bounding on navigable or tidal waters the right to protect, under specified conditions, their shore against erosion. To ensure this right within the administration of this Title, the following procedures are followed.

(1) A natural person who owns land bounding on tidal waters may apply to this Administration for a license to reclaim upland lost by erosion or avulsion during his ownership of the land. If this owner provides proof at the public hearing that such erosion or avulsion of fast land occurred during his period of ownership, since January 1, 1972, the owner's right to reclaim such land will be presumed by the Board of Public Works and a license issued for this work. A public hearing is required in such case and the license or permit issued to include such conditions as necessary to minimize any adverse effect on environment. Land lost to erosion or avulsion before January 1, 1972, is not covered by this rule and any request for reclamation of such land will be considered on its own merits in the same manner as an original proposal to extend solid fill to encroach into the wetland area and will be disapproved unless there is overriding benefit to the public.

(2) The previously mentioned state policy described in Title 9 to protect the wetlands while allowing the exercise of the right to a riparian owner to protect his shore against erosion is carried out using the following criteria in the review of proposed projects.

a) The construction of bulkheads or other shore protection measures shall include only such filling as necessary for effective use of such measures. Such structures shall generally be located at the mean high water line or no further channelward than needed for proper tie-back emplacement, or in cases of a steep bank or cliff, no further channelward than needed to obtain a stable slope.

b) Where shore protection is needed and a marsh exists in front of an applicant's land, the shore protection structure shall be placed behind the marsh except for such work that would not interfere with normal tidal flow into the marsh.

c) Bulkheads shall extend in length to connect with existing bulkheads, where this is practicable, and if not so extended, shall provide for retaining the backfill material at bulkhead ends by bulkhead returns to the shore.

d) Because of their possible detrimental effect, shoreline protective structures may not be approved or recommended for approval in the following cases, except where there is no alternative means to achieve a necessary public benefit whose need significantly outweighs the harm done by the proposed work:

- Litttle or no erosion is occurring or likely.
- Marshland will be filled or otherwise destroyed.
- Marshland is adequately serving to buffer erosion.
- Surface drainage channels will be filled or occluded.
- The adjacent properties could be detrimentally affected, such as by erosion of the shoreline or sedimentation and accretion in the boat mooring area.
- A precedent will be set by bulkheading a reach of a cove, river, etc. which has no existing protective structures and which might not otherwise be justified by the rate of erosion.
- Navigation will be adversely affected.
- Unique or rare and endangered flora or fauna will be affected.

- Important historical or archeological sites will be adversely affected.
- Views of adjacent property owners will be completely obscured or the project will seriously detract from the aesthetic appearance of the area.
- Private oyster leases or natural oyster bars in adjacent open waters will be affected.

e) The Administration shall encourage the provision of shoreline protection in locations subject to severe erosion where conditions described in d above do not apply. In the review of such projects in locations certified by Maryland Geological Survey to have severe erosion, the Administration shall approve such protective works to be constructed in such way to have minimum adverse effect upon the ecological, economic, hydrological, aesthetic, historical, and recreational values in the area.

f) Permits or licenses may not be granted for shore structures or filling unless adequate provision is made for drainage from inland areas. The construction of bulkheads in wetland areas shall involve only such filling as is necessary for the effective operation of the shore protection work.

g) Dredging for fill to be used for the efficient operation of shore erosion control works shall be allowed only where access for land source material is not feasible or costs are excessive and it is determined not to have an extended or permanent adverse environmental impact. Dredging seaward of an existing bulkhead will alter the graduated bottom depth that now helps dissipate wave energy. Accordingly, it shall be restricted to that which is needed for access to navigable water. If dredging is used for fill, adequate compensation shall be provided to the state for this material. Examples of cases where dredging to obtain backfill material may be permitted is where:

● A steep bank or cliff exists which makes trucking-in fill material infeasible.

● Large trees or buildings prevent trucking-in fill material.

For both, however, if grading is to be done, trucking-in fill material usually becomes feasible. The fact that dredged material is less expensive than trucked-in fill is not a decisive factor.

h) The shore protection measures used shall satisfy the following criteria regarding quality and permanence.

● When site conditions permit the use of a sloping bank stabilized with vegetation, with or without riprap, this method should be encouraged as an economical solution while preserving the natural conditions.

● Junk metal, tires, tree stumps and logs or other material not placed as an interlocking structure shall not be used as part of any shore protection measures.

● Bulkhead design shall be shown in the permit application and be adequate to retain backfill and to serve its intended purpose for at least twenty (20) years.

● If jetties or groins are used, they shall be designed and be at a minimum length to serve the purpose intended and only placed in a location not harmful to navigation or to nearby land owners and the general public. They shall be approved only if they do not interfere with public access, create adverse sand transportation patterns or adversely disturb the aquatic ecosystem.

● The approval by this Administration of any shore protection measures does not constitute state certification of the adequacy of the fixed structures for the particular circumstances or for any specified time period.

Before issuing State permits, the Department of Natural Resources and the Board of Public Works will require assurance that the proposed work meets the requirements and standards of other State agencies, of county and local government, and that the applicant has obtained or sought approval from the Corps of Engineers.

Local

Local codes and regulations pertaining to shoreline protection structures vary with jurisdiction. Requirements of local government should be ascertained during the early planning stage of a proposed project. Soil Conservation Districts are required to review and approve sediment control plans before grading or building permits are issued. Early contact with the local Soil Conservation District is desirable.

AGENCIES

Additional information concerning shoreline protective structures or agency criteria concerning their review may be obtained by contacting:

The District Engineer
U.S. Army Engineer District
P.O. Box 1715
Baltimore, Maryland 21203

Supervisor, Southern Area Office
U.S. Fish and Wildlife Service (ES)
1825-B Virginia Street
Annapolis, Maryland 21401

Environmental Protection Agency
Region III
Curtis Building
6th & Walnut Streets
Philadelphia, Pa. 19106

Wetland Permit Section
Permits Division
Water Resources Administration
Tawes State Office Building
Annapolis, Maryland 21401

U.S. Department of Agriculture
Soil Conservation Service
4321 Hartwick Road
College Park, Maryland 20740

Shore Erosion Control
Capital Programs Administration
Tawes State Office Building
Annapolis, Maryland 21401

Maryland Geological Survey
The Johns Hopkins University
Baltimore, Maryland 21218

Energy and Coastal Zone Administration
Tawes State Office Building
Annapolis, Maryland 21401

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CREDITS

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Water Resources Administration
Capital Programs Administration
Energy and Coastal Zone Administration
Maryland Geological Survey

Chesapeake Research Consortium,
University of Maryland

U.S. Fish and Wildlife Service
Southern Area Office

U.S. Army Corps of Engineers
Planning Division, Baltimore District