Treating Shoreline Erosion – A Concise Guide for Woodlake Homeowners
July, 2010

Introduction:

The Woodlake Community Association (WCA) owns the nearly all of the reservoir's shore and riparian buffers within our community. The Woodlake Covenants Part IV requires that any proposed action taken along the shore within the buffers has to be approved by the WCA. It is in the best interests of waterfront landowners to insure that shoreline adjacent to their property remains stable. Sometimes, due to wind and wave action, erosion problems threaten the shoreline, causing landowners to ask for permission to stabilize the shore near their property.

This guidance is intended to set guidelines for both WCA and owner-initiated stabilization projects and to speed up the WCA approval process. The WCA is responsible to insure that all upgrades or remedial action along the shoreline are in the best interests of the community and protect the health of the reservoir. Because of the legal issues associated with land ownership around and under the reservoir, and because it is part of the Chesapeake Bay watershed, any work in the common areas along the shore shall be approved in advance by both the Woodlake Environmental Committee (WEC) and the Architectural Review Board (ARB) of the WCA, likely has to be approved by East/West Partners who own a majority of the land under the reservoir water, and has to be permitted by Chesterfield County and the U.S. Army Corps of Engineers.

Shoreline Erosion Problems:

Shoreline erosion and deposition are a constant in natural systems where water, land and wind interact. Consideration of basic concepts related to erosion processes and stabilization techniques is essential to assure that your investment in shoreline erosion control achieves your objectives, protects the reservoir and the interests of our community.

1) Loss of land, trees, shrubs and other wildlife habitat as well as aesthetic beauty;
2) Damage to erosion prevention devices, stop-a-whiles, or other mooring areas;
3) Damage to existing shoreline features such as beach areas, access points, etc.
4) Deposition of sediment and nutrients into the reservoir with water quality degradation implications;

Sources of Shoreline Erosion:

<u>Wave action</u> is the primary cause of shoreline erosion and is typically found along land that intercepts the prevailing winds and associated waves (wakes from boats can also cause erosion, but this is not a concern in Swift Creek Reservoir due to the prohibition of motorized boats).

<u>Wave action combined with poorly secured/moored recreational boats such as pontoon boats.</u> The leading edges of aluminum pontoons can cause shoreline erosion by repetitively impacting the banks of the reservoir where they are moored as a result of wave action.

<u>Surface runoff</u> caused erosion can also occur and is typically found where a combination of factors conspires to cause concentrated runoff. Concentrated runoff of surface water provides the energy needed to remove soil and deposit it down-slope including into the reservoir. Steeper slopes, lack of natural vegetation, amount of drainage area up-slope, amount of impervious surfaces up-slope and the amount, quality and frequency of access trails and use by property owners and others all contribute to concentrated surface runoff.

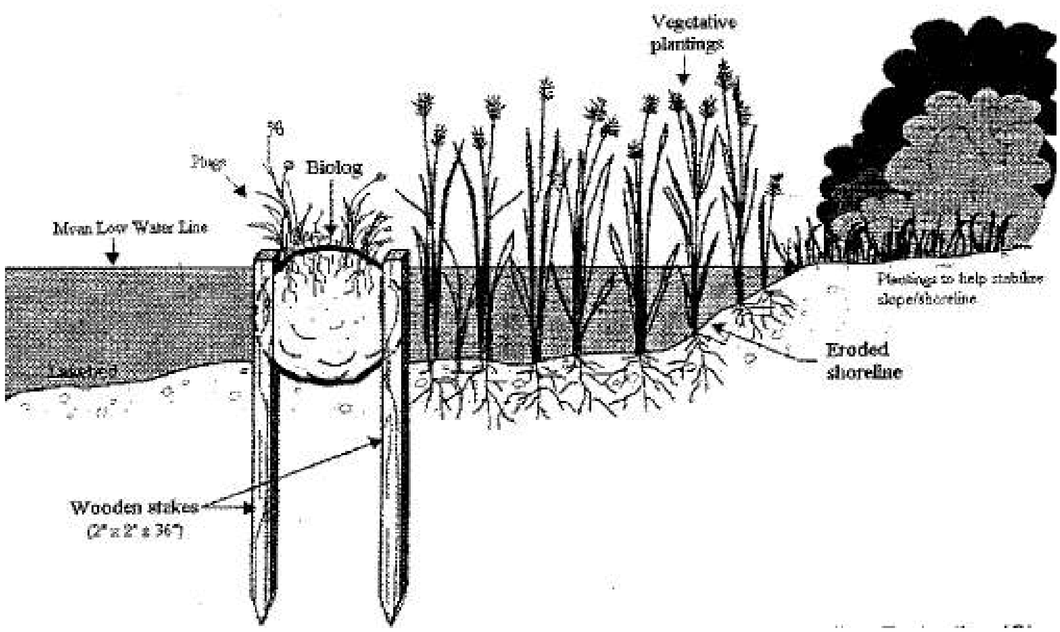
Treatment Options:

For Shoreline Erosion:

Below are the principal means of treating shoreline erosion, rank-ordered from most preferred to least preferred for Woodlake residents. Each project will need to be treated on an individual basis based on site conditions.

Bioengineering approaches use earth-work methods, typically shaping and grading, to reduce the steepness of the slope, along with planting of vegetation, typically trees and shrubs and biodegradable energy dissipaters/sediment collection devices such as coconut fiber logs(a manufactured product that is staked into the toe of the slope). These installations protect shorelines by dissipating wave energy and protecting the shore behind them. They allow natural building of the shoreline as the vegetation behind the logs trap soil particles and nutrients. Bioengineering approaches are preferable from an aesthetic and ecological functions perspective, and should be used whenever possible. They don't fit all shoreline erosion situations, e.g., steep bank and deep water settings.

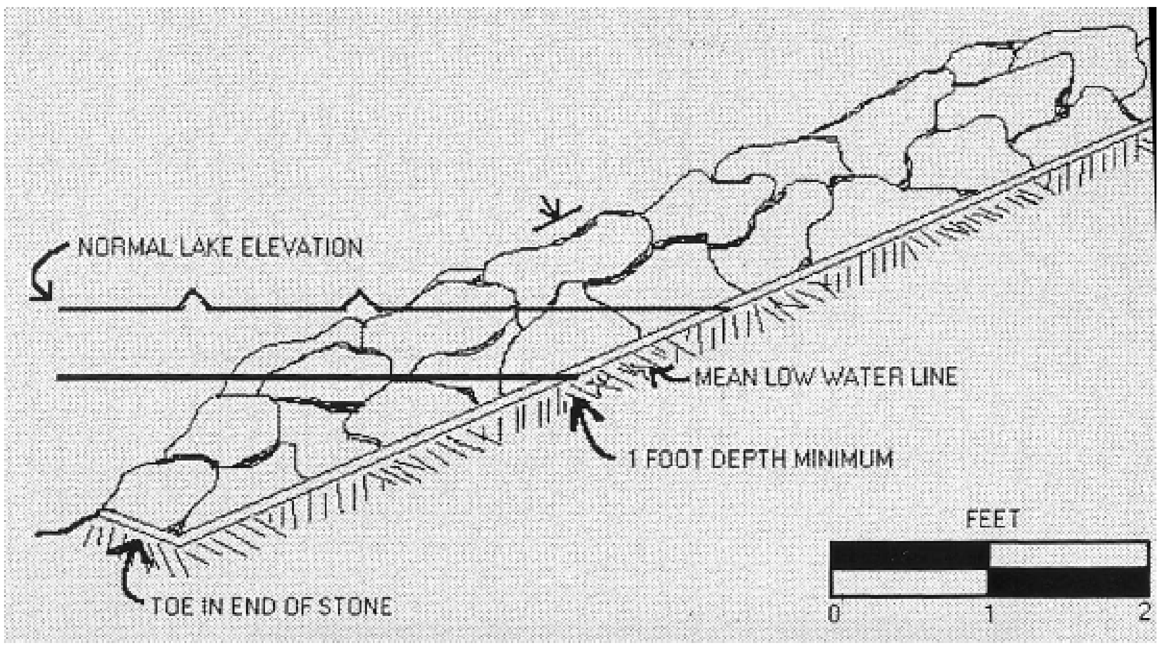
Schematic depicting one of many bioengineering options



Schematic borrowed from "Chapter 16 - Streambank and Shoreline Protection" from the USDA/Natural Resource Conservation Service's Engineering Field Manual; (also please see "Shoreline Stabilization Guidelines" from the Reston Association, Reston, VA for specific plant species recommended for shoreline erosion sites).

Riprap revetments use large rocks, concrete slabs or gabions placed along the shore above and below the water level (gabions are galvanized metal baskets containing small riprap). This approach, when installed properly, is the longest lasting alternative (potentially indefinitely) and is preferred when "hardening" is needed. "Hardening" measures may be needed where shoreline erosion has created vertical or near vertical banks and where the bed of the reservoir drops off steeply. Key features of riprap revetments are adequately sized rocks, a "toed-in" bottom row of riprap to prevent the rocks placed above from sliding down the slope into the water, extension of the rocks far enough below the low water line to prevent collapse. Most contractors will want to end-dump riprap rather than place the rocks in an intentional manner. Intentional and careful placement of riprap is a requirement to insure proper construction. Also, most contractors will not use large enough nor adequate quantities of rock. Riprap has to withstand both wave action as well as human interference, especially in places where the public has access. The stones need to be at least Class I which is large enough to prevent kids from picking it up and throwing it into the water. Riprap should be installed to a minimum thickness of 2 times deeper than the width of the largest rocks. A thick layer permits the rocks to lock themselves into place and better resist wave action. A thinner layer of riprap will cause the rock to move and slip.

Schematic depicting a Riprap Revetment



Schematic borrowed from "Shoreline Stabilization Guidelines" from the Reston Association, Reston, VA

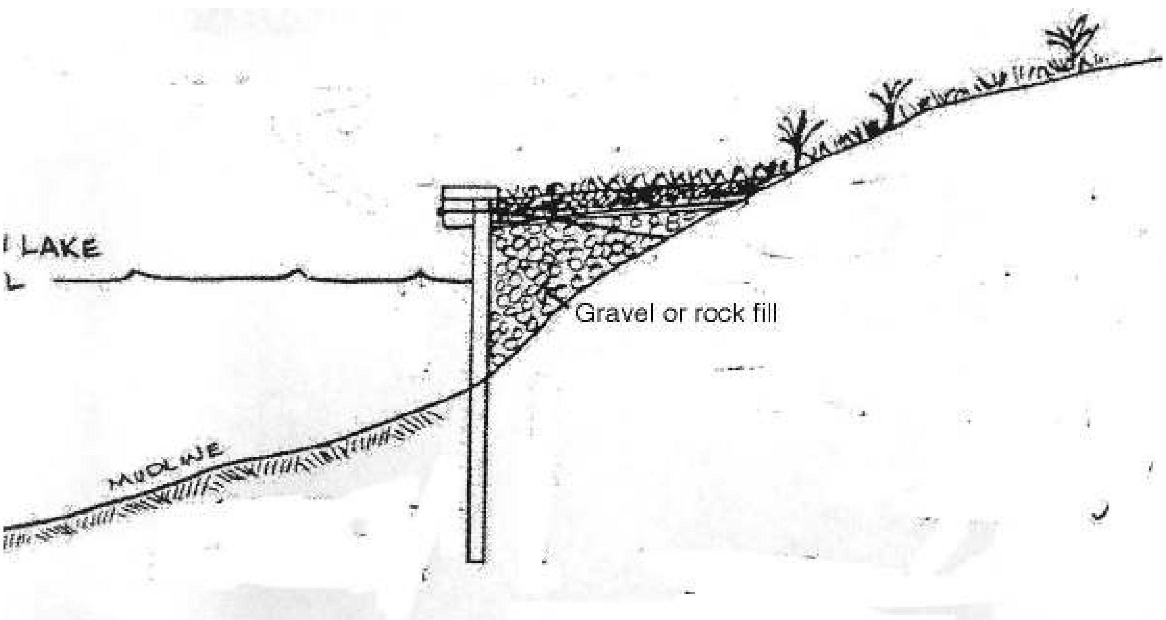
Some contractors use geotextile (filter fabric) under riprap to prevent soil movement underneath that could contribute to destabilization of the rock. This should be avoided in riprap projects in general , but especially on sites with steep slopes as the fabric can cause the riprap to slide around. Such fabrics can interfere with the rock settling into themselves and the underlying soil (geotextile works well in other circumstances such as behind bulkhead walls to prevent soil erosion).

A hybrid combination called <u>vegetated riprap</u> involves planting trees in the joints and spaces between the rocks. The vegetation helps anchor the riprap and stabilizes the adjoining upslope areas. This is an excellent way to increase the eye appeal of the riprap and creates conditions that will encourage a living mat of tree roots under the riprap. Lastly, if aesthetics are a major concern, river cobble or even soil can be back-filled into the voids within the riprap to give it a softer and more appealing look. This will also make it a safer surface for foot traffic.

<u>Bulkheads</u> typically consist of treated tongue and groove sheet lumber piles driven into the bed of the reservoir. The service life of bulkheads is much less than riprap and will be determined by the quality of the engineering design and the materials and workmanship applied during installation. The height of a bulkhead is determined by

the slope of the land behind the bulkhead and the reservoir bottom below it, and the height of storm generated waves you are trying to control. Installation of bulkheads may be limited by the depth to bedrock where the piles are intended to be driven. If bedrock is an issue, the design of a bulkhead can be modified to accommodate this concern, but it would drive up the cost significantly.

Schematic depicting a Bulkhead



Schematic borrowed from "Shoreline Stabilization Guidelines" from the Reston Association, Reston, VA

<u>Breakwaters</u> consist of large riprap or fabricated concrete forms placed in shallows off shore to dissipate wave energy. Note: Since breakwaters entail installation of structures offshore out in the reservoir, they are discouraged because they obstruct navigation and complicate the permitting process.

<u>Groins</u> are perpendicular structures of riprap and/or timber pilings with sheet piles in between intended to dissipate littoral drift or along shore currents/wave action. Note: Since groins entail installation of structures offshore out in the reservoir, they are discouraged because they obstruct navigation and complicate the permitting process.

<u>Combinations of the "hardening" approaches shared above along with bioengineering (plantings and earth work commonly referred to as shaping and grading)</u> should be considered when plantings of vegetation or bioengineering alone will not solve a given site's shoreline erosion.

Bioengineering approaches are preferable from an aesthetic, environmental functions, and wildlife habitat perspective, and should be used when possible, but don't fit all shoreline erosion situations. Some problems require more "hardened" approaches. Regardless of the approach, geotextile fabrics, commonly referred to as filter fabrics or erosion control fabrics, are very useful for assisting nature in holding works of improvement together. They are especially helpful underlying riprap and coconut logs, behind bulkheads, etc. and as long as they are covered and not exposed to the sun, and not punctured, they will last indefinitely.

Comparison of Shoreline Erosion Treatment Alternatives for Reservoirs

Aspect/ Alternative	Bio-engineering	Riprap	Bulkheads	Break-waters	Groins	Com-binations
Lifespan[1/]	indefinite	indefinite	15-20 yrs.	indefinite	15-20 yrs.	15 yrs. - indefinite
Initial Cost	$15-$20/linear ft. of shoreline	$50-$75/linear ft.	$75-$125/linear ft.	$60-$80/linear ft.	$35-$50/linear ft.	$35-$50/linear ft.
Annual Maintenance	low	very low	low to moderate	very low	very low	low to moderate
Replacement Costs	low	n/a if sized & installed correctly	moderate if partial replacement to high if all	n/a if stone is sized & installed correctly	moderate if partial replacement to high if all	low to moderate
Energy Dissipation[2/]	fair to good	excellent	poor	excellent	poor	good to excellent
Energy Deflection	low	low	very high	low	moderate to high	low to moderate
Access	easy	very poor	excellent	n/a	easy	easy
Aesthetics[3/]	excellent	very low	architecturally pleasing	low to fair	low to fair	good to excellent
Wildlife Value	highest	low	very low	good	very low	good to excellent
Environmental Functioning[4/]	highest	fair	very low	low to fair	low to fair	good to excellent
Risk of Failure[5/]	moderate	very low	moderate to high	very low	moderate to high	moderate
Leaching of Chemicals?	n/a	n/a	yes	n/a	n/a	n/a
Debris a Concern?	yes	yes	no	n/a	low	yes

1/ Lifespan is a function of the materials used and the quality of the design and installation, e.g., properly sized and installed riprap will last indefinitely; riprap that is too small will fail either gradually or during major storms; plants with adequate moisture will last for whatever their typical lifespan is (shrubs - 20-50 yrs., trees - 60-300 yrs or more);

2/ Rocks used for riprap, groins or any other structure are much more effective at energy dissipation than wooden structures. Rocks also reduce energy deflection more than wooden structures such as bulkheads or groins built with wood;

3/ Aesthetics are individual values/perception determined, i.e., "Beauty is in the eye of the beholder."

4/ Environmental functioning includes, e.g., wildlife habitat, uptake of nutrients, filtering/remediation of chemicals such as herbicides applied to lawns that get transported towards the water, the trapping of sediment and vegetative debris, etc. all of which are pollutants if they end up in the reservoir;

5/ Risk of failure is primarily a function of the quality of the design and installation with steepness of the shoreline and severity of wave action being the main factors affecting risk;

It should be noted that erosion prevention devices (EPDs) in Woodlake require a permit by the Woodlake Community Association. The standard design and drawing is available from the WCA and they are designed to provide secure mooring for recreational boats to prevent wave induced degradation of the shoreline. They also greatly aid access to recreational boats which further helps to prevent shoreline erosion. However, they are not suitable for treating shoreline erosion problems derived primarily from wind driven waves. Thus, they are complementary to the shoreline stabilization techniques listed above, but are not a substitute for them.

For Upland Erosion:

1) A vegetative buffer with native vegetation is the best alternative for controlling upland erosion if conditions for them alone makes sense.
2) "Waterbars" - Sometimes vegetative plantings alone don't make sense such as when rills (small gullies) or large open gullies have formed as a result of concentrated runoff. In these cases, waterbars (small diversions) that slow runoff down, and divert it to controlled outlets that spread concentrated flow into shallower and less damaging surface runoff.
3) "Water gardens" – Earthen swales (drainage-ways) and shallow depressions that collect storm runoff and allow it to percolate into the soil profile slowly avoiding concentrated surface flows.
4) Hardened drainage-ways – There are many ways to achieve this approach.

In addition to the above treatments, "silt-fences" and/or straw bale "check-dams" are often used as complementary erosion and sediment control devices for temporary control until either the vegetative treatments get established and/or until hardened approaches are completed. Erosion and sediment control measures are essential during any project that moves soil, drives piles, places riprap into or above the water or otherwise stirs sediment near or in the bed of the reservoir.

Planning Considerations:

Shoreline geography/landscape features affect erosion problems and treatment options, e.g., earthen embankments with limited or no bedrock control call for more toe of slope stabilization below the normal water level and wave actions. The depth to bedrock concern limits how deep piles can be driven. If they cannot be driven into the soil to an adequate depth, then engineering techniques will need to used to address stability concerns.

Fetch, or the distance prevailing winds can accelerate over directly relates to the magnitude of energy that waves can gather then dissipate on the shoreline. The greater the open fetch, the larger the waves, and the larger and more erosive the wave actions will be. The fetch to the north and west of Rock Harbor, Clipper Cove, West Shore, Watercrest and Beechwood Point is quite long ranging up to almost two miles long.

Lakebed slope adjacent to the shoreline directly affects treatment options with steepness/rapidly increasing depth increasing both treatment complexity and cost to stabilize;

Steepness of the shoreline above the water affects treatment options also with steeper slopes being more complex and expensive to stabilize. Steeper slopes also complicate/increase the need for greater load-bearing capacity behind riprap and/or bulkheads.

Storm-related, and/or seasonal wind driven high water elevations from related wave action and major storm events such as hurricanes need to be taken into account when designing and installing stabilization measures;

Zone or area of scour erosion in between high water marks and lowest hydrodynamic effects below the normal water level (typically lift and drag) must be considered in designing and installing treatment options. This zone is typically to a depth a little more than half the length of the waves that cause erosion. Below this zone the water hardly moves at all.

Riprap sizing is very important (too small and it will be moved around become less effective and possibly blown-out; too big and you've paid too much, but it is better to err on the side of being too big as larger rocks will do the job);

Access to your site will determine how construction will have to proceed whether via your lot and common property and/or from a barge that delivers heavy rock and other construction materials. Heavy equipment access through your property and that of the WCA may well destroy vegetation and cause some damage to common property. A permit from the WCA for accessing the common property is required before any project is implemented. The planting of new trees, shrubs and/or groundcover after project completion will be a requirement of the WCA.

Leave plenty of time for the approval process. The WCA will strive for quick approval, but dealing with other entities may take a significant amount of time, depending on the project's circumstances and complexity.

Potential After-Treatment Mechanisms of Failure:

Undermining of the toe of the slope – wave action can continue to erode the toe of the slope where riprap, a bulkhead or bioengineering treatments have been installed. It is imperative that whatever treatment is used, the toe of the slope must be stabilized ("keyed-in") below the zone of wave energy scour.

Waves overtopping the structure with erosion occurring above and behind the structure;

Slippage of stabilization works of improvement away from the shoreline from excessive loading/backfilling behind the control device;

Tipping of structures from excessive loading/backfilling behind the control device;

Flanking failures (potential for upwind or downwind adjustments/energy transfer and dissipation on adjoining property; effectively a transfer of the problem or part of it causing or exacerbating problems elsewhere);

Contracting Recommendations for larger/more expensive projects:

1) Solicit 5-10 licensed and insured contractors to make an initial survey of the site; discuss issues and concerns with them and ask lots of questions then get them to submit initial proposals/bids in writing;
2) Clarify any issues or concerns you might have and be sure to understand each firm's terms and conditions of doing business (how much is due at signing, completion of certain phases, warranty coverage, etc.);

3) Solicit references from prior clients for each bidder, then contact them to learn about their experiences and the things that they liked and disliked;
4) Determine the treatment approach you want to use and develop a single set of technical specifications;
5) Identify the 2-3 contractors you are most impressed with and solicit final detailed bids and project proposals in writing;
6) Ask your final questions; get any needed clarifications and adjustments to their bids, also in writing by an exchange of correspondence or revised bids;
7) Negotiate final terms and award best bidder with a contract;

Questions to ask when soliciting bids from contractors:

1) Do you have experience working with the Chesterfield County Environmental Engineering Department and/or the Army Corps of Engineers permitting section regarding needed permits?
2) For bulkheads, how will you determine whether or not the depth of soil to bedrock will prevent or allow pilings to be driven to an adequate depth (required depth = a little over half the length of typical waves assaulting your shoreline)?
3) For bulkheads, if bedrock will prevent pilings from be driven to an adequate depth, then how do you propose to engineer the bulkhead to stabilize it and the earth behind it?
4) For bulkheads, how do you plan to prevent tipping from excessive loading/weight behind it?
5) How do you propose to analyze and deal with the possibility of the toe of the slope becoming eroded and causing the structure to fail?
6) How do you propose to tie-in the limits of the structure so that energy is not allowed to transfer around the ends on the common property of my neighbor and cause failure from behind the structure?
7) Do you understand that any add-on pier/dock must meet, and cannot exceed, the WCA Architectural Review Board requirements for “Erosion Prevention Devices” or EPDs?

Other Thoughts:

Care and attention to details in implementation is more important than the same during the design phase. A well-designed and thought-out design is not worth much if project installation is sloppy.

If your neighbors have the same type of shoreline erosion problems, then discuss with them the possibility of jointly contracting for needed repairs as both could potentially enjoy an economy of scale discount as well as a discount arising from dividing the costs of a single mobilization/demobilization.

Conclusions:

Stabilization of eroding shorelines requires careful planning, design and installation. It also requires approval from the WCA through the Woodlake Environmental Committee (WEC) and Architectural Review Board (ARB), East/West Partners, who own a majority of the lakebed, Chesterfield County Environmental Planning and the Army Corps of Engineers. It should also be noted that “hardening” practices are not required in every situation and not all hardening practices are equal. For example, properly sized and installed riprap dissipates wave action very well. Conversely, bulkheads are very poor at dissipating wave energy and as a result transfer a majority of the energy received back out either towards deeper waters, the land underneath the water or to adjacent shoreline.

Vegetative and bioengineering solutions are the preference of the Woodlake Environmental Committee (WEC) where they will meet the site's needs. Where shoreline erosion processes are most severe, and bioengineering is deemed not likely to solve the problem, then riprap is the preference of the WEC. Ultimately, any project will have to be approved by the WEC and the ARB and the property owner is responsible for obtaining the needed permits. The WEC wants to work with all property owners with shoreline erosion problems to make your project a success.

Other Resources:

http://nsgd.gso.uri.edu/lcsg/lcsgh04001.pdf for a guide from the University of Vermont for shoreline erosion problems along Lake Champlain;

http://www.reston.org/LinkClick.aspx?qenc=ShZJAGgkmIovzuiOvezSItH8SkPtq03Feb4BDCoez%2BX8BAQhrT0k1%2BWjfufd906Kq%2BYYx7NiR7A%2FFdB0qmkje5xAqtuwExOtH6BeEUZLkSc%3D&fqenc=HzT9ACzZbNs%3D for a guide entitled "Shoreline Stabilization Guidelines" from Reston Virginia;

ftp://ftp-nhq.sc.egov.usda.gov/NHQ/pub/outgoing/jbernard/CED-Directives/efh/EFH-Ch16.pdf for Chapter 16 – Streambank and Shoreline Protection of the USDA/NRCS's Engineering Field Manual;

http://chl.erdc.usace.army.mil/Media/2/4/0/sect54govt.pdf for "Low Cost Shore Protection" by the Army Corps of Engineers or http://chl.erdc.usace.army.mil/Media/7/5/1/lcsp-1981.pdf for an abbreviated version of the same document;