NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

STREAMBANK AND SHORELINE PROTECTION

(Feet)

CODE 580

DEFINITION

Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.

PURPOSE

- To prevent the loss of land or damage to land uses, or facilities adjacent to the banks of streams or constructed channels, shoreline of lakes, reservoirs, or estuaries including the protection of known historical, archeological, and traditional cultural properties.
- To maintain the flow capacity of streams or channels.
- Reduce the offsite or downstream effects of sediment resulting from bank erosion.
- To improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, recreation.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to streambanks of natural or constructed channels and shorelines of lakes, reservoirs, or estuaries where they are susceptible to erosion. It does not apply to erosion problems on main ocean fronts, beaches or similar areas of complexity.

CRITERIA

Because each reach of a channel or lake is unique, measures for streambank and shore protection must be installed according to a plan and adapted to the specific site. Practices shall be defined as follows:

Vegetative - Woody and herbaceous plants used to reduce streambank erosion and prevent land losses and sediment damages but do not directly stabilize the channel bottom grade.

Bio-technical - A system of living plant materials used as structural components to stabilize streambanks. Components include live stakes, live facines, branch packing, vegetated geogrids, live cribwall, joint planting and brush mattress.

Structural - A system using hard measures to stabilize streambanks and shorelines. Practices include tree revetments, root wads, piling revetments, jacks, riprap, coconut fiber rolls, stream jetties, stream barbs, gabions and concrete or timber retaining walls.

General Criteria Applicable to All Purposes

Treatments shall be in accordance with all applicable local, state and federal laws and regulations.

Treatments applied shall seek to avoid adverse effects to endangered, threatened, and candidate species and their habitats, whenever possible.

Treatments applied shall seek to avoid adverse effects to archaeological, historic, structural, and traditional cultural properties, whenever possible.

An assessment of unstable streambank or shoreline sites shall be conducted in sufficient detail to identify the causes contributing to the instability (e.g. livestock access, watershed alterations resulting in significant modifications of discharge or sediment production, in channel modifications such as

gravel mining, head cutting, water level fluctuations, boat-generated waves, etc.).

Proposed protective treatments to be applied shall be compatible with improvements being planned or installed by others.

Protective treatments shall be compatible with the bank or shoreline materials, water chemistry, channel or lake hydraulics, and slope characteristics above and below the water line.

End sections of treatment areas shall be adequately anchored to existing treatments, terminate in stable areas, or be otherwise stabilized to prevent flanking of the treatment.

Protective treatments shall be installed that result in stable slopes. Design limitations of the bank or shoreline materials and type of measure installed shall determine steepest permissible slopes. Steep, unstable slopes and deep undercuts in banks and shorelines will require grading to a stable slope or will require structural measures such as tree revetments, root wads, cribwalls, rock riprap, or gabions.

For planting purposes, the steepest acceptable slope is 1.5 horizontal to 1 vertical. Slope stability analysis or design shall be subject to acceptable engineering practice and federal, state, and local regulations.

Erosion protection shall be provided to newly graded banks. The top of the bank shall be graded or a diversion at the top of the bank be installed to prevent erosion to the slope by overbank flow.

Vegetative practices without structural measures may only be considered on low hazard sites. With exception to tree revetments and root wads, structural practices must be used on all medium and high hazard sites. However, vegetation may be incorporated on all medium and high hazard sites to improve fish and wildlife habitat and aesthetics of the site.

Designs will provide for protection of installed treatments from overbank flows resulting from upslope runoff and flood return flows.

Internal drainage for bank seepage shall be provided when needed. Geotextiles or properly designed filter bedding shall be incorporated with structural measures where there is the potential for migration of material from behind the measure.

Treatments shall be designed to account for any anticipated ice action, wave action, and fluctuating water levels.

All disturbed areas around protective treatments shall be protected from erosion. Disturbed areas that are not to be cultivated shall be protected as soon as practical after construction.

Vegetation shall be selected that is best suited for the site conditions and achieves the intended purpose(s). Seeding recommendations can be found in Critical Area Planting, Code 342 and recommendations for planting woody material can be found in Tree/Shrub Establishment, Code 612.

In order to ensure plant community establishment and integrity, a vegetative management plan shall be prepared in accordance with NRCS conservation practice standard Critical Area Planting, Code 342.

Additional Criteria for Streambanks

Stream segments to be protected shall be classified according to a system deemed appropriate by the state. Segments that are incised or that contain the 5-year return period (20 percent probability) or greater flows shall be evaluated for further degradation or aggradation.

A site assessment shall be performed to determine if the causes of instability are local (e.g. poor soils, high water table in banks, alignment, obstructions deflecting flows into bank, etc.) or systemic in nature (e.g. aggradation due to increased sediment from the watershed, increased runoff due to urban development in the watershed, degradation due to channel modifications, etc.). The assessment need only be of the extent and detail necessary to provide a basis for design of the bank treatments and reasonable confidence that the treatments will perform adequately for the design life of the measure.

Changes in channel alignment shall not be made without an assessment of both upstream and downstream fluvial geomorphology that evaluates the affects of the proposed alignment. The current and future discharge-sediment regime shall be based on an assessment of the watershed above the proposed channel alignment.

Bank protection treatment shall not be installed in channel systems undergoing rapid and extensive changes in bottom grade and/or alignment unless the treatments are designed to control or accommodate the changes. Bank treatment shall be constructed to a depth at or below the anticipated lowest depth of streambed scour.

If the failure mechanism is a result of the degradation or removal of riparian vegetation, stream corridor restoration shall be implemented, where feasible, (see Additional Criteria for Stream Corridor Improvement) as well as treating the banks.

Toe erosion shall be stabilized by treatments that redirect the stream flow away from the toe or by structural treatments that armor the toe. Additional design guidance is found in the EFH Part 650, Chapter 16, Streambank and Shoreline Protection.

Where toe protection alone is inadequate to stabilize the bank, the upper bank shall be shaped to a stable slope and vegetated, or shall be stabilized with structural or soil- bioengineering treatments.

Peak discharge and/or hydrographs for capacity shall be determined by using appropriate analysis methods, such as:

- NRCS Technical Release No. 55 or No. 20,
- U.S. Army Corps of Engineers HEC-1,
- EFH, Chapter 2.
- Johnson and Tasker (March 1974) or other approved methodology.

Channel clearing to remove stumps, fallen trees, debris, and sediment bars shall only be performed when they are causing or could cause unacceptable bank erosion, flow restriction, or damage to structures. Habitat forming elements that provide cover, food, pools, and water turbulence shall be retained or replaced to the extent possible.

Treatments shall be functional and stable for the design flow and sustainable for higher flow conditions.

Treatments shall not induce an increase in natural erosion.

Treatments shall not limit stream flow access to the floodplain.

Where flooding is a concern, the effects of protective treatments shall not increase flow levels above those that existed prior to installation. A water surface profile analysis or other appropriate method (such as WSP2, HEC- 2, or Manning's formula) shall be used to determine the velocities in the channel.

Vegetative protection shall only be installed above the 2-year storm water surface elevation, regardless of whether it requires incorporation with other measures.

Structural and bio-technical measures shall be utilized individually or in combination with other systems to provide an appropriate level of protection based on design flows, velocities and hazard classification of the area being protected. Refer to East Region Supplement #1 to Chapter 16, EFH, for hazard classification system. They shall also be designed to avoid undesirable impacts upstream and downstream.

A minimum of 25 foot buffer width from the top of bank shall be established in grass and/or woody plants.

Additional Criteria for Shorelines

All revetments, bulkheads or groins are to be no higher than 3 feet (1 meter) above mean high tide, or mean high water in non-tidal areas

Structural shoreline protective treatments shall be keyed to a depth to prevent scour during low water. End sections shall be adequately bonded to existing measures or terminate in stable areas.

Recommended treatment shall be based on soil type and slope characteristics both above and below the waterline. For the design of structural treatments, the site characteristics below the waterline shall be evaluated for a minimum of 50 feet (15 meters) horizontal distance from the shoreline measured at the design water surface.

The height of the protection shall be based on the design water surface plus the computed wave

height and freeboard. The design water surface in tidal areas shall be mean high tide.

Vegetative protection shall be encouraged on eroding shorelines, especially on areas that are not susceptible to frequent or daily inundation. When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation. A minimum of 25 foot wide buffer area, measured from the top of bank, shall be established in grass and/or woody plants.

Appropriate bio-technical measures and installation procedures may be found in EFH Chapter 16 and East Regional Supplement.

Additional Criteria for Stream Corridor Improvement

Stream corridor vegetative components shall be established as necessary for ecosystem functioning and stability. The appropriate composition of vegetative components is a key element in preventing excess long-term channel migration in re-established stream corridors.
The establishment of vegetation on channel banks and associated areas shall also be in accordance with conservation practice standard Critical Area Planting, Code 342.

Treatments shall be designed to achieve habitat and population objectives for fish and wildlife species or communities of concern as determined by a site-specific assessment or management plan. Objectives shall be based on the survival and reproductive needs of populations and communities, which include habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors and native plant communities. The type, amount, and distribution of vegetation shall be based on the requirements of the fish and wildlife species or communities of concern to the extent possible.

Treatments shall be designed to meet aesthetic objectives as determined by a site-specific assessment or management plan. Aesthetic objectives shall be based on human needs, including visual quality, noise control, and microclimate control. Construction materials, grading practices, and other site development elements shall be selected and designed to be compatible with adjacent land uses.

Treatments shall be designed to achieve recreation objectives as determined by a site- specific assessment or management plan.
Safety requirements shall be based on type of human use and recreation objectives.

Additional Criteria for Vegetative Practices

Vegetative Practices are woody and herbaceous plants used to reduce streambank erosion and prevent land losses and sediment damages but do not directly stabilize the channel bottom grade.

Plant species must be suitable for the intended use and adapted to the site's climate, soil, and water conditions. Non-native plant species should be avoided. Species that root easily, such as willow, are required for such bio- technical measures as live facines, brushlayering, and live staking or where unrooted stems are used with structural measures. Plant materials will be live, viable, woody or herbaceous vegetation. The plant materials will be obtained from commercial sources or, in the case of woody cuttings, may be harvested from native stands during dormant periods (October - April depending upon location). Plant materials shall be installed singly or in systems as described in USDA - Natural Resources Conservation Service, Engineering Field Handbook, Chapter 16.

Bank sloping for establishment of vegetation shall be no steeper than 1.5 horizontal to 1.0 vertical. Plantings shall be extended from the normal water level or elevation of protective riprap to the top of bank.

Exposed bare streambank areas shall be protected by installing erosion control matting such as coconut fiber or jute netting. Allowable velocities for vegetative practices shall not exceed those shown in Table 2 of the East Region Supplement No. 1 to Chapter 16 of the Engineering Field Handbook (EFH).

Additional Criteria for Riprap, Bedding and Filters

The riprap shall be designed for the storm frequency indicated in the stability check column of the Hazard Classification shown in Figure 2 of the NE Region Supplement to Chapter 16, EFH.

Riprap size and gradation shall be designed using Vermont exhibit 16-1 on page 16-21.1 through 16-21.13 of Chapter 16, EFH or other approved methods.

In all cases consider increasing the size of the rock to allow for ice action.

Riprap shall extend at least two feet below the channel bottom in a key trench. This minimum may be reduced when the channel bottom is durable rock.

The slope of the completed riprap shall be 1.5 horizontal to 1.0 vertical or flatter.

Filters - are pervious materials designed to prevent the movement of soil particles out of the bank (base) by seepage water. Filters under riprap must also satisfy the functions of bedding.

Filters are not needed under riprap except where the bank (base) material is a fairly clean, poorly graded sand with a high seepage gradient (flow from the material above normal stream level). NEH Part 633, Chapter 26, “Gradation Design of Sand and Gravel Filters” shall be used to design filters.

The thickness of the filter blanket shall range from 6 inches to 15 inches for single layer and from 4 inches to 8 inches for individual layers of a multiple layer blanket. The minimum thickness maybe used when the gradation curves of adjacent layers are approximately parallel. The thickness should be increased proportionately when the gradation curve of a layer departs from parallel.

Bedding - is a layer of granular material used to distribute the riprap load, prevent leaching of bank (base) material by flowing water at the rock surface, and fill voids in the bank (base) in providing a uniform surface for riprap placement.

Bedding or material that fulfills bedding requirements should be used for all riprap installations.
Bedding may consist of:

- Suitable off-site gravel.
- Natural on-site gravels or sandy or silty gravels. Sands and silts may leach from the bedding surface after placement.
- At low hazard sites on low gradient streams, riprap that contains 15 to 25 percent gravel size materials may be place without a separate bedding layer.

Bedding material shall be well graded between
¾ inch to No. 4 sieve size. Bedding should have a maximum of 10 percent fines. It may contain sand and/or larger gravels. The bedding layer shall range from 6 inches to 12 inches but may be thicker when necessary to fill inherent voids.

Check the stability of the vegetation above the proposed top of riprap using the allowable velocity approach. If vegetation is not stable for the condition, raise the top of rock to the design storm height plus one-foot.

Additional Criteria for Retaining Structures

Concrete, timber, gabion, cribwalls and other type of retaining structures shall be design in accordance to the following criteria:

Retaining structures shall be designed to resist over turning and sliding forces.

Retaining structures shall be designed in accordance to the appropriate ACI, ASAE or other appropriate codes and standards.

Ice actions shall be taken into consideration in the design.

Weep holes or other drainage system shall be design to allow water from behind the retaining structure to drain freely.

CONSIDERATIONS

When designing protective treatments, consider should be given to the changes that may occur in the watershed hydrology and sedimentation over the design life of the treatments.

Consider utilizing debris removed from the channel or streambank into the treatment design when it is compatible with the intended purpose to improve benefits for fish, wildlife and aquatic systems.

Use construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, climate controls, buffers, etc. Avoid excessive disturbance and compaction of the site during installation.

Utilize vegetative species that are native and/or compatible with local ecosystems. Avoid introduced, invasive, noxious or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests. Species on noxious plant lists should not be used.

Select plant materials that provide habitat requirements for desirable wildlife and pollinators. The addition of native forbs and legumes to grass mixes will increase the value of plantings for both wildlife and pollinators.

Treatments that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered.

Consider maintaining or improving the habitat value for fish and wildlife by including treatments that provide aquatic habitat in the treatment design and that may lower or moderate water temperature and improve water quality.

Consider the need to stabilize side channel inlets and outlets and outlets of tributary streams from erosion.

Consider aquatic habitat when selecting the type of toe stabilization.

Consider maximizing adjacent wetland functions and values with the project design and minimize adverse effects to existing wetland functions and values.

Livestock exclusion shall be considered during establishment of vegetative treatments and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative treatments. Temporary and local population control methods should be used with caution and within state and local regulations.

When appropriate, establish a buffer strip and/or diversion at the top of the bank or shoreline protection zone to help maintain and protect installed treatments, improve their function, filter out sediments, nutrients, and pollutants from runoff, and provide additional wildlife habitat.

Consider conservation and stabilization of archeological, historic, structural and traditional cultural properties when applicable.

Consider safety hazards to boaters, swimmers, or people using the shoreline or streambank when designing treatments.

Protective treatments should be self-sustaining or require minimum maintenance.

Consideration shall be given to the water quantity effects on the water budget, especially on volumes and rates of runoff, infiltration, deep percolation, and water recharge.

Consideration shall be given to the water quantity effects on downstream flows and aquifers that affect other uses and users.

Consideration shall be given to the water quantity effects on the water table of adjoining fields and the effects on the interflow discharge into streams.

Planning, design and installation of this practice will be performed in accordance with acceptable engineering practice and local, state, and federal government regulations. This shall include Vermont's Accepted Agricultural Practices, local ordinances on stream buffer width and "Streambank and Lakeshore Vegetation Management (June 16, 1996)" by the VT Agency of Natural Resources, VT Dept. of Fish and Wildlife and, VT Dept. of Forest, Parks and Recreation.

Cost of measures vary widely and must be evaluated closely for monetary cost versus risk.

Transportation cost of measures can contribute significantly to the expense of the practice and must be evaluated carefully.

Plant materials of adequate quantity and quality are often a scarce resource. Their availability is critical to bio-technical solutions.

In situations where a key trench cannot be installed due to a durable rock stream bottom, the riprap should be pinned to the stream bottom by installing a minimum of one - one inch diameter steel pin per

five feet of streambank or one pin per base rock. Pins should be drilled and grouted into the first course of riprap rock and at least 18 inches in to the stream bottom.
The pin should not extend above the first course of rock on the stream bank.

Where it is not feasible to key the toe of riprap into the stream bottom due to access or depth of water, additional riprap bulk may be added to the toe to compensate.

PLANS AND SPECIFICATIONS

Plans and specifications for streambank and shoreline protection shall be prepared for specific field sites and based on this standard and shall describe the requirements for applying the practice to achieve its intended purpose.
Plans shall include treatments to minimize erosion and sediment production during construction and provisions necessary to comply with conditions of any environmental agreements, biological opinions or other terms of applicable permits.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be prepared for use by the owner or others responsible for operating and maintaining the system. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components or erosion.

REFERENCES

NEH Part 650, Chapter 2, Estimating Runoff

NEH Part 650, Chapter 16, Streambank and Shoreline Protection and East Region Supplement #1

NEH Part 650, Chapter 18, Soil Bioengineering for Upland Slope Protection and Erosion Reduction

NRCS Conservation Practice Standard, Channel Bank Vegetation, Code 322