NATURAL RESOURCES CONSERVATION SERVICE
MONTANA 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 **or minimize** 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. **When constructing, improving, re-creating, or restoring channel systems utilize Field Office Technical Guide (FOTG), Section IV, Practice Standard, Open Channel (Code 582).**

CRITERIA

General Criteria Applicable to All Purposes

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

Treatments applied, shall seek to avoid adverse effects to **federally listed** endangered, threatened, **proposed,** candidate species and their habitats, **including federal, state, or tribal species of concern,** whenever possible. **When federally listed or proposed species and/or designated critical habitat are present within or adjacent to the planning area, General Manual, Title 190, Subpart B, Section 410.22 and Montana FOTG, Section II, General Resource References, Threatened and Endangered Species shall be followed.**

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.). **Due to the complexity and interaction between vegetative, biological, and engineering issues and attributes, an interdisciplinary team should be utilized throughout project implementation.**

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,

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard contact the Natural Resources Conservation Service.

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channel or lake hydraulics, and slope characteristics above and below the water line. **Preference shall be given to treatments which utilize materials readily available to the site.**

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.

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. **Geotextiles for this purpose shall be needle punched and non-woven, meeting criteria for Class I requirements as outlined in the Construction Specification for Rock Riprap, MT-107.**

Commonly, with gravel bed streams, an appropriate gradation of material for filter bedding can be found on site under the armored channel bed material. Guidance and example calculation for the proper gradation of sand/gravel filter material can be found in the National Cooperative Highway Research Program Report 108 (HRB 108), Chapter 2, pages 35 through 39. Similar design criteria are briefly presented in TR-59.

Treatments shall be designed to account for any anticipated ice action, wave action, and fluctuating water levels. **Design considerations for counteracting effects from ice on riprap include:**

1. **Increase the rock size by a Factor of Safety. Local experience has determined safety factors as high a 2-5 to be appropriate for flat gradient streams.**

2. **Utilize a rock gradation that assures sufficient quantities of smaller rock to fill the voids between the largest rocks. This can be achieved by using the "Graded Rock" gradation chart in TR-69, Figure 10.**

3. **Place topsoil over the rock blanket to fill voids as well as promote grass establishment.**

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).

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. **In Montana, the Rosgen Stream Classification System shall be used to classify stream segments. Guidance can be found in NEH, Part 654 Stream Restoration Design, Chapter 11 as well as in the 1996 publication "Applied River Morphology" by Dave Rosgen.** 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 **by an interdisciplinary team** 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 follow FOTG, Section IV, Practice Standard, Open Channel (Code 582) and** 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. **In the case of riprap, the rock section shall be keyed into the riverbed a minimum of the D_{100} or 3 feet, whichever is greater. For rock structures, the footer material shall be placed a minimum of the D_{100} into the streambed or 2.5 times the minimum exposed height of rock, whichever is greater.**

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 **as well as NEH, Part 654, Chapter 14, Stream Restoration Design, and associated technical supplements.**

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. **Rock sizing methodologies are presented in NEH, Part 654, Technical Supplement 14C. Far West States - Lane's Method is the preferred methodology for determining the D_{75} of the designed rock gradation. Following the "Graded Rock" gradation chart in TR-69, Figure 10, the minimum allowable D_{50} shall be computed as $D_{75}/1.25$.**

On flat, low gradient streams, tractive stress or velocity based rock sizing systems, such as Lane's Method, will compute rock size that is inadequate for the stream size and characteristics. In these cases, computed rock size should be increased by a factor as determined from local experience. Factors can vary by as little as 1.25, which occurs when one assumes the computed value for the D_{75} (Lane's Method) is equal to the D_{50}, to 5 as may be needed to resist ice action.

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. **If possible, woody debris should be placed near the toe of the bank and/or at an elevation where the majority of the structure will remain submerged. This effort minimizes the deterioration of wood due to wetting and drying and also promotes a saturated condition facilitating its stability within the bank.**

Treatments shall be functional and stable for the design flow and sustainable for higher flow **(minimum 10-year event)** conditions. **Large woody debris placement shall be evaluated for floatation under the high flow condition. Stream barbs (rock sill structures projecting upstream at 20-45 degrees off a tangent to the bank) can be designed according to Oregon's Technical Note No. 23, "Design of Stream Barbs" and/or NEH, Part 654, Technical Supplement 14H. Bendway weirs, known by some as Stream Barbs, can be designed according to guidance presented in NEH, Part 650, Chapter 16, for Stream Barbs, pages 57-59. These structures are typically used on large streams and are oriented upstream 50 to 80 degrees off a tangent to the bank.**

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.

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.

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.

When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation.

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. **Detailed reference material for selection, propagation, and establishment of vegetative components can be found in the following documents:**

1. **Users' Guide to Description, Propagation, and Establishment of Native Shrubs and Trees for Riparian Areas in the Intermountain West, (Plant Materials Technical Note MT-36).**

2. **Users' Guide to Description, Propagation and Establishment of Wetland Plant Species and Grasses for Riparian Areas in the Intermountain West, (Plant Materials Technical Note MT-37).**

3. **FOTG, Section IV, Montana Standard and Specification for Riparian Forest Buffer (Code 391).**

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 **(Montana Biology Technical Note, MT-19, Rev. 2)** 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.

CONSIDERATIONS

Factor of safety should be considered with regards to rock stability for straight and curved sections of the project reach. Guidance for this evaluation can be found in TR-59. Suggestions for appropriate Factors of Safety (Minnesota Technical Release 3) are as follows:

1.0 – 1.2 Uniform flow: straight or mildly curving reach; little or no uncertainty in design.

1.2 – 1.4 Gradually varying flow: moderate bend curvature; limited or minor impact from floating debris or ice.

1.4 – 1.6 Sharp bend: Significant impact potential from floating debris or ice;

When designing protective treatments, consideration 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 in 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. **Treatments for this purpose include woody debris, woody riparian vegetation, or other bio-engineered measures which provide shade and cover.**

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.

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

National Engineering Handbook (NEH), Part 650, Chapter 16, Streambank and Shoreline Protection.

Applied River Morphology, Dave Rosgen, 1996.

Fischenich, J. Craig and James V. Morrow, Jr., Streambank Habitat Enhancement with Large Woody Debris, ERDC TN-EMRRP-SR-13, May 2000.

Fischenich, J. Craig, Stability Thresholds for Stream Restoration Materials, ERDC TN-EMRRP-SR-29, May 2001.

NRCS, Minnesota Technical Note 3, Loose Riprap Protection, July 1989.

NRCS, National Engineering Handbook (NEH), Part 654, Stream Restoration Handbook.

NRCS, National Engineering Handbook (NEH), Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters.

NRCS, Technical Release 59 (TR-59), Hydraulic Design of Riprap Gradient Control Structures, (1/1976).

NRCS, Technical Release 69 (TR-69), Riprap for Slope Protection Against Wave Action (2/1983).