BOARD OF WATER AND SOIL RESOURCES

River and Stream Bank Stabilization

Updated 8-18-2025

Document Purpose – This fact sheet is a companion to BWSR's Native Vegetation Establishment and Enhancement Guidelines and provides detailed considerations for project planning and design, with an emphasis on vegetation selection, installation and management.

Introduction – Stabilization of river and stream banks has been an increasingly common practice in Minnesota. Common goals of stream projects include decreasing soil loss, preventing damage to infrastructure, improving water quality, reconnecting to the floodplain, and improving wildlife habitat.

Site Selection – Program and project goals should be reviewed as a first step for site selection. Projects for streambank restoration are commonly selected based on identified threats to human safety, infrastructure and homes, impairment of water quality and wildlife habitat needs. Streambank projects may be part of efforts to widen habitat corridors that can provide multiple landscape benefits. Before a project is started the watershed should be assessed to determine the factors that may influence the success and sustainability of the project, such as flashy hydrology. The assessment can also help identify the highest priority areas along a waterway.

Bank stabilization with cedar revetments and erosion control

General Planning Considerations – River and streams are dynamic and constantly changing and their characteristics reflect watershed and local environmental conditions. Strong multi-disciplinary technical teams and conservation partnerships are needed to ensure the success of projects, and it is important that clear goals are defined for projects before detailed planning is started. Depending on project goals, potential project team members may include environmental planners, engineers, hydrogeologists, biologists, landscape ecologists, landscape architects and experienced contractors. Additional conservation practices may also be needed upstream in the watershed concurrent or prior to the stream project to address hydrologic fluctuations (flashiness) impacting the stream. Proposed projects should be assessed to avoid pushing problems downstream. It is also important to consider that streams can naturally meander over time, and allowing for these changes may be best long term.

Structural Design Considerations – Thorough assessments are needed for watersheds and site conditions that investigate geology, soils, groundwater seeps, existing vegetation, flow velocities, normal high water levels, flood levels and frequency, extent of the project floodplain, and use of the watercourse. For areas with severe erosion, various engineering or bioengineering solutions are often needed in addition to revegetation strategies. Engineering solutions may include the installation of rock, stumps, or toe-wood mats to secure the toe of the slope, or regrading to restore floodplain storage or water currents. Erosion usually occurs at the outside bank of a stream bend where the water velocity is the highest, so additional stabilization is often used along the toe of

the slope and in-stream practices may be used to direct the flow of water. Bioengineering techniques used to stabilize slopes can include branch packing, brush layering, brush mattresses, live fascines, toe wood sod mats, and live stakes.

Restoration Evaluation Program Recommendations:

The Minnesota Restoration Evaluation Program was established to help ensure the success of state-funded restoration projects. The following are key program recommendations for river and stream restoration that provide helpful guidance while planning projects.

Project Teams

The success of stream restoration projects is closely linked to having strong project teams and partnerships.

1) Use multidisciplinary project teams appropriate to project scale/complexity, including environmental planners, stream hydrologists, fisheries biologists, vegetative restoration specialists, hydrogeologists (to address groundwater seeps), and other staff as needed to meet project goals.
2) Engage state/granting agencies, local government units and technical experts early in the planning phase to receive additional technical input about projects.

Project Planning

Project managers should complete consistent project planning for all stream projects. This information is particularly valuable for stream and river restorations due to the complexity, cost, and risks associated. This consistent project planning process should include:

1) Identifying problems (e.g. stressors or impairments)
2) Documenting specific, multiple project goals – habitat, water quality, flooding, climate resilience
3) Designing strategies to address identified problems and specific goals based on a stream assessment
4) Budgeting funds adequate to achieve goals, including necessary easements
5) Creating an inspection schedule and operation and maintenance plan for all components of the project

Vegetation

Well established vegetation is critical for the long-term success of stream projects. While cover crops can provide temporary stabilization, establishing native vegetation takes planning and diligent maintenance especially in dynamic stream systems that are subject to frequent flooding. The following are important vegetation considerations:

1) Establish and apply performance standards for vegetation
2) Consistently apply BWSR's Native Vegetation Establishment and Enhancement Guidelines focusing on diverse native vegetation
3) Incorporate climate resiliency into vegetation planning

Documentation

Project documentation is critical for understanding, tracking and achieving successful restorations. The following are key considerations for documentation:

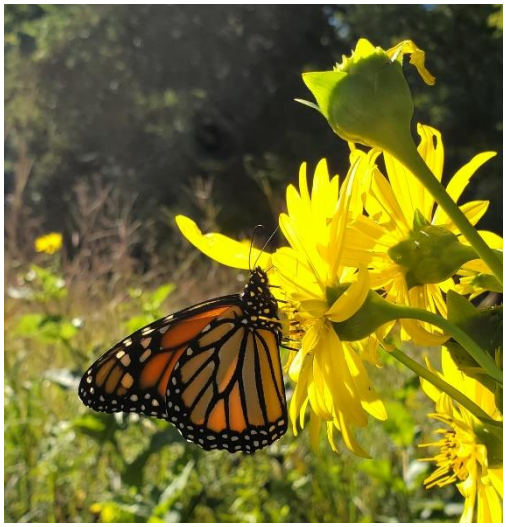
1) Documenting clear outcome-based goals is crucial for establishing a common understanding and tracking progress
2) Consistently document restoration project data in a simple and accessible format
3) Ensure that details of implemented actions are recorded and linked to the initial plan
4) Designate one project partner to permanently store project records and data

Plant and Seed Selection – The goal of slope stabilization is to provide rapid establishment as well as long term slope integrity. Fast growing species are often used to ensure initial stability. More long lived and deep-rooted species are used for long term stability. Native legumes that add nitrogen and promote plant growth are also commonly planted, with the added benefit of supporting pollinators. Many trees and shrubs can play an important role in providing long-term slope stability. Species with tap roots such as bur oak, hickory, pines and walnut can effectively anchor slopes. Species such as willow and dogwoods that establish from cuttings can also be used as part of bioengineering methods (branch packing, brush layering, brush mattresses, live fascines, revetments and live stakes). Sufficient moisture is needed for establishment of vegetation on steep slopes, so supplemental watering is typically needed.

A combination of fast-growing native species, deep rooted species, legumes, trees and shrubs are commonly used for bank stabilization.

Commonly Used Native Species in River and Stream Bank Stabilization

Cover Crops	Oats (Avena sativa), Winter wheat (Triticum aestivum), Red fescue (Festuca rubra)
Fast growing native grasses and forbs:	Side oats grama, Fringed brome, Nodding Wild Rye, Slender Wheat grass, Virginia wild rye, Fowl bluegrass,
Long lived deep rooted native grasses:	Big bluestem, Indian grass, Switch grass, Little bluestem, Hairy grama, Blue grama, Western wheat grass, Prairie dropseed
Long lived deep rooted native forbs:	Liatris, Coreopsis, Coneflowers, Asters, Sunflowers, Showy goldenrod
Native legumes:	Canada milk vetch, Partridge pea, American vetch, Prairie clovers, Lupine
Deep rooted native trees and shrubs:	Bur oak, White Oak, Northern pin oak, Red oak, Walnut, Butternut, hickory, Red oak, Basswood, Pines, Ironwood, Blue beach, Hazelnut, Paper birch, Hackberry, Hawthorn, Red cedar, Black cherry, American basswood
Plants that establish from cuttings:	Dogwoods, Willows, Viburnum



Plant Source Considerations – The source sequence included in Section 2 of the Native Vegetation Establishment and Enhancement Guidelines is recommended for bank stabilization projects, particularly if perennial species are planted near natural communities. Source is less of a concern for short lived cereal grains and native cover species that are used for stabilization such as wild ryes and slender wheatgrass.

Steep bank stabilized with flowers, grasses and erosion control blanket

Vegetation Establishment – A variety of methods may be used to plant steep slopes along streambanks, including hydroseeding, broadcast seeding, tree plantings, and promoting natural succession. Upland portions of restored slopes are typically broadcast or hydroseeded, as they are often too steep for seed drills. Seed to soil contact is very important for successful establishment, so the use of rollers or erosion control fabric to cover seed will aid establishment. Very steep eroding banks can be very difficult to stabilize. In some cases, slopes can be regraded to decrease steepness. If regrading is not possible, willow cuttings can sometimes be inserted from the base of the slope. Hydroseeding, where seed and water are simultaneously blown onto slopes followed by a tackifier to improve seed to soil contact, may also be an option. Plants that can germinate and grow on dry slopes should be a priority for these types of plantings. Trees and shrubs are commonly planted into slopes to aid stabilization and establishment. Many projects will also benefit from the natural colonization of native species due to seed coming in from surrounding plant communities.

Operations and Maintenance – Upland portions of plantings may be mowed with mechanical or hand-held equipment during the first two years to suppress annual and biennial weeds and promote seedling growth. Hand weeding is conducted in some smaller plantings to control weeds. Spot herbicide treatment may be used for perennial weeds, but it is important that aquatic-safe herbicides are used adjacent to water bodies. Supplemental watering is often necessary on steep slopes to support the growth of trees and shrubs and herbaceous plant seedlings. A water truck with a fine spray nozzle may be needed to spray water from the top of steep slopes. Fencing or signage may be needed to minimize foot traffic as vegetation establishes. River and streams are subject to changes over time, so periodic monitoring is needed to ensure the future success of projects.

Information Sources

Slope and Site Stabilization http://www.pca.state.mn.us/index.php/view-document.html?gid=7421
A Soil Bioengineering Guide for Streambank and Shoreline Stabilization www.fs.fed.us/publications/soil-bio-guide/
Restore Your Shore http://www.dnr.state.mn.us/restoreyourshore/index.html
Minnesota Soil Bioengineering Handbook, Minnesota Department of Transportation, 1999.
BWSR What's Working for Conservation Website: What's Working for Conservation