Stream and Lakeshore Restoration Best Management Practice Manual

Conservation Practices to Protect Surface and Ground Water

Wyoming Department of Environmental Quality
Water Quality Division
Nonpoint Source Program

2014 Update
Document #14-0532

The purpose of this document is to provide information about best management practices that the Wyoming Nonpoint Source Program supports as eligible for Clean Water Act Section 319 funding. This document is prepared as part of the Wyoming Nonpoint Source Management Plan as required by Section 319(b) of the Clean Water Act.

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Contents

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Introduction

1.1 Purpose of this Document

The purpose of this document is to provide information about stream and lakeshore restoration best management practices (BMPs) that can be voluntarily implemented to prevent, reduce, or eliminate nonpoint source pollution to Wyoming's water resources. This document focuses on those BMPs that the Wyoming Department of Environmental Quality (WDEQ), Nonpoint Source Program has determined are eligible for Clean Water Act (CWA) Section 319 funding. This document is prepared as part of the Wyoming Nonpoint Source Management Plan as required by Section 319(b) of the CWA, which states that management programs and BMPs must be developed by each state to reduce identified causes of nonpoint source pollution. For the purposes of this manual, "stream" refers to streams, rivers, creeks, or other non-lacustrine perennial/ephemeral waterbodies.

The Wyoming Nonpoint Source Program works through voluntary and incentive methods to reduce nonpoint source pollution and will work with agencies, individual producers, and other stakeholders to promote the implementation of BMPs on a voluntary basis with financial assistance from Section 319 grants. More information about Section 319 grants and how to apply for grant funding can be found on the WDEQ Nonpoint Source Program website. Please note that Section 319 funds are not eligible for activities that are required as part of a permitting or regulatory action.

Inclusion of a BMP in this manual does not guarantee Section 319 funding for that BMP. The Wyoming Nonpoint Source Program will recommend funding for BMP implementation projects on a project-by-project basis, and will take into consideration the advantages and limitations of proposed BMPs to evaluate the most efficient and cost-effective solutions possible.

BMPs and conservation practices that are listed in United States Department of Agriculture (USDA) technical guides, manuals, or handbooks will be considered for Section 319 funding, even if not listed in this manual. In particular, the USDA Natural Resources Conservation Service's (NRCS) Field Office Technical Guides (FOTGs) offer information about BMPs and conservation practices that are utilized by the NRCS throughout Wyoming. Wyoming's electronic FOTG is available on the NRCS Wyoming website. Other BMPs will be evaluated on a case-by-case basis for funding by the Wyoming Nonpoint Source Program and the Nonpoint Source Task Force.

1.2 How to Use this Document

This document provides a summary of selected BMPs and references to more detailed information about those BMPs. This document should be used as follows:

- As documentation of which BMPs the Wyoming Nonpoint Source Program and Nonpoint Source Task Force endorse as eligible for funding through the Section

319 grant program,
- As an educational tool about BMPs, and
- As a tool to direct users to detailed information about selected BMPs.

This document provides a basic description of each BMP, a brief summary of their criteria and maintenance needs, and links to reference documents where more information can be found on that BMP. This document is not an exhaustive resource on BMP design and implementation, but rather, should be used as an educational tool and a directory of where to find more information about selected BMPs.

The blue, underlined text in this document represents a website link. If viewing this document in an electronic format, the user can be directed to the appropriate website by clicking on the blue, underlined text. The full URL addresses are also provided for all referenced websites to accommodate users who are not viewing an electronic copy of this document. Typing the URL address into an internet browsing application will direct the user to the appropriate website. For websites outside the WDEQ, the WDEQ is not responsible for the content or maintenance of those websites.

1.3 Nonpoint Source Pollution and Hydrologic Modifications

Unlike point source pollution, which can be traced back to a single defined source, nonpoint source pollution is caused by surface water runoff that is diffuse in nature and often widespread, making it difficult to assess the source of the problem. Nonpoint source pollution occurs when runoff from rainfall or snowmelt travels over and/or percolates through the ground and picks up contaminants. These contaminants are deposited into streams, lakes, rivers, and ground water. Nonpoint sources of pollution continue to be recognized as the nation's largest remaining cause of surface water quality impairments, and the 2012 Wyoming Integrated 305(b)/303(d) Report shows that the majority of surface water quality impairments in Wyoming are due wholly or in part to nonpoint source pollution.

When surface water systems are physically modified, nonpoint source pollution and water quality degradation can occur. Hydrologic modification refers broadly to activities that alter the physical structure, form, or flow patterns of surface waters. This can include very simple activities, such as a utility line crossing a minor stream, to very complex activities such as construction of a dam on a major river or the straightening of a stream channel. Hydrologic modification can also be indirect, such as when land-use activities adjacent to a stream cause erosion and alter the natural physical properties of the stream.

Surface water systems are usually modified for some kind of public benefit, such as flood control, property protection, urban development, water supply storage, or irrigation water diversion. However, altering the physical structure of a waterbody will have impacts on that system; the impacts may be beneficial in some cases, insignificant in others, and harmful to devastating in others. While natural processes such as erosion also modify surface water systems, human activities can exacerbate natural processes and cause impacts beyond those seen under natural conditions.

The United States Environmental Protection Agency (EPA) divides hydrologic modifications into three categories—(1) channelization and channel modification, (2) dams, and (3) streambank and shoreline erosion (USEPA 2007). Channelization and channel modification refers to activities that straighten, widen, or deepen channels, and to clearing channels of debris and sediment. Dams are man-made structures that impound water for storage, power generation, recreation, and many other uses. Stream bank and shoreline erosion are natural processes that can be exacerbated by human activities (e.g. urbanization, recreation and grazing) that occur adjacent to streams or lakes.

The nonpoint source pollution impacts from hydrologic modifications can be numerous and varied, depending on the type of modification, the extent of the modification, and many site specific factors. By directly impacting the physical structure of a waterbody or by altering hydraulic regimes, hydrologic modifications can reduce habitat for fish and other aquatic life within a stream and can alter or reduce riparian habitat outside the stream. Hydrologic modifications can also alter water temperatures, the amount and types of sediment present in surface waters, and rates and patterns of sediment transport and deposition.

Again, it is important to note that streams are active and dynamic systems that transport sediment from natural erosive processes. Per Rosgen (1996), streams and rivers that have a stable dimension, pattern, and profile over time such that channel features are maintained and the system neither aggrades nor degrades are naturally stable systems. Such systems are able to consistently transport sediment loads associated with local deposition and scour (Rosgen 1996). However, when channel dimensions, patterns, and profiles are altered, the resulting changes in channel features and subsequent changes in sediment transport, aggradation, and degradation can impact water quality and aquatic and riparian habitat. Altered sediment loads can affect fish spawning grounds, macroinvertebrate community composition, and the amount of sunlight reaching aquatic plants. In addition, sediment often transports other pollutants, such as phosphorus, nitrogen, pathogens, and heavy metals.

1.4 Best Management Practices

Hydrologic modification is one of the leading reasons why surface waters in the United States are impaired (USEPA 2007). As discussed above, there are many reasons why hydrologic modifications may be necessary for public benefit. Through proper planning and use of BMPs, nonpoint source pollution from hydrologic modifications can be mitigated. Projects that work to address impacts from past hydrologic modification can result in significant improvement to surface water systems.

BMPs can reduce nonpoint source pollution by reducing the amount of pollutants available for transport, reducing or slowing the transport or delivery of pollutants, or by treating the pollutants before or after they are delivered to a surface water system. Planning and evaluation are important first steps for any hydrologic modification BMP project. It is important to determine how a particular BMP will impact not only the site where it is implemented, but how it will impact the system upstream and downstream of the site. In

addition, it is important to understand overall impacts to habitat and water chemistry. Any operation and maintenance requirements for BMP systems should be considered in the planning stage. Experts from multiple fields, representatives from regulatory agencies, and affected stakeholders may need to be consulted to fully plan and evaluate a project. Appendix A includes an outline of factors that should be considered when planning a project that will alter a stream channel; considering these factors in the planning stage can also facilitate applying for permits that may be required (See Section 1.5).

Over the last several decades, our understanding of how hydrologic modifications impact stream geomorphology, aquatic ecosystems, and overall watershed health has increased greatly. Practices that used to be commonly accepted, such as channelizing streams and armoring streambanks with hard structures to mitigate localized erosion, are now analyzed more critically for their impacts to the system as a whole. A notable shift from an emphasis on traditional hard structural practices (such as riprap, revetments, check dams, and gabions) to an emphasis on vegetative practices and the use of native materials has occurred. Many traditional structural practices can be effective; however, due to their ability to cause or exacerbate localized or downstream erosion, their use should be evaluated carefully and in general should only be used as a last resort when other methods are not feasible.

Sometimes called soil bioengineering, vegetative practices refer to the use of plant materials as a main structural component in controlling streambank and shoreline erosion (USDA NRCS 1992). Vegetative practices have been defined as "the use of live and dead plant materials, in combination with natural and synthetic support materials, for slope stabilization, erosion reduction, and vegetative establishment" (FISRWG 1998). Use of vegetative practices over the last several decades has shown them to be physically and ecologically successful and potentially less costly than traditional engineered structures (USEPA 2007). Additional benefits that can result from using vegetative practices include enhanced fish and riparian habitat, aesthetics, and less long-term maintenance. Several of the general references noted in Section 1.7 provide detailed information on vegetative practices.

Because of their benefits, the WDEQ Nonpoint Source Program strongly encourages and prefers the use of vegetative practices over structural practices. However, it is noted that vegetative practices may not be suitable in all circumstances, and in some situations, structural practices may be the most appropriate solution. In other cases, an integrated approach of using both vegetative and structural practices together may be most appropriate. In other cases, adding vegetative practices to existing structural practices may enhance the functionality of those structural practices. In all cases, careful evaluation and planning should be done to evaluate the most effective, long-term, sustainable solution and to fully understand the impacts of selected practices.

Because hydrologic modifications often affect entire watersheds, project planning and BMP installation may require comprehensive watershed evaluations and/or the use of models or other assessment approaches to understand the effects of the hydrologic modifications and BMPs. Design and construction oversight by an engineer or other natural resources professional may be required. All structures capable of significantly

redirecting the main force of the water should be designed or approved by a professional hydrologist or registered professional engineer knowledgeable in stream and river dynamics. Specific BMPs may or may not always be appropriate for a particular site or situation; therefore, thorough research, planning, and design should always go into the selection, implementation, and installation of any BMP. BMPs are often not complete in and of themselves and should be used as part of an integrated management plan to improve and maintain natural resources, including soil, vegetation, and water resources. Implementing or installing more than one BMP in a series can overcome the drawbacks of any single method while providing enhanced pollution prevention.

1.5 Regulatory Considerations

There are many local, state, and federal regulations in Wyoming governing hydrologic modification and restoration activities. The United States Army Corp of Engineers (USACE) administers the CWA Section 404 permitting program which regulates the discharge of dredged or fill materials in waters of the United States. This is the primary regulation governing most hydrologic modifications.

Section 404 permits are required from the Corps whenever material of any kind is placed into a surface waterbody. Some activities are exempt from permitting (see Appendix B). Prior to issuing a permit, the Corps must be presented with a certification from the State that the proposed project will not result in a violation of the state's water quality standards. This is referred to as a CWA Section 401 certification and is provided by the WDEQ, Water Quality Division. The application to the Corps for a 404 permit also serves as the application to the State for 401 certification.

Stormwater permits through the WDEQ Wyoming Pollutant Discharge Elimination System (WYPDES) Program are needed for construction activities that will clear, grade, or otherwise disturb one or more acres. A WYPDES discharge permit may also be required for point source discharges to surface waters not related to storm water runoff, such as discharges from gravel crushing and washing operations, cofferdam or site dewatering, vehicle or machinery washing, or other material processing operations. Depending on the type of operation, the length of operation, and the type of discharge, either a general temporary discharge permit or an individual discharge permit may be required. Turbidity waivers may also be needed from the WDEQ Water Quality Division for in-stream activities that cause temporary increases in turbidity above water quality standards.

The State Engineer regulates water allocations in the State. Permits are required from the State Engineer for those structures whose purposes are to divert, impound or otherwise develop water for a beneficial use.

It is imperative that the Wyoming Game and Fish Department (WGFD) be consulted for hydrologic modification projects that could potentially impact fish habitat or spawning. Instream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Since these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

Preventing the spread of aquatic invasive species (AIS) is a priority for the State of Wyoming, and in many cases, the intentional or unintentional spread of organisms from one body of water to another would be considered a violation of State statute and Wyoming Game and Fish Commission regulation.

The role of Section 404 permits, 401 certifications, WYPDES permits, AIS prevention protocols, and other select regulatory processes are explained in detail in Appendix B with additional information provided in Appendix D. Appendix E includes contact information for agencies that can provide technical and/or financial assistance for BMP implementation. Be certain to check with appropriate agencies during the planning process to determine permit or other regulatory requirements. Civil and/or criminal penalties can be assessed for violations or noncompliance for programs that are regulatory and enforceable.

Nothing in this section is intended to change or contradict any existing policies, procedures, or regulations related to hydrologic modification. It is the intention of WDEQ to present voluntary management practices which will assist in maintaining the aquatic ecosystem while allowing those activities which are necessary. It can also be used as a guide to plan projects which are subject to heavy regulation. Accurate and descriptive permit applications will result not only in environmentally sound construction, but also expeditious permit processing and savings in time and money. This manual presents voluntary management practices that, when used in conjunction with regulatory mechanisms, can help protect and restore aquatic ecosystems.

1.6 Importance of Riparian Area and Wetland Protection

The ecological benefits of riparian areas and wetlands are numerous. Relating to water quality, they help filter pollutants such as nutrients and sediment, control streambank erosion, and lower water temperatures. They also can help provide flood control and critical habitat. Many human activities, including hydrologic modification, can and have impacted riparian and wetland areas such that they are no longer able to provide the benefits described above. Therefore, the WDEQ Nonpoint Source Program encourages the rehabilitation of degraded riparian areas and wetlands and the protection of healthy riparian areas and wetlands as part of watershed restoration projects funded through the Section 319 program.

Furthermore, the State of Wyoming has recognized the importance of wetland systems to overall health of the state's natural environment as well as the impact that wetland regulation can have on economic development. The state legislature, in the 1991 general session, passed the "Wyoming Wetlands Act." The Act states that "…it is the policy of this state that water management and development and wetland preservation activities should be balanced to protect and accommodate private property, industry, water and wetland interests and objectives."

1.7 General Resources

Many resources already exist that provide information about BMPs used to restore and protect streams and lakes. The WDEQ notes the following references as good general sources of information about stream and lakeshore restoration BMPs:

FISRWG 1998. Federal Stream Corridor Restoration Handbook (NEH-653). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/restoration/?&cid=stelprdb1043244

Part 654 Stream Restoration Design National Engineering Handbook (210-VI-NEH). Bernard J., J.F. Fripp & K.R. Robinson (Eds.),. Washington, D.C.: USDA Natural Resources Conservation Service.
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/quality/?&cid=stelprdb1044707

NRCS Wyoming Electronic Field Office Technical Guide, County Locator. U.S. Department of Agriculture, Natural Resources Conservation Service.
http://efotg.sc.egov.usda.gov//efotg_locator.aspx

The Practical Streambank Bioengineering Guide. *User's Guide for Natural Streambank Stabilization Techniques in the Arid and Semi-arid Great Basin and Intermountain West*. 1998. Bentrup, G. and J.C. Hoag, Contributors. USDA-NRCS Plant Materials Center, Interagency Riparian/Wetland Project.
http://www.plant-materials.nrcs.usda.gov/pubs/idpmcpu116.pdf

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-United States Forest Service (FS-683).
http://www.fs.fed.us/publications/soil-bio-guide/

National Management Measures to Control Nonpoint Source Pollution from Hydromodification (Chapter 7). 2007. EPA
http://water.epa.gov/polwaste/nps/hydromod_index.cfm

National Best Management Practices for Water Quality Management on National Forest Lands. Volume I: National Core BMP Technical Guide. April 2012. United States Department of Agriculture, Forest Service. FS-990a.
http://www.fs.fed.us/biology/resources/pubs/watershed/FS_National_Core_BMPs_April2012.pdf

Management Measures Digital Library Ecosystem Restoration. 2007. Institute of Water Resources, U.S. Army Corps of Engineers Publications.
http://www.iwr.usace.army.mil/docs/MMDL/ECO/index.asp

Relative Effects of Selected Stream Restoration Practices. 2012. U.S. Environmental Protection Agency Water Archives: Table 3-1.
http://water.epa.gov/type/watersheds/archives/31.cfm

Applied River Morphology. Rosgen, D. L., 1996. Wildland Hydrology Books. Available for order at: http://www.wildlandhydrology.com/

Glossary of Stream Restoration Terms. Fischenich, C. (1999). *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SR-01), U.S. Army Engineer Research and Development Center, Vicksburg, MS.
http://el.erdc.usace.army.mil/elpubs/pdf/sr01.pdf

In addition to the WDEQ Water Quality Division, the following agencies and nonprofit organizations are important resources for stream restoration technical and/or financial assistance (additional contact information provided in Appendix E). Private consulting firms can also provide technical assistance.

- Wyoming Game and Fish Department (WGFD)
- United States Army Corps of Engineers—Wyoming Regulatory Office
- Natural Resources Conservation Service (NRCS) Wyoming
- Bureau of Land Management—Wyoming Office
- United States Forest Service—Rocky Mountain Region
- United States Forest Service—Intermountain Region
- United States Fish and Wildlife Service—Mountain-Prairie Region
- EPA Region 8
- Wyoming Association of Conservation Districts and Local Conservation Districts
- Wyoming State Engineer's Office
- Wyoming Department of Transportation
- Wyoming Trout Unlimited
- Wyoming Ducks Unlimited
- The Nature Conservancy, Wyoming Chapter
- Wyoming Wildlife and Natural Resource Trust

There are volumes of references in existence detailing structure designs and methods for all types of stream channel alterations. Many of the documents contain specific practices and design criteria for a full range of stream channel modifications. The purpose of this manual is not to attempt to select certain practices or designs and require that only those are used in the state. It is not possible to evaluate all the known practices and make determinations as to which are "best", nor is it advisable. What is best must be determined as the result of a site specific investigation of the problem to be solved, the hydrologic character of the waterbody, and an evaluation of its habitat condition or potential. Through the fact sheets presented in the next section of this manual, the WDEQ hopes to promote an awareness of the use of BMPs and direct users to detailed information and sources of technical assistance to help plan and implement projects. In addition to the fact sheets presented in this manual, additional BMP considerations for some selected activities are presented in Appendix C. Appendix A provides additional planning and mitigation measures that should be used in all in-stream construction activities.

Please note that pictures and diagrams provided in the following fact sheets are for general reference only and are not intended to be used for design purposes.

BMP 1: Coconut Fiber Roll

Photo of coconut fiber roll installed on streambank.
Source: USDA-Forest Service, 2002.

Reduces erosion by stabilizing the toe of the slope and by trapping sediment from the streambank.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Coconut fiber rolls (also known as coir rolls, fiberschines, coir fascines, and bio-logs) are cylindrical structures composed of coconut husk fibers bound together with twine woven from coconut. Fiber rolls are typically installed near the toe of the streambank, with dormant cuttings and rooted plants inserted into holes cut into the rolls. The rolls are most commonly manufactured in 12-inch diameters and lengths of 20 feet. They are staked in place at the toe of the slope, generally at bankfull level, providing a good substrate for promoting plant growth.

Fiber rolls protect slopes from shallow slides or undermining while trapping sediment that encourages plant growth within the roll. They are flexible, molding to the existing curvature of the streambank, and produce a well-reinforced slope without much site disturbance. Manufacturers estimate the product has an effective life of 6 to 10 years; ideally, by the time the fiber roll decomposes, riparian vegetation will have stabilized the streambank.

The fiber rolls function as breakwaters along the shores of lakes. In addition to reducing wave energy, this product can help contain substrate and encourage development of wetland communities. Fiber rolls are effective in lake areas where the water level fluctuates, as they protect the shoreline and encourage new vegetation.

Feasibility: Using coconut fiber rolls is appropriate where short-term moderate toe stabilization is needed and ideal for sites that are especially sensitive to disturbance. Fiber rolls are not appropriate in streams with bedrock or boulder beds because staking cannot be accomplished.

Maintenance: Periodic maintenance includes checking on the fiber logs to ensure that the posts and twine are holding them in place. Additional plantings may be necessary.

BMP 1: Coconut Fiber Roll

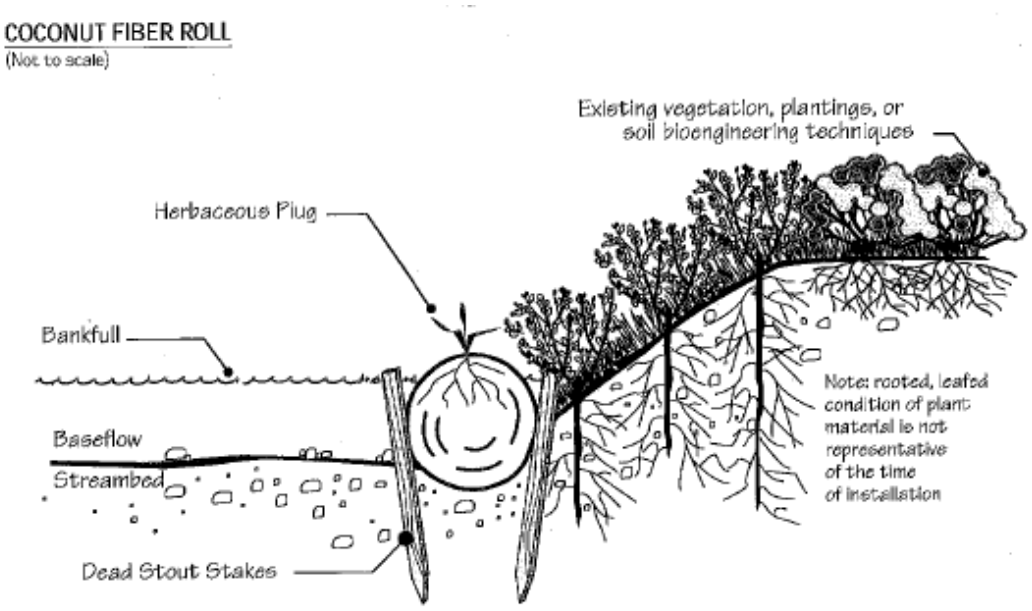

Figure 1. Schematic design of coconut fiber roll installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002

Advantages:

- Minimal site disturbance
- Acts as filter barrier to prevent erosion and scouring of the bank
- Flexible, can be molded to existing contours
- Maintains a natural bank appearance
- Useful where space is limited

Limitations:

- Inability to withstand high velocities
- Inability to withstand large ice buildup
- Can be fairly expensive to construct (in some areas, similar and abundant locally available materials, such as cornstalks, are being used instead of coconut materials)
- Requires additional anchoring systems, which increases the initial cost and installation time

BMP 1: Coconut Fiber Roll

References:

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-FS (FS-683).
http://www.fs.fed.us/publications/soil-bio-guide/

Coconut Fiber Rolls. 2006. Massachusetts Nonpoint Source Pollution Management.
http://projects.geosyntec.com/npsmanual/Fact%20Sheets/Coconut%20Fiber%20Rolls.pdf

Coconut Fiber Roll, Coir Rolls, Coir Mats and Coir Netting. 2007. Institute of Water Resources, U.S. Army Corps of Engineers Publications
http://www.pmcl.com/mmdl/MM_Description.asp?ID=8

National Management Measures to Control Nonpoint Source Pollution from Hydromodification (Chapter 7). 2007. EPA
http://water.epa.gov/polwaste/nps/hydromod_index.cfm

The Practical Streambank Bioengineering Guide (Appendix A). *User's Guide for Natural Streambank Stabilization Techniques in the Arid and Semi-arid Great Basin and Intermountain West*. 1998. Bentrup, G. and J.C. Hoag, Contributors. USDA-NRCS Plant Materials Center, Interagency Riparian/Wetland Project
http://www.plant-materials.nrcs.usda.gov/pubs/idpmcpu116.pdf

BMP 2: Live Stakes

Photo of streambank live stakes. Source: WDEQ

Dormant woody cuttings are inserted directly into the streambank to minimize erosion and improve habitat for aquatic plants and animals.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Live stakes (also known as woody cuttings, live posts, pole plantings, or stubs) are used to establish streambank vegetation and help stabilize selected slope areas. This form of soil bioengineering involves the planting of live cuttings from shrubs or trees along the streambank. As the cuttings develop, they protect the bank from erosion while minimizing sediment and associated nutrient impacts downstream. Established cuttings also moderate bank and water temperatures, facilitate colonization of other species, and provide forage.

Live stakes provide long-term streambank stabilization with delayed onset and are best used as part of a system which includes immediate means of buffering streambanks from erosive flows, such as tree revetments; a component to deter undercutting at the bed/bank interface, such as stone toe revetments; and a means of reducing the erosivity of incoming flows at their source, such as livestock/wildlife exclusion or urban detention ponds. Live stakes can also be planted in the joints between rock spaces in existing riprap to improve the functionality of the riprap.

Feasibility: Live staking is appropriate for relatively uncomplicated site conditions when construction time is limited. The practice is most useful on streambanks of moderate slope (2:1 or less), and most successful where stakes will have some contact with a seasonally high water table. Stakes are generally 1 to 2 inches in diameter and 2 to 3 feet long. Specific site requirements and available cutting sources will determine size.

Vegetation selected should be able to withstand the degree of anticipated inundation, provide year-round protection, have the capacity to become well established under sometimes adverse soil conditions, and have root, stem and branch systems capable of resisting erosive flows. Most willow species are ideal for live staking; cottonwood and sycamore are also commonly used. Native species should be used where possible. Invasive species should not be used.

Maintenance: Live stakes should be checked annually and after significant storm events for damage, soil slumping, and loose stakes or fasteners. Immediately repair and replace as needed. Ensure stakes stay moist to facilitate rooting and sprouting until vegetation becomes established. Irrigation may be needed during the first two years after planting.

BMP 2: Live Stakes

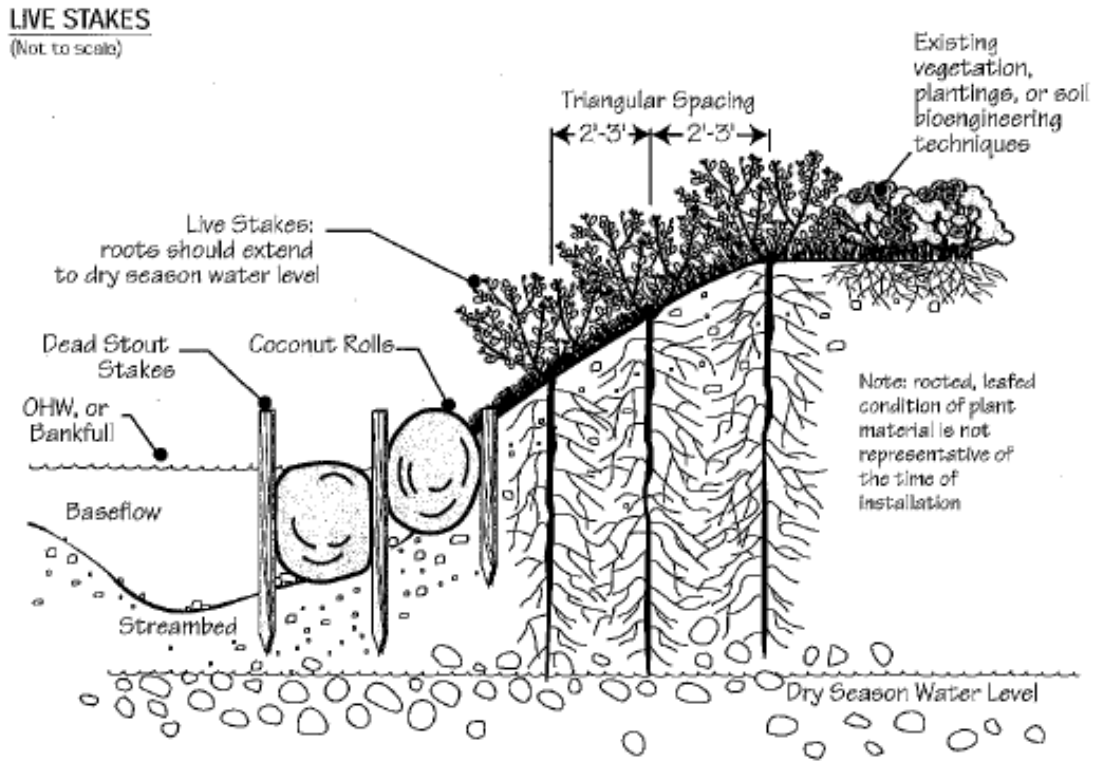

Figure 2. Schematic design of live stake installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002. "OHW" in diagram is an acronym for Ordinary High-Water Mark.

Advantages:

- Economical when cuttings are locally available
- Can be used to reinforce existing banks without heavy equipment
- Effective stabilization and revegetation method for simple or small problem sites
- An effective barrier to siltation from erosion of adjacent land
- Good proactive method for increasing vegetative cover along a stream where existing vegetation is sparse
- Good activity for volunteer groups

Limitations:

- Often not feasible alone, and should be combined with other techniques
- Does not provide surface protection until top growth has occurred
- Installation period is limited to time when water is low and vegetation is dormant
- Requires animal control (both domestic and wildlife)
- May require fertilization, mulch, and/or water during establishment

BMP 2: Live Stakes

References:

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-FS (FS-683).
http://www.fs.fed.us/publications/soil-bio-guide/

Federal Stream Corridor Restoration Handbook (NEH-653) Appendix A. FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044608.pdf

Live Stakes. 2006. Massachusetts Nonpoint Source Pollution Management.
http://projects.geosyntec.com/npsmanual/Fact%20Sheets/Live%20Stakes.pdf

Live Stakes. 1999. Mississippi State University College of Agriculture and Life Sciences Center for Sustainable Design
http://abe.msstate.edu/csd/NRCS-BMPs/pdf/streams/bank/livestakes.pdf

Live Staking. 2007. Institute of Water Resources, U.S. Army Corps of Engineers Publications
http://www.pmcl.com/mmdl/MM_Description.asp?ID=18

National Management Measures to Control Nonpoint Source Pollution from Hydromodification (Chapter 7). 2007. EPA
http://water.epa.gov/polwaste/nps/hydromod_index.cfm

The Practical Streambank Bioengineering Guide (Appendix A). *User's Guide for Natural Streambank Stabilization Techniques in the Arid and Semi-arid Great Basin and Intermountain West*. 1998. Bentrup, G. and J.C. Hoag, Contributors. USDA-NRCS Plant Materials Center, Interagency Riparian/Wetland Project
http://www.plant-materials.nrcs.usda.gov/pubs/idpmcpu116.pdf

BMP 3: Brush Mattress

Photo of a brush mattress. Source: USDA-NRCS

Thick layer of live branch cuttings physically protects streambank, minimizing erosion and capturing sediment.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: A brush mattress (also known as live brush mats or brush matting) is a revegetation technique that provides immediate stabilization and protective cover to a slope or streambank. The goal of a brush mattress is to create structural streambank protection that will eventually root and provide vegetative stability.

A brush mattress is typically constructed using live willow branches or other species that root easily from cuttings, but can be constructed with any brushy, woody branches in order to provide immediate and effective slope protection. A thick mat of dormant cuttings is placed on the bank and held down with stakes. Used in conjunction with other methods such as live stakes, live fascines, and stone toe protection, brush mattresses can restore riparian vegetation and enhance conditions for colonization of native plants. They reduce soil erosion and intercept sediment while improving streamside habitat.

Feasibility: Of all the streambank biotechnical practices, brush mattresses can withstand the highest velocities. They can be used on fast-flowing streams and are appropriate where exposed streambanks are threatened by high flows prior to vegetation establishment. Brush mattresses should not be used on slopes which are experiencing mass-movement or other slope instability, or on slopes greater than 2:1. The technique is also effective on lakeshores.

Maintenance: Maintenance requirements vary depending on the velocity, flood frequency, flood stage, timing and sediment load of the stream system. Repairs may be necessary until the vegetation becomes well-established. Inspection is necessary after each of the first few floods, or at least annually. As the brush mattress becomes established and the live cuttings root, maintenance requirements are significantly reduced.

BMP 3: Brush Mattress

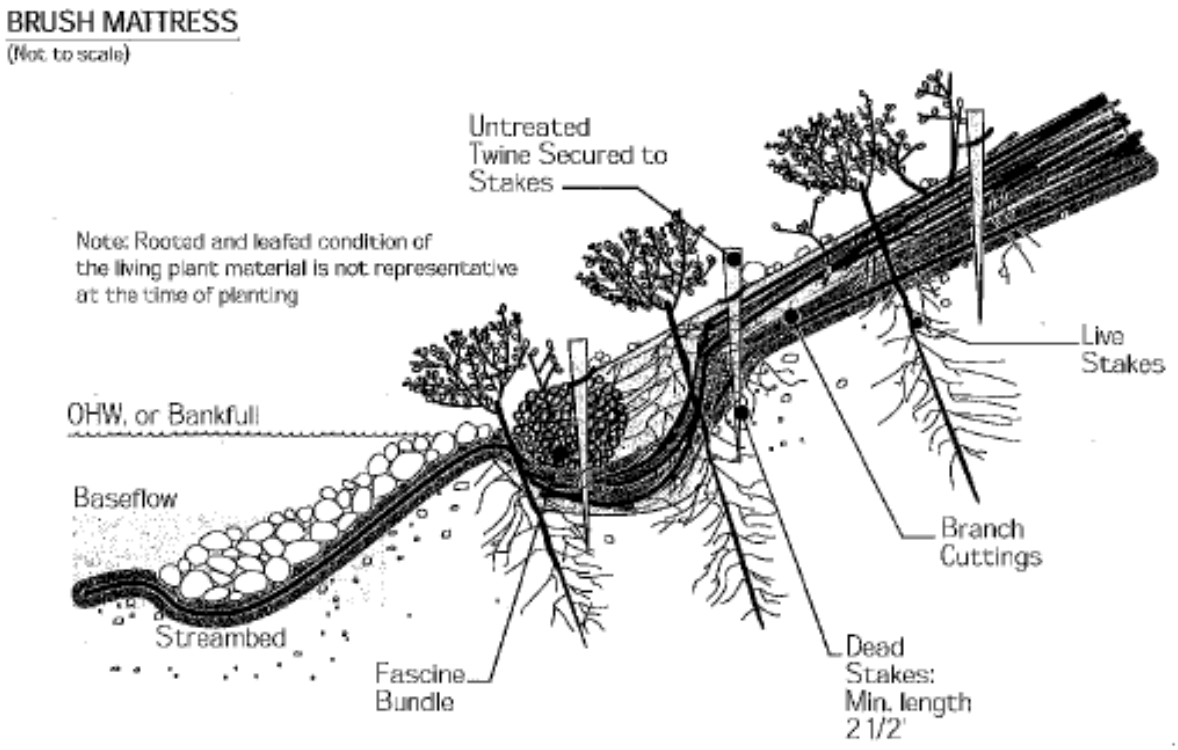

Figure 3. Schematic design of brush mattress installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002. "OHW" in diagram is an acronym for Ordinary High-Water Mark.

Advantages:

- Works well on fast-flowing streams
- Provides immediate protective cover for the streambank
- Rapidly restores riparian vegetation and streamside habitat
- Captures sediment during flood conditions
- Enhances colonization of native vegetation

Limitations:

- Must be installed during dormancy period
- Labor-intensive and requires large numbers of cuttings
- Only streambanks with a maximum slope of 2:1 are suitable
- Should not be used on slopes experiencing mass-movement or other slope instability
- Requires good soil to stem contact – will not grow if all branches are exposed

BMP 3: Brush Mattress

References:

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-FS (FS-683).
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http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/ndcsmc/?cid=nrcs143_009158

BMP 4: Live Fascines

Photo of dormant live fascines being planted. Source: U.S. EPA, Green Landscaping: Greenacres

Minimizes bank erosion while improving habitat for aquatic plants and animals.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Live fascines (also called wattles) are inexpensive to construct and install, and offer immediate protection from surface erosion when securely anchored. They are a very effective soil stabilization technique once rooting is established. The installed fascines protect banks from washout and seepage, particularly at the edge of a stream and where water levels fluctuate only moderately.

A fascine is a long bundle of live, dormant branches. The branches used to make the bundle should be at least 4 feet long. The butt ends face the same direction and the branches are bound in an overlapping pattern to create the full length of the fascine. Bundles are generally 6 to 8 inches in diameter and tied with biodegradable twine. Live fascines are made with species that root easily, such as willows and shrub dogwoods.

Working up the slope, live fascine bundles are placed in shallow trenches and held in place by dead stakes. Soil is foot-tamped in place along the sides of the bundle and live stakes are installed on the downslope side. Placement must be secure so water cannot wash soil out from beneath the bundles.

Feasibility: Live fascines should generally be used above the high-water mark or bankfull level except on very small drainage area sites, and between the high- and low-water marks on the bank in arid climates. They require soil moisture or regular precipitation during the growing season. On steep or long slope lengths, high runoff velocities can undermine live fascines near drainage channels. A significant quantity of plant material is required and it can dry out if not properly installed. Live fascine construction should occur during the dormancy period, usually late fall or early spring.

Maintenance: Maintenance requirements depend on the velocity, flood frequency, flood stage, timing, and future planned use of the stream. Repairs or protective measures, such as enclosures, may be required until the vegetation becomes well established. The fascines should be inspected after each flood (or at least twice) during the first year, and at least once a year afterwards.

BMP 4: Live Fascines

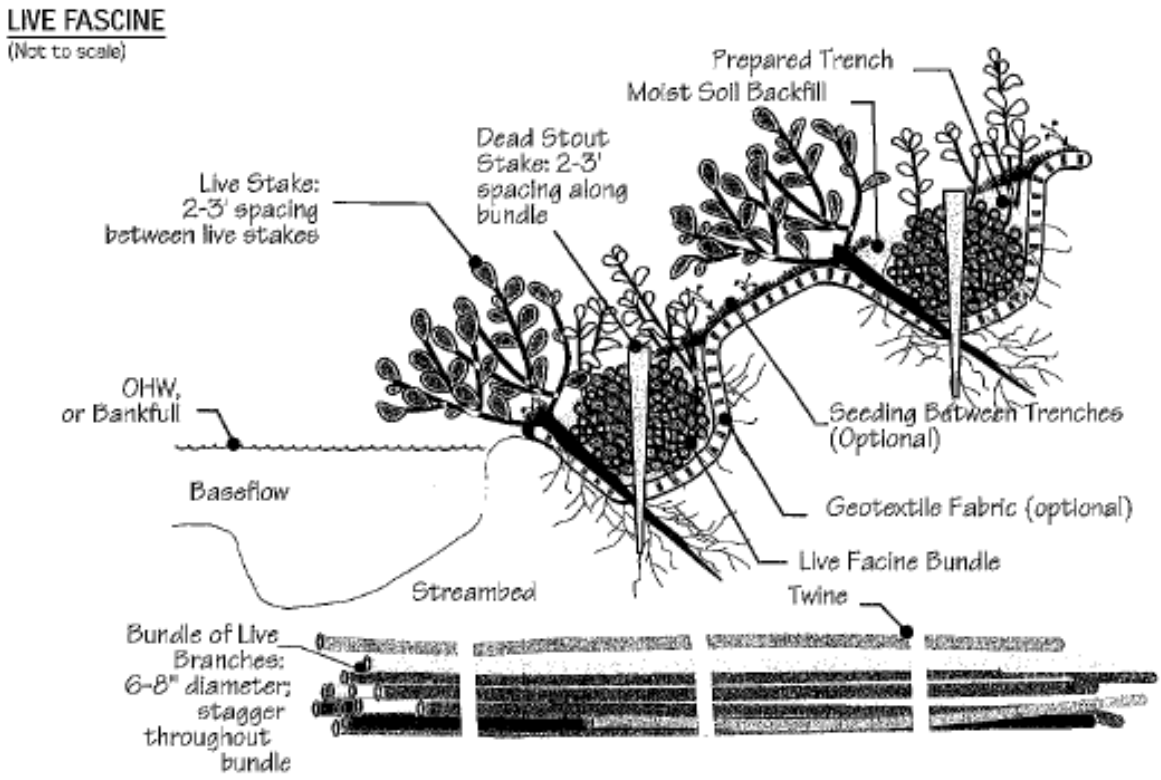

Figure 4. Schematic design of live fascine installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002. "OHW" in diagram is an acronym for Ordinary High-Water Mark.

Advantages:

- Protects slopes from shallow slides
- Causes minimal site disturbance when properly installed
- Offers immediate protection from surface erosion
- Enhances conditions for colonization of native vegetation by creating surface stabilization and a microclimate conducive to plant growth
- Serves to facilitate drainage when installed at an angle

Limitations:

- Requires toe protection where toe scour is anticipated
- Not appropriate for treatment of slopes undergoing mass movement
- Construction should only occur during dormancy period
- Only appropriate above bankfull discharge levels

BMP 4: Live Fascines

References:

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-FS (FS-683).
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BMP 5: Branchpacking

Photo of branchpacking installation. Source: Robbin B. Sotir & Assoc., Inc. in USDA Forest Service, 2002.

Repairs existing slopes that have small slips or slumps by filling in the failed area with plant materials and soil.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Branchpacking (also known as brushpacking and trenchpacking) consists of alternate layers of live branch cuttings and compacted backfill to repair small, localized slumps and holes in slopes. The branches trap sediment that refills the localized slump or hole, while roots spread throughout the backfill and into the surrounding earth to form a unified mass.

The branches also reinforce slopes by serving as tensile inclusions which provide frictional resistance to sliding or other types of displacement. The protruding brush slows runoff and reduces surface erosion.

Feasibility: Branchpacking is an appropriate technique for repairing slip areas that do not exceed 4 feet deep or 4 feet wide. It should not be used as a slope stability measure if structural embankment support is needed. Branchpacking should be implemented only after the stresses causing the slump have been removed. Integration with toe revetment may be necessary where erosion is occurring below bankfull levels. Plant material harvest and installation should be performed during the dormant season, generally late fall to early spring.

Maintenance: Installations should be inspected frequently during the first year or two of establishment. Missing or damaged plant materials should be replaced as soon as possible. Sloughs or breaks in the drainage pattern should be repaired as quickly as possible to maintain site stability.

BMP 5: Branchpacking

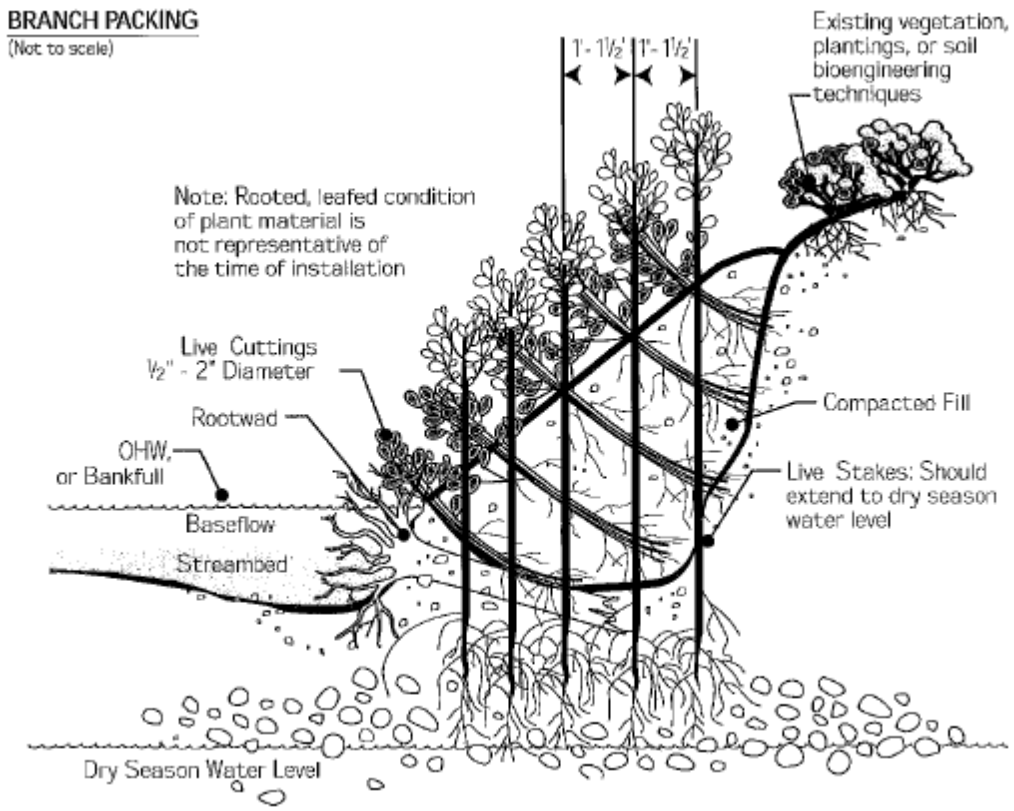

Figure 5. Schematic design of branchpacking installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002. "OHW" in diagram is an acronym for Ordinary High-Water Mark.

Advantages:

- Repairs slumps and holes effectively and inexpensively
- Establishes a vegetative streambank rapidly
- Enhances conditions for colonization of native vegetation
- Provides immediate soil reinforcement

Limitations:

- Typically not effective in slump areas greater than 4 feet deep or 4 feet wide, or on slopes steeper than 2:1

BMP 5: Branchpacking

References:

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-FS (FS-683).
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BMP 6: Brushlayering

Photo of installed brushlayering. Source: California DOT, 2003.

Minimizes bank erosion while enhancing aesthetics through the establishment of vegetation.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Brushlayering is the technique of laying cuttings on horizontal benches that follow the contour of either an existing or filled streambank. Branches serve as tensile inclusions or earth-reinforcing units to provide shallow stability of slopes. The cuttings are oriented perpendicular to the slope face. The portion of the brush that protrudes from the slope face assists in slowing runoff and reducing surface erosion.

Brushlayering can be used to stabilize a slope against shallow sliding or mass wasting in addition to providing erosion protection. Cuttings or branches of easily rooted tree species are rooted between successive lifts of soil fill to construct a reinforced slope or embankment.

Feasibility: Brushlayering is more effective on filled (rather than cut) slopes because longer stems can be used in fill. Installation should occur during the dormant period, generally late fall to early spring. Steep slopes should not exceed 30 feet in length, and the slopes should not be steeper than 3:1.

Maintenance: Installations should be inspected frequently during the first year or two of establishment. Missing or damaged plant materials should be replaced as soon as possible. Sloughs or breaks in the drainage pattern should be repaired as quickly as possible to maintain site stability.

BMP 6: Brushlayering

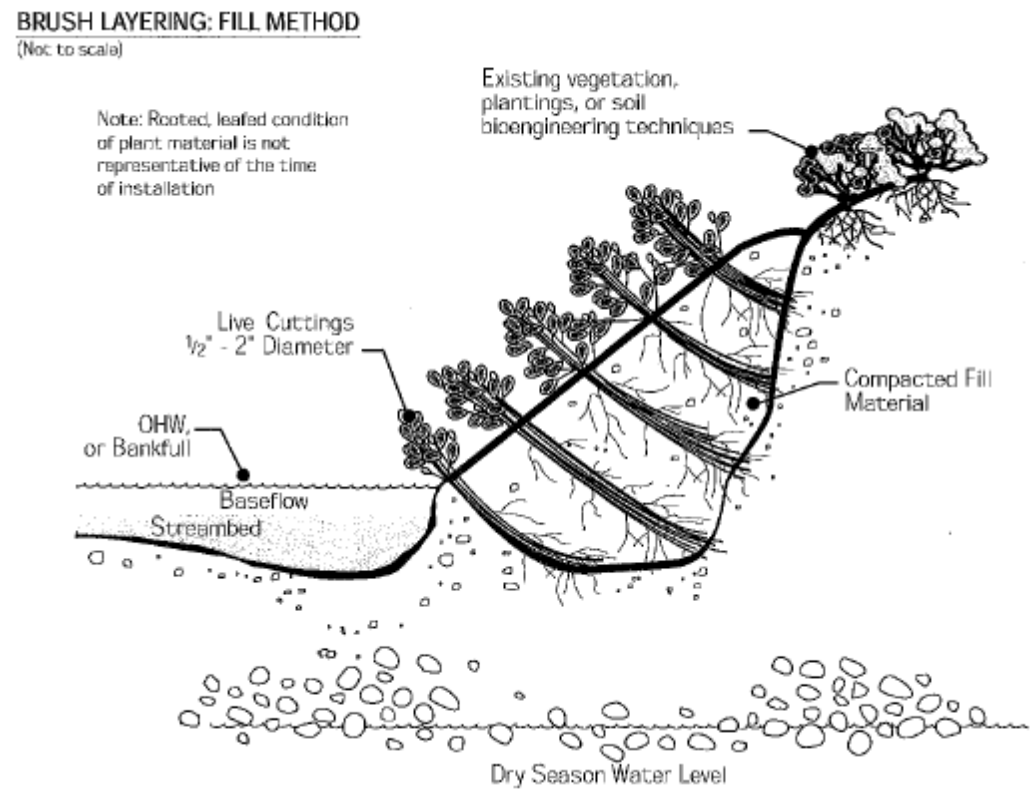

Figure 6. Schematic design of brushlayering installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002. "OHW" in diagram is an acronym for Ordinary High-Water Mark.

Advantages:

- Breaks up the slope length into a series of shorter slopes separated by rows of brush layer
- Dries excessively wet sites
- Aids infiltration on dry sites
- Reinforces the soil, adding resistance to sliding or shear displacement
- Traps debris on the slope

Limitations:

- High flow may wash soil from between layers
- Does not work on outside bends

BMP 6: Brushlayering

References:

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-FS (FS-683).
http://www.fs.fed.us/publications/soil-bio-guide/

Brush Layering. 2003. California Dept. of Transportation Landscape Architecture Program
http://www.dot.ca.gov/hq/LandArch/ec/plants/brush_layering.htm

Branchpacking and Brushlayering. 2007. Institute of Water Resources, U.S. Army Corps of Engineers Publications
http://www.pmcl.com/mmdl/MM_Description.asp?ID=5

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Standards and Specifications for Brush Layer. 2005. New York Standards and Specifications For Erosion and Sediment Control.
http://www.dec.ny.gov/docs/water_pdf/sec4.pdf

BMP 7: Live Cribwall

Photo of a live cribwall. Source: New York Dept. of Environmental Conservation, 2005.

Provides immediate protection in areas with near vertical streambanks where bank sloping options are limited.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: A live cribwall is a hollow box-like structure made with an interlocking arrangement of untreated logs or timbers spiked together and anchored to the slope. The structure is filled above baseflow with suitable earthfill materials and layers of live branch cuttings which root inside the structure and extend into the slope. The establishing vegetation gradually takes over the structural function.

Live cribwalls protect exposed or eroded streambanks from the erosive forces of flowing water. They afford a natural appearance, immediate protection, and accelerate the establishment of woody species.

Feasibility: The technique is generally applicable where flows are less than 6 feet per second, and no degradation of the streambed is occurring. Live cribwalls can reduce steepness and provide stability where space is limited and a vertical structure is needed. They are not intended for use where the integrity of a road or structure is dependent on the cribwall, since it is not designed to resist large lateral earth pressures.

Live cribwalls are appropriate in locations where the streambank slope is steep and there is insufficient space to provide a more horizontal type of treatment, on the outside of bends, where there is a need to provide a natural streambank appearance, and where there is a need for immediate protection before vegetation can be established.

Maintenance: Installation should be inspected frequently during the first year or two of establishment. Missing or damaged plant materials should be replaced as soon as possible. Sloughs or breaks in the drainage pattern should be repaired as quickly as possible to maintain site stability.

BMP 7: Live Cribwall

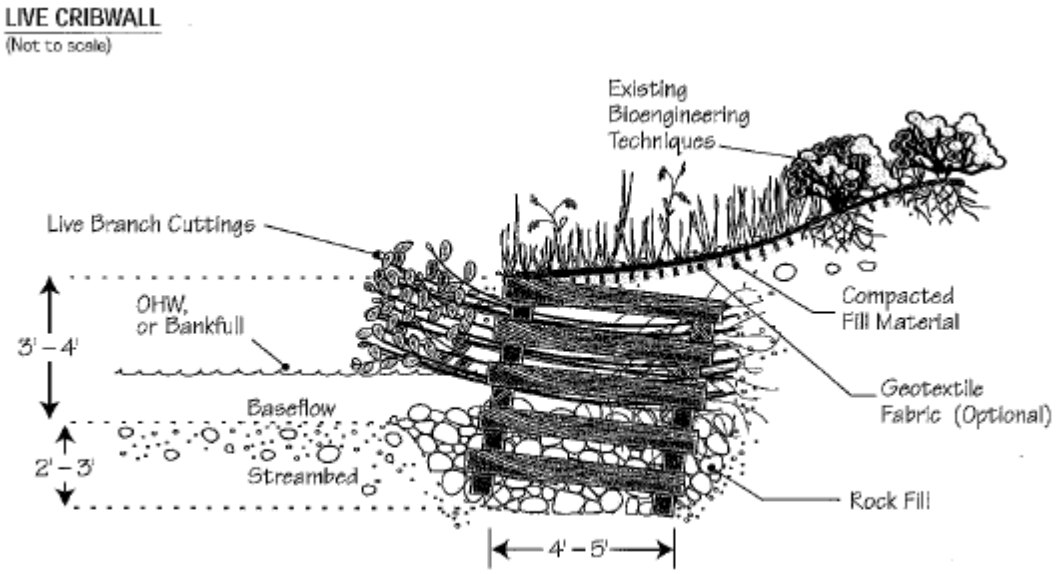

Figure 7. Schematic design of live cribwall installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002. "OHW" in diagram is an acronym for Ordinary High-Water Mark.

Advantages:

- Effective on the outside of bends where high velocities are present
- Appropriate at the base of a slope where a low wall might be required to stabilize the toe and reduce slope steepness
- Appropriate above and below water level where stable streambeds exist

Limitations:

- Should be kept to heights under 7 feet and should not exceed 20 feet in length
- Not appropriate where rock ballast and logs are not readily available
- Must be installed during the dormant period, generally late fall to early spring
- Must be implemented during low water period
- Can be complex and expensive

BMP 7: Live Cribwall

References:

A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. 2002. USDA-FS (FS-683).
http://www.fs.fed.us/publications/soil-bio-guide/

Federal Stream Corridor Restoration Handbook (NEH-653) Appendix A. FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3
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http://www.dec.ny.gov/docs/water_pdf/sec4.pdf

BMP 8: Erosion Control Blankets

Photo of erosion control blanket installation.
Source: Source: Wyoming Game and Fish Department

Temporarily stabilizes and protects disturbed soil from surface erosion and conserves soil moisture.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Erosion control blankets are used to temporarily stabilize and protect disturbed soil from raindrop impact and surface erosion, to increase infiltration, decrease compaction and soil crusting, and to conserve soil moisture. Mulching with erosion control blankets will increase the germination rates for grasses and legumes and promote vegetation establishment. They also protect seeds from predators, and reduce desiccation and evaporation by insulating the soil and seed environment.

Some types of erosion control blankets and turf reinforcement mats can aid the establishment of vegetation in waterways and increase the maximum permissible velocity of the given channel by reinforcing the soil and vegetation to resist the forces of erosion during runoff events. Stems, roots, and rhizomes of the vegetation become intertwined with the blanket, reinforcing the vegetation and anchoring the mat.

Feasibility: Erosion control blankets are suited for post-construction stabilization, but may be used for temporary stabilization of highly erosive soils. They are suitable for steep slopes, streambanks, and places where vegetation will be slow to establish itself. Blankets and mats may be used for channels where water velocities over 6 feet per second are likely to wash out new vegetation. Erosion control blankets made of excelsior, coconut, or straw must be stapled or staked to the surface especially in waterways and on steep slopes.

Maintenance: Close inspection after rainfall events and major runoff occurrences is essential. Check for damage due to water running under the mat or blanket, and displacement due to wind. Restabilize with staples or stakes. If significant erosion has occurred, fabric repair, reseeding, and/or grading may be necessary. Continue inspections until vegetation is firmly established.

BMP 8: Erosion Control Blankets

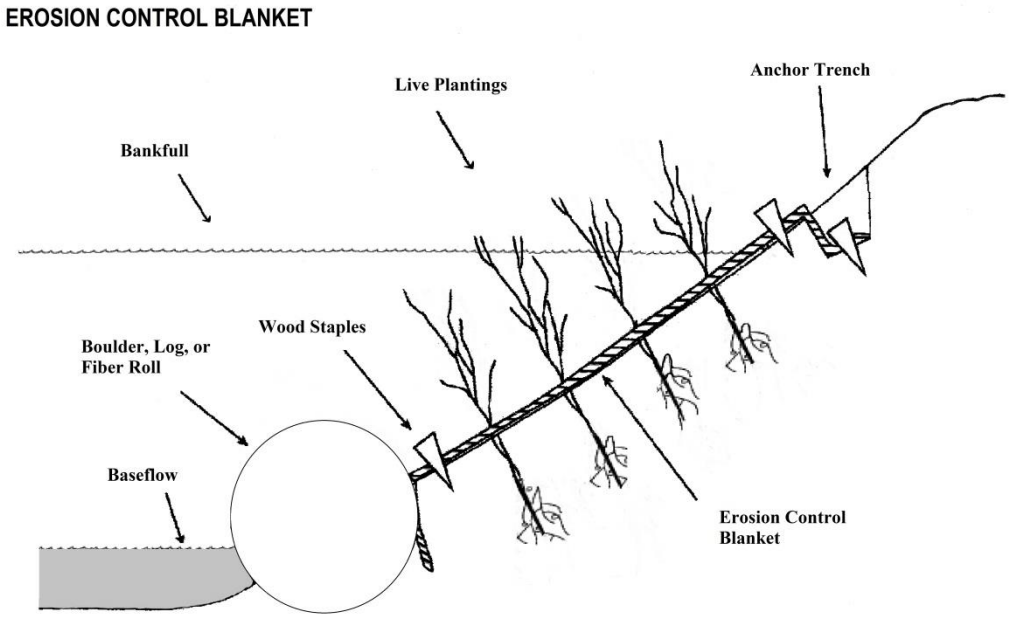

Figure 8. Schematic design of erosion control blanket installation. Source: Wyoming Department of Environmental Quality/Water Quality, 2012,

Advantages:

- Suitable for steep slopes and high velocities
- Many varieties suited to differing specifications available
- Highly flexible

Limitations:

- Care must be exercised in the choice of material; blankets made of jute and straw rapidly degrade on steeper slopes

References:

Erosion Control Blanket, Fabric Form. 2007. Institute of Water Resources, U.S. Army Corps of Engineers Publications
http://www.pmcl.com/mmdl/MM_Description.asp?ID=10

Erosion Control Mats & Blankets. 2008. Natural Resources Management South, Soil & Water Management.
http://www.nrmsouth.org.au/uploaded/287/15130373_94factsheet8.pdf

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http://www.plant-materials.nrcs.usda.gov/pubs/idpmcpu116.pdf

BMP 9: Vegetated Buffer

Photo of vegetative buffer. Source: USDA-Forest Service, 1991.

Maintains the integrity of the waterway, reduces pollution, and provides food, habitat, and thermal protection for fish and wildlife.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Vegetated buffers (also known as buffer zones or buffer strips, and including variants such as forest buffers and riparian buffers) consist of planted or naturally occurring vegetation such as trees, shrubs, and plants. The vegetation serves as a filter, straining out sediments, nutrients, pesticides, and other pollutants before they reach the waterbody.

The buffers stabilize streambanks and shorelines, and prevent bank erosion and slumping. Runoff slows down and loses much of its erosional force when it passes through the strip of vegetation. Trees and shrubs along streams and lakes provide shade, improving habitat for aquatic organisms and providing cover and habitat for wildlife. A network of buffers acts as the right-of-way for a stream and functions as an integral part of the stream ecosystem. The use of naturally occurring vegetation can make this a very inexpensive technique.

Feasibility: Vegetated buffer design is flexible and can be adapted to the location. Suggested buffer width is at least 20 feet; 200 feet is recommended. Even a smaller width is more useful than no buffer at all. The ability of a vegetated buffer to remove pollutants is dependent on the width of the buffer, the type of vegetation, the manner in which runoff traverses the vegetated areas, the slope, and the soil composition. Unstable areas such as those with high surface erosion rates, mass soil movement, or active gullies will require stabilization prior to establishment of vegetated buffers.

Maintenance: Potential maintenance activities include watering for the first year of replanting or in drought conditions, selective cutting, replanting, and weed control (hand weeding or careful spraying). Existing vegetated areas need little or no maintenance. Fertilization should be avoided. Maintenance activities should not cause soil compaction, excessive disturbance, or impact close to the waterbody. Fallen or decaying streamside vegetation in established areas should not be removed. Excessive raking, brush clearing or plant removal can reduce water detention time and the breakdown of pollutants by plants and microorganisms.

BMP 9: Vegetated Buffer

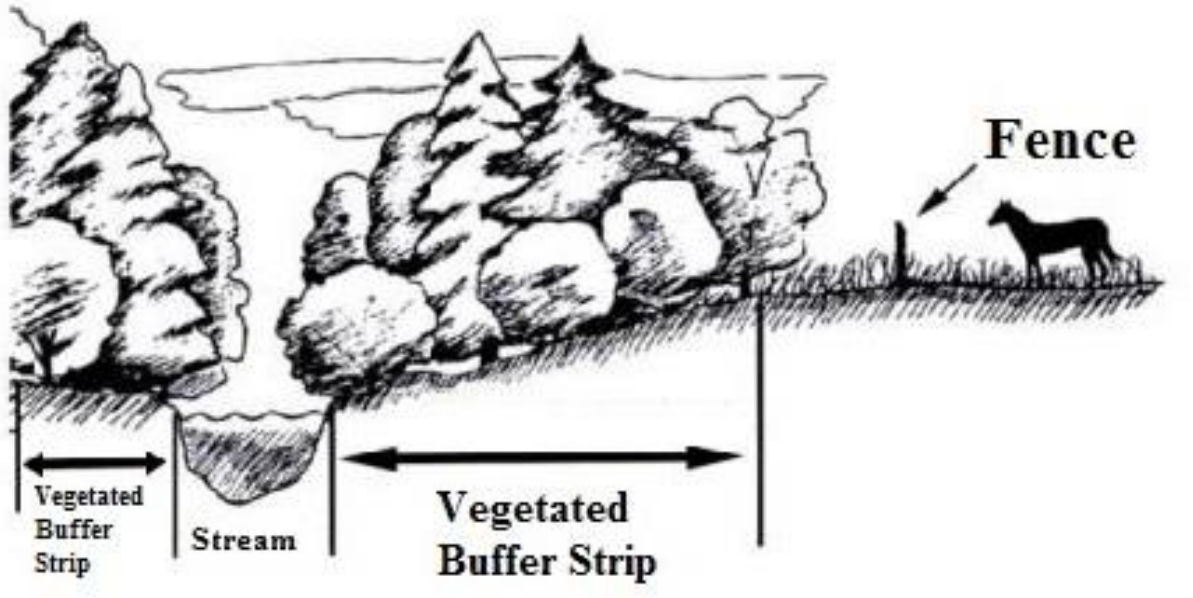

Figure 9. Schematic design of vegetated buffer strips. Source: Massachusetts Department of Environmental Protection

Advantages:

- Enhances habitat conditions for colonization of native species
- Integrates well with other streambank protection techniques
- Filters out sediment and other contaminants
- Provides a visually appealing greenbelt and recreational opportunities

Limitations:

- Runoff into the buffer zone should not be channeled
- Livestock should be prevented from entering the vegetated area or should be managed carefully to maintain vegetation

BMP 9: Vegetated Buffer

References:

Federal Stream Corridor Restoration Handbook (NEH-653) Chapter 8. FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3
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Riparian Forest Buffers. 2006. Massachusetts Nonpoint Source Pollution Management.
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Vegetated Buffer Strips. Massachusetts Department of Environmental Protection – Water, Wastewater & Wetlands: Water Resources & Wetlands
http://www.mass.gov/eea/agencies/massdep/water/watersheds/vegetated-buffer-strips-slow-the-flow.html

Riparian Forest Buffers. 1991. USDA/USFS Northeastern Area – Forest Resources Management, D. J. Welsch.
http://na.fs.fed.us/spfo/pubs/n_resource/buffer/cover.htm

BMP 10: Native Material Revetment

Photo of log revetment with large boulders and rootwads. Source: WDEQ

Minimizes bank erosion and improves habitat for aquatic plants and animals.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Log, rootwad, and boulder revetments are systems selectively placed in and on streambanks. They protect the streambank from erosion and provide excellent in-stream and overhead cover for fish, shelter for insects and other fish food organisms, substrate for aquatic organisms, and sediment flushing and deeper scour pools due to increased stream velocity.

These revetments provide effective streambank erosion control in higher velocity streams, and they trap sediment between components, support restoration of slope vegetation, and distribute flow velocities and in-stream sediments for fishery use. They offer a natural look, an abundance of cover, shading, detritus, and diversity of habitats.

Feasibility: Native material revetments are used for stabilization and to create in-stream structures for improved fish rearing and spawning habitat. They are suited to streams where fish habitat deficiencies exist. These revetments enhance the diversity in the riparian corridor when used in conjunction with soil bioengineering systems.

The method should be used in combination with soil bioengineering systems or vegetative plants to stabilize the upper bank and ensure a regenerative source of streambank vegetation. Native material revetments are effective on meandering streams with out-of-bank flow conditions and will tolerate high boundary shear stress if logs and rootwads are well anchored. They have a limited lifespan depending on climate and tree species used. The use of cottonwood or willow may increase the potential for sprouting and accelerate natural colonization.

Maintenance: These revetments may need eventual replacement if natural colonization does not take place or soil bioengineering methods are not also used.

BMP 10: Native Material Revetment

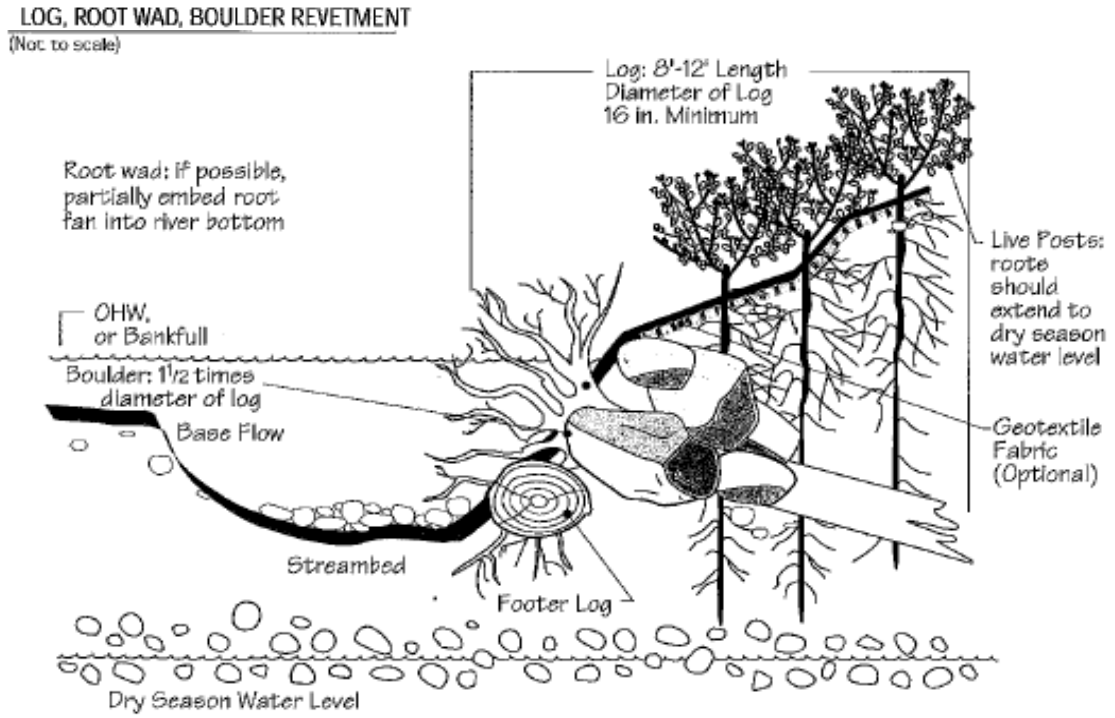

Figure 10. Schematic design of native material revetment installation. Source: USDA-FS 'A Soil Bioengineering Guide' 2002. "OHW" in diagram is an acronym for Ordinary High-Water Mark.

Advantages:

- Provides maximum in-stream habitat for fish to feed, rest, and escape
- Contains numerous crevices and large amounts of surface area onto which aquatic macroinvertebrates can attach
- The design life of native material revetments can be greater than 25 years, depending on species used
- Because rootwads are installed perpendicular to the bank, this robust technique reinforces the river bank, is resistant to propeller wash and wave and ice action, and can withstand woody debris accumulation

Limitations:

- May need replacement if colonization does not take place or soil bioengineering systems are not used
- Site must be accessible to heavy equipment
- Materials might not be readily available at some locations
- Can be expensive
- Requires professional design and installation

BMP 10: Native Material Revetment

References:

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BMP 11: Bank Shaping and Vegetation

Photo of bank shaping. Source: Wyoming Game and Fish Dept.

The use of bank shaping and vegetation is often a preparatory step for other bank stabilization techniques.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description: Bank shaping and vegetation involve excavating and filling the raw eroded streambank to establish a stable slope angle, placing topsoil and other material needed for plant growth on the streambank, and selecting and installing appropriate plant species. This technique is most effective on streambanks where moderate erosion and channel migration are anticipated. Reinforcement at the toe of the bank is often required, especially where flow velocities exceed the tolerance range for plantings, and where erosion occurs below base flows. To determine the appropriate slope angle, slope stability analyses that take into account streambank materials, groundwater fluctuations, and bank loading conditions are recommended.

This method should be used in conjunction with other protective practices when the flow velocities exceed the tolerance range for available plants, and where erosion is occurring below base flow levels. Banks that are experiencing mass movement should be stabilized prior to shaping and vegetating.

Feasibility: Properties such as streambank soil materials, probable groundwater fluctuation, and bank loading conditions need to be used to determine an appropriate side slope. Check other stable reaches of streambank along the stream or in neighboring watersheds for appropriate plant materials, similarity of soil materials, loading conditions, groundwater fluctuations, side slope, channel slope, and other features.

Shaping should occur during periods when the work will not interfere with key aquatic species reproduction and should end during the planting windows for the selected vegetation.

Maintenance: Irrigation during the first year will improve effectiveness. Installation should be inspected frequently during the first year or two of establishment. Missing or damaged plant materials should be replaced as soon as possible. Sloughs or breaks in the drainage pattern should be repaired as quickly as possible to maintain site stability.

BMP 11: Bank Shaping and Vegetation

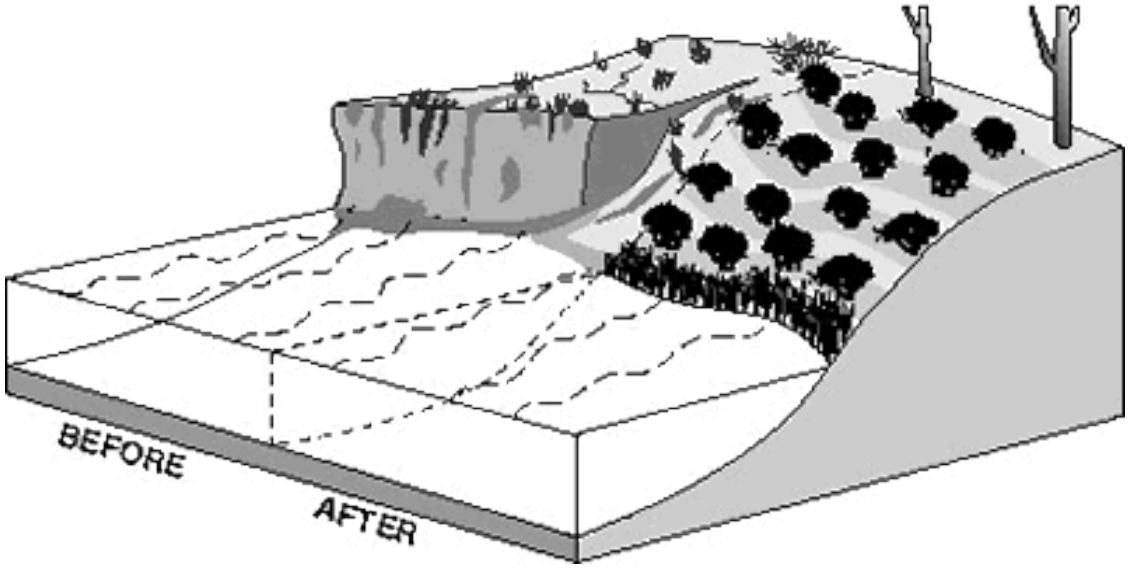

Figure 11. Schematic design of bank shaping and vegetation installation. Source: Stream Corridor Restoration: Principles, Processes, and Practices – 10/98, Federal Interagency Stream Restoration Working Group

Advantages:

- Enhances conditions for colonization of native species
- Integrates well with other streambank protection methods

Limitations:

- The bank to be shaped must not currently be experiencing mass movement
- Reinforcement at the toe of the embankment is often needed

BMP 11: Bank Shaping and Vegetation

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BMP 12: Stone Toe Revetments

Photo of stone toe revetment with erosion control on upper bank. Source: WDEQ

Reduces erosion by stabilizing the toe of the bank, preventing undermining of the upper banks.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description:

Stone toe revetments (also known as rock toe revetments or stone toe protection) are used to stabilize the lower portion (the toe) of a bank that is most susceptible to erosion. Stabilizing the toe of the bank prevents the upper bank from being undermined and collapsing. Properly sized rock material is placed at the toe of the bank slope and into the streambed to a point below the design scour depth. The rock is also placed up the bank only to bankfull height. It is important that the rock material not extend above bankfull height in order to allow access to the flood plain to maintain or restore natural channel dimensions. Stabilizing the toe of the bank in this fashion with permanent, non-erosive material provides a stable foundation for the upper bank.

Although sediment will deposit between and behind the stones over time, the void spaces between rocks may need to be filled during installation to ensure stability. Live stakes (see BMP 2) can be planted in the spaces between rocks, which will also improve aesthetics and aquatic habitat. Depending on the situation, the upper bank may also need to be stabilized through re-grading, soil bioengineering, and or vegetative plantings. The use of vegetation within and above the structure will help improve aesthetic and aquatic habitat values. Upland erosion above the stream bank should be controlled and a healthy riparian buffer should be maintained in order to support the effectiveness of this practice.

Feasibility:

This practice works well in small and mid-size streams. Because of their benefit to aquatic and riparian habitat, native material revetments (see BMP 10) should be considered first and rock revetments used when native materials are not feasible. If stone is not locally available, stone toe revetments can be relatively expensive due to transportation costs. This practice should not be used on streams that are actively incising unless the vertical instability has also been addressed. Heavy equipment will be needed for installation.

Maintenance:

Maintenance requirements vary depending on the characteristics of the stream system, including velocity, flood frequency, flood stage, timing, and sediment load. Generally, the revetment should be inspected periodically for scour or dislodged stones and weeds should be controlled as necessary.

BMP 12: Stone Toe Protection/Rock Riprap

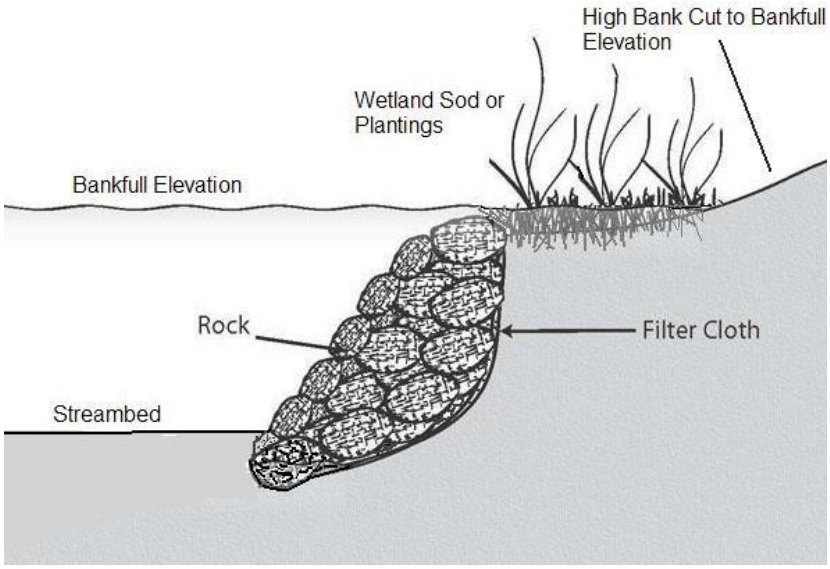

Figure 12. Schematic design of rock toe protection. Source: WDEQ

Advantages:

- Works well on small or mid-size streams
- Integrates well with other streambank protection methods
- Lasts indefinitely, even when exposed to high velocities
- Flexible and not impaired by slight movement from settlement or other adjustments

Limitations:

- Hydrologic and hydraulic analyses by an engineer are required
- Heavy equipment is necessary for installation
- Costs are typically very high if rock not locally available
- Provides minimal riparian or fish habitat

BMP 12: Stone Toe Protection/Rock Riprap

References:

Federal Stream Corridor Restoration Handbook (NEH-653) Appendix A. FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3
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BMP 13: Log, Rock, and J-Hook Vanes

Photo of J-hook vane installation. Source: Wyoming Game and Fish Dept.

Protect the streambank from erosion and enhance pool and riffle habitat.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased ammonia

Description:

Vanes are linear structures that extend out from the streambank into the stream channel in an upstream direction. They essentially mimic the effect of a tree partially falling into the stream. They are usually placed along the streambank where erosion is occurring at the toe of the slope. The purpose of vanes is to reduce erosion along the streambank by redirecting the stream flow toward the center of the stream. In addition, they tend to create scour pools on the downstream side.

Vanes can be made of rock or log. They slope gently down from the bankfull elevation at the streambank to their end in the stream. Vanes generally extend out from the stream 1/3 of the bankfull width (the "hook" in a J-hook vane takes another third of the width) and are angled upstream from the bank at a 20 to 30 degree angle. They should be carefully located and installed to avoid producing additional erosion on the upstream side where they meet the bank, and also to prevent flows from outflanking the vane, exacerbating existing bank erosion problems.

The only difference between the log vane and the rock vane is the material used. The J-hook vane is basically the same structure, with the addition of a curl at the end in the shape of a "J." The curved end serves to enhance downstream scour pool formation.

Feasibility:

Vanes can be used to deflect erosional forces away from the streambank at the upstream end of the outer meander bend or other unstable areas. Rock and J-hook vanes are most appropriate in streams with gravel or larger substrate. In sand-bed streams, a log vane or a combination of log and rock to create a J-hook vane is more effective. Vanes are useful when fish habitat enhancement and/or flow deflection are desired.

Maintenance:

The installation should be inspected periodically for undercutting, bank erosion, or any other damage, and appropriate repairs conducted. Eroding streambanks should be stabilized and any scouring and/or deposition of material identified. Logs degrade over time and may need periodic repair or replacement.

BMP 13: Log, Rock, and J-Hook Vanes

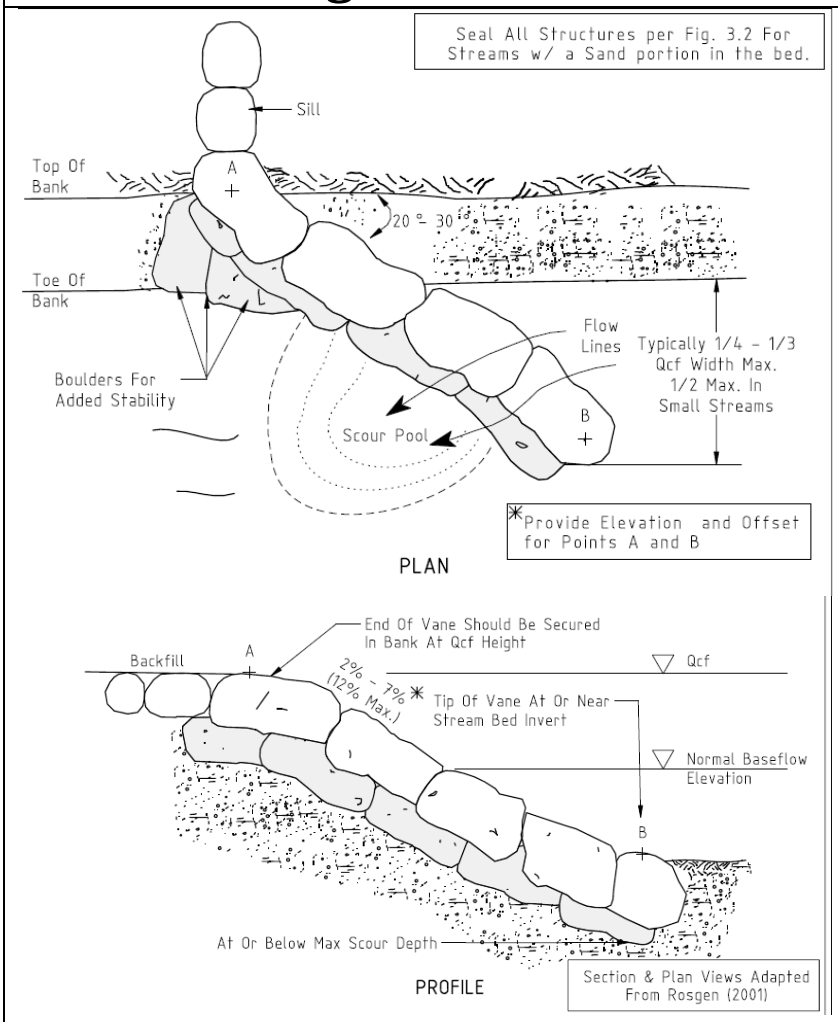

Figure 13. Schematic design of rock vane structure, plan and profile view. Source: The Virginia Stream Restoration & Stabilization BM P Guide, 2004. Figure 3.2 refers to the source document referenced. Qcf is the channel forming discharge.

Advantages:

- Enhances habitat conditions for colonization of native species
- Integrates well with other streambank protection techniques
- Provides immediate protection from erosive forces

Limitations:

- Large rock size requirements may make it difficult to use in small streams
- May require heavy equipment and skilled operators to place rock correctly
- Rock may sink or subside in streams with sand and clay beds; geotextile fabric may be necessary
- Vanes should not be used in stream reaches with channel slopes greater than 3%

BMP 13: Log, Rock, and J-Hook Vanes

References:

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http://www.wildlandhydrology.com/assets/cross-vane.pdf

BMP 14: Grade Control Structures

Photo of cross vane. Source: Wyoming Game and Fish Department

Reduce streambank erosion, enhance fish habitat, and provide for irrigation diversion structures.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased ammonia

Description:

Grade control measures include a variety of rock, wood, and earthen structures placed across the channel and anchored in the streambanks to provide a "hard point" in the streambed that resists the erosion forces of the degradational zone and maintains a streambed elevation. They either raise the stream invert or maintain the channel invert at its current elevation. Nearly all stream restoration projects incorporate some form of grade control in the project design. Examples of grade control structures include rock cross vanes, rock vortex weirs, W-weirs, log drops, V-log drops, K-dams, and step pools.

A rock cross vane is a stone structure consisting of footer and vane rocks constructed in a way that provides grade control and reduces bank erosion. The vane is composed of a center section perpendicular to the streambank (taking up 1/3 of the bankfull width) joined to two arms (each taking up another 1/3 of the bankfull width) that extend into the streambank. The rock cross vane accumulates sediment behind the vane arms, directs flow over the cross vane, and creates a scour pool downstream of the structure.

Cross vanes were developed to eliminate stability problems encountered in the use of check dams, which are small dams, either temporary or permanent, built across a minor channel, or drainage ditch. Check dams reduce erosion and gullying in the channel and allow sediments and pollutants to settle, and also lower the speed of water flow during storm events. Check dams can be built with logs, stone, or sandbags. They can cause severe bank erosion unless extensive bank stabilization measures are used both upstream and downstream.

The W-weir is similar to a cross vane, but intended primarily for use in larger rivers, and producing two scour pools. Rock vortex weirs are also similar to cross vanes, but have a parabolic form and open gaps in the structure incorporated into the design. Log drops and V-log drop structures are typically used in high gradient perennial and intermittent headwater streams, and ephemeral gullies. Step pools are rock grade control structures constructed in the stream channel that re-create natural step-pool channel morphology. Step pools are built in series and allow for "stepping down" the channel over a series of drops.

BMP 14: Grade Control Structures

Feasibility: These structures are appropriate where stabilization of a vertically unstable stream bed requires grade control, for bridge protection, when fish habitat enhancement and grade control are both desired, and for providing irrigation diversion. Grade control should be considered as a first step before further restoration measures are implemented.

Maintenance: Structures should be monitored to ensure that their orientation and geometry do not hinder fish migration. They should also be inspected for deposited sediment, and for bank instabilities or undesirable lateral stream movement.

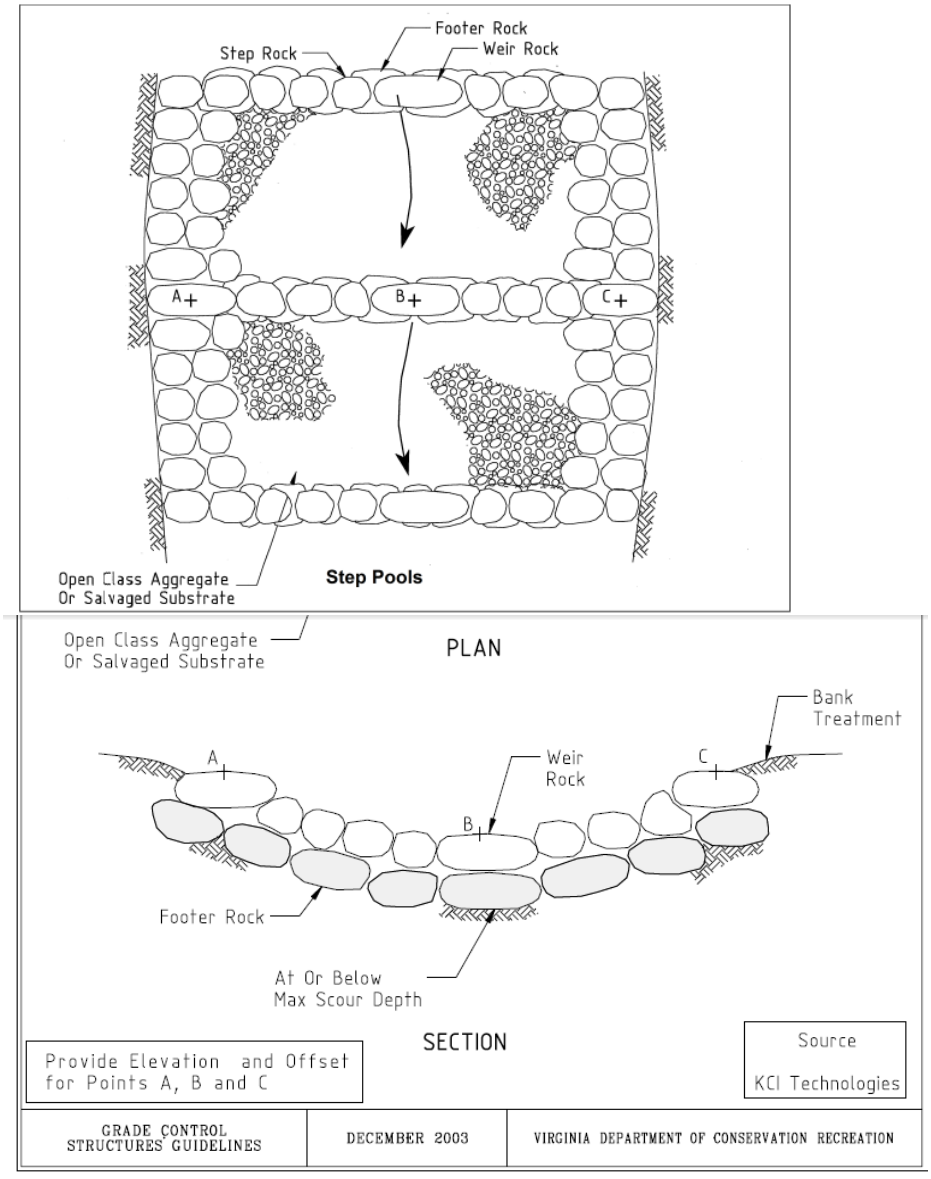

Figure 14. Schematic design of Step Pool grade control structure, plan and cross section views. Source: The Virginia Stream Restoration & Stabilization BM P Guide, 2004

BMP 14: Grade Control Structures

Advantages:

- Enhances habitat conditions for colonization of native fish species
- Integrates well with other streambank protection techniques
- Provides immediate protection from erosive forces
- Flexible and adaptable to many different sets of conditions

Limitations:

- Potential to become a low flow migration barrier
- May require heavy equipment and skilled operators to place rock correctly
- Deposition of sediment upstream from the structure can cause downstream channel degradation or increased meandering tendencies
- Rock may sink or subside in streams with sand and clay beds

References:

Federal Stream Corridor Restoration Handbook (NEH-653) Appendix A. FISRWG (10/1998). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3
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http://www.wildlandhydrology.com/assets/cross-vane.pdf

BMP 15: Culverts: Modification and Replacement

Photo of modified culvert. Source: Wyoming Game and Fish Department

Protects infrastructure from damage while removing barriers to upstream migration of fish; improves habitat and reduces siltation.

Water Quality Benefits

Reduced siltation

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description:

Many culverts are undersized, and lack the capacity to pass flows from a flood for which they may have originally been designed. Undersized culverts act as a hydraulic control during floods, backing water upstream and depositing sediments, which can further reduce the capacity of the culvert. On the downstream end, higher velocities of water exiting undersized culverts during high flows can cause erosion. Consequently, many culverts are good candidates for modification or replacement in order to protect roads and other infrastructure from damage while improving water quality and stream stability. During the modification process, culvert design can be changed to promote better fish passage.

Five basic design options are available to replace culverts: Zero Slope Culverts convey water without a change in slope, slowing current velocities so that fish can pass; Bridge Replacements span the stream and allow for a stream bottom under the bridge; Embedded Culverts are oversized and installed below the current invert of the streambed, allowing the placement of natural stream substrate on the bottom of the pipe; Bottomless Culverts are also oversized and the natural grade is maintained, allowing sediment transport and fish passage; and Permanent Removal, also known as Stream Daylighting, which simply removes the culvert and restores the channel as naturally as possible. Permanent Removal is often an option in populated areas, where previous development may have enclosed a stream segment with a culvert. Measures such as "relief culverts" can be added within the active floodplain of the stream (i.e. at bankfull height on either side of the main culvert) to provide for conveyance of flood flows and to establish floodplain connectivity. Culvert modification techniques include the installation of *baffles*, which provide resting areas for fish, concentrate water, and reduce current velocities; creation of a *low flow channel* within the existing culvert to ensure an adequate depth or volume of water to allow fish passage; and the use of *downstream grade controls* to raise the elevation of the streambed so that backwater from the last grade control reaches above the culvert invert at low flow.

Feasibility:

Culvert replacement or removal techniques are preferred long-term to promote fish passage because culvert modification and fish passage devices only provide temporary benefits, do not pass all fish species, and require frequent maintenance. Replacement or removal may not always be feasible or appropriate, however; culvert modification may achieve the same goals in the short term at a lower cost. Open bottom culverts are preferred to maintain natural bottom substrate.

BMP 15: Culverts: Modification and Replacement

Maintenance: The new culvert or open area should be inspected at the onset of spawning season to ensure that it is free of sediment deposition, debris jams, or organic matter. Fish monitoring is advised to determine whether the replacement worked as designed or needs further modification.

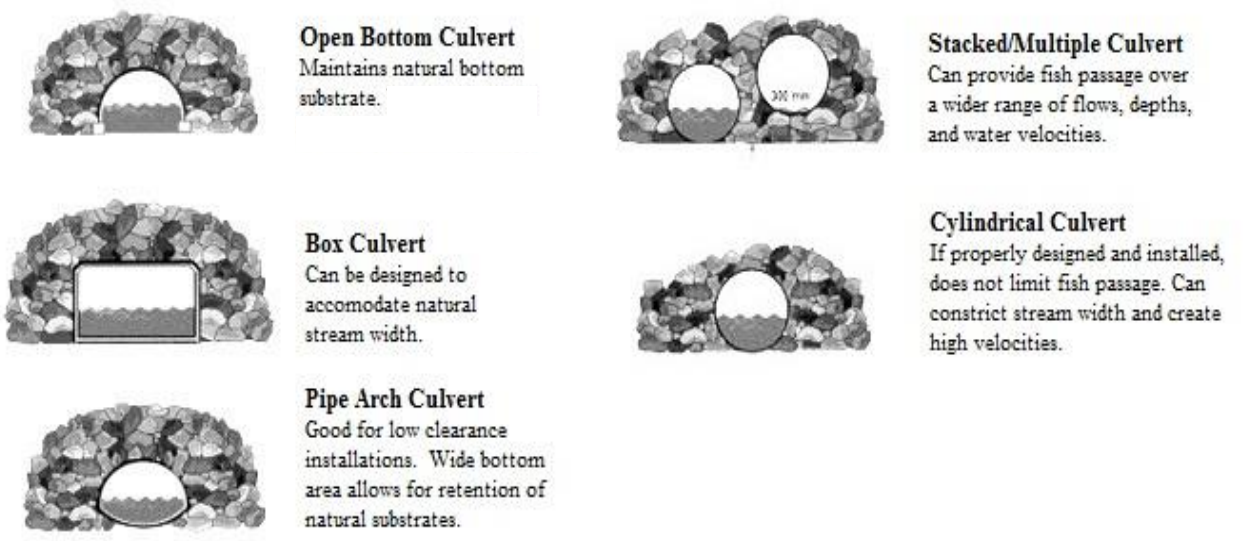

Figure 15a. Various types of culverts. Source: Adapted from Gosse et al., 1998.

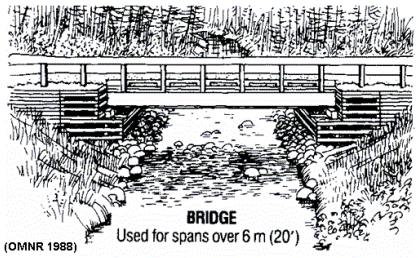

Figure 15b. Culvert replacement. Source: FWS, 2008

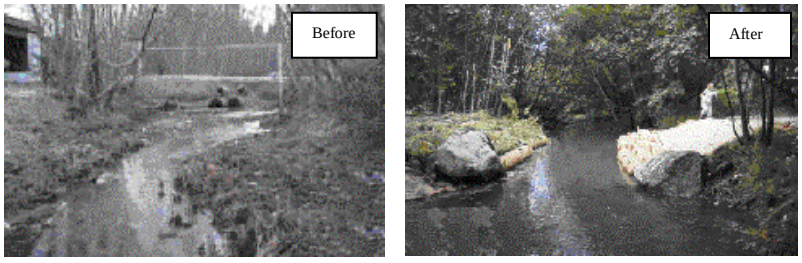

Figure 15c. Culvert removal. Source: Center for Watershed Protection, 2004

Advantages:

- Enhances habitat conditions for colonization of native species
- Integrates well with bioengineering techniques
- Removes barriers to fish migration
- Reduces siltation

Limitations:

- Construction should be scheduled to avoid fish migration and spawning seasons
- May require heavy equipment and skilled operators to place rock correctly
- Can be expensive

BMP 15: Culverts: Modification and Replacement

References:

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BMP 16: Channel Redesign & De-channelization

Photo of redesigned stream channel.
Source: Wyoming Game and Fish Department

Comprehensive stream repair application that alters the dimensions, pattern, and profile of an unstable channel.

Water Quality Benefits

Reduced soil erosion and stabilized stream banks

Increased dissolved oxygen

Decreased temperature, pH, and ammonia

Description:

The goal of channel redesign is to create a new channel that will not aggrade or degrade, given its projected hydrologic regime and sediment load. The geometry and dimensions of the new channel are designed based on a reference stream reach (a portion of a river segment that represents a stable channel within a particular valley morphology), regional hydraulic geometry curves, hydraulic modeling, or a combination of all three methods.

The nature of the interaction of the flows and sediments with the channel boundary should be used in the selection of the appropriate design approach. Channels can be divided into two types based on the sediment load and the stability of the channel boundary during normal flow: threshold and alluvial. Threshold channels do not have the ability to quickly adjust their geometry, as do alluvial channels, and there is no significant exchange between the sediment in transport and the bed. Alluvial channels have beds and banks formed of material transported by the stream under normal flow conditions. There is an exchange of material between the inflowing sediment load and the bed and banks of the stream.

The flow conditions that a channel may experience throughout the year also have an influence on the choice of appropriate channel design technique. Both threshold and alluvial streams may be classified as perennial, intermittent, or ephemeral, depending on the duration of flow over the course of the year.

De-channelization, or increasing the sinuosity of a stream by reintroducing a natural meander pattern, involves the same process as channel redesign. De-channelization is somewhat more complex, however, given the physical alterations of the channel and stream corridor restraints.

Feasibility:

Since channel redesign seeks to predict new stable channel dimensions, it requires a thorough understanding of fluvial geomorphology, as well as current and future subwatershed conditions. Undertaking a channel redesign project without fully understanding future channel evolution or upstream subwatershed conditions can lead to greater channel instability and project failure.

BMP 16: Channel Redesign & De-channelization

Maintenance: Ideally, a channel should be self-sustaining and not require any maintenance. In reality, however, channels may aggrade or degrade over time or in response to specific storm events and require monitoring to identify problems before stability is threatened.

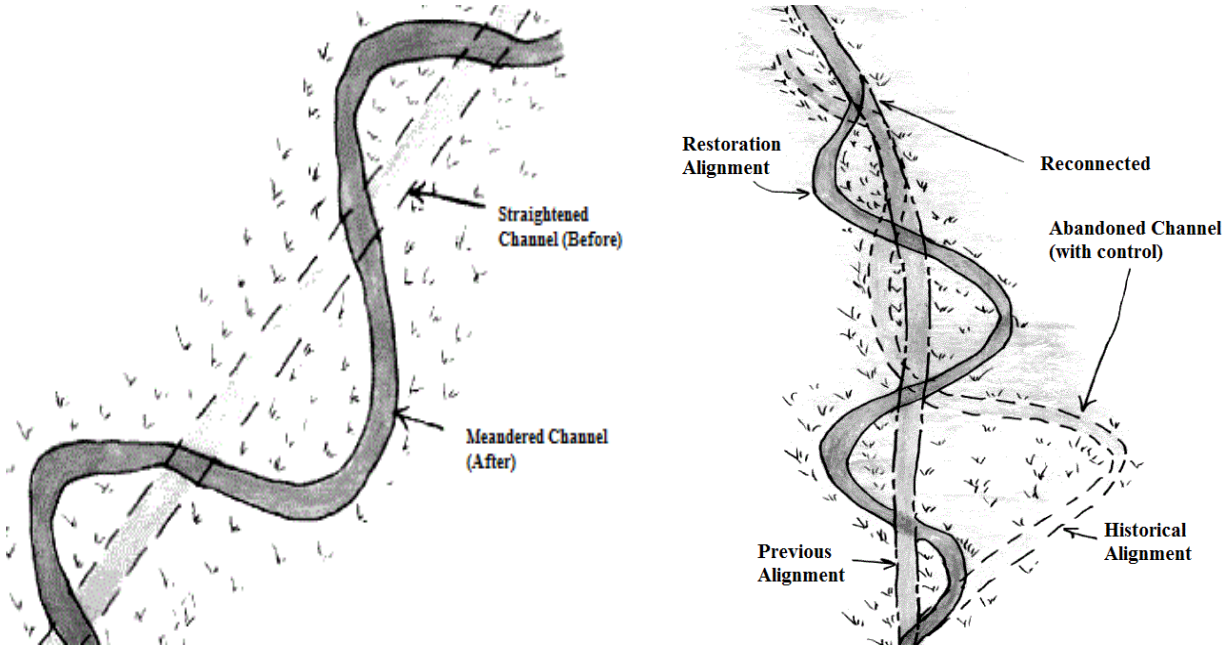

Figure 16. Schematic design of de-channelization techniques - stream meander restoration (left) and maintenance of hydraulic connections (right). Source: Institute of Water Resources

Advantages:

- Increases habitat diversity
- Integrates well with bioengineering techniques
- Recreation value may be enhanced
- Creates long-term stability

Limitations:

- Requires a high level of analysis
- May cause an increase in flood elevations
- Streambank protection might be required on the outside of bends
- May not be feasible in watersheds experiencing rapid changes in land uses
- May be expensive

BMP 16: Channel Redesign & De-channelization

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Appendix A: Planning Considerations for Stream Channel Alteration Projects and Construction Measures for All Projects

PLANNING CONSIDERATIONS

Stream channel alteration projects should be systematically evaluated to help make decisions as to the need, appropriateness and design of a project. For projects requiring permits, proper planning will result in a clear and complete application, thereby facilitating that process and resulting in savings of time and effort. Stream channel alteration means to obstruct, diminish, destroy, alter, modify, relocate, improve or change the natural existing shape of the channel or to change the direction of flow or velocity of water of any stream channel within or below the mean high water mark. It includes removal of material from the stream channel and emplacement of material or structures in the stream channel.

The following questions should be considered before undertaking any project involving channel alteration:

1. What is the purpose of doing the work?
2. What is the necessity and justification for the proposed alteration?
3. Is the proposal a reasonable means of accomplishing the purpose?
4. Will the alteration be a permanent solution and will the method create a stable situation?
5. Will the alteration allow anticipated water flows to pass without creating harmful flooding or erosion problems upstream or downstream?
6. What effect will the alteration have on fish habitat or fish passage?
7. Will the operation be long-term or short-term?
8. Will the materials used, or removal of ground cover create turbidity or other water pollution problems?
9. Will the alteration interfere with other beneficial uses of the stream?
10. What alternative solutions are reasonably possible that would reduce the disturbance to the stream channel and its environment and/or better accomplish the desired goal of the proposed alternative?
11. Is the project economically feasible?
12. What permits and/or authorizations are necessary?
13. What maintenance activities will be required?
14. What preventative measures and application standards apply?

If all of the above questions can be answered satisfactorily, a solid basis for a Section 404 permit and/or 401 water quality certification has been formed (See Appendix B).

Because of the complexity of river and stream systems, and because permits are often necessary from several agencies, it is important that the project proponent coordinates early in project development with WDEQ, WGFD, U.S. Fish and Wildlife Service, United States Army Corps of Engineers, Natural Resources Conservation Service, State Engineer's Office and others for regulatory information and technical support (see also Appendices B, C and D). It is also

appropriate that all channel realignments and/or structures capable of significantly redirecting the main force of the water should be designed or approved by a professional hydrologist or registered professional engineer knowledgeable in the dynamics of streams and rivers.

Instream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Because these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

CONSTRUCTION MEASURES

It is not only important to select the proper treatment to prevent an erosion problem, but it is equally important to construct the selected structure or treatment in a low impact manner. Most often, violations of the water quality standards will occur during construction; therefore, construction should be done in accordance with the following procedures unless other procedures have been specifically authorized by the conditions of an individual section 404 permit or 401 water quality certification. Achieving the following will ensure that all construction is done in a low impact manner when implementing any management practice or structure in or adjacent to surface water bodies.

1. Vegetation should be protected except where its removal is absolutely necessary for completion of the work. Disturbed soil should be revegetated in a manner that optimizes plant establishment for that specific site. Revegetation may include topsoil replacement, planting, seeding, fertilization, and weed-free mulching as necessary. Native material should be used where appropriate and feasible. All cut and fill slopes should be revegetated with appropriate species to prevent erosion.
2. All equipment should be inspected for oil, gas, diesel, anti-freeze, hydraulic fluid and other petroleum leaks. All such leaks will be properly repaired and equipment cleaned prior to being brought on-site. Leaks that occur after the equipment is on-site will be repaired within one day or removed from the project area. The equipment is not allowed to continue operating upon discovery of a leak. In addition, compliance with all State and Federal requirements for storage of petroleum products and solvents is required.
3. Construction equipment should not be operated below the existing water surface except as follows:
    a. Impacts from fording should be minimized.
    b. Work below the waterline which is essential should be carried out in a manner which minimizes impacts to the aquatic system and water quality.
4. In all coldwater fisheries and drinking water supplies (Class 1, 2A, 2AB, and 2B streams), activities shall not increase turbidity by more than 10 nephelometric turbidity units (NTUs). In all warmwater or nongame fisheries (Class 2AB or 2C streams), turbidity shall not be increased by more than 15 NTUs.
    a. In accordance with Section 23(c)(2) of Chapter 1 of the Wyoming Water Quality Rules and Regulations, the administrator of the Water Quality Division may authorize temporary increases in turbidity above the limits described above in response to an individual application for a variance (see Appendix B). The variance must be approved before the authorized activity may elevate turbidity above these limits.

5. Any temporary crossings, bridge supports, cofferdams or other structures should be designed to handle high flows anticipated to occur while these structures are present. All temporary structures should be completely removed from the waterbody at the conclusion of the permitted activity and the area restored to a natural appearance.
6. The period and timing of construction should be adjusted as necessary to minimize conflicts with fish migration and spawning. Instream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Since these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

Appendix B: Section 404 Permits, Section 401 Certifications, and Other Regulatory Considerations

SECTION 404 REGULATORY PROGRAM

The Section 404 Regulatory and Permitting Program (404 program) is administered by the U.S. Army Corps of Engineers (Corps) and provides for the regulation of discharges of dredged or fill material into all waters of the United States, including wetlands. The 404 program covers all discharges of dredged or fill material into waters of the United States unless specifically exempted. "Waters of the United States" is broadly defined to include "all interstate and intrastate waters and their tributaries, including lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, natural ponds, and all impoundments". It is the primary regulatory tool used in Wyoming to ensure environmental consideration is given to all types of construction projects requiring discharge of dredged or fill material into surface water bodies.

The CWA Section 404 environmental guidelines [404(b)(1)] are the regulations intended to be the basis for decision-making on all permit applications and are contained in 40 CFR part 230. The guidelines govern the determination of the environmental effects of discharging dredged and fill material into waters of the United States for analysis of state and Corps permit applications. They require consideration of the adverse environmental impacts of a proposed discharge, as well as alternatives to the project. Specific guidance is provided on steps to minimize adverse impacts and tests needed to make a determination of environmental effects.

There are two types of permits issued under this program - Individual and General. General permits can be established for national or regional application. Upon application, the Corps will make the determination based on the environmental guidelines of which type of permit is appropriate. An individual permit is required for all regulated activities which cannot be authorized by a general permit.

Individual Permits - Applications for individual permits undergo the greatest amount of environmental scrutiny and therefore require a great deal more time to process than the other types. At a minimum, a well-planned and documented application will take 90 days to process. Large complicated projects which have the potential for significant environmental impact may require years of review before a final decision is reached. It is always prudent to involve the Corps as early as possible in the planning of a project to minimize delays.

Individual permit processing usually begins by submitting a written application to the Corps describing an activity which entails the discharge of dredged or fill material into waters of the United States. The application forms are available from the Corps regulatory office in Cheyenne. There are detailed instructions contained on the application form which describe all the necessary information.

When an individual permit is required, a public notice is circulated to federal agencies including the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency, state agencies including the WGFD and the State Historical Preservation Office, local agencies, and interested individuals and organized groups. The application form requires the names and addresses of adjacent landowners who may be affected by the project. These individuals also receive the public notice and are encouraged to submit their concerns. Comments received are considered individually by the Corps in the permitting decisions.

Permits can be denied if a proposed project will impact threatened or endangered species or otherwise significantly impact wildlife populations or habitat. Other reasons for permit denial include noncompliance with public interest review, noncompliance with 404(b)(1), or noncompliance with Federal laws. The U.S. Environmental Protection Agency (EPA) also comments on permit applications as to their compliance with the intent of the Clean Water Act (CWA) and specifically the 404(b)(1) guidelines. In cases where there is a dispute over the issuance of a permit, EPA maintains the right to prohibit discharges into areas they determine to be environmentally sensitive.

General Permits (Nationwide and Regional) - Certain categories of activities which are considered to have only minor individual or cumulative environmental impacts or which are subject to regulation by another agency have been authorized under general permits. General permits involve an abbreviated permitting process and normally requires only a minimal amount of application review.

Nationwide general permits are used for the majority of all activities requiring authorization under the 404 program. The purpose for nationwide permits is to expedite the permitting process for minor activities so as not to unnecessarily delay needed projects. This abbreviated process however, does result in a lower level of environmental protection and increases the need for BMPs. For this reason, many of the BMPs developed in this manual are meant to be practices which can be implemented when operating under authorization of a nationwide permit.

For many nationwide permits, an applicant must first notify the Corps in writing of his/her intent to conduct the activity authorized by that nationwide permit. The applicant cannot proceed with the work until a response has been received from the Corps which verifies an authorization under the permit and also contains any conditions that must be met. Activities that do not require preconstruction notification can sometimes be undertaken without contacting the Corps but it is always in the applicant's best interest to do so. There are conditions that apply to all nationwide permits and the Corps will send written notification of what those are for any particular situation.

Regional general permits work very much the same way as nationwide permits. They usually apply to very specific types of activities or structures that are constructed on a routine basis but are not authorized by one of the nationwide permits. They can be issued to a single agency or organization or authorized for use by the general public. Most of the regional permits are issued on a statewide basis and permits established for use in Wyoming can only be applied in Wyoming.

The process to establish a regional permit is the same as an application for an individual permit. An application is made to the Corps which describes the activity for consideration. The same process for environmental review, public notice and water quality certification occurs. If

approved, the covered activities are authorized for a period of five years after which time the regional permit must be reauthorized or dropped. Any projects which meet the stipulations of the regional permit can then be authorized without the more extensive review associated with an individual permit.

Certain activities are exempt from regulation under Section 404. These activities include:

1. Normal farming, silviculture, and ranching practices;
2. Maintenance of existing serviceable structures such as dikes, dams, riprap, bridge abutments, and transportation structures;
3. Construction or maintenance of farm or stock ponds and irrigation ditches, and maintenance of drainage ditches;
4. Temporary sedimentation basins or construction sites, if no fill material will be placed into navigable waters;
5. Construction or maintenance of farm or forest or temporary mining roads, where best management practices are applied.

It is important to realize that a certain amount of interpretation is necessary to determine whether or not any particular project is covered by one of the above exemptions. It is best to contact the Corps first as penalties for unauthorized activities can be severe.

SECTION 401 WATER QUALITY CERTIFICATION

Section 401 of the Clean Water Act requires that any applicant for a federal license or permit to conduct any activity, including but not limited to the construction or operation of facilities that may result in a discharge to the waters of the state, shall provide the licensing or permitting agency a certification from the state. This certification establishes that any such discharge will not result in a violation of applicable water quality standards and policies. In Wyoming, this certification is provided by the WDEQ, Water Quality Division. Thus, all Section 404 permitted activities must also obtain a Section 401 certification from the WDEQ, Water Quality Division.

General permits are certified by Wyoming every five years. At this time WDEQ must either provide or deny certification for those general permits which involve discharges. WDEQ's certification of the 2012 nationwide permits is available in a letter dated March 16th, 2012 to the Wyoming Regulatory Office of the Corps, and includes Attachment 1 (Class 1 Waters), Attachment 2 (Nationwide Permit #27 Certification and Conditions) and Table 1 (Certification of Nationwide Permits). If certification is denied for a general permit, an individual certification review of the preconstruction notification materials is required.

Individual permits are certified on a case-by-case basis. In an effort to reduce paperwork and simplify application procedures, the WDEQ and the Corps have developed a joint application agreement. A single application form with all the attendant plans and specifications for any project requiring a 404 permit needs only to be submitted to the Corps' regulatory office in Cheyenne. This will automatically serve as an application to the state for the required water quality certification. The ensuing public notice and comment process is also a joint venture. WDEQ reviews all comments submitted as they apply to state water quality standards and policies when making a certification decision.

An application to establish a regional general permit is evaluated and certified in the same manner as an individual permit. Once the application is certified by the state and the general permit is issued by the Corps, however, projects which fall under the general permit's authorization do not need individual certifications. If an application is received by the Corps, and they determine that the activity applied for is covered by the general permit, authorization to proceed is granted with no further review.

Generally, 401 certifications are conditional. This means that WDEQ will attach stipulations which must be implemented for the certification to be valid. These stipulations can require that certain design criteria are met, restrict timing of operations, require water quality monitoring, require that certain management practices are followed, and require any other conditions determined to be necessary to protect water quality. Any of the BMPs developed in the Wyoming Nonpoint Source Management Plan can and will be attached when appropriate to 401 certifications. All 401 certification conditions are attached by the Corps as conditions of the permit and are mandatory and enforceable. Nothing in a 401 certification can ever be interpreted as authorizing violations of the state water quality standards, or relieving liability for damage to another person's property or rights.

Additional information on Section 401 certifications can be found on the WDEQ 401 certification website.

TURBIDITY WAIVERS

Section 23 of Chapter 1 of Wyoming Water Quality Rules and Regulations establishes that in cold water fisheries and drinking water supply waters (Class 1, 2AB, 2A, and 2B waters), discharges from anthropogenic activities shall not cause a turbidity increase of more than ten nephelometric units (NTUs). For warm water or non-game fisheries, a turbidity increase of more than 15 NTUs is prohibited. However, short-term turbidity increases that are determined to have minimal effect on water use are allowed. Activities that cause such short-term increases are approved on a case-by-case basis and are subject to controls, monitoring, or BMPs that the WDEQ determines are needed to maintain and protect water uses. The WDEQ February 2007 Turbidity Implementation Policy establishes how the WDEQ will make these case-by-case determinations of acceptable short-term turbidity increases. The WDEQ will issue turbidity waivers in accordance with the February 2007 Turbidity Implementation Policy. In instances where activities within a water of the state increase turbidity in that water to levels above the prescribed standard, an authorization for a temporary increase of the turbidity standard for the duration of the activity may be issued if it is determined that the activity will have a minimal effect on water uses. WDEQ will review all applications for a temporary turbidity increase, coordinate the activity with any water intakes in the area, require daily sampling to indicate the actual increase during the activity, and require BMPs in order to minimize any increase in the turbidity. The application and instructions for applying for turbidity waivers are available on the WDEQ website.

WYPDES GENERAL PERMITS FOR STORMWATER DISCHARGES

A WYPDES storm water permit for construction activities is required from the WDEQ before any surface disturbance takes place that will clear, grade, or otherwise disturb one or more acres. A general permit has been established for this purpose and either the project sponsor or general

contractor is responsible for complying with the provisions of the general permit if total disturbance exceeds one acre, and for filing a Notice of Intent (NOI) if total disturbance exceeds five acres. The NOI should be filed no later than 30 days prior to the start of construction activity. Contact the WYPDES Stormwater Program at 307-777-7570 for additional information or access the WYPDES Storm Water Program website. Copies of the general permit and application materials and instructions can be found on this website.

The major requirements of the storm water general permit pertain to the development and implementation of a pollution prevention plan along with regular inspection of pollution control facilities. The permit is required for the surface disturbances associated with construction of the project, access roads, construction of wetland mitigation sites, borrow and stockpiling areas, and equipment staging and maintenance areas. Many of the projects that require coverage under the storm water construction general permits have components that involve hydrologic modifications (road crossings, utility line construction, gravel mining etc.). The BMPs presented in this manual may be useful in preparing the pollution prevention plans required under the storm water general permits; however, it is important to realize that these plans are not restricted or limited to the use of these BMPs.

OTHER WYPDES DISCHARGE PERMITS FOR CONSTRUCTION ACTIVITIES

A WYPDES discharge permit from WDEQ may be required for point source discharges to surface waters not related to storm water runoff, such as discharges from gravel crushing and washing operations, cofferdam or site dewatering, vehicle or machinery washing, or other material processing operations. Depending on the type of operation, the length of operation, and the type of discharge either a general temporary discharge permit or an individual discharge permit may be required. Please be advised that if an individual permit is required, processing will require at least 90 days. Contact the WYPDES Program at 307-777-7093 for additional information or access the WYPDES Point Sources website.

AQUATIC INVASIVE SPECIES

Preventing the spread of aquatic invasive species (AIS) is a priority for the State of Wyoming, and in many cases, the intentional or unintentional spread of organisms from one body of water to another would be considered a violation of State statute and Wyoming Game and Fish Commission regulation. To prevent the spread of AIS, the following is required:

- If equipment has been used in a high risk infested water [a water known to contain Dreissenid mussels* (zebra/quagga mussels)], the equipment must be inspected by an authorized aquatic invasive species inspector recognized by the state of Wyoming prior to its use in any Wyoming water.
- Any equipment entering the State by land from March through November (regardless of where it was last used), must be inspected by an authorized aquatic invasive species inspector prior to its use in any Wyoming waters.
- If aquatic invasive species are found, the equipment will need to be decontaminated by an authorized aquatic invasive species inspector.
- Any time equipment is moved from one 4th level (8-digit) Hydrological Unit Code watershed to another within Wyoming, the following guidelines are recommended:

- DRAIN: Drain all water from watercraft, gear, equipment, and tanks. Leave wet compartments open to dry.
- CLEAN: Clean all plants, mud, and debris from vehicle, tanks, watercraft, and equipment.
- DRY: Dry everything thoroughly. In Wyoming, we recommend drying for 5 days in Summer (June - August); 18 days in Spring (March - May) and Fall (September - November); or 3 days in Winter (December - February) when temperatures are at or below freezing.

*A list of high risk infested waters and locations in Wyoming to obtain an AIS inspection can be found at: http://wgfd.wyo.gov.

Appendix C: Additional Considerations for Select Activities

The following sections provide additional information about BMPs to use for specific, selected activities that may be conducted in Wyoming.

REMOVAL OF SAND AND GRAVEL DEPOSITS

This work consists of removal of sand and gravel deposits from within a stream channel. The following conditions must be adhered to in order to minimize impacts associated with sand and gravel removal from streambeds, unless other methods have been specifically authorized or approved by permit. These practices apply whenever the activity occurs and especially when operating in Class 1, 2 or 3 surface waters of the state. Classification of surface water may be found in Appendix A of Chapter 1 of the Wyoming Water Quality Rules and Regulations.

- Depending upon the size of the operation, either a mining permit or a Letter of Authorization (LOA) may be required from WDEQ Land Quality Division for the removal of sand or gravel from a stream channel. The Land Quality Division must always be contacted before conducting any dredging activities.
- Sand and gravel removal operations should be conducted "in the dry". This can be accomplished by diverting the stream away from the area of operation by the construction of cofferdams, diversion channels, berms or by restricting work to areas of the stream channel that is above the existing water surface. Where work involves removing a plug from a new diversion channel, work below the water level is acceptable but should not be done until all other work in the new channel is completed. Channel stabilization techniques should be employed before diverting water into a temporary diversion channel or re-establishing flow in the original channel after construction is complete.
- A buffer zone of undisturbed material should be maintained between the work area and the existing stream. All reasonable precautions should be taken to ensure that turbidity is kept to a minimum, and in no case shall violations of the Chapter 1 surface water standards occur (see Appendix B, Turbidity Waivers).
- It is acceptable for equipment to ford the stream in one location only, but should not push or pull material across the streambed. Equipment should be steam-cleaned prior to doing any work in the stream.
- In-stream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Since these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

In only rare instances can sand and gravel operations be conducted in class 1, 2 or 3 streams without violating the state water quality standards for turbidity or settleable solids unless the work is "done in the dry" as described above. Although removal of material from waters of the U.S. does not require a 404 permit from the U.S. Army Corps of Engineers, the placement of berms, cofferdams and diversions often does. Reclamation of the streambanks at the conclusion of the mining activity might also require 404 authorization. Therefore, most in-stream operations that

are designed to comply with the water quality standards will require 404 permits. Consideration of fish migration and spawning impacts should be made when performing these operations.

SUCTION DREDGES (RECREATIONAL GOLD MINING)

Recreational gold dredging is acceptable if the equipment is portable (floating dredges), has a suction hose diameter of no larger than 3 inches, uses no greater than a 10 horsepower motor, and is operated on drainages that are not determined to be sensitive by the WGFD or the WDEQ Water Quality Division. Utilizing the following practices will help minimize water quality and fish habitat impacts by conducting recreational dredging in a low impact manner. These practices apply on all Class 2, 3, and 4 surface waters. Recreational dredging is not appropriate on Class 1 streams.

- In order to be considered a recreational activity, the dredge should be a small portable unit with a suction hose diameter no larger than 3 inches and a 10 horsepower motor or less. Larger equipment will generally require a permit and bond from the WDEQ Land Quality Division (LQD), and possibly a discharge permit from the WDEQ Water Quality Division, WYPDES Point Sources Program.
- Dredging of materials such as silt or clay is unacceptable because it will cause degradation of water quality downstream and will probably result in a violation of the Chapter 1 turbidity standard.
- Dredging of beaver ponds should be avoided to minimize impacts on fish populations and habitat. These ponds accumulate sediments which cannot be dredged without degrading water quality downstream from the operation.
- Dredging operations should be confined to the channel bottom to avoid disturbances to shoreline vegetation and stream banks. These disturbances can contribute to excessive erosion, as well as destroy fish habitat.
- Spilling of oil, gas, or grease must be avoided.
- In-stream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Since these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

Please see the WDEQ LQD Guideline No. 19, Noncoal: Recreational Prospecting in Wyoming for more information about LQD operational requirements for recreational prospecting. For activities on federal lands, prospectors should contact the appropriate Federal land management agency (e.g., the Bureau of Land Management (BLM) or the United States Forest Service (USFS)). Only gravity separation operations should be considered recreational.

UTILITY LINE CROSSINGS

The following practices apply to any installation which requires trenching across stream channels such as utility crossings of a gas line, sewer line, electrical line, communications line, water line or similar line.

- Directional drilling should be considered when crossing perennial streams. When directional drilling is utilized, drilling pits should be located far enough back from the channel that stream bank stability is not reduced.

- Where pipeline crossings of streams will be done by trenching, stream banks should be re-stabilized. Substrate layers should be replaced in the same order that they are removed. Double-ditching techniques are recommended to separate the top one foot of stream bottom substrate from deeper soil layers. Reconstruct the original layers by replacing deeper substrate first. Pipeline crossings of riparian areas and streams should be at right angles to minimize area of disturbance.
- The line should be installed below the streambed to a depth which will prevent erosional exposure of the line to free flowing water. In areas of high stream velocity where scouring may occur, measures should be taken to prevent the pipeline from becoming exposed (e.g. using a thicker sidewall pipe (bore pipe), encasing the pipe in concrete, covering the pipe with rock riprap, and/or boring well below the channel bottom to minimize the potential for exposure from scouring).
- The joints should be welded, glued, cemented or fastened together in a manner to provide a durable water tight connection. Whenever possible, the stream should be spanned by a single un-jointed section of pipe. It is recognized that an un-jointed section of pipe may not be feasible in all situations. If steel piping is used, the joints should be welded together and x-rayed.
- For pipelines carrying toxic or hazardous material, crossings of live streams should be protected by automatic shutoff valves. However, given the remoteness of some areas where electricity is not available, automatic shutoff valves may not be practical. Block valves shut off the flow of fluid through a pipe and can be operated manually or electronically (remotely). By locating a block valve on either side of a river or stream, the section of pipe crossing under the river/stream can be isolated and contamination to the waterbody minimized should a leak occur.
- Construction methods should provide for eliminating or minimizing discharges of turbidity, sediment, organic matter or toxic chemicals. A settling basin or cofferdam may be required for this purpose. Where possible, construction should be performed during low flow conditions.
- Special consideration should be given to utility line crossings in the vicinity of public water supply intakes. The operation should be timed and designed so as not to interfere with the use of the water by the water supplier.
- Upon completion, the streambed should be returned to its original elevation and configuration. All temporary fills must be removed in their entirety.
- Riparian canopy or stabilizing vegetation should not be removed if possible. Crushing or shearing streamside woody vegetation is preferable to complete removal. Any such vegetation that is removed in conjunction with stream crossings should be re-established immediately following completion of the crossing. Proper riparian grazing management strategies, including rest, need to be applied to disturbed streambanks. The use of large wood plank matting joined with cable can help minimize impacts to the riparian habitat.
- Streambanks should be returned to a stable condition and revegetated with appropriate endemic species; care must be taken to avoid introducing non-native, invasive species.
- In-stream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Since these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

- For crossings of minor waterbodies, the Federal Energy Regulatory Commission (FERC 2013) recommends that instream construction activities (except for blasting and rock breaking measures) be completed within 24 hours. For intermediate waterbodies, instream construction activities should be completed within 48 hours. For major waterbodies (>100' wide), the WGFD recommends that instream construction activities should be completed within 72 hours.

Most utility line crossings are authorized by nationwide permit 12 (see Appendix B), however, on some streams it may be necessary to divert the water from the work area in order to comply with the state water quality standards. Construction of berms, diversions or cofferdams may require an individual 404 permit from the U.S. Army Corps of Engineers. Also, the discharge of hydrostatic test water or trench dewatering may require WYPDES discharge permit from the WDEQ, Water Quality Division. The Wyoming Game & Fish Department or the US Fish and Wildlife Service should also be contacted for information concerning the protection of fisheries.

FISH HABITAT IMPROVEMENT AND REMOVAL OF FISH BARRIERS

Maintaining or improving fish habitat is directly related to the land uses in the watershed. If the existing habitat has been degraded or eliminated because of current upland land uses, any attempt to correct the situation without addressing the surrounding land use will be unsuccessful. All fish habitat improvement efforts should be coordinated with the WGFD early in the planning process. Contact the local WGFD Regional Aquatic Habitat Biologist for technical assistance.

A Section 404 Regional General Permit (#8202-05) (see Appendix B) has been established for use by the general public for the construction of fish habitat improvement structures in Wyoming streams. The general permit contains an approved list of structures along with other important information and can be accessed on the United States Army Corps of Engineers, Wyoming Regulatory Office Regional General Permits website.

In-stream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Since these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

Poorly designed fish habitat improvement projects have the potential to do more harm than good. Whenever possible, both a fisheries biologist and a hydrologist should be consulted for approval of the project design. The Corps of Engineers should be contacted prior to any in-stream activity to determine permit requirements.

Landowners or land management agencies may wish to modify or remove in-channel structures such as dams, flow diversions, culverts, and road crossings that are blocking fish passage. Such fish barriers can negatively impact fish populations by disrupting habitat connectivity, restricting access to spawning grounds, and limiting access to resources needed by rearing juveniles and resident adults. While the majority of fish barrier removals are anticipated to be beneficial to fisheries, in some cases, the removal of fish barriers may have a detrimental effect on the aquatic system. An example is when removal of a barrier would allow non-native fish species to threaten populations of native species. In all cases, fish passages should be maintained. All fish barrier removal projects should be coordinated with the WGFD early in the planning process. Contact the local WGFD Regional Aquatic Habitat Biologist for technical assistance.

BOAT RAMPS

All boat ramps that have not been authorized by an individual section 404 permit should be of the type and conform to the specifications and conditions of Regional General Permit # 9202-04 (see Appendix B and the Wyoming Regional General Permits website. Please refer to this regional general permit for more information, including information about BMPs to use to prevent adverse impacts to aquatic ecosystems.

EMERGENCY FILLS

Emergency fills are those placed in order to prevent imminent damage to life, property or the environment as a result of flooding or hazardous substance spills. Even though these structures are constructed on short notice in response to an emergency, they should be properly planned.

Any project which requires the storage of hazardous substances or petroleum products should develop a contingency plan to handle accidental spills. Spills or releases of hazardous substances can be reported to the WDEQ by phone at 307-777-7781 or on-line at https://deq.state.wy.us/spl/. More information on reporting spills or releases to WDEQ is available on WDEQ's Emergency Response website.

All emergency fills are temporary and must be removed and the waterbody returned to its original condition after the emergency has passed. The Corps of Engineers must be notified of all such action. The U.S. Fish and Wildlife Service should be notified of any emergency fills in the event that the fill could result in the mortality of migratory birds or other wildlife.

STREAM CHANNELIZATION

In very few instances is it possible to channelize a stream or river without damage to either habitat or water quality. It is, therefore, very important that alternatives to channelization are always considered and implemented where possible. The WDEQ, WQD does not support stream channelization except when channelization is the only practical way to protect life or property of significant value. If (1) all other options have been exhausted and stream channelization is necessary for flood control or other important societal benefits, and (2) these projects are determined to have a probability of lowering water quality, they can only be permitted under the process outlined in the "Procedures for the Implementation of the Antidegradation Section of Quality Standards for Wyoming Surface Waters". These procedures require that:

1. The water quality cannot be lowered below the narrative and numerical limits specified in the standards;
2. All existing water uses are fully maintained and protected;
3. The highest statutory and regulatory requirements for all new and existing point sources and all cost effective and reasonable best management practices for nonpoint sources have been achieved; and
4. The lowered water quality is necessary to accommodate important economic or social development in the area which the waters are located.

Upon meeting the above conditions, projects should be designed to meet the following minimum criteria for channelization when it cannot be avoided; these criteria apply only to natural streams and rivers and are not intended to affect in any way artificial canals or irrigation systems.

- The channel realignment should be designed or approved by a registered professional engineer or professional hydrologist.
- The cross-sectional area of the channel should not be significantly increased or decreased.
- The effective channel slope should not be significantly increased or decreased.
- Mean water velocity in the altered reach should not be increased or decreased.
- In-stream construction during the spring (March 15 to July 31) and fall (September 15 to November 30) may need to be restricted to minimize impacts to fish spawning. Since these dates can vary based on elevation, the fisheries biologist at the local WGFD office should be contacted during the planning phase of a project.

Stream channelization is often done to solve a local problem on a stream segment and results in unforeseen and unintended damage both upstream and downstream from the channelized segment. All projects involving stream channelization should be designed by a professional hydrologist or licensed professional engineer knowledgeable in stream and river dynamics. For technical assistance, contact the NRCS, WGFD, US Fish and Wildlife Service, the US Forest Service or private consulting firms. The Corps of Engineers should be contacted prior to any in-stream activity to determine permit requirements.

Appendix D: State and Federal Agency Resources for Regulatory Requirements

The following lists some common state and federal regulatory requirements, such as permits, that may need to be considered as part of BMP implementation (see also Appendix B). This list is not intended to be comprehensive and additional local permits or regulations may also apply. Please contact the appropriate government agency for more information. Your local NRCS and/or conservation district may also be able to assist with understanding regulatory requirements associated with BMP implementation (see also Appendix E**).**

Permit/ Regulation	Description	Agency	Contact and Website
WYPDES Storm Water Permits	Some activities require WYPDES permits for storm water discharge, including runoff from large and small construction sites.	Wyoming Department of Environmental Quality, Water Quality Division, WYPDES Program	307-777-7570 http://deq.state.wy.us/wqd/WYPDES_Permitting/WYPDES_Storm_Water/stormwater.asp
WYPDES General Permit for Temporary Discharges Involving Construction Practices	This general permit for temporary discharge will cover activities associated with Construction Activities such as Construction Dewatering; Disinfection of Potable Water Lines; and/or Hydrostatic Testing of Pipes, Tanks, or Other Similar Vessels.	Wyoming Department of Environmental Quality, Water Quality Division, WYPDES Program	307-777-7093 http://deq.state.wy.us/wqd/WYPDES_Permitting/index.asp
Temporary Turbidity Waivers	Waiver to authorize temporary increases in turbidity for certain short-term, construction-related activities. Projects working in live waters and activities that may cause an excursion above allowable turbidity levels may qualify for a turbidity waiver.	Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program	307-777-6891 http://deq.state.wy.us/wqd/watershed/index.asp#Assure
Clean Water Act Section 404 permits	Any person, firm, or agency (including Federal, state, and local government agencies) planning to work in navigable waters of the United States, or discharge dredged or fill material in waters of the United States, including wetlands, must first obtain a permit from the Corps of Engineers.	United States Army Corps Engineers, Wyoming Regulatory Office	307-777-772-2300 http://www.nwo.usace.army.mil/Missions/RegulatoryProgram/Wyoming.aspx

Permit/ Regulation	Description	Agency	Contact and Website
Section 401 Certifications	The WDEQ Water Quality Division reviews and issues water quality certifications under Section 401 of the Clean Water Act. Section 401 water quality certification is required for any federal license or permit which may result in a fill or discharge into waters of the United States (see Section 404 permits).	Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program	307-675-5638 http://deq.state.wy.us/wqd/watershed/index.asp#401_Certification_
Surface Water Rights Permits	Permits for any request for putting surface waters of the state to a beneficial use: includes transporting water through ditch or pipelines, storage in reservoirs, storage in smaller reservoir facilities for stockwater or wildlife purposes, and enlargements to existing ditch or storage facilities, and for instream flow purposes.	Wyoming State Engineer's Office	307-777-6475 http://seo.state.wy.us/SW/index.aspx
Ground Water Rights Permits	A permit is required from the State Engineer's Office prior to the drilling of all water wells; ground water rights are issued for the same beneficial uses as for surface water rights.	Wyoming State Engineer's Office	307-777-6163 http://seo.state.wy.us/GW/index.aspx
Pesticide Certification	Training, licensing, certification, and/or inspection of pesticide users, dealers, commercial applicators, and public agencies using restricted use pesticides.	Wyoming Department of Agriculture	307-777-6585 http://wyagric.state.wy.us/divisions/ts/sections-a-programs/148
Open Burn and Smoke Management	Vegetative and non-vegetative burns may require a permit and/or registration with the WDEQ Air Quality Division.	Wyoming Department of Environmental Quality, Air Quality Division	307-777-6993 http://deq.state.wy.us/aqd/Smoke%20Management%20and%20Open%20Burning.asp
Private Fish Plant Application	Permits are required prior to stocking private ponds with fish.	Wyoming Game and Fish Department, Fish Division	307-777-4559 http://wgfd.wyo.gov/web2011/fishing-1000194.aspx
Aquatic Invasive Species Protocols	Actions required to prevent the spread of Aquatic Invasive Species in Wyoming.	Wyoming Game and Fish Department	307-745-5180 Ext. 256 http://wgfd.wyo.gov/web2011/fishing-1000206.aspx

Appendix E: Sources of BMP Technical and/or Financial Assistance and Contact Information

Bureau of Land Management--Wyoming
5353 Yellowstone
Cheyenne, WY 82009
Phone: (307) 775-6256
Fax: (307) 775-6129
http://www.blm.gov/wy/st/en.html

The Nature Conservancy, Wyoming Chapter
258 Main Street, Suite 200
Lander, WY 82520
Phone: (307) 332-2971
Fax: (307) 332-2974
http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/wyoming/index.htm

United States Army Corps of Engineers—Wyoming Regulatory Office
2232 Dell Range, Suite 210
Cheyenne, Wyoming 82009
Phone: 307-772-2300
Fax: 307-772-2920
http://www.nwo.usace.army.mil/Missions/RegulatoryProgram/Wyoming.aspx

United States Environmental Protection Agency—Region 8
1595 Wynkoop St.
Denver, CO 80202-1129
Phone: (303) 312-6312
Fax: (303) 312-6339
Toll free: (800) 227-8917
Email: r8eisc@epa.gov
http://www.epa.gov/aboutepa/region8.html

United States Fish and Wildlife—Mountain-Prairie Region
134 Union Blvd.
Lakewood, Colorado 80228
Phone: 303-236-7905
http://www.fws.gov/mountain-prairie/

United States Forest Service—Intermountain Region
Federal Building
324 25th Street
Ogden, UT 84401
Phone: (801) 625-5605
http://www.fs.usda.gov/r4

United States Forest Service—Rocky Mountain Region
740 Simms Street
Golden, CO 80401
Phone: (303) 275-5350
http://www.fs.usda.gov/r2

Wyoming Association of Conservation Districts
517 E. 19th Street
Cheyenne, WY 82001
Phone: (307) 632-5716
Fax: (307) 638-4099
http://www.conservewy.com/

Wyoming Department of Transportation
5300 Bishop Blvd.
Cheyenne, WY 82009-3340
Phone: (307)777-4375
http://www.dot.state.wy.us/home.html

Wyoming Game and Fish Department
5400 Bishop Blvd.
Cheyenne, WY 82006
Phone: (307) 777-4600
http://wgfd.wyo.gov/web2011/home.aspx

Wyoming Wildlife and Natural Resource Trust
Hathaway Building, 1st Floor
2300 Capitol Avenue
Cheyenne, WY 82002
Phone: (307) 777-8024
http://wwnrt.wyo.gov/home

Wyoming State Engineer's Office
122 West 25th Street
4th Floor East
Cheyenne, WY 82002
Phone: (307) 777-6150
Fax: (307) 777-5451
http://seo.state.wy.us/

Wyoming Ducks Unlimited
http://www.ducks.org/wyoming/wy-content/wyoming-du-volunteer-leaders

Wyoming Trout Unlimited
250 N. 1rst
Lander, WY 82520
Phone: 307-332-7700 ext. 12
http://wyomingtu.org/

Wyoming Water Development Commission
6920 Yellowtail Rd.
Cheyenne, WY 82002
Phone: (307) 777-7626
Website:
http://wwdc.state.wy.us/wconsprog/wconsprog.html

Wyoming NRCS State Office
P.O. Box 33124
100 East B Street, 3rd Floor
Casper, WY 82602-5011
Phone: (307) 233-6750
Fax (mailroom): (307) 233-6795
Fax (Admin): (307) 233-6783
Fax (Front Office): (307) 233-6753
Website: http://www.wy.nrcs.usda.gov

Wyoming NRCS Field Offices

East Area NRCS Office
911 South Wind River Drive
Douglas, Wyoming 82633
Phone: (307) 358-3050, ext. 5
Fax: (307) 358-5719

West Area NRCS Office
508 N. Broadway Ave.
Riverton, Wyoming 82501-3458
Phone: (307) 856-7524
Fax: (307) 856-2383

Afton NRCS Field Office (West)
P.O. Box 1606
625 Washington Street, Room C
Afton, Wyoming 83110
Phone: (307) 886-9001
Fax: (307) 886-3744

Baggs NRCS District Office (East)
P.O. Box 217
285 North Penland Street
Baggs, Wyoming 82321-0217
Phone: (307) 383-2550
Fax: (307) 383-7861

Buffalo NRCS Field Office (East)
621 West Fetterman
Buffalo, Wyoming 82834-2342
Phone: (307) 684-2526
Fax: (307) 684-5972

Casper NRCS Field Office (East)
5880 Enterprise Drive, Suite 100
Casper, Wyoming 82609
Phone: (307) 261-5436 or (307) 261-5402
Fax: (307) 261-5435

Cheyenne NRCS Field Office (East)
11221 East Highway 30
Cheyenne, Wyoming 82009
Phone: (307) 772-2314
Fax: (307) 772-2120

Cokeville NRCS District Office (West)
P.O. Box 98
110 Pine Street, Cokeville Town Hall, Room 1
Cokeville, Wyoming 83114-0098
Phone: (307) 279-3256
Fax: (307) 279-3024

Douglas NRCS Field Office (East)
911 South Wind River Drive
Douglas, Wyoming 82633
Phone: (307) 358-3050
Fax: (307) 358-5719

Dubois NRCS Field Office (West)
P.O. Box 27
706 Meckem Street
Dubois, Wyoming 82513-0027
Phone: (307) 455-2388
Fax: (307) 455-3098

Fort Washakie NRCS Field Office (West)
P.O. Box 127
Ft. Washakie, Wyoming 82514-0127
Phone: (307) 332-9636

Gillette NRCS Field Office (East)
601 4J Court, Suite C
Gillette, Wyoming 82716
Phone: (307) 682-8843
Fax: (307) 682-3813

Greybull NRCS Field Office (West)
408 Greybull Avenue
Greybull, Wyoming 82426-2036
Phone: (307) 765-2483
Fax: (307) 765-9243

Kaycee NRCS District Office (East)
P.O. Box 48 (350 Nolan Avenue)
Kaycee, Wyoming 82639-9900
Phone: (307) 738-2321

Lander Quiet Presence NRCS Office (West)
221 South 2nd Street
Lander, Wyoming 82520-2801
Phone: (307) 332-3114
Fax: (307) 332-3154

Laramie NRCS Field Office (East)
5015 Stone Road
Laramie, Wyoming 82072
Phone: (307) 745-3698
Fax: (307) 745-6764

Lovell NRCS District Office (West)
359 Nevada Avenue
Lovell, Wyoming 82431-2007
(307) 548-7422
FAX (307) 548-7422

Lusk NRCS Field Office (East)
P.O. Box 659 (905 South Main, Suite 120)
Lusk, Wyoming 82225-0659
Phone: (307) 334-2953
Fax: (307) 334-3539

Lyman NRCS Field Office (West)
P.O. Box 370
100 East Sage Street
Lyman, Wyoming 82937-0370
Phone: (307) 787-3211
Fax: (307) 787-3810

Medicine Bow NRCS District Office (East)
P.O. Box 6
510 Utah
Medicine Bow, Wyoming 82329-0006
Phone: (307) 379-2542

Newcastle NRCS Field Office (East)
1225 Washington Boulevard, Suite 3
Newcastle, Wyoming 82701-2930
Phone: (307) 746-3264
Fax: (307) 746-2870

Pinedale NRCS Field Office (West)
P.O. Box 36 (1625 W Pine)
Pinedale, Wyoming 82941-0036
Phone: (307) 367-2257
Fax: (307) 367-2282

Powell NRCS Field Office (West)
1017 Highway 14A
Powell, Wyoming 82435
Phone: (307) 754-9301
Fax: (307) 754-2761

Riverton NRCS Field Office (West)
508 N. Broadway Ave.
Riverton, Wyoming 82501-3458
Phone: (307) 856-7524
Fax: (307) 856-2383

Rock Springs NRCS Field Office (West)
Gateway Office Bldg.
79 Winston Drive, Suite 110
Rock Springs, Wyoming 82901
Phone: (307) 362-3062
Fax: (307) 362-1459

Saratoga NRCS Field Office (East)
P.O. Box 607
101 Cypress
Saratoga, Wyoming 82331
Phone: (307) 326-5657
Fax: (307) 326-8572

Sheridan NRCS Field Office (East)
1949 Sugarland Drive, Suite 102
Sheridan, Wyoming 82801-5720
Torrington NRCS Field Office (East)
1441 East M Street, Suite B
Phone: (307) 672-5820
Fax: (307) 672-0052

Sundance NRCS Field Office (East)
P.O. Box 1070
117 S. 21st
Sundance, Wyoming 82729-1070
Phone: (307) 283-2870
Fax: (307) 283-2170

Thermopolis NRCS Field Office (West)
601 Broadway, Suite A
Thermopolis, Wyoming 82443
Phone: (307) 864-3488
Fax: (307) 864-4167

Torrington, Wyoming 82240-3521
Phone: (307) 532-4880
Fax: (307) 532-5783

Wheatland NRCS Field Office (East)
1502 Progress Ct.
Wheatland, Wyoming 82201-3211
Phone: (307) 322-9060
Fax: (307) 322-4109

Worland NRCS Field Office (West)
208 Shiloh Road
Worland, Wyoming 82401
Phone: (307) 347-2456
Fax (307) 347-8806

Wyoming Conservation Districts

Campbell County Conservation District
PO Box 2577
601 4J Ct, Suite D
Gillette, WY 82717
307-682-1824 (phone) 307-682-3813 (fax)
www.cccdwy.net
icd@vcn.com

Cody Conservation District
1145 Sheridan Ave, Suite 5
Cody, WY 82414
307-899-0037
codycd@bresnan.net

Converse County Natural Resource District
911 Windriver Drive
Douglas, WY 82633
307-358-3050
michelle.huntington@wy.nacdnet.net
www.conserveconverse.org

Crook County Natural Resource District
PO Box 1070
117 S. 21st Street
Sundance, WY 82729
307-283-2501
sdm.mason@gmail.com
www.ccnrd.org

Dubois-Crowheart Conservation District
PO Box 27
706 Meckem Street
Dubois, WY 82513
307-455-2388
dccd@dteworld.com

Hot Springs Conservation District
601 Broadway, Suite A
Thermopolis, WY 82443
307-864-3488
carla.thomas@wy.nacdnet.net
www.conservewy.com/hscd.html

Lake DeSmet Conservation District
621 West Fetterman
Buffalo, WY 82834
307-684-2526
nikki.lohse@wy.nacdnet.net
www.ldcd.org

Laramie County Conservation District
11221 US Highway 30
Cheyenne, WY 82009
307-772-2600
info@lccdnet.org
www.lccdnet.org

Laramie Rivers Conservation District
5015 Stone Road
Laramie, WY 82070
307-721-0072
tony.hoch@wy.nacdnet.net
www.LRCD.net

Lincoln Conservation District
PO Box 98
110 Pine Street
Cokeville, WY 83114
307-279-3256
brenda.lazcanotegui@wy.nacdnet.net
www.lincolnconservationdistrict.org

Lingle-Fort Laramie Conservation District
1441 East M, Suite B
Torrington, WY 82240
307-532-4880
nancy.borton@wy.nacdnet.net
www.goshencountyconservationdistricts.com

Little Snake River Conservation District
PO Box 355
285 North Penland Street
Baggs, WY 82321
307-383-7860
lsrcd@yahoo.com

Lower Wind River Conservation District
508 N. Broadway
Riverton, WY 82501
307-856-7524
cathy.meyer@wy.nacdnet.net

Medicine Bow Conservation District
PO Box 6
510 Utah Street
Medicine Bow, WY 82324
307-379-2221
todd@medbowcd.org

Meeteetse Conservation District
PO Box 237
2103 State Street
Meeteetse, WY 82433
307-868-2484
mcd@tctwest.net

Natrona County Conservation District
5880 Enterprise Drive, Suite 100
Casper, WY 82609
307-234-4022
lisa.ogden@wy.nacdnet.net
www.natronacountyconservationdistrict.com

Niobrara Conservation District
PO Box 659
Lusk, WY 82225
307-334-2953
lshaw@wyoming.com

North Platte Valley Conservation District
1441 East M, Suite B
Torrington, WY 82240
307-532-4880
nancy.borton@wy.nacdnet.net
www.goshencountyconservationdistricts.com

Platte County Resource District
1502 Progress Court
Wheatland, WY 82201
307-322-9060
brady.irvine@wy.nacdnet.net

Popo Agie Conservation District
221 S. 2nd Street
Lander, WY 82520
307-332-3114
pacd@wyoming.com
www.popoagie.org

Powder River Conservation District
PO Box 48
Kaycee, WY 82639
307-738-2321
anita.bartlett@wy.nacdnet.net
www.powderrivercd.org

Powell-Clarks Fork Conservation District
1017 Highway 14A
Powell, WY 82435
307-754-9301
ann.trosper@wy.nacdnet.net
www.pcfcd.org

Saratoga-Encampment-Rawlins Conservation District
PO Box 633
101 Cypress Avenue
Saratoga, WY 82331
307-326-8156
jarrunner@gmail.com
www.sercd.org

Sheridan County Conservation District
1949 Sugarland Drive, Suite 102
Sheridan, WY 82801
307-672-5820
carrie.rogaczewski@wy.nacdnet.net
www.sccdofwyo.org/

Shoshone Conservation District
359 Nevada Avenue
Lovell, WY 82431
307-548-7422
shoshonecd@tctwest.net

South Big Horn Conservation District
408 Greybull Avenue
Greybull, WY 82426
307-765-2483
janet.hallsted@wy.nacdnet.net
http://www.sbhcd.org/

South Goshen Conservation District
1441 East M, Suite B
Torrington, WY 82240
307-532-4880
nancy.borton@wy.nacdnet.net
www.goshencountyconservationdistricts.com

Star Valley Conservation District
PO Box 216
61 E. 5th Avenue
Afton, WY 83110
307-885-7823
bashworth@starvalleycd.org
www.starvalleycd.org

Sublette County Conservation District
PO Box 647
1625 W. Pine Street
Pinedale, WY 82941
307-367-2257
sccd@wy.nacdnet.net
http://www.sublettecd.com/

Sweetwater County Conservation District
79 Winston Drive, Suite 110
Rock Springs, WY 82901
307-362-3062
admin@swccd.us
www.swccd.us

Teton Conservation District
PO Box 1070
420 W. Pearl Avenue
Jackson, WY 83001
307-733-2110
randy@tetonconservation.org
www.tetonconservation.org

Uinta County Conservation District
PO Box 370
100 East Sage Street
Lyman, WY 82937
307-787-3794
ksabey@bvea.net
www.uintacountycd.com

Washakie County Conservation District
208 Shiloh Road
Worland, WY 82401
307-347-2456
wccd@rtconnect.net
www.washakiecd.com

Weston County Natural Resource District
1225 Washington Boulevard, #3
Newcastle, WY 82701
307-746-3264
jennifer.hinkhouse@wy.nacdnet.net

Wyoming Game and Fish Department Regional Office Contact Information

Habitat Protection Program
Rick Huber, Staff Aquatic Biologist, 307-777-4558
Beth Bear, AIS Coordinator, 307-745-5180 Ext. 256

Aquatic Habitat Section; Fish Division
Paul Dey, Aquatic Habitat Manager, 307-777-4505
Dennis Oberlie, Aquatic Habitat Biologist Supervisor, 307-332-7723 Ext. 235

Jackson Region
Rob Gipson, Fisheries Supervisor, 307-733-2321 Ext. 226
Lara Gertsch, Aquatic Habitat Biologist, 307-733-2383 Ext. 235

Cody Region
Steve Yekel, Fisheries Supervisor, 307-527-7125 Ext. *816
Lew Stahl, Aquatic Habitat Biologist, 307- 527-7322 Ext. *829

Sheridan Region
Paul Mavrakis, Fisheries Supervisor, 307-672-7418 Ext. 236
Travis Cundy, Aquatic Habitat Biologist, 307- 672-8003 Ext. 230

Green River Region
Robb Keith, Fisheries Supervisor, 307-875-3225 Ext. 251
Kevin Spence, Aquatic Habitat Biologist, 307-875-3225 Ext. 253

Pinedale Region
Hilda Sexauer, Fisheries Supervisor, 307-367-4347 Ext. 231
Floyd Roadifer, Aquatic Habitat Biologist, 307-367-4337, Ext. 243

Laramie Region
Mike Snigg, Fisheries Supervisor, 307-745-5180 Ext. 237
Christina Barrineau, Aquatic Habitat Biologist, 307-745-5180 Ext. 240

Lander Region
Kevin Johnson, Fisheries Supervisor, 307-332-7723 Ext. 227
Nick Scribner, Aquatic Habitat Biologist, 307-332-7723 Ext. 277

Casper Region
Al Conder, Fisheries Supervisor, 307-473-3405

Appendix F: Additional References

The following are references for photos that were not listed within the factsheet, along with full references for websites that were provided within paragraphs but not fully cited thereafter. References used for information on individual best management practices can be found at the end of each fact sheet. If viewing this document in an electronic format, click on the blue underlined text to be redirected to the appropriate website. URL addresses are also provided for those who are viewing the hard copy. For websites outside the WDEQ, the WDEQ is not responsible for the content of or maintenance of those websites.

2012 Wyoming Integrated 305(b)/303(d) Report. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/watershed/Downloads/305b/2012/WY2012IR.pdf

Chapter 1, Wyoming Water Quality Rules and Regulations. Wyoming Department of Environmental Quality, Water Quality Division.
http://soswy.state.wy.us/Rules/RULES/6547.pdf

Federal Energy Regulatory Commission. 2013. Wetland and Waterbody Construction and Mitigation Procedures (May 2013 version).
http://www.ferc.gov/industries/gas/enviro/procedures.pdf

FISRWG 1998. Federal Stream Corridor Restoration Handbook (NEH-653). Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/restoration/?&cid=stelprdb1043244

Green Landscaping: Greenacres. Environmental Protection Agency – Landscaping with Native Plants
http://www.epa.gov/greenacres/tooltestkit/gallary/TKSlide22.html

Guideline No. 19, Noncoal: Recreational Prospecting in Wyoming. WDEQ Land Quality Division.
http://deq.state.wy.us/lqd/downloads/Guidelines/Guideline_19_(11_2012).pdf

Letter dated March 16th, 2012 from WDEQ to United States Army Corps of Engineers, Wyoming Regulatory Office: 2012 Nationwide permit certifications. Wyoming Department of Environmental Quality, Water Quality Division.
Letter: http://deq.state.wy.us/wqd/watershed/Downloads/401/WDEQ%20NP%20Cerification%20letter%203-19-2012.pdf
Attachment 1: http://deq.state.wy.us/wqd/watershed/Downloads/401/NWP_certification_%20attachment1_2012.pdf
Attachment 2: http://deq.state.wy.us/wqd/watershed/Downloads/401/NWP_certification_attachment2_2012.pdf
Table 1: http://deq.state.wy.us/wqd/watershed/Downloads/401/NWP_certification_table1_2012.pdf

Institute of Water Resources, 2007. U.S. Army Corps of Engineers Publications; Floodwalls, Levees and Dams: Local Flood Risk Management. Management Measures Digital Library.
http://library.water-resources.us/docs/MMDL/FLD/

Nationwide General Permits, Section 404 Program. United States Army Corps of Engineers.
http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/NationwidePermits.aspx

Regional General Permits, Section 404 Program. United States Army Corps of Engineers, Wyoming Regulatory Office.
http://www.nwo.usace.army.mil/Missions/RegulatoryProgram/Wyoming/RegionalGeneralPermits.aspx

Rosgen, D.L. 1996. *Applied River Morphology*. Wildland Hydrology Books. Available at: http://www.wildlandhydrology.com/

Section 401 Certification Website. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/watershed/index.asp#401_Certification_

Section 404 Regulatory and Permitting Program. United States Army Corps of Engineers, Omaha District.
http://www.nwo.usace.army.mil/Missions/RegulatoryProgram.aspx

WDEQ Emergency Response Website. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/out/spills.htm

WDEQ February 2007 Turbidity Waiver Implementation Policy. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/watershed/surfacestandards/Downloads/Standards/Policies_Final_Ag_rev.pdf

WDEQ Land Quality Division. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/lqd/

WDEQ Nonpoint Source Program. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/watershed/nps/NPS.htm

WDEQ Turbidity Waiver Application. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/watershed/Downloads/401/9-0855-TURBIDITY%20WAIVER%20APP.pdf

WDEQ Turbidity Waiver Instructions:. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/watershed/Downloads/401/2-1907-doc.pdf

WDEQ Water Quality Division. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/

Wyoming NRCS. Wyoming Natural Resources Conservation Service.
http://www.wy.nrcs.usda.gov/

WYPDES Point Sources. Wyoming Department of Environmental Quality, Water Quality Division.
http://deq.state.wy.us/wqd/WYPDES_Permitting/index.asp

WYPDES Storm Water Program Website. Wyoming Department of Environmental Quality.
http://deq.state.wy.us/wqd/WYPDES_Permitting/WYPDES_Storm_Water/stormwater.asp