BANK PROTECTION CONSTRUCTION, MODIFICATION, AND REMOVAL

1 DESCRIPTION OF TECHNIQUE

Bank protection consists of a wide variety of individual techniques to directly armor or reinforce a bank, deflect flows away from a bank, decrease bank height, or increase the strength of bank material for the specific purpose of decreasing bank erosion. Banks form the lateral perimeters of natural streams, constructed channels, lakes, reservoirs, estuaries, and tidal areas. Bank protection, as it relates to habitat restoration, is a subset of the entire realm of stabilization techniques and may or may not be appropriate, depending upon the circumstances.

Bank erosion and lateral channel migration are natural and important geomorphic processes, although in many disturbed systems the erosion is occurring at an accelerated rate. Bank erosion recruits sediment and wood to the stream, creates and maintains in-stream and floodplain habitats (e.g., side channels), maintains overall habitat diversity within the stream corridor, and enables the stream to respond to changing conditions within its watershed. As a result, installing bank protection is a justifiable component of restoration projects in only limited circumstances. Bank protection is most appropriate where it is designed to reestablish natural functions and does not preclude natural stream processes from occurring in the long-term. An example is the use of large wood to reinforce a streambank, providing temporary protection while native vegetation becomes established on the floodplain and along the streambank. Without this temporary protection, it can be very difficult to establish riparian vegetation allowing enough time for maturation, especially in narrow valleys where the floodplain width is constrained. Ultimate system stability comes from the interaction of floodplain/riparian vegetation and accumulations of sediment and large wood. Note that even in this context, the project would generally still be identified as bank stabilization rather than habitat restoration. A full description of various streambank stabilization techniques is available in the Washington State's Integrated Streambank Protection Guidelines (ISPG)[1].

Existing bank protection presents a number of restoration and enhancement opportunities. Removing artificial armoring, such as riprap or concrete, and replacing it (if necessary) with natural, deformable alternatives, such as large wood and vegetation should be seriously evaluated. Removal or replacement of existing bank protection may be a viable option where the infrastructure or land use have changed such that cessation of bank erosion is no longer of concern or some degree of channel migration is now acceptable. Where neither removal nor replacement is feasible, habitat in the vicinity of existing bank protection can be enhanced by adding large wood or other roughness features to create scour, deposition, shade, cover, and complex hydraulics, and by using appropriate native plant materials to restore riparian plant communities. Such measures may be the only habitat enhancement opportunities in the affected reach where otherwise modifying existing bank protection is not an option.

2 PHYSICAL AND BIOLOGICAL EFFECTS

Bank protection projects that seek to provide or improve natural bank stability, as opposed to

those that create a permanent artificial armor, generally provide the most benefits to fish and wildlife. In a restoration context, armoring or reinforcing a bank with either wood or rock should be a short-term approach to stabilization. Long-term bank stability should be self-sustaining, working with the natural tendencies of the stream system. Both approaches require careful site and reach-based assessments.

Potential effects associated with constructing new bank protection, or modifying or replacing existing bank protection, vary depending upon the type of reach (source, transport, response) and the type and extent of the treatment or modification. Potential positive effects may include:

- Providing cover – large wood, boulders, vegetation, and bank protection structures with natural analogs that create scour and thus provide cover.
- Providing a long-term source of all sizes of large wood by reestablishing native riparian forests or other appropriate native riparian plant communities.
- Providing an opportunity to increase, connect, and improve wildlife habitat by reestablishing native riparian plant communities.
- Providing an opportunity for habitat succession.
- Reducing fine sediment supply if it has been specifically identified as a limiting factor.
- Replacing existing bank protection projects that were inappropriately selected and/or designed for the site and/or reach conditions.
- Restoring the natural rate of sediment recruitment.
- Increasing shade and microclimate effects.
- Allowing natural channel migration processes to occur over time, though not necessarily in the short-term.

Potential negative impacts may include:

- Reduction of lateral channel migration; eliminating or minimizing creation of complex in-stream and side channel habitats and recruitment and deposition of sediment and large wood.
- Locking a channel into an unstable channel pattern.
- Reduction in meander belt width.
- Encouraging land use change or encroachment due to stabilization, which puts them at greater risk than if they were outside the channel migration zone.
- Unintentional downstream impacts due to sediment reduction and changes in boundary conditions.
- Loss of vertical cutbank habitat.

Removal of existing bank protection and reestablishing a natural bankline may be an option where the infrastructure or land use for which it was installed to protect has changed. Removal allows natural bank erosion and migration processes to occur, which provide many long-term benefits to the stream ecosystem as a whole. However, negative impacts derived from the short-term channel instability that is likely to occur following bank protection removal must also be considered. They may include:

- Excessive channel widening and subsequent sediment deposition within the adjacent or downstream channel where natural bank stabilizing features, such as riparian vegetation and large wood, are immature or lacking. Channel migration may occur at an accelerated

rate. Nearby property and infrastructure may be placed at increased risk.

- Large wood recruited into the channel from bank erosion may redirect flow, backwater the upstream channel, or transport further downstream. Such changes can benefit habitat through increased cover and habitat diversity. But the changes may place nearby infrastructure and the public at risk. Refer to the *Large Wood and Log Jams* technique for further information regarding the effects and risks associated with adding and recruiting wood to streams.

There is an inherent uncertainty in the rate of bank erosion and channel migration once the protection is removed. The risk of accelerated bank erosion increases with the extent of the project, the degree of channel confinement, channel slope, and the degree of instability within the watershed. It varies with the soil type and depth, and with the extent and nature of vegetative cover; these collectively determine the banks' resistance to erosion. Removing bank protection requires reach and site assessments to understand possible channel responses such as lateral channel migration, chute/neck cutoff or an avulsion. Based on project objectives and risk assessment, appropriate bank protection to protect high risk infrastructure or property needs to be balanced with restoring habitat within the stream corridor and preserving habitat diversity.

3 METHODS AND DESIGN

Factors to consider when constructing bank protection (including assessment requirements in general and the application, risk, mitigation, design, construction, cost, monitoring, and maintenance considerations associated with individual techniques) are discussed in detail in the ISPG. When modifying, replacing, or removing existing bank protection, many of the same factors apply; additional factors to consider are described below.

3.1 Data and Assessment Requirements

Prior to undertaking a bank protection removal, enhancement, or restoration project, it is imperative that existing habitat be identified and assessed with respect to desired habitat conditions. Minimally, a site and reach assessment, and possibly a watershed assessment are necessary to understand the underlying cause(s) of bank erosion and aid in selecting appropriate restoration and enhancement techniques. The degree of assessment will depend upon the extent of bank protection and the degree of channel stability/instability. Such an assessment should occur early in project planning. See the ISPG Chapter 2, *Site Assessment* and Chapter 3, *Reach Assessment* for guidance on conducting site and reach assessments. The risk to property and habitat of leaving the existing bank protection in place versus the risk of modifying or removing the bank protection and restoring the bank also needs to be assessed. See the ISPG Chapter 4, *Considerations for a Solution* for guidance on these assessments.

Gathering the design report and as-built plans for the existing bank protection project may help with understanding how and why it was originally designed, materials used, and design constraints. The design report may also have information about buried infrastructure (such as gas pipelines), hydrology, hydraulics, property lines/easements, and site, reach, risk, and habitat assessments. If a design report and plans are not available, then this information should be gathered by conducting a field survey and seeking sources such as watershed management plans, limiting factors reports, local government offices, et cetera.

3.2 Selecting Restoration and Enhancement Measures

If modifying or replacing existing bank protection, refer to ISPG[1] Chapter 5, *Identify and Select Solutions* for guidance on the selection of appropriate bank protection techniques. The selection process described there takes into account site and reach conditions, the underlying causes of bank erosion, and the risk to habitat, infrastructure, and public safety.

Because of the invasive nature of removing existing bank protection, it may be necessary to employ temporary bank protection techniques in order to leave the raw banks in a stable condition, even though the intent of the project is to permanently remove bank protection. Required techniques may range from simple bank pull-back and revegetation to installation of deformable bank toes such as coir wrapped streambed material or large wood.

4 CONSTRUCTION CONSIDERATIONS

Access and Staging

The selection of construction access and staging areas to remove bank protection and install restoration measures in mature, complex riparian areas should strive to minimize any impacts to existing riparian habitat. Riparian habitat not only benefits fish and wildlife, but it is also a stabilizing factor for banks. Several approaches to access and stage a bank restoration project may be employed; impacts to riparian habitat vary with the approach. These approaches are listed below in order of most protective to least protective of riparian habitat:

1. Access the site from the opposite bank if easier access is available, and cross the stream either using a floating platform or driving equipment across the channel during low flows. This approach has the least impact to the riparian area though it may have impacts on the opposite bank if a new access road is constructed. Impacts to the stream channel and water quality from equipment working in the channel will also need to be addressed.

2. Construct access road(s) perpendicular to the streambank. A rock platform may need to be constructed projecting slightly into the channel and sized to accommodate the turning radius of equipment, allowing for heavy equipment to reach upstream and downstream. Once construction is complete, the platform is removed and the streambank restored.

3. Construct access road(s) perpendicular to the stream and a temporary in-channel road at the toe of the streambank. The in-channel road runs parallel to the bank allowing an equipment operator to remove bank protection material and construct restoration measures. Operations start at the far end of the in-channel road and progresses to the access road, removing the road as restoration activities are completed.

4. Construct an access road on top of, and parallel to, the bank. This provides easiest construction access and staging, though has the greatest impact to the riparian area. This approach may be appropriate for low quality riparian area where a component of the restoration project is planting the riparian area. This approach is not appropriate in mature riparian areas.

For all the above approaches, access roads should be decommissioned by grading to a natural slope, decompacting the material, applying erosion control measures, and planting with appropriate riparian and floodplain species.

Hazard Trees

Whenever bank protection is removed, there is a risk of riparian trees falling and possibly damaging equipment and/or harming people. Prior to undertaking bank protection removal, flag all hazard trees and either avoid disrupting their root system or remove them. Trees should be removed with rootwad intact if possible and incorporated into the restoration or enhancement project.

Dewatering and Water Quality

Many bank protection projects are partially or completely submerged. As such, sediment control measures will be necessary so equipment operators can work the site and minimize turbidity for water quality protection. These include coffer-dam isolation or partial isolation and dewatering. See the *Construction Considerations Appendix* for guidance on sediment control.

5 EXAMPLES

Examples of various bank protection techniques are provided in ISPG Chapter 6, *Bank Protection Techniques*.

6 REFERENCES

[1] Cramer, M., K. Bates, D. Miller, K. Boyd, L. Fotherby, P. Skidmore, and T. Hoitsma. 2003. *Integrated Streambank Protection Guidelines*. Co-published by the Washington departments of Fish & Wildlife, Ecology, and Transportation. Olympia, WA. 435 pp.