Guidelines for Streambank Protection

Instructor: John Poullain, PE

2012

PDH Online | PDH Center
5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone & Fax: 703-988-0088
www.PDHonline.org
www.PDHcenter.com

An Approved Continuing Education Provider
Streambank Protection

The stabilization of the side slopes of a stream to reduce streambank erosion. It is often necessary in areas where development has occurred in the upstream watershed and full channel flow occurs several times a year. Streambank protection can be vegetative, structural or a combined method where live plant material is incorporated into a structure (bioengineering). Vegetative protection is the least costly and the most compatible with natural stream characteristics. Additional protection is required when hydrologic conditions have been greatly altered. Because each reach of channel is unique, measures for streambank protection should be installed according to a plan developed for the specific site and watershed.

Streambanks tend to erode in areas where upstream development has increased water volume and velocity or where vegetation has been removed near the channel.

Considerations in determining which type of streambank protection to use include: current and future watershed conditions, discharge, velocity, sediment load, channel slope, control of bottom scour, soil conditions, present and anticipated channel roughness, compatibility with other improvements, changes in channel alignment, and fish and wildlife habitat.
Streambank Protection

**Recommended Minimum Requirements**

Prior to start of construction, streambank protection should be designed by a registered design professional and/or an interdisciplinary team. Protection methods should not affect stream hydraulics; a floodplain study and 404 permit may be required. Plans and specifications should be referred to by field personnel throughout the construction process.

- **Velocities**: Up to 6 feet per second for vegetation alone when stream is stable. Use structural protection for velocities greater than 6 feet per second. Use the velocity associated with the peak discharge of the design storm.

- **Channel Bottom**: Must be stabilized before installing bank protection. Grade control may be needed to prevent downcutting.

- **Vegetative Protection**: Consider the natural zones of a streambank community when placing vegetation.

- **Plant Materials**: Use native plant materials for establishment and long term success. Lists of suitable species may be obtained from the Missouri Department of Conservation (MDC), Kansas Wildlife and Parks, or NRCS.

- **Structural Methods**: May be needed in trouble spots such as bends in the channel or changes in channel slope; or where changes in hydrology, sediment load and channel alignment are occurring.

- **Combined Methods**: Many bioengineering practices are useful to protect streambanks (see *Soil Bioengineering for Slope Protection* Section; also consult with MDC for information on specific practices such as cedar tree revetments).

- **Permits**: Contact the Corps of Engineers and local authorities for permit requirements; permits may be needed if placing fill in wetlands or streams.
**Construction**

**Site Preparation**

Follow all local, state and federal government regulations on stream modifications.

Determine exact location of all underground activities.

Stabilize the channel bottom as specified in the design plan before streambank protection measures are installed.

Start and stop bank protection at stable points along the channel.

**Vegetative Protection**

Provide vegetative protection in zones as indicated on the design plan. The location of each zone depends on the elevations of the mean high water level, the mean water level and the mean low water level as shown in Figure 5.52. Vegetative protection usually works for stabilization only when a channel has become unstable because vegetation has been removed.

*Aquatic Zone*

The aquatic plant zone includes the stream bed and is normally submerged at all times.

No artificial planting is required in the aquatic plant zone.

*Shrub Zone*

The shrub zone lies on the bank slopes above the mean water level and is normally dry, except during floods.

Willows, silver maple and poplar can be planted (staked) from top-of-bank to waterline. They are preferred because: They have high root densities, root shear and tensile strength is higher than that of most grasses or forbs, and they can transpire water at high rates.

Upland trees should not be planted in the shrub zone. Refer to plan or consult NRCS, the Missouri Department of Conservation, Kansas Wildlife and Parks, or a forester for appropriate wetland shrub and tree species.
Some grasses can be planted in the shrub zone if velocities are not too high and plants are not submerged frequently or for long periods of time. Plant grasses in the spring or the fall.
To seed grasses, roughen the seedbed, lime and fertilize according to soil test results. Check with the local Natural Resources Conservation Service or University Extension office for an appropriate seed mixture.

**Tree Zone**

Plant upland trees along the banks of the stream and not on the slopes.

If trees provide shade to the streambank, grasses should be planted which will thrive in shady conditions.

Riprap is one of the most commonly used methods of protecting streambanks.

Structural Protection

Structural protection should be provided in locations where velocities exceed 6 feet per second, along bends, in highly erodible soils and in steep channel slopes. Common materials include riprap, gabions, fabric-formed revetments and reinforced concrete. Grouted riprap is not recommended, because grouted rock does not move with freeze/thaw and wetting/drying cycles. Voids quickly form under grouted rock, allowing erosion. The upstream and downstream ends of the structural protection should begin and end along stable reaches of the stream.
Streambank Protection

Riprap

Riprap is the most commonly used material for streambank protection. Properly sized, graded, bedded and placed riprap rises and settles with soil movement.

Stream banks should be sloped at 2:1 or flatter.

Place filter fabric or a granular filter between the riprap and the natural soil.

Construct the riprap layer with sound, durable rock. Refer to plan for gradation and layering.

Place the toe of the riprap at least 1 foot below the stream channel bottom or below the anticipated scour depth. Install toe walls as specified in plan.

Extend the top of the riprap layer at least up to the 2-year water surface elevation. Vegetate remainder of bank.
Chapter 5

**Gabions**

Gabions are rock-filled wire baskets. They are very labor intensive to construct but are semi-flexible, permeable and can be used to line channel bottoms and streambanks.

Construct gabions in accordance with manufacturer’s guidelines or as specified in the design plan. Use only durable crushed limestone, dolomite or granitic rock. Shale, siltstone and weathered limestone should not be used.

Place filter fabric or a granular filter between streambank material and gabions.

Install gabions and counterforts as indicated in the design plan.

**Fabric Formed Revetments**

Fabric formed revetments are manufactured, large, quilted envelopes that can be sewn or zipped together at the site to form continuous coverage. Once the fabric is in place, it is pumped full of grout to form a solid, hard and impervious cover.

Clear, grub and grade the streambank surface to prepare for revetment installation. Install revetments according to manufacturer’s recommendations.

Reinforced concrete may be used to stabilize the stream bed or the streambank.

**Reinforced Concrete**

Reinforced concrete retaining walls and bulkheads provide good erosion protection for streambanks. Anchor the foundation for these structures to a stable, nonerodible base material such as bedrock.

Place filter fabric or a granular filter between streambank material and the retaining wall or bulkhead.

Construct water stops at all joints in concrete retaining walls.

Construct the top of the retaining wall or bulkhead up to the design water surface elevation plus freeboard, and vegetate the rest of the streambank.
Construct weep holes in the retaining wall or bulkhead to provide drainage behind the structure.

**Combined Methods of Protection**

Combinations of vegetative and structural protection provide some of the advantages of both. The structures provide immediate erosion, sliding and washout protection. Vegetation provides greater infiltration than some structural methods, increases channel roughness, and filters and slows surface runoff entering the stream. Vegetation also helps maintain fish and wildlife habitat, and a natural appearance along the stream.

Combined methods can be used in areas where velocities exceed 6 feet per second, along bends, in highly erodible soils and on steep channel slopes. Common materials include cellular matrix confinement systems, grid pavers and bioengineering techniques. The upstream and downstream ends of the protection should begin and end along stable reaches of the stream.

**Grid Pavers**

Grid pavers are modular concrete units with interspaced void areas that can be used to armor a streambank while also establishing vegetation. Grid pavers are typically tied together with cables and come in a variety of shapes and sizes.
Clear, grub and grade smooth the streambank surface to prepare for the installation of the grid paver material.

Grid pavers should be designed and installed in accordance with manufacturer’s recommendations. The size and shape of the grid paver will depend on the expected velocity, the shape of the channel and the soil type.

**Cellular Confinement Matrices**

Cellular confinement matrices are commercial products usually made of heavy-duty polyethylene formed into a honeycomb-type matrix. The cellular confinement matrices are flexible to conform to surface irregularities. The combs may be filled with soil, sand, gravel or cement. If soil is used to fill the combs, vegetation may also be established.

Clear, grub and grade the streambank surface to prepare for installing the matrices. Install systems according to manufacturer’s recommendations.

**Soil Bioengineering**

Soil bioengineering uses live, woody vegetative cuttings to increase slope stability and repair slope failures. Two approaches can be used: woody vegetation systems and woody vegetation systems combined with simple inert structures.

Soil bioengineering is advantageous where there is minimal access for equipment and workers and in environmentally sensitive areas where minimal site disturbance is required. Most techniques can also be used for stream channel or bank protection. Once established, woody vegetation becomes self-repairing and needs little maintenance. (For complete description and installation guide to individual practices see Soil Bioengineering for Slope Protection section.)

Design for capacity at rank growth. Design for stability at low or dormant growth.

More information on bioengineering practices can be obtained from your local Natural Resources Conservation Service/Soil and Water Conservation District and the Missouri Department of Conservation. (Also see Turf Reinforcement Mats in Erosion Control Blankets section.)
Streambank Protection

**Erosion Control**
Minimize the size of all disturbed areas and stabilize as soon as each phase of construction is complete.

Use temporary diversions to prevent lateral surface water from running onto the streambank protection area.

Direct all overland flow to the streambank at low velocities.

Establish vegetation to stabilize all disturbed areas immediately after construction.

**Safety**
Store all construction materials well away from the stream.

At the completion of each workday, move all construction equipment out of and away from the stream to prevent flooding.

While working in streams with flowing or still water, the following precautions should be taken:

- Avoid steep slopes on the streambank.
- Fence area and post warning signs if trespassing is likely.
- Provide an uncontrolled means of draining the construction site.

**Construction Verification**
For vegetative protection, check to see that planting and seeding was done in compliance with the design specifications. For structural protection, check cross section of the channel, thickness of protection and confirm the presence of filter cloth between the protection and the streambank.

**Troubleshooting**
Consult with registered design professional if any of the following occur:

- Variations in topography on site indicate protection will not function as intended; changes in plan may be needed.
- Design specifications for vegetative or structural protection
cannot be met; substitution may be required. Unapproved substitutions could result in erosion damage to the streambank.

**Maintenance**

Check the streambank after every storm event. Fix gaps in the vegetative cover with structural materials or new plants. Make needed repairs to structural systems with similar material.

Protect new plantings from livestock or wildlife.

Check the streambank for signs of voids beneath gabions, riprap and concrete. Deterioration or erosion of the filter fabric or granular material should be repaired.

Check and repair gabion connections and grid paver connections.

**Common Problems**

Erosion of streambank; caused by inadequate vegetation, improper structural protection or an increase in stream velocity due to upstream development—repair erosion, establish adequate vegetation or structural protection, and reduce stream velocities.

Slumping failure or slides in streambank; caused by steep slopes—repair slide by excavating failed material and replacing with properly compacted fill. Consider flattening slope.

Sinkholes in riprap; caused by failure of the filter beneath the riprap—remove riprap, repair filter, reinstall riprap.

Reduction in stream capacity; caused by overgrowth of vegetation on the streambank—selectively remove overgrown vegetation at regular intervals.
Streambank Protection
Streambank Setback

Practice Description

The practice of limiting vegetation removal and grading of the riparian area along flowing waters. This practice is intended to protect the banks of natural streams from damage due to development, lessen the risk of flooding in developed areas and provide a buffer between the developed area and the stream. A properly maintained streambank setback will help maintain channel capacity and stability, reduce the sediment load in the channel and reduce the movement of pollutants into the stream. Setbacks help preserve natural channel meander and protect homes and other buildings from damage due to bank erosion.

Streambank setbacks can also apply to areas adjacent to excavated open channels used for site drainage, drainageways and watercourses that route runoff to streams.

Recommended Minimum Requirements

Prior to the start of construction, the 100-year floodplain established by the Federal Emergency Management Agency (FEMA) and the streambank setback area should be shown on the design plan prepared by a registered design professional. Plans should be referred to by field.
Streambank Setback personnel throughout the construction process. The streambank setback should be established according to the planned alignment and grade. Vegetation should be inventoried and flagged for retention.

- **Channel:** Ensure that the channel is stable before determining the width of streambank setback.

- **Streambank Setback in Developed Areas:** The greater of the following is recommended:

  A *minimum* of 50 feet from the top of the streambanks (larger setbacks will be needed where channels are downcutting, hydrology is shifting and in large drainage areas---if sufficient land is available, a 100-foot setback is encouraged to protect the stream from degradation and to protect property), or Beyond the 100-year floodplain.

- **Vegetation:** If possible, preserve desirable natural vegetation within the setback area, especially on steep slopes. Establish vegetation on all areas without sufficient cover (see *Vegetative Protection* in the *Streambank Protection* section). Overall fish and wildlife habitat requirements and landscape character should be considered in determining the scope of streambank setback.

- **Street Setback:** Streets in new developments should be constructed so that they remain usable during runoff from the design storm or according to local requirements.

- **Water Surface Elevation:** A *minimum* of 1 foot below the ground floor of private dwellings and commercial buildings in a new development during the 100-year frequency, 24-hour duration storm.

- **Permits:** Contact the Corps of Engineers and local authorities for permit requirements; permits may be needed if placing fill in wetlands or streams.
Section: Construction

Site Preparation

Follow all federal, state and local regulations for channel improvements required to increase stream capacity (due to development).

Open channel cross sections should not be reduced in order to increase streambank setback. The use of levees within small watersheds is discouraged.

Natural Channels

Natural channel side slopes should not be disturbed. When disturbance is necessary to develop a site, reestablish vegetation on channel side slopes as soon as possible after excavation or improvement.

Consider the natural zones of a streambank community when placing vegetation. Use native plant materials for establishment and long-term success. Lists of suitable species may be obtained from the Missouri...
Streambank Setback

Department of Conservation (MDC) or NRCS. (See Streambank Protection.)

Existing woody vegetation adjacent to the stream should not be disturbed.

Leave any right-of-ways in the best condition feasible, consistent with the project purposes and adjacent land uses.

Preserve or plant adapted trees to provide shade to prevent thermal pollution in the stream, help stabilize banks and provide wildlife habitat in those areas of perennial flow or where woody cover exists.

Erosion Control

Minimize the size of all disturbed areas and stabilize as soon as each phase of construction is complete.

Establish vegetation on all disturbed areas immediately after construction.

The streambank setback area should not be used as a filter strip during construction.

Use temporary diversions to prevent lateral surface water from running onto the streambank setback area.

After construction, direct all overland flow through the streambank setback area at low (5 feet per second or less) velocities.

Safety

- At the completion of each days work, move all construction equipment away from the streambank setback area in anticipation of flooding.

- Temporary stream crossings should be used by construction equipment to prevent destruction of the streambank setback areas.

- Construction materials and waste material should not be stored in the stream channel or streambank setback area.

- Provide temporary fencing and post warning signs until vegetation is established in areas that are disturbed.
Chapter 5

- Provide site drainage.

Construction Verification

The alignment and width of the setback should be maintained during all construction activities. The final grades and elevations of the setback area should be checked to insure compliance with plans and specifications.

Troubleshooting

Consult with a qualified design professional if any of the following occur:

- Variations in topography on site indicate setback or channel is inadequate or will not function as intended; changes in the plans may be needed.

- Design specifications for seed variety, trees, mulch and fertilizer cannot be met; substitution may be required. Unapproved substitutions could result in additional flooding and erosion of the streambank.

Maintenance

Check the streambank setback area after every storm event. Fix gaps in the vegetative cover by seeding and mulching or with new plants.

Protect new plantings in the streambank setback area from livestock or wildlife.

Mulch, spray (with an herbicide approved for aquatic use) or chop out undesirable vegetation periodically to prevent its growth.

Keep inlets to side drainage structures open.

Keep subsurface drain outlet pipes open and protected.

Common Problems

Erosion of streambank setback; caused by disturbed land in setback area, inadequate vegetation or concentrated flow—establish adequate vegetation in all areas or install measures to reduce flow concentrations.
Streambank Setback

Slumping failure or slides in streambank; caused by steep slopes—repair by excavating failed material and replacing with properly compacted fill. Consider reducing slope or installing streambank protection measures.

Reduction in stream capacity; caused by overgrowth of vegetation on the streambank—selectively cut overgrown vegetation.