CHAPTER 8

WATER QUALITY
BEST MANAGEMENT PRACTICES

8.4 Streambank Restoration

Although effective watershed runoff controls are needed to eliminate the root causes of stream degradation, stream health can also benefit from restoration effects that directly target the stream channel and stream banks. Stream bank erosion needs to be halted, and both in-stream and riparian habitats restored. Such a program requires expertise in areas such as stream forming processes, slope stabilization, plant science, and aquatic biology. Local Soil Conservation Service and U. S. Fish and Wildlife Service staff may be able to provide some of this expertise. Stream restoration includes three major activities:

- Riparian reforestation.
- Streambank stabilization.
- Streambed restoration.

8.4.1 Riparian Reforestation

The contribution of trees and woody understory vegetation to the maintenance of stream health cannot be overstated. Streamside forested areas not only provide habitat, shade, and forage for both aquatic and land-based species, but their ability to filter pollutants and rainfall provides a buffer, a last line of defense, from watershed runoff. A program to restore forested streamside areas should receive early consideration, because it can be one of the most cost-effective steps that a community takes in its stream restoration efforts. The objective should be to replicate or mimic the natural ecosystem as much as possible, so mixed-age native plant and tree species are preferred. The cost-effectiveness of the program can be increased by encouraging participation by citizen volunteers. Though most revegetation efforts focus on streambanks, the hydrologic characteristics of the watershed can be improved by upland reforestation as well.

8.4.2 Streambank Stabilization

Anyone faced with an eroding or collapsing stream bank needs first to determine the cause of the problem. Streambank erosion occurs for a number of reasons, including increased stream velocity, obstacles in the stream, floating debris, wave action, and direct rainfall. Streambank failure occurs when a large section of streambank collapses into the stream channel. Among the causes of streambank failure are changes in channel cross-section through down-cutting of the streambed and undercutting of

the bank, increased load on the top of the bank, and internal pressure from uneven water absorption.

Selection of an appropriate bank stabilization method requires careful analysis of each site. No single method is appropriate in all situations. Technical advice will often be needed, and is available from sources such as the local Soil Conservation Service and Cooperative Extension Service offices, or from private consultants. One important note: a Corps of Engineers permit may be needed before any material is placed in a stream or adjacent wetlands. The Corps of Engineers Savannah District office should be contacted (1-800-448-2402 or 1-912-652-5347.)

Detailed discussion of the many possible stream and streambank stabilization techniques is beyond the scope of this Manual, but one general approach needs to be mentioned because of growing realization of its contribution to the overall health of streams. The approach has been called the bioengineering or biotechnical approach. Its aim is to replicate or reintroduce natural stream and slope stabilization processes as much as possible. The biotechnical approach to slope protection combines the use of mechanical (or structural) elements with biological elements (plants), functioning together and mutually reinforcing each other (Gray and Leiser, 1982). Biotechnical techniques in which plant materials are the primary structural component have come to be identified by the term "soil bioengineering". Techniques include installing plantings of woody vegetation such as willows, either as individual live cuttings, or in bundles of cuttings. If planted correctly and given time to establish root systems, the cuttings can grow into a dense network of protective vegetation that can bend but not break under stress and that is self-repairing. The vegetation's root matrix provides resistance to the sliding and shear displacement forces involved in slope erosion.

Although "living construction" methods have been systematically studied and used in Europe for more than half a century, technical information on such methods became easily available in the United States only recently. The Pennsylvania Scenic Rivers Programs" 1986 guidebook for landowners is an attractive, reader-friendly publication (Pennsylvania Scenic Rivers Program (1986). The Izaak Walton League of America has published a 21-page survey of stream-bank stabilization methods (Izaak Walton League of America, 1989). The Washington Department of Ecology's draft Storm Water Management Manual for the Puget Sound Basin includes bioengineering methods among the many groups of protection measures that it describes (Washington Department of Ecology, 1992). Also, the Georgia Soil and Water Conservation Commission plans to include a detailed description of the concepts in a new guidebook titled Controlling Streambank Erosion which will soon be available.

Gray and Leiser (1982) list four reasons of prefer biotechnical approaches:

- Their cost-effectiveness. Lower cost vegetative treatments can reduce the amount of higher cost structural treatments that may be needed.
- Their environmental compatibility. Biotechnical systems tend to blend into the landscape and are less visually intrusive. Examples include log or timber cribs gabion and rock breast walls, and reinforced earth. In addition, wherever possible, vegetation is incorporated into the structures, for example by planting in the spaces between structural members.
- Their use of indigenous, natural materials. Wherever possible, natural locally available materials are used: earth, rock, timber, vegetation – in contrast to man-made materials such as steel and concrete.
- Their labor- and skill-intensiveness. Well-supervised, skilled labor can often be substituted for high-cost, energy-intensive materials.

Most importantly, biotechnical methods contribute to the support and protection of the ecology of a stream in ways that purely structural techniques do not.

If possible, a qualified bioengineer should be consulted to evaluate site conditions and determine the appropriate mix of measures that will adequately solve the problem and stand up to the test of time. In some cases, a solely vegetative approach may be all that is needed. In others, conditions such as excessive stream velocities or poor soil conditions may required a combination of vegetative and structural elements. And in still other, space limitations or other conditions may require a solely structural approach such as stone walls or bulkheads. Some of the most common conditions that may preclude the soil bioengineering preference for vegetative measures include inadequate space, heavy pedestrian traffic, the need for an unobstructed view, or too much shade.

8.4.3 Streambank Restoration

Prior to any streambed restoration, upstream conditions should be assessed. Without corrective measures or retrofitting upstream, storm water flows could quickly destroy any restoration work. If the stream is in equilibrium, or if appropriate corrective measures are in place, streambed restoration can recreate the habitat conditions needed to support aquatic life. Several factors may need to be addressed in streambed restoration:

- Replacement of pools and riffles.
- Velocity control.
- Restoration of the stream gradient and normal flow channel.
- Removal of major stream obstructions.
- Restoration of suitable channel patterns. There are three major channel patterns: (1) meandering – which is characterized by repetitive bends, (2) irregular – which is more or less straight; and (3) braided – which separates and rejoins around islands. Which pattern is

appropriate depends upon surrounding soil and slope conditions, as well as original stream patterns (Dunne, 1978).

- Restoration of the substrate (removal of sediment and replacement with gravel and cobbles, as appropriate for the streams).
- Restoration of adjacent wetlands and floodplains.

The number of factors affected by restoration and the extent of the measures taken will depend upon individual stream conditions. Some techniques permit the stream flows themselves to work to restore healthier streambed conditions; others require excavation and physical realignment of the stream channel. Three basic techniques include deflectors, in-stream boulders and drop structures. With many variations, these techniques are used throughout the country.

8.4.3.1 Deflectors

Deflectors can be easily constructed of common, local material such as cobbles, boulders and logs, and are adaptable to a variety of conditions and stream sizes. They are sited in the channel with the intent of deflecting the current into a more narrow channel. Deflectors can use the stream flow for a variety of purposes, including deepening channels, developing downstream pools, enhancing pool riffle ratios and assisting in the restoration of meander patterns with channelized reaches. There are several deflector designs, such as a simple double "wing deflector" that consists of rock structures on each bank deflecting the streamflow to a central channel, single deflectors along bank, deflectors offset on opposite banks of the stream to imitate meanders, and V-type deflectors, which are placed in the middle of channels with the point of the "V" pointing upstream to deflect water towards both banks. This type of deflector helps re-establish riffles and pools downstream. An underpass deflector is a log placed across a small stream several inches off the bottom. Water is deflected under the log which helps remove sediment deposits and restore pools (Gore, ed., 1985; Kumble, 1990).

8.4.3.2 Drop Structures

Drop structures include a number of variations such as weirs, check dams, sills and plunges. They can serve a variety of functions in streambed restoration depending upon their design, including: slowing streamflow; deepening existing pools; and creating new pools upstream and downstream. Structures with notches can be used to control heavy storm water flows and can help re-establish deep pools immediately downstream. Drop structures can be made of concrete, logs or boulders. Log

or boulders structures can be used to replicate small falls or rapids. Single log dams across a streambed are simple and effective in restoring plunge pools. The K-dam is a variant of the single log dam, so named by added downstream bracing. In some areas, especially headwater areas, reintroducing beavers has been effective in restoring habitat (Gore, ed., 1985). Their dams function as drop structures in headwaters and on-small streams.

8.4.3.3 Boulder Placement

Boulder placement is a third in-channel treatment that can assist streambed restoration. Boulders can be used to reduce velocity, restore pools and riffles, restore meanders, provide cover and protect eroded banks by deflecting flow (Gore, ed., 1985). Boulders can be placed randomly or in a pattern. Placing them in a "V" pointed upstream produces eddies that replicate riffles and restore downstream pools. Combined with placement of cobbles and gravels, boulder placement can also help restore the stream substrate.

Excavation and fill may also be necessary to restore the stream gradient, the normal flow channel and the stream channel pattern, including meanders and braids, where appropriate. Channel pattern restoration should be combined with streambank restoration and re-vegetation. Streams that have been severely degraded by large amounts of sediment or heavy storm water flows may require greater restoration work. Sediment may have to be removed mechanically and replaced with gravel and cobbles to replicate the original streambed. Major debris accumulation that is obstructing flows may also need to b removed.

Restoration of riparian wetlands and floodplains can also be included in re-vegetation projects with special consideration given to planting species appropriate to the specific site conditions, including soil types and degree of saturation. The following sources can provide further information on streambed restoration:

- Guidelines for Streambank Restoration. State Soil & Water Conservation Commission, 1994.
- Soil Conservation Service Engineering Field Book, Part 650, 1992.
- The Restoration of Rivers and Streams. James A. Gore, Editor, 1985.

- Stream Restoration Along the Greenways in Boulder, Colorado. John L. Barnett, 1991.
- The State of the Anacostia 1989 Status Report, Peter A. Kumble, 1990.
- A Streambank Stabilization and Management Guide for Pennsylvania Landowners. Commonwealth of Pennsylvania, Department of Environmental Resources, 1986.
- Stream Obstruction Removal Guidelines. Wildlife Society and American Fisheries Society, 1983.

END OF SECTION 8.4