RIVER BANKS & BUFFERS

No. 3

# Streambank Stabilization

## METHODS FOR THE CONNECTICUT RIVER WATERSHED

People cannot stop erosion—they can only speed it up or slow it down. It is the nature of rivers and streams to move, and there is no guarantee for the success of any erosion control project. Each erosion site is unique and presents a variety of factors that play a role in the situation. Therefore, technical assistance coupled with an organized and well-planned approach can help you as a property owner or town road agent to set realistic goals should you decide to attempt a stabilization project.

**Each site is different**

The methods described here have all been used in the Connecticut River Watershed. While stone riprap was once the solution of choice, today's professionals, permitting agencies, and property owners alike favor vegetative stabilization, with or without stone at the base or "toe." These methods offer the most benefit in stabilizing banks and reducing sedimentation from erosion, while minimizing adverse impacts upon the stream ecosystem and downstream property. Sources of information on other methods of bank stabilization can be found in the bibliography.

**Avoid setting up an erosion-prone situation**

The most cost-effective approach by far is to avoid setting up an erosion-prone situation in the first place. Avoid building in the floodplain or locating roads close to waterways. Keep animals and heavy equipment off the banks and respect the riparian buffer. Survey your property before, not after the next flood, to check for undersized culverts or other potential erosion sites. If you are a town road agent, know your trouble spots and locate a source of stabilization materials in advance, to avoid hastily-designed emergency repairs that are not well suited to the stream.

## VEGETATIVE STABILIZATION

Stabilization with plant materials tends to be much less expensive than with stone. A number of new techniques are showing good results in the Connecticut River Valley on streambanks that traditionally might have been riprapped**.** The following methods, sometimes called bioengineering, use live woody vegetation installed in streambanks for erosion protection, reinforcement of the soils, and in time, a woody vegetative surface cover and protective root network. In addition to protecting a riverbank from erosion, these methods also provide a natural appearance and improved wildlife habitat.

*If livestock use the adjacent land, fencing is essential to keep them off the banks and away from plantings.* This will likely be well worth any extra effort that fencing may require, by ensuring that vegetation has a chance to become well established.

### TREE REVETMENTS

Tree revetments consist of densely branched softwood trees or tops with a butt diameter of 6-12". Cedar, hemlock, fir, and spruce all work well, but pine is too sparse and breakable. Usually installed without heavy equipment, the trees are anchored to the toe of the bank in an overlapping pattern with the trunks facing upstream. Cables are run through holes

drilled in the tree trunks, or wrapped around the trunks, and clamped tightly to duckbill anchors driven into the bank. The trees both keep the current away from the bank and trap sediment in their branches, which forms a shelf for planting and catches slumping bank material from above. Fascines or willow wattles (page 4) can be used to revegetate the upper portion of these sites.

## Where to use

- On all types of waterways.
- Alone on most streams, or on top of "low toe" stone riprap on difficult sites.
- At the toe of a steep bank where there is little room to work.
- Not appropriate near culverts or other structures where there is high potential for blocking the flow, resulting in downstream damage if the revetment dislodges during flood events.

## Timing

- Install at low water at any time of year.

## Advantages

- Inexpensive.
- Easy for volunteers to prepare and install.
- Uses a natural biodegradable material that will stabilize the bank until vegetation has become established.
- Provides immediate resistance to wave and wake action.
- Has self-repairing abilities following flood damage if used with other plantings.
- Encourages current to scour the stream bed instead of the bank, thus forming a deeper cover for fish next to and among the branches.

## Disadvantages

- Commonly used "duckbill" anchors may need to be ordered.
- Helpful to use specialized cable cutters for installation.
- May require periodic maintenance to replace trees or plantings damaged by high flows.

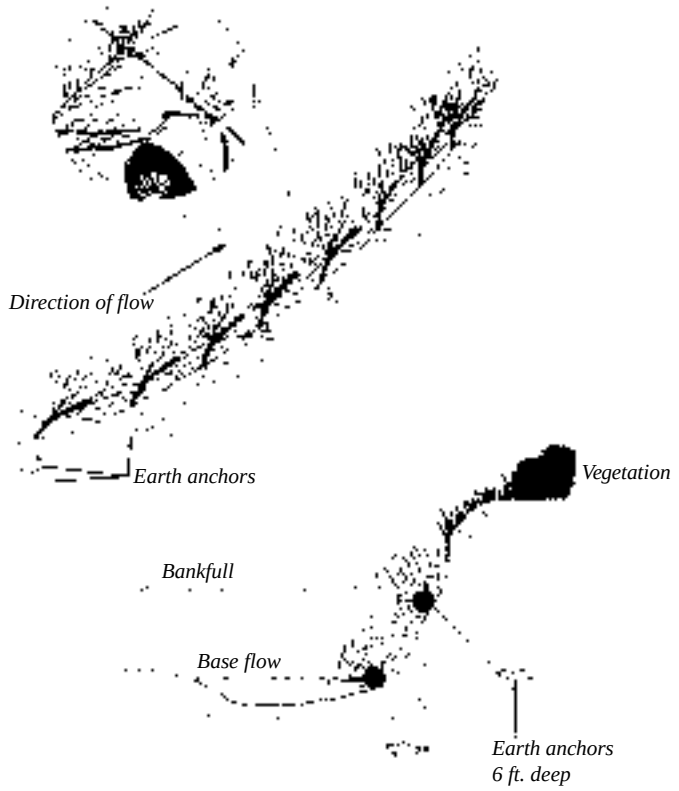


*Figure 1. Tree revetment.*

## ROOT WADS

This technique, also favored for its ability to improve fish habitat, protects a riverbank from erosion by armoring it with the exposed root systems of trees driven into the bank. Trees with 8-12' long trunks and good-sized root systems are used, the trunks driven or trenched into the bank so that their root systems are flush to the bank and angled slightly in the direction of streamflow. The bank is backfilled and planted with other vegetative material such as live willow stakes. Irregular 16"+ footer and/or cover logs are also placed at the expected scour depth on sites where the bank is very unstable.

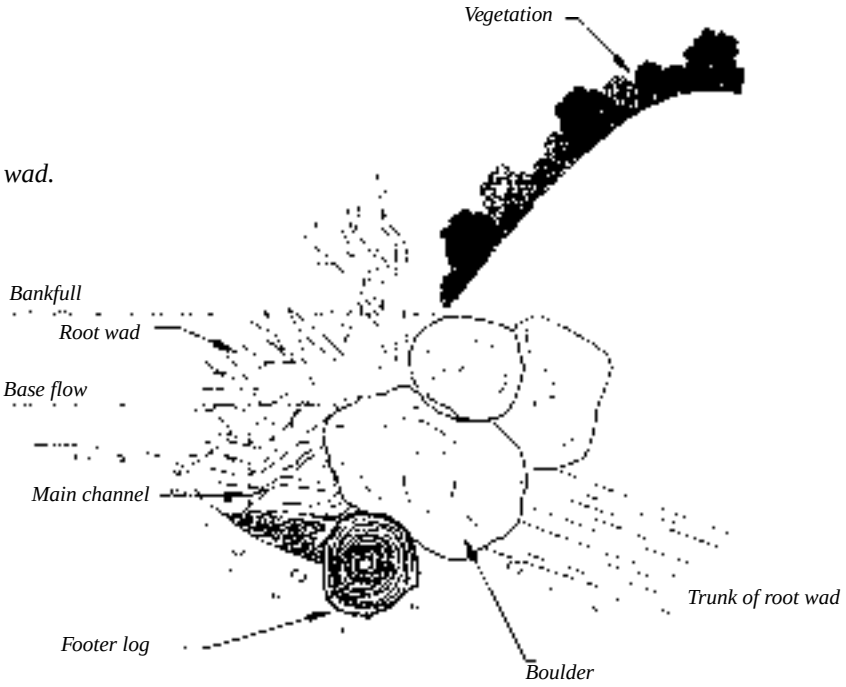


*Figure 2. Root wad.*

### Where to use

- On meandering streams that may overflow their banks.
- Where fish habitat is degraded.
- Should be used in combination with live stakes or other vegetative plantings.
- May not be as useful in water less than 6-8" deep.

### Timing

- Install at low water at any time of year.

### Advantages

- Very inexpensive.
- Easy for volunteers to prepare and install.
- Presents a natural appearance and uses a natural biodegradable material that will stabilize the bank until vegetation has become established.
- Provides immediate resistance to wave and wake action.
- Improves fish habitat by providing overhead cover, resting areas, deeper pools, and shelters for fish and their food supplies.

### Disadvantage

- May have limited life if vegetation does not take hold.

## BRUSH or COIR FIBER ROLLS

Brush rolls are large (24" diameter) bundles of any type of brush. Coir fiber rolls are flexible, dense biodegradable rolls of coconut-husk fiber. Carefully staked or anchored into the bank as low as possible, they deflect current away from the bank and collect sediment, forming a small shelf. They can be planted with live material either before or after installation. In combination with other methods they can be very useful for immediate erosion resistance and as a sediment trap.

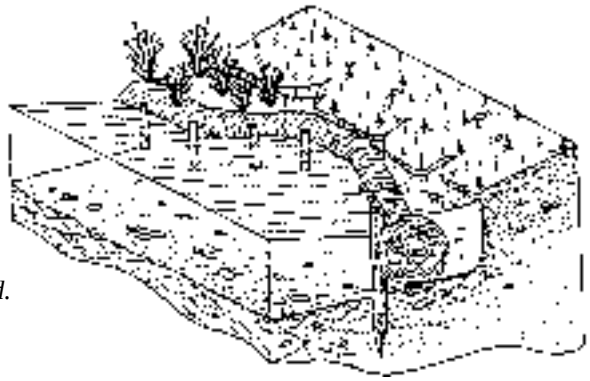

*Figure 3. Coir fiber roll, installed.*

**Where to use**

- Alone, only on low velocity streams.
- In combination with other toe protection strategies.
- At the toe of a steep bank where there is little room to work.
- Can be used to fill an undercut bank and protect it from further erosion.

**Timing**

- Install at low water at any time of year.

**Advantages**

- Rolls constructed of brush are very inexpensive.
- Easy for volunteers to prepare and install.
- Uses a natural biodegradable material that will stabilize the bank until vegetation has become established.
- Provides immediate resistance to wave and wake action.
- Very effective on steep banks with little space in which to work.

**Disadvantages**

- Brush rolls require large amounts of material.
- Coir fiber rolls may be more expensive than stone riprap.
- Coir fiber rolls, even after installation, have been known to ignite upon exposure to sparks.

## LIVE FASCINES OR WATTLES

Live fascines are sausage-like bundles of live woody cuttings, tied together. Placed in shallow ditches cut into the streambank, and secured with live or dead stakes, they will sprout to produce a thick cover of brush. Most often placed on slopes parallel to the contour, fascines may be used in combination with other vegetative stabilization methods.

**Where to use**

- Live fascines are used to protect banks from washout and seepage.
- On streams of all sizes and character.

**Timing**

- Construction must occur when plant material is dormant.

**Advantages**

- Economical where materials are locally available.
- At the water's edge, is effective even before the cuttings have rooted.
- In combination with other vegetative methods, fascines offer an immediate measure of stabilization.
- Once established, shrubs bend well under ice to protect the bank.
- Flexible, simple method requiring little soil disruption.
- Grows into durable, natural appearing bank cover.
- A very effective stabilization technique once rooting is established.
- Live fascines are capable of collecting sediment.

**Disadvantages**

- Hand labor is required.
- Installation is limited to periods when plant material is dormant.

## LIVE STAKES OR CUTTINGS

Live stakes are living, dormant, woody plant cuttings capable of quickly rooting in the streamside environment. Stakes are 1"-2" in diameter. Cuttings are finger-sized. Stakes and cuttings root and grow into mature shrubs that stabilize the streambank.

**Where to use**

- Most useful on streambanks of moderate slope (2:1 or less).
- On original bank soil.
- Where active erosion is light and washout is unlikely.
- Often in combination with other natural or structural methods.
- On streams of all sizes and character.

**Timing**

- Installation must occur in the dormant season during low water.

**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.

**Disadvantages**

- Often not feasible alone, and should be combined with other techniques, especially in zones of active erosion.
- Does not provide initial 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 or mulch during establishment.

## BRUSH LAYERS OR MATTRESS

A brush mattress is a combination of living units: live stakes, fascines and a mattress branch cover of live and/or dead material. This forms an immediate, protective surface cover on the streambank. Brush mattress systems are intended to root and grow, while the mattress itself slows water at the bank surface.

**Where to use**

- Particularly useful method for washed-out banks.

**Timing**

- Construction must occur at low water and when plant material is dormant.

**Advantages**

- Provides immediate surface protection against floods, greatly reducing water velocity at the soil surface.
- Well-anchored mattress provides some resistance to ice scour.
- Cuttings are normally available locally.
- Economical.
- Captures sediment during flood conditions and assists in rebuilding of the bank.
- Produces riparian vegetation rapidly and enhances wildlife habitat value.

**Disadvantages**

- Large amount of material is required.
- Considerable labor is required.
- Water must not drain over the bank through the brush mattress installation.

## UNDERWATER EROSION CONTROL MATS

This new technology, successfully employed in Europe's North Sea, uses a floating polypropylene mat anchored to the river bottom. The mat consists of nearly 22,000 individual filaments that mimic natural seagrass. These filaments slow water velocity and catch water borne sediments, compacting them with their waving motion. This creates a fiber-reinforced berm to protect the base of scoured banks. This technology is currently being tested in the Connecticut River Watershed, and may offer a way to slow erosion on steep, sandy banks.

# VEGETATIVE STABILIZATION WITH STONE TOE

A combination of vegetative and stone stabilization techniques, this method has proved successful in the Connecticut River Watershed for addressing the many factors that affect the river ecosystem. On actively eroding sites, it offers a measure of balance between the needs to reduce erosion, sedimentation, and loss of riverfront property with the needs to avoid flooding, filter pollution, maintain riparian habitat, and retain the natural appearance of the riverbank.

A "toe" of stone riprap is placed only at the foot of the bank and keyed into the streambed to provide erosion resistance in the zone most often attacked by waves and other erosive forces. Plantings of shrubs and herbaceous plants immediately above and to the top of the bank hold soil in place while providing pollution filtering, habitat, temperature control, and a natural appearance.

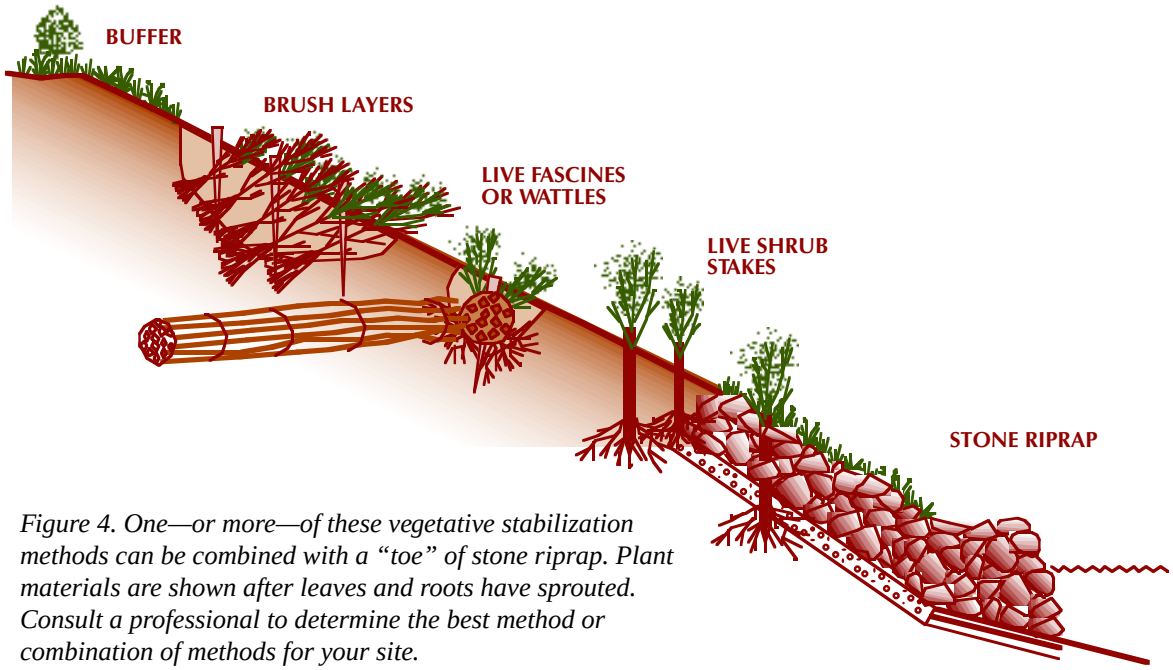


*Figure 4. One—or more—of these vegetative stabilization methods can be combined with a "toe" of stone riprap. Plant materials are shown after leaves and roots have sprouted. Consult a professional to determine the best method or combination of methods for your site.*

## Where to use

- On streams of all sizes and character.
- In combination with cuttings for initial stabilization while vegetation takes hold.

## Timing

- During low water, preferably when vegetation is about to begin active growth. May need to be done in stages with rock and seeding installed in summer with shrubs planted later, in the dormant season.

## Advantages

- Can be installed fairly quickly and is at least partially effective immediately.
- Bank plantings offer pollution filtering in addition to that performed by adjacent buffer vegetation.
- Stone at toe offers effective resistance where it is most needed.
- Provides more natural appearance than stone riprap on bank.
- Offers better temperature control than riprap.
- Offers cover for wildlife using the riverbank.

## Disadvantages

- If appropriate stone (large and angular enough to resist the force of high water flows) is not available nearby, trucking costs can make this method expensive.
- Changes stream dynamics and can cause problems for downstream landowners.

# STONE RIPRAP

Stone riprap is large, angular rock placed on the foot and slope of the streambank. This method was widely used in the past because it is durable, but its many disadvantages have led experts and permitting agencies to discourage its use over the entire bank surface. Vegetative cuttings and seedlings can be planted in the joints of hand-placed riprap to improve the strength and lend a more natural appearance to the site.

## Where to use

- On streams where water levels fluctuate widely or on severely eroding banks on high value land. *The NH Wetlands Bureau will now consider riprap applications only where anticipated turbulence, flows, restricted space, or similar factors render vegetative and diversion methods physically impractical (Wt. 404.04).*

## Timing

- At low water between June 15 and Oct. 1 to avoid disturbance of spawning fish.

## Advantages

- Can be installed quickly and is effective immediately.
- Can be installed in mid-summer at low water.
- When properly keyed into the streambed and bank, riprap is highly resistant to scour from current and ice.
- Useful where erosion is an immediate threat to high value roads and other public investments.

## Disadvantages

- May increase potential for flooding and washout downstream because riprap may speed up flow, rather than absorbing water's energy and slowing it down.
- Can cause problems for other landowners by deflecting the current against opposite or downstream banks and initiating new erosion.
- Destroys natural vegetation and habitat on the bank.
- Cannot absorb pollutants entering stream from runoff.
- Vegetation is difficult to establish among rocks.
- Riprapped banks absorb heat and cause water temperatures to rise, particularly on smaller streams, adversely affecting stream habitat.
- Unnatural appearance.
- If appropriate stone is not available nearby, trucking costs can make this method expensive.
- Placement by machine can cause significant disturbance to the sediments and bank soils.

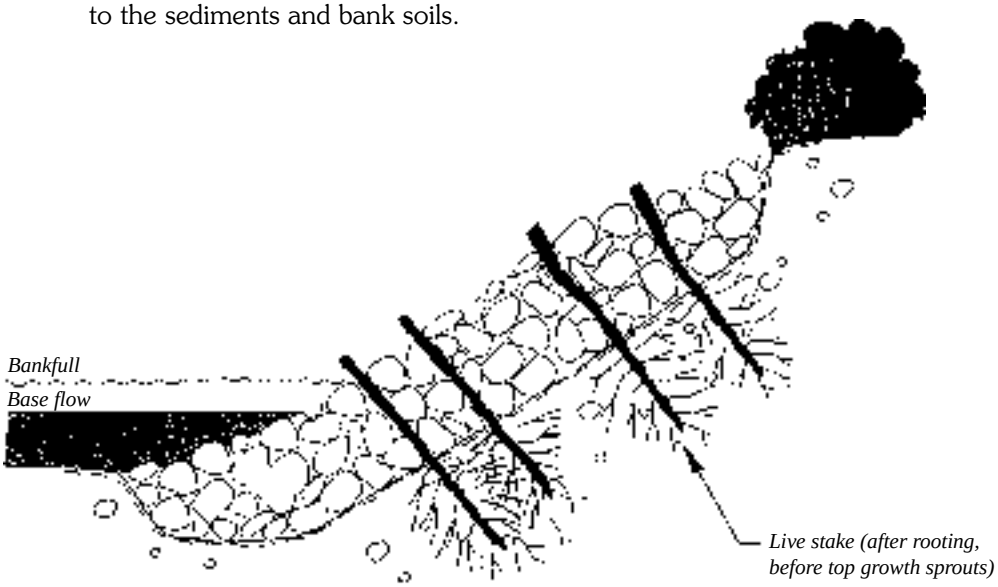


*Figure 5. Live stakes planted in riprap joints.*

## TECHNICAL SOURCES

Conservation Districts within the counties listed below are the first places to go for help.

### VERMONT

ESSEX/CALEDONIA COUNTIES
26 Main Street, St. Johnsbury, VT 05819
Ph: (802) 748-3885 • Fax: (802) 748-1621

ORANGE /WINDSOR COUNTIES
Gilman Office Center, Suite 3, Building 12
White River Junction, VT 05001
Ph: (802) 295-1504 • Fax: (802) 296-3654

WINDHAM COUNTY
Federal Bldg/Rm 321, Brattleboro, VT 05301
Ph: (802) 254-5323 • Fax: (802) 254-3307

### NEW HAMPSHIRE

COOS COUNTY
RR 2, Box 235, Lancaster, NH 03246
Ph: (603) 788-4651 • Fax: (603) 788-2538

GRAFTON COUNTY
Swiftwater Road, POB 229
Woodsville, NH 03785
Ph: (603) 747-2001 • Fax: (603) 747-3477

SULLIVAN COUNTY
24 Main Street, Newport, NH 03773
Ph: (603) 863-4297

CHESHIRE COUNTY
196 Main Street, Keene, NH 03431
Ph: (603) 352-3602 • Fax: (603) 352-8629

These Conservation Districts work with the USDA Natural Resources Conservation Service and the Cooperative Extension Service to help landowners carry out voluntary plans. Some services are free, and others are available at reduced cost. Some of the services provided are:

TECHNICAL EXPERTS: Soil scientists, agronomists, engineers, geologists, economists, biologists and other specialists.
INFORMATION: Soil maps and interpretations, manuals, booklets, and fact sheets.
EDUCATION: Seminars, field trips, and demonstration sites.
MATERIALS: Trees, shrubs, seed and erosion matting.

## FINANCIAL ASSISTANCE

These regional, state and federal programs may provide some financial support:

- Clean Water Act nonpoint pollution control program
  VT Agency of Natural Resources: 802-241-3770 • NH Dept. of Environmental Services: 603-271-2358
- Environmental Quality Incentives Program (EQIP) *and* Wildlife Habitat Incentives Program (WHIP)
  Contact county NRCS offices listed above
- Connecticut River Valley Partnership Program: Connecticut River Joint Commissions 603-826-4800
- Partners for Wildlife Program
  VT office, US Fish & Wildlife Service: 802-951-6313 • NH office, US Fish & Wildlife Service: 603-225-1411
- Conte Refuge Challenge Cost Share Program: US Fish & Wildlife Service: 413-863-0209

## CONNECTICUT RIVER EROSION INVENTORIES

As of 1998, the entire Connecticut River shoreline in New Hampshire and Vermont has been surveyed for the presence and degree of erosion, largely with funding from the CRJC's Connecticut River Valley Partnership Program. Contact your county NRCS office for information about erosion in your area.

## SUGGESTED READING


Finehock, K., J. Dohery, 1995. *A Citizen's Streambank Restoration Handbook*, The Izaak Walton League of America, Inc., Gaithersburg, MD.

Georgia Soil and Water Conservation Commission, 1994. *Guidelines for Streambank Restoration*.

Pennsylvania Department of Environmental Resources, Division of Scenic Rivers, 1986. *A Streambank Stabilization and Management Guide*. (Contact: POB 1467, Harrisburg, PA 17120.)

Rosgen, Dave, 1996. *Applied River Morphology*, Wildland Hydrology, Pagosa Springs, Colorado.

Tennessee Department of Environment and Conservation, 1994. *Riparian Restoration and Streamside Erosion Control Handbook*. (Contact: 401 Church St., Nashville, TN 37243)

Tumosa, Judy, 1997. *Soil Bioengineering Streambank Protection Measures on the Connecticut River in Grafton County*. Grafton County Conservation District, Woodsville, NH.

Vermont Riparian Enhancement Project, 1996. *Vermont Stream Bank Restoration Guide*. An AmeriCorps Project sponsored by the NRCS.



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PO Box 1182 • Charlestown NH 03603 • 603-826-4800