Streambank Stabilization Using Geomatrix Matting—Simpson Creek, Virginia

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Abstract: Highway construction necessitated relocating 0.8 km of Simpson Creek, a small Appalachian trout stream. Streambank stabilization was undertaken using a flexible soil reinforcement matting made of heavy nylon monofilaments fused into an 18-mm thick mat of open construction followed by grass seeding. The matting provided a matrix for vegetative root development and accelerated revegetation over untouched banks and banks only hydro- or hand-seeded. Loss of the project during a 100+ year flood is attributed primarily to soil type and channel configuration problems.

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Road construction is one of a suite of human activities that severely impacts stream ecosystems (Elser 1971, Kanaly 1975, Wingate et al. 1979, Platts 1981). Streambank stabilization work often consists of using riprap, gabion weirs, boulder placement, log sills, and streambank plantings of grasses, shrubs and trees (Helfrich et al. 1985). This project incorporated most of these techniques but of primary focus is the vegetative stabilization of the streambanks.

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Methods

Simpson Creek, a third order stream, originates near the Rockbridge/Alleghany County line east of Clifton Forge, Virginia. The stream flows southwest 15.2

[1]Registered trademarks of the American Enka Company, Enka, N.C. Use of product does not constitute Forest Service endorsement of the product.

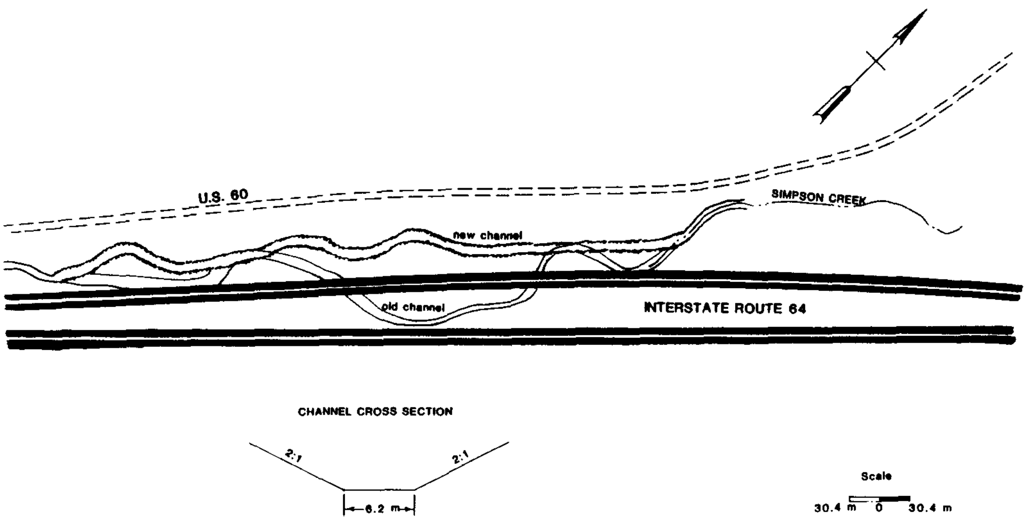

Figure 1. Upper relocated stream segment, Simpson Creek. Taken from construction blueprints.

km to the Cowpasture River, a tributary of the James River. The upper two-thirds of the drainage contains reproducing population of rainbow trout (*Salmo gairdneri*) and brook trout (*Salvelinus fontinalis*) as well as numerous non-game fish species. Soils in this area are the Craigsville Series. It is mixed gravelly sandy loam throughout with as much as 35% to 65% by volume of cobblestones and pebbles (Soil Conservation Service 1977).

In 1975, the pending construction of Interstate Highway 64 necessitated relocation of 3 sections of Simpson Creek. This study covers activites on the uppermost relocated section of approximately 0.8 km in length. An attempt was made to maintain channel shape, length, meanders and stream gradient, but options were constrained by the Interstate 64 location on 1 side of the stream and U.S. Route 60 on the other side (Fig. 1). In some places, <100 meters separates the 2 highways.

In addition, efforts were made to retain maximum shade canopy over the stream by leaving steep banks along the relocated stream channel. Before and after channel configuration data indicates a shorter and more confined channel (Table 1). The relocated channel was constructed in the fall of 1975 and the interstate highway was completed and opened to traffic in the fall of 1978. At the time of channel relocation at least 5 gabion double wing deflectors and numerous boulders were added to create pools and trout cover in the new stretch and all raw banks were seeded and mulched.

By 1980, streambanks still had not stabilized. Autumn olive (*Elaegnus umbellata*), brookside alder (*Alnus serrulata*), sycamore (*Platanus occidentalis*), and bristly locust (*Robinia hispida*) were planted on some steep banks in 1981. In 1982, 2 streambank segments, both 3.7 m high and totalling 45.8 m long were treated

Table 1. Simpson Creek channel configuration pre- and post-relocation.

Dimension	Original channel	Relocated channel	Difference
Segment length	861 m	791 m	−8%
Stream width	6.2 m	6.2 m	0
Stream gradient	2.1%	2.3%	+9.5%
Bank height	Varied with 1 bank ≤1 m	Both banks between 1 to 8 m	More confined flood channel

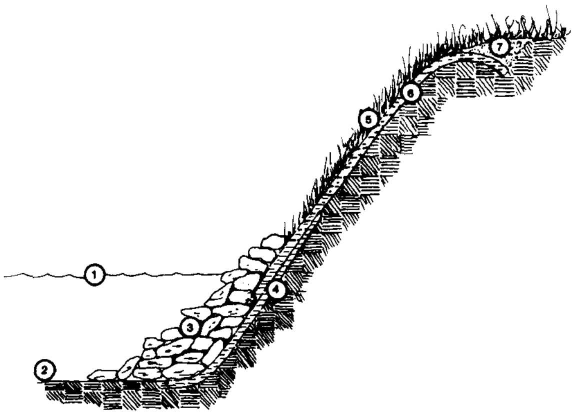

Figure 2. Streambed stabilization using Enkamat. 1 = variable water line, 2 = streambed, 3 = rock riprap, 4 = Stabilenka, 5 = Grass, 6 = Enkamat and 7 = soil key.

with T-100 Stabilenka[1] filter fabric and T-7020 Enkamat[1] matting. Stabilenka is a nonwoven polyester fabric specially designed and used as a soil/water filtration medium. Enkamat is a flexible soil reinforcement matting made from heavy black nylon monofilaments fused at their intersections. This 3-dimensional structure is a bulky mat 18 mm thick of very open construction, leaving 90% of its volume to be filled by soil, plant roots, or other appropriate materials.

Prior to laying of the fabrics, the streambanks were cleared of vegetation and debris and smooth dressed back to a slope of 80% to 125%. Existing grass clumps and small shrubs and trees with solid root development were left undisturbed as much as possible. One strip of the filter fabric was laid horizontally along the bank centered at the average water line. Starting at the downstream end of the bank, the Enkamat was laid in vertical overlapping (6-8 cm) strips from the bottom of the bank to the top and trenched in at the top of the bank. The mat was then staked on 0.6 m to 1.0 m centers. The material was not backfilled with soil but was rip-rapped from the streambed to the normal high waterline with rock from the stream (Fig. 2). The banks were hydroseeded in 1982 and bare spots were hand seeded and mulched in 1983. Kentucky 31 fescue (*Festuca arundinacea*), orchard grass

(*Dactylis glomerata*), lespedeza (*Lespedeza cuneata*), crown vetch (*Coronilla varia*),and clover (*Trifolium repens*) was used in the seeding mix and straw was used for mulch.

In 1983, an additional 139.4 m^2 of Enkamat was laid; in 1984, 870.9 m^2; and in 1985, 74.3 m^2. Stabilenka was not used in these treatments. These banks were also seeded with the same species as the pilot project. In 1984, a 133-m long by 7.7-m tall bank was seeded, mulched, and tacked down using stakes and jute string. In 1985, 50 red maple (*Acer rubrum*), 50 sycamore, 120 hybrid poplar (*Populus euramericana clone carolina DN34*), and 2,100 autumn olive were also planted along the sides and tops of the banks in the upper half of the relocated channel section.

Results

Streambanks that were initially seeded after channel relocation work never fully stabilized. The upper half of the relocated channel downcut up to 0.6 meters. Most of the large boulders placed in the stream were flushed out prior to the fall of 1984. Within the first year or two after construction the toes of the streambanks in many places in the relocated channel stretch were cut away to a vertical height of 1.2 m, a stage height that seemed to occur once or more a year in this stream reach.

Banks that received the Enkamat treatment developed good grass stands and visually appeared stable within 1 year of seeding. After a second seeding the vegetation usually was dense enough to hide the black Enkamat and wooden stakes. By the third to fourth year the banks showed evidence of native pioneering vegetation and were taking on a more ragged natural appearance. Treatment of 1,254.1 m^2 of streambank with Enkamat cost $11,615 excluding seeding costs (Table 2). Little difference was seen between banks with the Stabilenka and Enkamat and those with only Enkamat other than the white Stabilenka was visible in spots between the rock riprap.

The streambank treatment using stakes and jute string to hold the seed and mulch was significantly cheaper than the Enkamat treatment (Table 2), but did not provide sufficient slope stability/protection for a stand of grass to become developed on the full slope.

Table 2. Time and costs of the Simpson Creek Project, 1981–1985.

Project	Time (hrs)	Time $5/hr	Enkamat	Other material	Total
Enkamat[a] 1,254 m^2	1,019	$5,095	$6,220	$300	$11,615
Bank treatment without Enkamat	50	$250	—	$48	$298
1985 tree planting	91	$455	—	$227	$682
TOTAL	1,160	$5,800	$6,220	$575	$12,595

[a]Excluding donated seed, mulch, and hydro-seeding done by Virginia Department of Highways and Transportation.

Trees planted in 1981 had a 10% survival rate by 1984. Success was limited to minor stabilization of upper stream banks. Trees planted in 1985 had a 50% survival rate into the fall. One hybrid popular planted as rooted stock 0.5 meters tall had grown to 1.2 meters 5 months later.

A 100+ year flood event 3 and 4 November 1985 resulted in loss of all but scattered portions of the tops of several banks treated with Enkamat. Most streambanks were cut to a vertical slope or undercut and numerous sloughs occurred. The streambed in the upper portion of the relocated channel downcut approximately 1 m with cobble deposition of 1 m in depth in the middle third of the relocated channel. Parts of only 2 gabion structures remained and all remaining fish cover boulders were washed out. Few if any of the planted trees remained except on the tops of banks.

Discussion

The original vegetative stabilization work failed due to a combination of scour, oversteepening of streambanks, and sloughing due to frost heave. Difficulties associated with the Craigsville soil are difficult area reclamation, cutbank slump-off, and flooding. It has a moderate potential for frost action when undisturbed. Disturbed or exposed soil has a greater potential for frost-heave and cut slope slumps (Soil Conservation Service 1977).

The Enkamat provided for a good catch of seed and stabilized the slope while the vegetation was getting established. The matrix of the material provided for a more "instant" sod. This provided slope erosion resistance and improved the aesthetics of the area until the catastrophic flood of 1985. Areas that received treatments other than Enkamat failed long before the flood. Their failure is attributed to frost-heave, bank sloughing, and stream scour. Tree planting success was poor but the trees were beginning to contribute to long term bank stability and stream shading.

Failure of the project is attributed to poor soils, a confined channel with no floodway to reduce velocities, insufficiently sized riprap, and overly steep banks in combination with a flood beyond any design criteria. Additionally, the impermeable pavement and extensive cut and fill slopes of the interstate highway has increased runoff which likely contributed to stream channel instability. The Enkamat treatment had stabilized the streambanks better than the other treatments prior to the 1985 flood and had sustained several high flows up to 1.2 m above the average flow line with little to no damage. Woody vegetation growing up through the Enkamat appears to increase the stability of the Enkamat-treated banks.

With stream habitat modification structures, a trial-and-error design by past experiences has evolved. The lack of post-installation performance evaluation for many projects, or the limited availability of such information, is identified as a major deficiency of this design-by-past-experience approach (Klineman 1984). This project points out the importance of examining channel morphology and soils during the design phase. Enkamat is a material that certainly has use for bank stabilization and revegetation, but at a cost of $9.26/m^2 for material and installation, the material must be used judiciously.

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