
Case Study 7

**Spafford Creek, Otisco Lake
Watershed, New York**



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Cover photo: Completed section of Spafford Creek, Otisco Lake Watershed, New York

Advisory Note

Techniques and approaches contained in this handbook are not all-inclusive, nor universally applicable. Designing stream restorations requires appropriate training and experience, especially to identify conditions where various approaches, tools, and techniques are most applicable, as well as their limitations for design. Note also that product names are included only to show type and availability and do not constitute endorsement for their specific use.

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Introduction

The Otisco Lake Watershed is in a rural, primarily agricultural area with approximately 4,000 acres of forest. Slopes in the forested areas are in excess of 35 percent. The soil type in the stream channel is Teel silt loam. This soil type is characteristic of flood plains, and these soils are formed from alluvial deposits of silt and very fine sands. The Teel series is normally flooded in the spring and rarely flooded during the growing season, as found on this site. This soil is easily eroded, by evidence of the existing conditions along Spafford Creek, south of Sawmill Road (fig. CS7-1). Phelps gravely loam, Rhinebeck silt loam, and Fredon loam soil types are found associated with the Teel series.

The stream has been typed as a G4, according to the Rosgen Stream Classification System. A G4 stream type is deeply incised in depositional material, very unstable due to its high sediment supply, moderate gradient, low width to depth ratio, and low sinuosity. The reference reach is an E4 stream type with a low sinuosity, gentle to moderate channel gradient, and low width to depth ratio. The E4 type stream has

a riffle-pool pattern. Streambanks of this type are of finer material than that found in the channel bed. The banks are stabilized with wetland vegetation that has formed extensive, deep root mats similar to the stabilized reach of Spafford Creek north of Sawmill Road to Otisco Lake. The proposed stream type is a C4, meaning it is a slightly entrenched, meandering, gravel dominated, high width to depth ratio, riffle-pool channel with a well-developed flood plain. The sediment supply is low due to the stability of the streambanks. The natural progression over many decades is to accelerate the process and transform the existing G4 to a C4.

Until the 1930s, the landscape included a riparian forest buffer approximately 250 feet in width on both sides of the stream channel. Clear-cutting and straightening of the channel have detrimentally impacted the fish habitat and water quality. In 1998, the riparian forest buffer was eliminated by the landowner. Large, mature black willow and sycamore were cut and removed from the stream corridor, with stumps left in place. Banks are steep to vertical, and the vegetation varies from none to moderately dense grasses and weeds. Some redosier dogwoods are present. Bank materials are mostly fine-grained with one gravel lens.

Establishing a vegetative buffer along the banks of Spafford Creek would eliminate the detrimental effects of tillage equipment on the plant root systems that are stabilizing the streambanks. The team evaluated the conditions of the stream corridor upstream and downstream of the proposed project. The downstream reach is well vegetated with a riparian forest buffer and has low-velocity flows and deep pools. The upstream section was similar to the proposed project reach, but with a steeper slope. Phase I of construction began in August 2001 and concluded in October 2001. Phase II of construction began in July 2002 and concluded in September 2002. The total project cost was \$263,649.

Figure CS7-1 Typical picture of streambank erosion along entire project reach south of Sawmill Road, Spafford Creek, NY



Determining project goals

The team approach was probably the most important aspect in developing the project plan. The cooperation between the following people and agencies led to success of the project:

- the landowner
- Onondaga County Soil and Water Conservation District (SWCD)
- U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)
- New York State Department of Conservation – Region 7 (DEC)
- U.S. Fish and Wildlife Service (USFWS)
- the Honorable James Walsh, Congressman

A technical team was created and consisted of representatives from the SWCD, NRCS, DEC, and the USFWS. The team took approximately 8 months to develop a comprehensive plan. The restoration objectives were to:

- reduce streambank instability and erosion and improve the quality of the fishery by designing a natural stream system that neither aggrades nor degrades
- use principles of fluvial geomorphology (how landforms change with time under the influence of streams and rivers) to stream corridor management
- reduce the amount of sediment load to Spafford Creek, which is the main tributary to Otisco Lake and a drinking water source managed by Onondaga County Water Authority (OCWA)
- reconnect the riparian corridor that is present at the upstream and downstream extents of the project area

The stream has the flexibility to move laterally with little interference. What is lost on one side is gained on another. Three bridges limit lateral movement, but they are approximately 1 mile apart. Due to the past logging operations, the stream experiences a significant amount of turbidity after approximately a half-inch rainfall event.

The biological attributes of the site were analyzed during the summer of 2001 and September 2002. The data shown in table CS7-1 are from the USFWS State Office located in Cortland, New York. The results of the fish sampling are shown graphically in figure CS7-2.

Design criteria

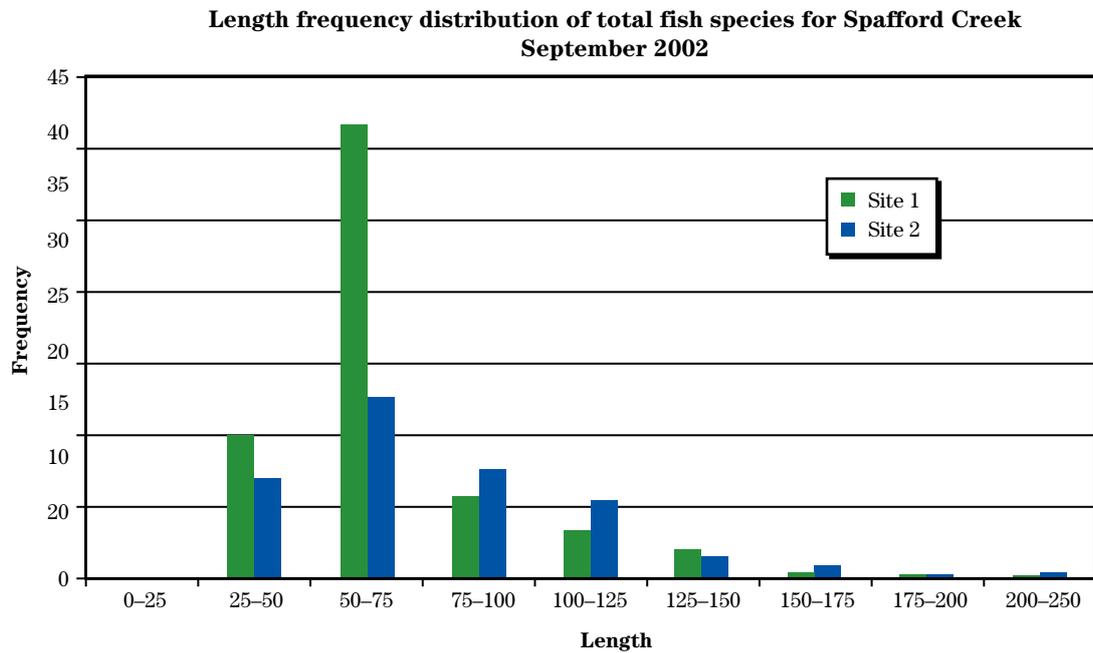
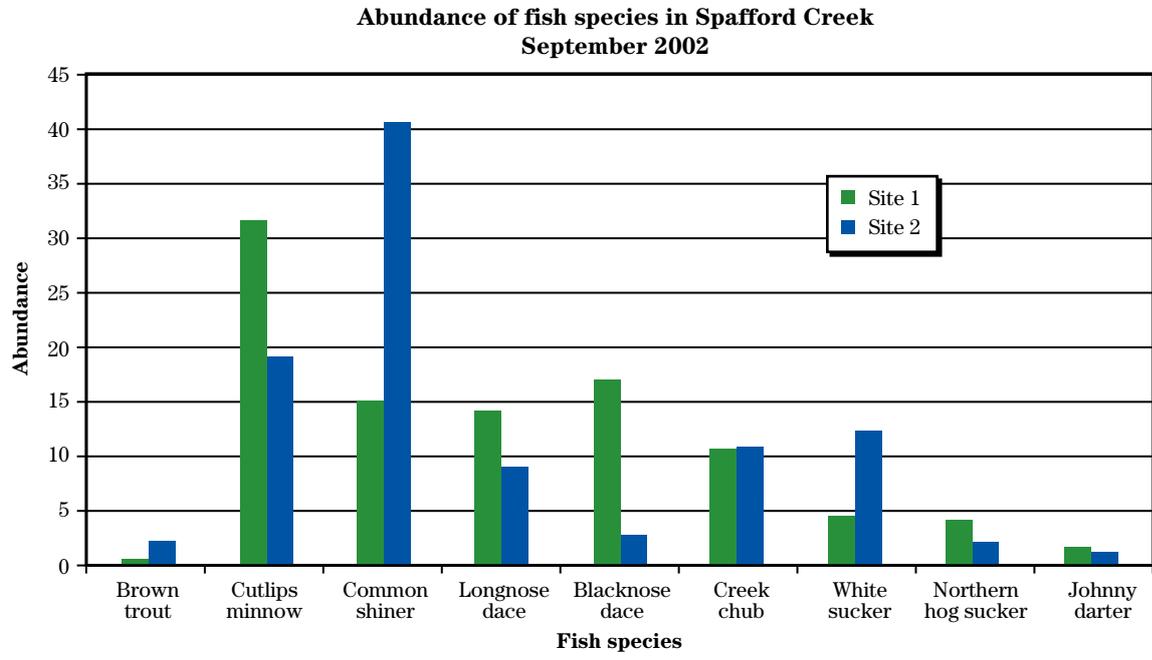
The design storm was the 10-year, 24-hour storm. This estimated discharge is 975 cubic feet per second. The hydrologic investigation of this reach included an in-depth analysis of the flow, the duration and frequency, and the sediment-carrying capacity. One of the most critical characteristics of a stream channel reach is identifying the bankfull stage. For this project, all bankfull indicators pointed to the top of the flood plain. This stream reach was typed as a G4 using Rosgen's Stream Classification System.

The analysis of the flow included the retrieval of stream gage data from the U.S. Geological Survey (USGS). The stream gage used for this project was located on Spafford Creek at the Sawmill Road Bridge. Baseflow velocity was measured at 1.9 feet per second. Bank pins were set to determine future erosion rates, and a cross-sectional survey was conducted on June 19, 2001. A typical 1.2-year storm event of 1.9 inches was experienced on June 21, 2001. This event caused 3.3 cubic yards of material to be eroded in a 75-foot length of streambank.

Table CS7-1 Spafford Creek fish species total numbers and percent abundance for two electro-fishing sites in September 2002

Fish	—Site 1—		—Site 2—	
	Total	%	Total	%
Brown trout	3	2.1	1	0.5
Cutlips minnow	28	19.2	68	31.5
Common shiner	59	40.4	33	15.3
Longnose dace	13	8.9	31	14.4
Blacknose dace	4	2.7	37	17.1
Creek chub	16	11.0	23	10.6
White sucker	18	12.3	10	4.6
Northern hog sucker	3	2.0	9	4.2
Johnny darter	2	1.4	4	1.8

Figure CS7-2 Results of fish sampling in Spafford Creek



Geomorphic data and analysis

Table CS7-2 shows the data that were collected or derived for the Spafford Creek restoration reach and a suitable reference reach. The reference reach is one that has similar valley characteristics and is located within the same geographical area. The stream chosen was Fall Creek in Cortland County. This stream reach was typed as an E4 using Rosgen's classification system (Rosgen 1994). The proposed reach was to be designed as a C4 stream type using Rosgen's Stream Classification System and the geologic time frame for stream channels. The Rosgen approach to geomorphic channel design is described in NEH654.11.

Tables CS7-3 and CS7-4 display results of sediment sampling and sediment transport analysis for Spafford Creek.

Construction issues

The riprap was hand selected at the quarry and identified with marking paint for shipment to the site (fig. CS7-3). The large riprap for the project was to be limestone of at least 4,200 pounds and stackable. The riprap was selected from the Callanan Quarry located north of Morrisville, New York. The riprap was hauled to the site by RMS of Dryden, New York. A total of 29 loads of riprap were delivered to the site. Delivery took approximately 6 days.

Table CS7-2 Spafford Creek hydraulic and geomorphic data for restoration reach and reference reach

Attribute	Units	Restoration reach (existing condition)	Reference reach	Restoration reach (designed condition)
Drainage area	mi ²	8.06	3.08	8.06
Bankfull width	ft	36	39	25
Bankfull depth	ft	4.2	3.7	5*
Width/depth ratio	—	8.6	10.5	7.2*
Bankfull cross-sectional area	ft ²	151.2	103.2	180*
Bankfull mean velocity	ft/s	2.3	2.0	1.9*
Bankfull discharge	ft ³ /s	348	207	348
Bankfull maximum depth	ft	6.6	4.8	7.0*
Maximum depth of riffle to depth bankfull ratio	—	0.66	0.83	0.75*
Low bank to maximum depth at bankfull	—	0.60	0.76	0.76
Width of the flood-prone area	ft	58	165	40
Entrenchment ratio	—	1.6	4.2	1.6
Meander length	ft	400	520	400
Ratio of meander length to bankfull width	—	11.1	13.3	16
Radius of curvature	ft	131	179	131
Ratio of radius of curvature to bankfull width	—	3.6	4.6	5.3
Belt width	ft	200	330	200
Meander width ratio	—	6.9	4.2	8.0
Sinuosity	—	1.38	1.55	1.38
Valley slope	ft/ft	0.0028	0.0045	0.0028

* Indicates a mean value based on Spafford Creek survey and Fall Creek survey

Table CS7-3 Sediment characteristics, Spafford Creek

Materials	Spafford Creek	Fall Creek (reference reach)
Particle size distribution of channel material (mm)		
D ₁₆	3	2
D ₃₅	8	7
D ₅₀	13	12
D ₈₄	24	25
D ₉₅	40	30
Particle size distribution of bar material		
D ₁₆	4	2
D ₃₅	7	4
D ₅₀	10	5.5
D ₈₄	12	10
D ₉₅	65	12
Largest size particle at the toe (lower third) of bar	75	4

Table CS7-4 Sediment transport validation (based on bankfull shear stress)

Analysis	Result
Value from Shields diagram	0.15 lb/ft ²
Critical dimensionless shear stress	0.0663
Minimum mean bankfull depth calculated using critical dimensionless shear stress equations	1.56 ft

Figure CS7-3 Equipment and rock used for construction, Spafford Creek, NY

Design features

The vegetation present within this reach is sparse redosier dogwoods, sumac, and weeds of various types. The mature trees that once existed had been eliminated in November 1998. The proposed vegetation for this reach was a mixture to be seeded on the finished streambanks and the 20-foot vegetated buffer established along both sides of the top of streambanks (table CS7-5). Note: The seed mixture was broadcast-seeded and mulched within the confines of the streambanks and no-till-drilled within the buffer area.

A series of 34 J-hooks and 18 cross vanes were installed. The design angle of the vanes is 25 degrees with a vane length of 21 feet. The J-hook vanes and cross vanes provided stability for the bed and banks and also provided wildlife habitat, in addition to the specific seed mixture used for bank stabilization and wildlife cover. The cross vanes are designed to:

- create instream cover
- reduce excess shear stress away in the near-bank region
- direct flows to the center of the channel to maintain lateral stability
- increase sediment transport capacity
- prevent downcutting below the structure

Figures CS7-4 and CS7-5 show the installation of a J-hook vane. The J-hook vanes are designed to:

- redirect velocity distribution and high velocity gradient in the near bank region

Table CS7-5 Seeding specifications, Spafford Creek, NY

Certified seed	Cultivar	P.L.S.* (lb/acre) (cool season)
Reed canarygrass	N/A	15
Orchardgrass	Axiom	5
Perennial rye	Linn	20
Switchgrass	Blackwell	10
Kentucky bluegrass	N/A	10

* Pure live seed

- stabilize the streambanks
- provide energy dissipation in the deep pool that they create
- create cover for fish spawning and protection

In addition to the structures, the seed mixture planted on this site provides additional wildlife cover and benefits including:

- shading to reduce water temperature
- promoting deposition of sediment and nutrients
- providing a visually pleasing green area
- maintaining aquatic food sources

Figure CS7-4 Installation of a J-hook vane, Spafford Creek, NY



Figure CS7-5 J-hook vane installed and final grading of streambank followed by seeding and mulch, Spafford Creek, NY



Project performance

The design performed as planned except for some minor shifts in the top course of stone of four J-hook vanes. These stone shifts have not negatively impacted the streambanks. The original goals were met. It will be interesting to evaluate the habitat that has been created and the number and species of fish that hopefully have used this project area for spawning.

The designed structures chosen appear to be working as planned. The vegetation that was planted on the streambanks is still intact. The silt fence used dur-

ing construction was left in place through the winter months (figs. CS7-6 and CS7-7).

Overall lessons learned

This project was the first of its kind for the author as a design engineer. The use of an excavator with a hydraulic thumb was specified in the contract but was not available. The large stone could have been handled much better and faster.

Figure CS7-6 Completed section of streambank stabilization, Spafford Creek, NY



Figure CS7-7 Completed section of streambank stabilization to include J-hook vane and intentional point bar, Spafford Creek, NY



