Mount Hope River Riparian and Stream Restoration Project

Final USEPA 319 Report : Project 03-19

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Executive Summary

Agricultural practices along an approximate 1,000 linear feet section of the Mount Hope River, in Ashford, Connecticut have resulted in the alteration of a forested riparian zone. Cattle have trampled portions of streambanks causing streambank instability, erosion/sedimentation and degradation of the riparian zone and instream habitats for the resident fish community. Overall objectives of the project were to: (1) Restore and stabilize over 1,000 feet of streambank and channel of the Mount Hope River, (2) Restore over 1,000 feet of a vegetative riparian buffer along the Mount Hope River with native vegetation, (3) Exclude cattle from restored riparian areas, (4) Restore instream habitats for fish and aquatic macroinvertebrates, and (5) Incorporate soil bioengineering and geomorphology techniques into restoration design and construction.

Streambanks were stabilized with a combination of bank placed boulders, logs, erosion control fabric and vegetation. Three boulder cross-vane and two J-hook structures were installed. These large rock structures serve key functions in that they help maintain grade control for the streambed, deflect and redirect high stream flows away from streambanks and towards the stream centerline and create deep water pool habitats that are necessary for the survival of resident stream fish species. Tree and rootwad structures were installed along the streambank to not only protect streambanks from erosion but also provide much needed large woody debris cover habitat for fish. Restoration also involved filling much of the channel to create a restored and stable stream width ranging between 20 to 36 linear feet. In addition, a gentle sloped bankfull bench was created along the streambank. Over 3,200 feet of electric fencing was installed by landowner Mike Sibiga to control beef cattle access and protect restored riparian areas. The initial planting of the riparian zone was completed with the installation of sand bar willow, banker willow, silky dogwood and highbush blueberry.

The WHAMM construction team mobilized to the project site on July 10, 2006. In river work began the following day. The project was constructed as designed with one exception; the lower section of Basset Brook at its confluence with the Mount Hope River was not relocated back to its original course and geometry. All river work was completed by September 29, 2006. Total number of construction days for the project was thirty-nine.

Post construction, several rain events resulted in moderate to high stream flows at the project site in which flows were conveyed along the bankfull bench providing an immediate test of project design and construction. A review of the entire project site indicated that all areas of the project survived this first initial high water test with no visible signs of channel erosion or instability.

The DEP Inland Fisheries Division has developed a comprehensive monitoring plan to assess the short as well as the long-term success of this stream restoration project.

Introduction

Agricultural practices along an approximate 1,000 linear feet section of the Mount Hope River, in Ashford, Connecticut had resulted in the alteration of a forested riparian zone. Major stressors on bank erosion were traffic from 45 heifers and dry cows in this 15-acre pasture that occurred more than 25 years ago. Present pasture use is 9 Black Angus beef cattle. Cattle have trampled portions of streambanks causing streambank instability, erosion/sedimentation and degradation of the riparian zone and instream habitats for the resident fish community. Streambank erosion had caused the channel of the Mount Hope

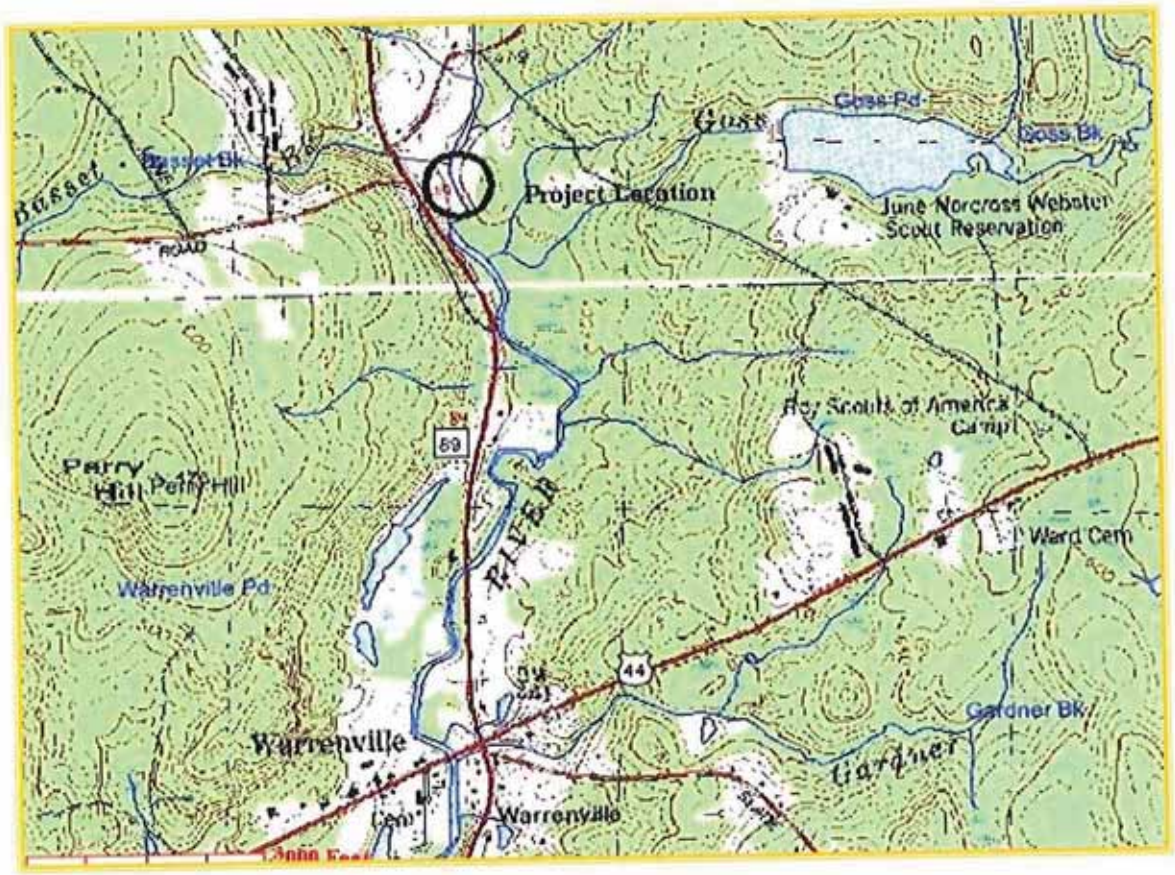


Figure 1. Topographic map showing Mount Hope River Restoration Project location.

River to severely overwiden to as much as 50 feet in some areas, a process fluvial geomorphologists call, "lateral expansion". As a result, significant quantities of fine soils, sands, and coarse gravels and cobbles were continuously eroded from the streambanks and deposited in the stream channel, especially after storm events. Over time, the stream channel could not effectively transport these additional bedload materials, further exacerbating river widening. The project is located on property owned by Mike and Susan Sibiga, off of James Road, at the intersection of Route 89 in Ashford, CT (Figures 1 and 2). The section of stream proposed for restoration is immediately downstream of the confluence of the East Branch Mount Hope River with the Mount Hope River main stem.

Overall objectives of the project were to: (1) Restore and stabilize over 1,000 feet of streambank and channel of the Mount Hope River, (2) Restore over 1,000 feet of a vegetative riparian buffer along the Mount Hope River with native vegetation, (3) Exclude cattle from restored riparian areas, (4) Restore instream habitats for fish and aquatic macroinvertebrates, and (5) Incorporate soil bioengineering and geomorphology techniques into restoration design and construction.

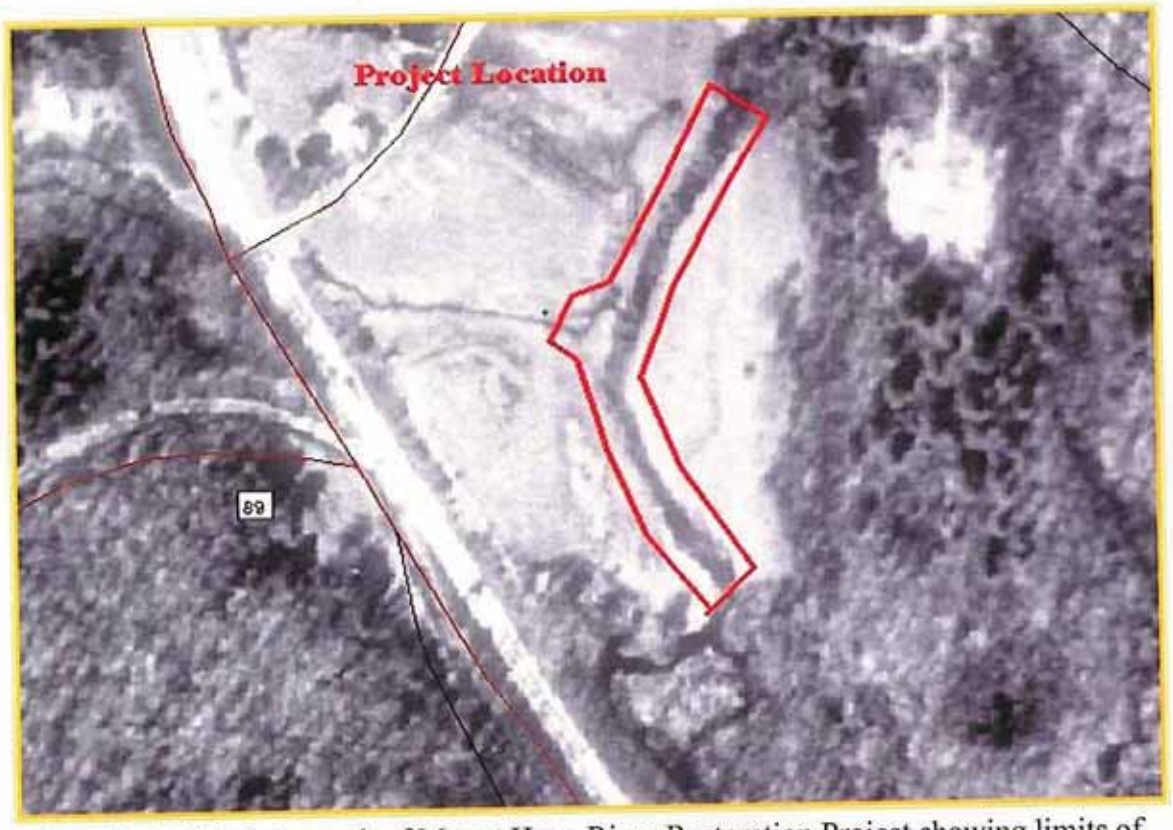


Figure 2. Aerial photograph of Mount Hope River Restoration Project showing limits of project work.

Fisheries Resources

The Mount Hope River system supports a diverse mixture of native resident stream fish as well as an excellent recreational coldwater fishery comprised of hatchery reared adult brook, brown, and rainbow trout. Fisheries resources adjacent to the project area were initially surveyed by the DEP Inland Fisheries Division within a 150-meter stretch of stream on July 17, 2003. Follow up surveys, "trout–only collection" were conducted in 2004 and 2005. Fish population size was determined in 2003 by the three pass Zippen removal method (Zippen 1958). Block nets were placed at the upstream and downstream ends of the sample area before sampling. After capture, all fish were identified, measured to the nearest millimeter (total length), counted, and released below the net. The most dominant fish species collected in the 2003 sample were as follows: blacknose dace, common shiner, fallfish, tessellated darter and white sucker. A total of 32 brown trout fingerlings, (less than 125 mm TL) were sampled. These fish originated from a spring stocking at the James Road Bridge Crossing, just upstream of the proposed

project. Only 4 adult trout (2 brown trout and 2 brook trout) were sampled on the property, a testament to the lack of adult size trout habitats in the project area.

Environmental Problems

As previously mentioned, past agricultural practices along an approximate 1,000 linear feet section of the Mount Hope River, in Ashford resulted in the alteration of a forested riparian zone. Cattle have trampled portions of streambanks causing streambank instability and erosion, sedimentation of the stream channel, degradation of the riparian zone and instream habitats for the resident fish community. Some woody vegetation is present within the riparian zone such as multi-flora rose and willow species. Existing vegetation has a shallow rooting depth, a low tolerance for shear stress and is highly susceptible to hoof-shear from beef cattle. Figure 3 provides an illustration of the pre-restoration streambank edge and approximate location of the edge prior to channel instability. Figure 4 illustrates one of the worst zones on the property where there is a complete lack of streambank and where uncontrolled cattle access had led to the creation large muddy area, which became a constant source of erosion during higher streamflow events.

Figure 3. Example of streambank erosion and stream widening along Mount Hope River prior to restoration.

In addition, streambank erosion and channel overwidening resulted in the lack of deep water habitats necessary for the survival of adult coldwater fish. Prior to restoration, there was minimal vegetation along eroded streambanks and no overhead canopy of mature forested vegetation; thus, this river section which lacks overhead shading experiences increases in ambient surface water temperatures during the summer, early fall base flow period. These increases are more severe given the predominance of shallow water riffle habitats, which heat faster than deep pool mesohabitats.

Figure 4. Area along streambank receiving heavy cattle traffic prior to restoration efforts.

Pools are very valuable habitats for adult size fish, especially trout that utilize pool habitats for resting and holding areas and are critical to the survival of coldwater species during the warm, summer months. Water velocities are slower in pool habitats, which reduces the output of energy required for fish to maintain their position in the water column. A reduction in fish energy expenditure increases the likelihood of long-term fish survival. Habitat suitable indices (HSI), a quantitative measure of instream microhabitats documents that optimal water depth for brown trout is 2.6 feet in depth (Raleigh et al. 1986). There is no optimal water depth habitat for trout in the project area during base flow periods.

The Solution- Project Design and Engineering

Project engineering and design was completed by the USDA, Natural Resources Conservation Service (NRCS). NRCS staff that worked on this project have applied, practical experience integrating principles of natural channel processes with river engineering techniques to design stable, naturally functioning channels. In addition, NRCS staff have long term, practical experience with agricultural management.

A plan view of the project design has been included in Appendix A. A general description of restoration project design follows. Streambanks will be stabilized with a combination of bank placed boulders, logs, erosion control fabric and vegetation. Three boulder cross-vane and two J-hook structures will be installed. These large rock structures serve key functions in that they help maintain grade control for the streambed, deflect and redirect high stream flows away from streambanks and towards the stream centerline and create deep water pool habitats that are necessary for the survival of resident stream fish species. These structures have been successfully utilized at other

stream restoration projects in Connecticut. Tree and rootwad structures will be installed along the streambank to not only protect streambanks from erosion but also provide much needed large woody debris cover habitat for the resident fish community. Pool mesohabitats will be restored throughout the project length to help facilitate fish survival throughout the summer. The riparian area on either side of the stream, minimum of 25 feet in width will be restored with a combination of trees, shrubs, and bare root seedlings comprised of bankers dwarf willow, silky dogwood, American sycamore, and highbush blueberry. The restoration blueprint calls for filling much of the channel to create a restored and stable stream width ranging between 20 to 36 linear feet. In addition, a gentle sloped bankfull bench will be created along the streambank. The bankfull bench is designed to dissipate damaging high stream velocities associated with storm events and also help flood flows more readily gain access to the Mount Hope River's natural floodplain, further dissipating flood energy. Restoration design is based upon placing the subject reach of the river back into dynamic equilibrium, that is to effectively transport water and sediment so that streambanks do not excessively erode and the stream channel neither aggrades nor degrades. Cattle will be fenced off from the restored riparian areas as shown on project plans. Installation of fencing is the responsibility of the landowner. Two cattle crossings will be constructed on the Mount Hope River and one on Basset Brook to protect the streambed and streambanks from future cattle damage. This strategy will take on a more proactive, immediate and long-term approach to control nonpoint sources of pollution on the property and improve ambient water quality conditions in the Mount Hope River. Approximately 110 feet of Basset Brook, at its confluence with the Mount Hope River will be relocated and restored back into its historic channel. Basset Brook will be conveyed into restored pool habitat, which will provide for summer refuge habitat for the resident fish community. The old channel will be filled-in and stabilized.

Project Partners and Funding

Major funding for this project was provided by the U.S. Environmental Protection Agency 319 non-point source pollution program, under the direction of Connecticut 319 coordinator Stan Zaremba. Connecticut Department of Transportation mitigation monies were utilized as non-federal matching funds.

This project was truly a collective effort that involved a variety of partnerships. Specifically, the DEP Inland Fisheries Division provided overall project management. The USDA, Natural Resources Conservation Service (NRCS), was contracted for project engineering and design. The NRCS was also contracting for assisting the DEP with onsite construction management. Project construction was the responsibility of the DEP Wetland Habitat and Mosquito Management Program (WHAMM). WHAMM utilizes specialized low ground pressure equipment thereby minimizing construction related disturbances. This unit has successfully constructed other stream channel and fish habitat restoration projects on the Blackledge River, Hop River and Willimantic River for the DEP Inland Fisheries Division. The DEP 319 NPS program was responsible for the administration of NRCS contracts. NRCS Wildlife Habitat Improvement Program (WHIP) grant monies were awarded to the landowner to install and maintain fencing to exclude cattle from restored riparian areas.

Results

In early June 2006, a baseline survey was conducted by NRCS and DEP staff. Construction stakes were installed to prepare for summer construction. Of note, this survey determined that several areas of the river had widened an additional 3 to 5 feet after the October 2005 100-year storm event.

The WHAMM construction team mobilized to the project site on July 10, 2006. In-river work began the following day. Daily construction logs were maintained by NRCS and DEP staff and DEP coordinated the purchase and delivery of construction materials. Construction was temporarily halted by three separate rain events and resultant high stream flows. Over 250 large boulders, 3-4 feet in diameter were used in this project, most of which were buried below the streambed's surface for use in the construction of cross vanes and J-hooks. Installation of fencing was coordinated with the landowner. Cattle were incrementally fenced out of areas as sections of river were constructed and stabilized according to design. Over 3,200 feet of electric fencing was installed by landowner Mike Sibiga to control beef cattle access and protect restored riparian areas.

The project was constructed as designed with one exception; the lower section of Basset Brook at its confluence with the Mount Hope River was not relocated back to its original course and geometry. Instead, this watercourse was stabilized along its present footprint with a series of small rock step–pools. One reason for this decision was that the area proposed for stream location contained wetland soils that were extremely saturated due to an unusually wet summer. Thus, proper containment of soil erosion was an issue of concern along with the lack of a suitable construction subsurface for the relocated channel. Secondly, another reason for the channel relocation was to induce cooler water from Basset Brook back into created pool habitats within the Mount Hope River. Thus, rather than to redirect the confluence into pool habitat associated with cross vane station 14 + 47, it was decided that we could achieve those same resource benefits by stabilizing the lower section of Basset Brook along its present course and directing its confluence into pool habitat created by the J-hook constructed at station 15 + 50. All river work was completed by September 29, 2006. Total number of construction days for the project was thirty-nine. Refer to Appendix B for photo documentation showing various engineering and design features of the project along with construction methodology.

Post construction, on October 2, 2006, the DEP established 6 permanent stations for cross-section monitoring. Cross sections were established in the scour pool of each cross-vane and J-hook grade control structure and through one riffle habitat. These monitoring stations are utilized to assess long-term stability of the stream channel and streambanks and to establish whether the channel streambed degrades, aggrades, or remains the same.

Rather than install all vegetation as proposed in the original design, it was decided to divide the planting into two time periods, fall 2006 and spring 2007. The fall 2006 riparian zone planting occurred on October 18 and 19, 2006. DEP WHAMM and Inland Fisheries crew installed vegetation along with volunteers from the University of Connecticut, inland fisheries program. This initial fall planting involved the installation

of 152 sand bar willow tubelings, 304 banker willow tubelings, 150 silky dogwood and 75 highbush blueberry container plants.

The project "as built" survey was completed by NRCS staff by mid November 2006. In addition to DEP cross-sections, the NRCS established another six cross sections for future monitoring.

Post construction, several rain events resulted in moderate to high stream flows at the project site in which flows were conveyed along the bankfull bench providing an immediate test of project design and construction. The USGS maintains a stream gaging station on the Mount Hope River in Warrenville, CT some 1.4 river miles downstream of the project area. At this stream gage, a bankfull storm event with a reoccurrence interval of 1.5 years has been determined to be 799 cfs. Peak streamflows at this station from a rain event on October 28, 2006 approached 650 cfs. A subsequent field inspection of natural debris lines at the Mount Hope River Restoration site on October 29, 2006 indicated that water surface elevations approached the top elevations of rock tiebacks associated with cross vane and j-hook grade control structures. These elevations equate to the estimated bankfull elevations of the project design, see example in Figure 5. A review of the entire project site indicated that all areas of the project survived this first initial high water test with no visible signs of channel erosion or instability.

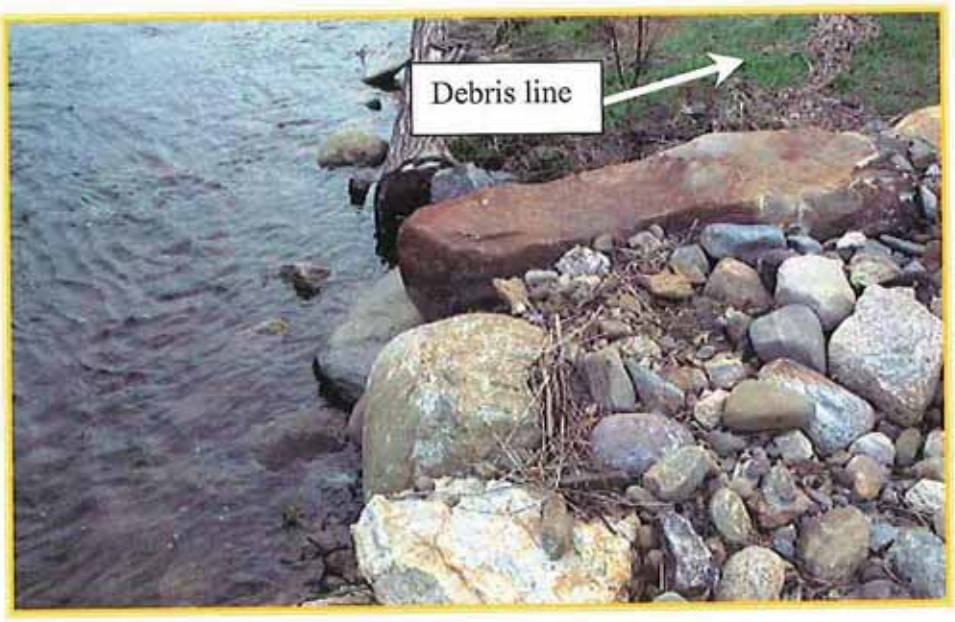


Figure 5. Debris line at J-hook station 15+50, elevation of which approximates estimated bankfull elevation of 403.1 feet.

Future Plans

The Inland Fisheries Division has developed a monitoring plan to assess the short as well as the long-term success of this stream restoration project. The monitoring plan is comprised of the following components:

1. Periodically field monitor the project after storm events to evaluate restoration design and function. Real-time streamflow discharge and elevation data on the Mount Hope River can be readily accessed from the USGS website.

2. Periodically monitor the project throughout the winter months to assess the formation of anchor ice and potential for ice jam formation.

3. Conduct an annual ground survey at several stream cross-sections to monitor channel stability.

4. The resident fish population will be surveyed annually, comparing fish species diversity and abundance, pre and post restoration.

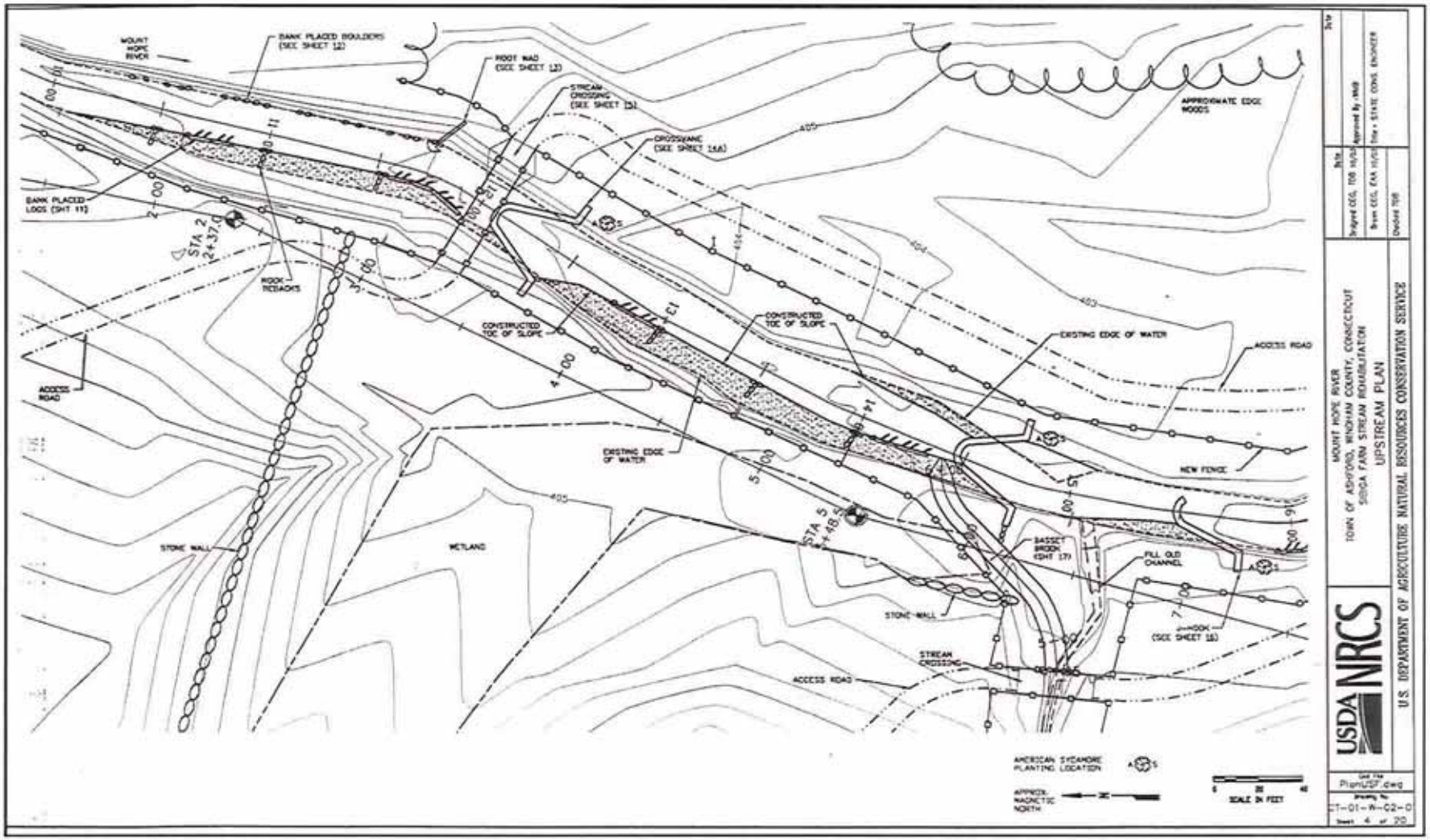
5. The restored riparian area will be annually monitored for invasive plant species, which will be removed before having an opportunity to become established.

6. Pro actively conduct public outreach efforts to educate the public relative to the Mount Hope River Restoration Project and overall stream restoration efforts in Connecticut.

Conclusions

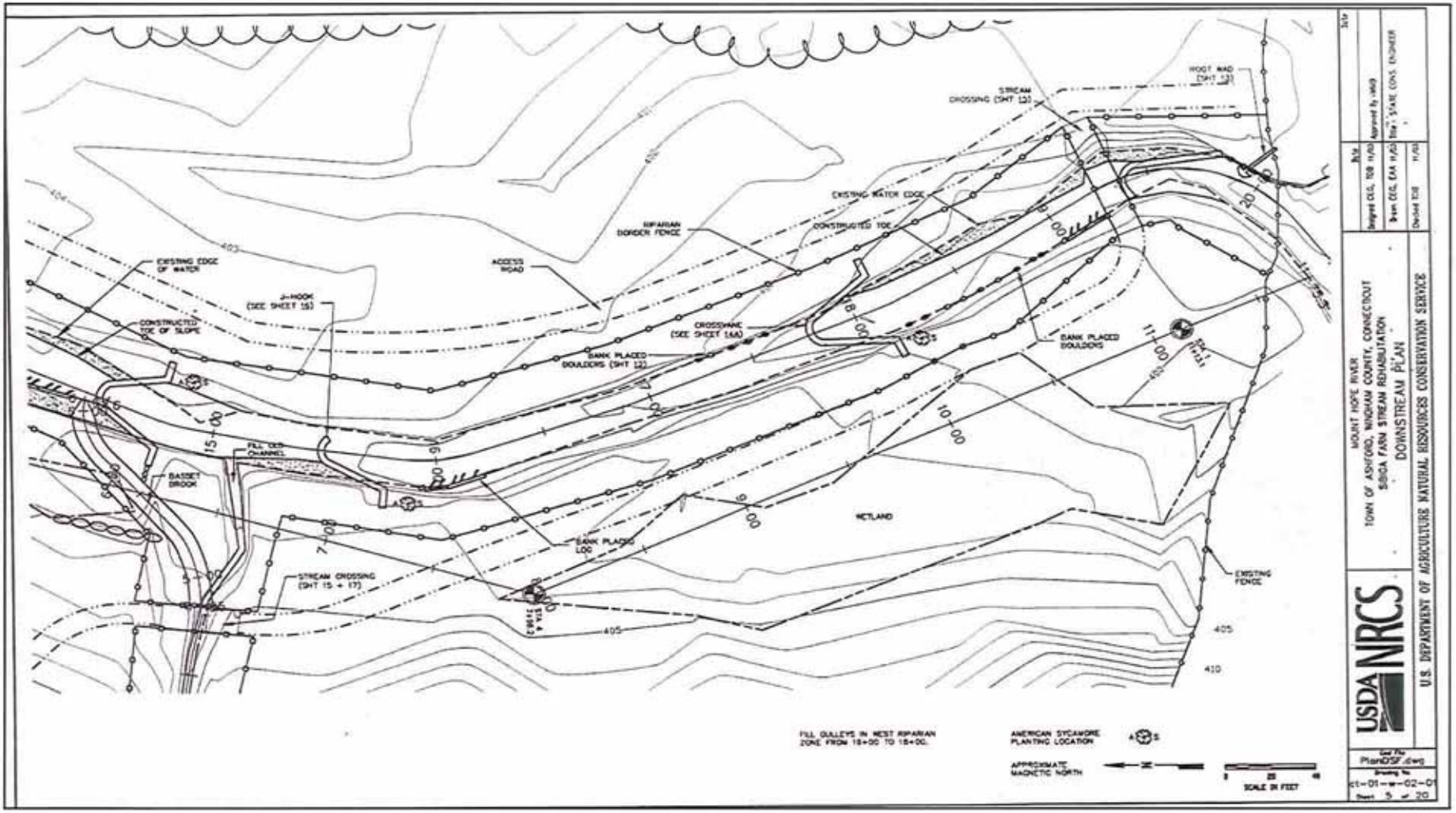
This project was designed to demonstrate restoration of streambanks, channels, fish habitats, and vegetated riparian zones through the use of agricultural best management practices along with the utilization of the latest innovations in soil bioengineering techniques and natural stream channel design concepts. Although the project partners are confident of the success of the project, only future data collection associated with project monitoring will collectively gather sufficient information to ultimately determine the success or failure of this restoration project. That being said, many design features of this project will quickly "jumpstart" the restoration process and immediately control nonpoint sources of pollution. The installation and long term maintenance of electric fencing designed to exclude beef cattle from riparian areas will ensure the rapid development and reestablishment of riparian vegetation and prevent streambank erosion and sedimentation as a result of hoof-shear trampling. With the implementation of more successful restoration projects, it is hoped that stream habitat restoration efforts undertaken by municipalities, non-governmental organizations and private landowners will incorporate natural stream channel designs that include soil bioengineering methods and a full understanding of fluvial geomorphology processes and form.

Appendix A : Plan View Design Drawings



Construction Drawing Sheet 4, Match with Sheet 5.

Appendix A : Plan View Design Drawings



Construction Drawing Sheet 5, Match with Sheet 4.

Appendix B : Project Photo Documentation

Figure 1. Completed construction of cross vane at station 12 + 10 immediately below the upstream cattle crossing.

Figure 2. Photograph of cross vane 12+10 during a storm event illustrating a primary function of the cross vane to redirect flow into the stream's centerline and away from the streambank.

Figure 3. Installation of coir erosion control blanket along the newly created bankfull bench.

Figure 4. Excavator moving into position to install a rootwad into the streambank for flow deflection and fish habitat purposes.

Figure 5. WHAMM staff installing reinforced bar to secure bank placed logs.

Figure 6. Construction and final grading of upstream cattle crossing.

Figure 7. Pre construction photograph of river demonstrating channel overwidening.

Figure 8. Photograph comparing preconstruction streambank edge and area of channel that will be filled to create the bankfull bench.

Figure 9. Photograph showing final grading, reduction in channel width and creation of bankfull bench.

Figure 10. Photograph showing vegetation reestablishment along bankfull bench.

Figure 11. Pre construction example of overwide and unstable channel conditions.

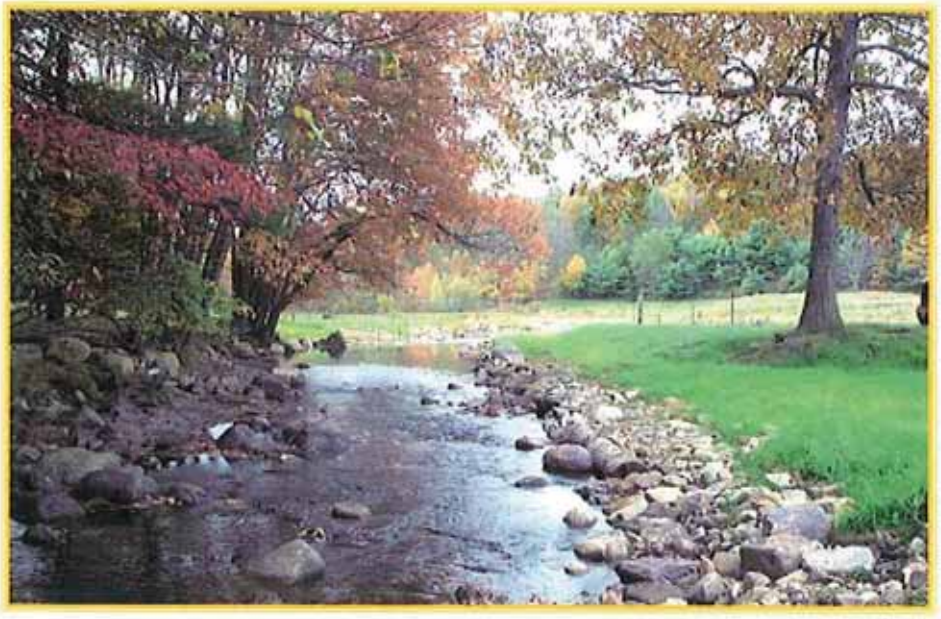


Figure 12. Post construction photograph of narrow channel and creation of bankfull bench.

Figure 13. Electric fence installation along the outside edge of newly created riparian zone.

Figure 14. WHAMM crew installing vegetation within newly established riparian zone.