Ashokan Watershed Stream Management Program

Esopus Creek at Woodland Valley Restoration Demonstration Project Evaluation October 30, 2008 Meeting Summary

Meeting Participants

DEP: Beth Reichheld, Dan Davis
DEC: Jack Isaacs, Mike Flaherty, Ed Van Put, Kim Clune (for Bruce Musset)
UCSWCD/NRCS: Gary Capella, Quentin Gahan, Deron Davis
US Army ERDC: Craig Fischenich, Sarah Miller
USGS: Barry Baldigo
Contractor: Rudd Hubbell
Local Stakeholders: Michelle Spark, Harry Jameson, Nancy and John Hadinger

Meeting Purpose

The stated goal for the meeting was to engage the various parties that participated in the Esopus Creek Restoration Demonstration Project in a discussion on evaluating its performance with respect to previously established goals and objectives. The anticipated outcomes of the meeting are to (1) document the discussion; (2) to learn from what has been "demonstrated" before we invest further funding in stream BMPs (as required by the 2007 FAD); and (3) encourage a more collaborative process for future projects.

This document is a summary of meeting findings and presents some recommendations for further action. This document is not meeting minutes that recount the lengthy and wide-ranging discussions. A brief account of project history with some maps and photos is provided to enhance the usefulness of this document.

Project History

The project history is reported in detail in several documents that are publically available and listed at the end of this document. Only the salient points are repeated here along with the stated goals and objectives:

- *Project location*: The site is at the confluence of Woodland Creek with Esopus Creek – a setting that is inherently dynamic given the variability in magnitude of water and sediment discharge from the two mountain streams (Figure 1). Anecdotal and aerial photo evidence suggests that the channel and bar formation have undergone dramatic shifts in response to large flood events. The setting's inherent "instability" is compounded by a double-span bridge located just downstream of the confluence that produces a clear constriction in channel dimensions.
- *The problem requiring a solution*: Following the January 1996 flood, a headcut into underlying glacial lake clay propagated through a secondary channel along the left descending bank and ended up capturing most of the Esopus Creek flow

(Figure 1). The altered alignment of the channel, the stratified composition of the 32-foot high terrace (from bottom to top: glacial lake clay, glacial till, pre-historic stream deposits) and subsequent floods resulted in a rapidly retreating eroding bank (approximately 3 feet/year). Risks associated with continuing erosion included increasing potential for exhuming several residential septic systems, causing additional property damage, producing a continuing source of turbidity and creating a hazard to recreational users of the stream (Figure 2).

- *Proposed solutions*: In 1998 NRCS proposed (but did not complete the design due to dissatisfaction among stakeholders) a concrete t-wall type revetment for the eroding bank and terrace. This proposed approach would not have addressed the underlying cause of the erosion but would have substantially armored the bank, presumably stabilizing it in place. In 2000, NYCDEP hired FIScH Engineering (principal engineer Dr. Craig Fischenich) to complete an analysis of the proposed NRCS t-wall and alternative solutions (FIScH Engineering, 2000). The hydraulic and stability analyses, sediment transport calculations, and geomorphic assessment demonstrated the t-wall to be high risk due to failure from scour, and the report recommended a more comprehensive project approach that incorporated several technical techniques including a channel relocation based upon natural channel design (NCD) principles, bioengineering and traditional bank revetment, and habitat and recreational enhancement features. The final design is presented in conceptual form in Figure 3. NYCDEP selected this project to be the demonstration stream restoration project for Esopus Creek required by the USEPA as part of the Filtration Avoidance Determination (FAD) schedule of compliance.
- *The implemented solution*: The selected alternative conceptual design was completed by FIScH Engineering with NRCS, an NYSDEC Article 15 permit was obtained and the project was constructed in 2003 in two stages: the channel work, bank revetment, and flood plain reconstruction were completed by October 01, 2003 and the vegetation (trees and willow fascines) and bioengineering (VRSS) were completed in early December, 2003. Figure 4 is an aerial view of the site taken approximately one year after construction (August, 2004).
- *Follow-up activities*: Post-construction monitoring and maintenance activities have continued since original construction. FIScH Engineering conducted an inspection following project installation, one year post-construction, and following the April 2005 flood, and prepared monitoring reports in each case. UCSWCD and DEP have completed x# visual inspections (see attached example) and x# topographic surveys in the form of reach scale surveys and cross-section surveys (Figure 5). UCSWCD has also contracted for two maintenance actions: (1) in summer 2005 (following the April 2005 flood), rip rap was added to downstream left bank and to the downstream channel block; (2) in late summer through early fall 2008 (also addressing damages following the April 2005 flood), the eroded right bank below Woodland Creek confluence was stabilized with a combination of stacked rock revetment and VRSS. Two modified rock vane structures designed by NRCS were also installed to help redirect erosive flows from the bank.

Project Goals/Objectives

The stated project goals and associated objectives for the demonstration restoration project were to:

- Protect water quality
    - Stabilize channel to prevent erosion into clay-rich sediments
    - Prevent excavation of septic systems
- Protect property
    - Restore reach to single channel away from eroding bank
    - Direct erosive flow away from banks
- Consider aquatic ecology and recreation
    - Create more complex habitat than exists
    - Provide good whitewater recreation conditions
- Test BMPs
    - Implement a set of BMPs
    - Monitor to evaluate performance

Meeting Discussion

The meeting was conducted in three parts:

- 10:00 – 11:30: Identification of meeting participant roles and interests in project; power point presentation on project site history, goals/objectives, and impact of April 2-3, 2005 flood; discussion on framing questions for fair project evaluation.
- 11:30 – 12:30: Site visit to view current project site condition
- 12:30 – 4:00: Discussion on project performance and implications for future projects.

The extreme flood event that occurred on April 2-3, 2005 caused considerable damage throughout the Esopus Creek watershed including the project reach (Figure 6). There has been a perception and/or declaration of project "failure" by some observers based on the changes occurring just downstream of the project reach, most notably:

- the removal of a large partially-vegetated cobble bar on the right bank between Woodland Creek confluence and the bridge crossing Esopus Creek ("WV bridge");
- erosion of the right descending bank adjacent to the eroded cobble bar and consequent damage of railroad grade;
- the "loss" of at least two of the NCD structures (rock vane and weir) below Woodland Creek; and
- the change in alignment toward the right bank and widening of the channel between Woodland Creek and the WV Bridge.
- Erosion along the left bank below the Woodland Bridge.

Others noted that while those changes did occur, the project did succeed in meeting the stated objectives, most notably preventing problems along the previously eroding bank protected by revetment and VRSS. The several developed properties along that bank were protected during this otherwise catastrophic flood event.

During the year and a half since completion of construction and prior to the April 2-3, 2005 flood event the project site experienced limited change in component integrity and performance. The April, 2005 flood was the highest flood recorded at the Allaben gage since it was established in 1964. It was estimated by USGS to be a 60 year recurrence interval (RI) flood at that gage and a 30 year (RI flood at the Coldbrook gage (Suro and Firda, 2007). The magnitude of the rainfall/snowmelt flooding was greatest in the north-facing drainages such as Woodland Valley, Fox Hollow and the Big Indian Hollow. The peak discharge from Woodland Creek could not be determined as the gage was destroyed during the flood but the estimated peak discharge was at least 10,000 cfs (personal communication with USGS). That flow combined with the peak flow of 21,700 cfs at Allaben would have sent somewhere between 30,000 – 35,000 cfs through the project site – that is approximately an order of magnitude greater than the bankfull discharge estimate (3400/4200 cfs at the upstream and downstream ends of the project, respectively), and half again the design limit flow of a 25-year event (21,000 cfs at the bridge). Deposition of sand and reports from several residents in the area indicate that the peak stage overtopped the bridge deck.

Several questions were raised during the meeting and are discussed below.

How did the project (as a whole and its individual components) perform with respect to the stated goals/objectives given the extreme flood situation?

The best way to present this information is to discuss each goal and objective.

Protect water quality by stabilizing the actively eroding channel to prevent erosion into clay-rich sediments and excavation of septic systems. Clearly the project has been successful to date on preventing erosion into the left bank terrace top properties. This episodic source of suspended sediment and septic leachate has been removed from the stream by re-routing the channel to a former alignment and stabilizing the formerly eroding bankline through a combination of riprap revetment and bioengineering with the VRSS. The project also halted the channel incision into lacustrine clays in the channel bed that were a source of turbidity even at flows insufficient to erode the bank. There was no water quality sampling prior to or following the construction to quantify water quality improvements (this is generally not done for this type of project, even if protection of water quality is an explicit goal, due to limited ability to detect contributions from individual projects because of great inter-event and background variability in turbidity levels). Thus, it is not possible to quantify the reduction in turbidity from suspended sediment entrained from this site, and this site may have had no significant contribution before or after the project during the large runoff events that entrain sediment from throughout the watershed.

Protect property by restoring the reach to a single channel away from the eroding bank and directing erosive flow away from all stream banks along the reach. All agreed that this was the primary goal of the project and should be prioritized as such. The private properties that line Esopus Creek along the left descending bank have all been successfully protected by this project. In particular the April, 2005 flood could have had devastating impacts on these properties had they not been protected by (1) rerouting the channel away from the bank; (2) constructing a flood plain in the former channel area; and (3) stabilizing the bank with rock and VRSS. If the channel had not been re-routed and the bank only protected by riprap or other revetment, the bank would have been exposed to excessive shear stress and turbulence along the bank. It is likely that some or much of the revetment could have been damaged or flanked during the flood. However; significant bank loss occurred from the flood along the right descending bank below Woodland Creek. The protection of this property was not an explicit project objective, and the channel restoration and stabilization measures that were implemented did not provide protection against the conditions that prevailed during the April 2005 flood. It is not known if the bank would have failed in the absence of the implemented project, or if the project contributed to the failure. There were no developed properties impacted by this bank loss, though the railroad grade and tracks were significantly damaged. As Jack Isaacs noted, those railroad tracks had been in place for at least a century before the project, and they were damaged after the project. On the other hand, there had never been a comparable flood in the past century, and this flood caused similar damages to the railroad in several other locations (without projects). See the discussion below on the flood impacts for details.

Consider aquatic ecology and recreation by creating more complex habitat than existed and providing good whitewater recreation conditions. This is a fairly subjective objective to evaluate. With respect to creating more complex habitat, the project did result in more riffle-pool structure and the in-stream rock structures do provide good cover. The connection of Woodland Creek with Esopus Creek has been improved. This is a dynamic reach and so adjustments to the aquatic habitat conditions are expected and desired. Similarly, the recreational conditions were improved immediately following construction by removing the hazard associated with the failing bank and creating a "wave" at the upper weir and a set of rapids in the bouldery run below the lower weir. Above Woodland Creek, the stream still functions well for recreational use (tubing and paddling). It is a commonly used swim hole in the summer time. However, at lower flows the upper weir has a number of exposed boulders that "tubers" can unintentionally hit. The lower weir was removed/buried by the April 2005 flood and that section of stream below Woodland Creek has widened and split into two around a mid-channel bar extending upstream from the bridge. This may have temporarily reduced the recreational benefit of this section, though no definitive assessment of recreational impacts has been completed.

Test Best Management Practice techniques by implementing a set of BMPs featuring natural channel design, bioengineering, and traditional bank stabilization engineering techniques. UCSWCD and DEP used a visual monitoring protocol and topographic surveys to evaluate BMP and project performance. During the meeting, each of the employed techniques were discussed and their performance assessed.

Channel features

- Rock vanes and weirs – four rock vanes and two rock weirs were installed. The two rock vanes and one rock weir above the Woodland Valley confluence continue to function properly, and withstood the extreme test of the April 2005 flood. There was some degradation of the left arm of the rock weir, the weir's upper tier of rocks, and some rocks on the rock vane just above the Woodland Creek confluence. None of these adjustments have degraded the performance of the features and they have, according to Craig Fischenich, performed their primary function of establishing the intended channel dimensions. It should also be noted that during the April, 2005 flood, the peak stage was well above the right bank terrace and the excessive deposition of sand and no erosion of the bankline strongly suggests that these velocity deflecting features worked very well under the circumstances. All the instream features below Woodland Creek were "lost" as a consequence of the April 2005 flood (Figure 7). The rock vane just upstream of the Woodland Bridge was largely non-functional prior to the April event - this rock vane could not be properly "footed" as it had to be constructed in the wet, so was not expected to perform as designed, and was a contributing factor to the addition of riprap on the left bank previously discussed.

  Mike Flaherty raised the question of how long are these structures supposed to "last" or function as originally intended. Craig noted that it depended on the purpose of the feature. The rock vane he felt was most important to last the longest (the one just above the Woodland Bridge across the Esopus) was never fully functional as discussed above, though like all structures implemented in this project it was not intended to be a "permanent" feature. With the exception of the blocks in the reconstructed floodplain and the left bank stabilization measures, the features above Woodland Creek are now past their intended function lifespan. So, if they degrade to the point that the weir no longer serves as grade control and the vanes no longer function to reduce shear stress at the banks, ideally it shouldn't matter, since the channel has set up a relatively stable configuration and the riparian vegetation has established in this section.

Floodplain features

- Reconstructed "flood plain" or "floodway" and channel blocks – the former actively eroding channel was filled and a continuous flood plain was constructed to (1) ensure that there was adequate flood routing through the reach and (2) provide space for a riparian forest to develop, and (3) to raise bank toe elevation to reduce flow depth and shear stress against the bank. The channel blocks are buried trenches of rip rap rock intended to prevent channel avulsions in the reconstructed floodplain placed at the upstream, “middle” and downstream ends of the filled channel (Figure 3). While the flood plain experienced minimal change from the frequent inundation prior to the April 2005 event it did experience significant change evident following the event (Figure 7). Deposition on the streamward side and scour between the middle and downstream channel blocks caused at least 6 feet of relief in places along the surface. It is noted that Craig Fischenich anticipated these adjustments (as well as those of the in-channel structures) and informed DEP and UCSWCD on several occasions of the expected changes. The semi-frequent inundation of the left margin of the flood plain from the upstream overflow channel has helped to create a small swale (bound by the channel blocks) that actually appears to function as a riparian wetland. The downstream channel block previously formed the channel boundary but currently an extensive point/lateral bar has prograded the flood plain several meters downstream (Figure 7.) The riprap key trench in the bar below Woodland Valley that keyed the lower weir into the railroad grade embankment was lost during the April flood.

- Vegetation – the vegetation in the VRSS continues to thrive and is performing as intended. Most of the plantings along the left bank above Woodland Creek were lost during the April 2005 flood. The willow fascines at the upper end of the project are still intact and thriving. All of the plantings and willow fascines placed in the cobble bar below Woodland creek were lost during the April 2005 flood (along with all the existing mature vegetation).

<u>Stream bank stabilization</u>

- Rip rap revetment – There were two traditional rip rap revetment techniques used to protect and stabilize the left eroding bank. NRCS designed and installed a “paved” rip rap wall along the stream bank now bordered by the reconstructed flood plain. Additionally, FIScH Engineering designed a self-launching graded rip rap along the bank bordered by the stream just downstream from the final channel block at the end of the constructed floodplain. Both rip rap jobs have held during several high water events but each have also had to be maintained by replacing displaced rock in the “paved” section and replacing some rock in the “graded” section. Both sections were installed to the elevation of the modeled 25 year flood stage. Both sections were overtopped during the April 2005 flood. The NRCS design was subjected to parallel flows up to 10 feet deep whereas the launching riprap endured impinging flows and depths in excess of 20 feet.
- VRSS – this unique bioengineering technique for stabilizing banks has been very successful to date in establishing a thickly vegetated embankment above the rip rap revetment. Two years of irrigation helped to get it established but now thrives without irrigation.
- Willow stakes and plantings – There was variable success with the willow stakes installed in the rip rap. Where they survived they thrived. Most,

however, did not survive. The stakes installed in the exposed alluvium of the right bank above Woodland Creek generally did not survive, presumably because of the lack of sunlight from a closed canopy.

This project has been successful in demonstrating some of the BMP techniques used in stream bank stabilization and restoration projects.

What happened during the flood to cause the observed changes?

Jack Isaacs expressed the opinion that the installation of the project caused the damage to the right bank and the loss of the cobble bar below Woodland Creek. The stated case for this view is that prior to the installation of the project the railroad grade had never been impacted since it was installed over a hundred years ago. (It should be noted that the railroad grade was maintained by periodic replacement of riprap revetment.) The design alignment of the stream had a tight radius of curvature for the meander bend constructed at the Woodland Creek confluence (Figure 4). Also, historical photos and anecdotal evidence suggests that this confluence reach has shifted often and had channel bifurcations that could distribute the flow across a larger area. The conclusion based upon these inferences is that the new alignment with the extreme flood flow (highest recorded at the Allaben gage) caused the erosion to occur.

Craig Fischenich pointed out that, mechanistically, there is no reason that the bar could have eroded as a consequence of the restoration effort. He opined that the bar and bank would likely have been eroded with or without the project under the conditions experienced in the 2005 flood. He suggested that the most likely scenario was that the hydraulic constriction presented by the bridge just downstream of the confluence was a primary causative factor in initiating erosion of the bar, which propagated upstream. Once the vegetated bar was removed, the subsequent flows undermined the stream bank. In other words the destabilization occurred from downstream and worked upwards, rather than from upstream, and was independent from the restoration action. The mechanics for this scenario involve understanding that the flood flow stage filled the channel from terrace wall to terrace wall and reached the bridge deck. The actual flow in the channel was relatively small compared with the flow coming down the valley bottom. This flow was constricted by the bridge (not designed to pass a 60 yr flood) and under these conditions the water surface can “dip” upstream of the bridge causing significant increase in shear stress to the stream bed which may have initiated the scouring of the downstream part of the bar and the upstream propagating erosion.

Additional points were raised in the attempt to derive a reasonable explanation for the changes that occurred during the flood:

- It is not known whether there were any floods of this magnitude through this reach since the railroad grade was constructed. During the flood of record (since 1933) for the Coldbrook gage in March 1980 the peak flow at Allaben was 15,900 cfs, slightly more than in the 1996 flood but still considerably less than in the April 2005 flood. Because of localized extreme flows as noted above, it is possible the combined flood flows of Esopus and Woodland Creek were the greatest since construction of the bridge and railroad grade.

- Michelle Spark noted that the railroad trestle had been removed following the 1996 flood and the trestle abutment may have been damaged and/or the bankline more exposed than prior to that removal, possibly increasing erosion potential along that section of bank.

Were all the goals for this project reasonable?

Though explicit effort was made to create a multi-objective project, it was clear that the primary goal was property protection through channel realignment and bank stabilization. All present were in agreement this was a reasonable goal.

The goal to protect water quality was also deemed reasonable by DEP. The nine septic systems are no longer apparently discharging leachate into the stream or under threat to being exhumed by stream bank erosion. It is unlikely that this could be considered a turbidity reduction success, given (1) the relatively small contribution of turbidity from this site during the problematic turbidity inducing events and (2) one potential source of turbidity (the exposed glacial till and glacial lake clay in the eroding stream bank) was arguably “traded” for another potential turbidity source (glacial lake clay exposed in new stream bed below upper boulder weir), though the actual proportion and extent of the “trade” is unknown. Furthermore, while projects such as this may have no measurable effect on turbidity reduction during large events, they can reduce local, persistent turbidity sources that are problematic at low flows throughout the basin. Some suggested that future projects that identify water quality as a primary goal should attempt to have measurable performance objectives that can be used to quantify success. The challenge, as stated before is that we have limited ability to detect suspended sediment contributions from individual projects because of great inter-event and background variability in turbidity levels during and following large runoff events.

The goal to enhance habitat and recreation was generally determined to be reasonable. However, the goal would be more meaningful if it were supported by quantifiable objectives.

The goal to test BMPs was reasonable and worthwhile.

Would anyone have done anything different given what we know now?

The responses to this question included:
Craig Fischenich – Would not have modified overall design (components and channel alignment). He would have preferred better “grading” of the rock delivered for the rip-rap and would have preferred not to have any “paved” rip rap.

Gary Capella – Would repeat the project with additional emphasis on the vegetation component.

Jack Isaacs – The lessons learned for DEC in dealing with a project of this scale (uncommon for Region 3) include making sure that the potential downstream impacts of the project are accounted for prior to issuing permit approval. The discussion did not get into the detail of how far downstream and how such an analysis is to be completed.

Dan Davis (and others) stated that an improved (and significantly more expensive) project would include rebuilding the bridge to better accommodate higher flows.

How can we improve the process in anticipation of the FAD-mandated stream restoration projects that will be implemented in the Ashokan watershed?

While this question was not fully addressed during the course of the meeting it was discussed at various stages of the meeting. The relevance is that DEP is committing at least $4.1 million dollars in contracts with UCSWCD ($2.1M) and CCE ($2M) that can be applied to stream restoration and/or stabilization projects. The $2.1M in the UCSWCD contract is specifically for stream restoration/stabilization projects, while the $2M in the CCE contract can be used for other stream management activities beyond stream restoration/stabilization projects. Within the next 5 years there will be at least one more large, reach-scale project. One of the recommended projects in the Upper Esopus Creek Management Plan discussed during the meeting is the relocation of the main Esopus channel to the historic alignment through Greeny Deep. This is another bifurcated reach with active erosion in a primary channel threatening several residential and business properties. Historically, the primary channel had been against the south valley wall (location of “Greeny Deep” hole and there has been an expressed interest by DEC in restoring the primary channel back to that location. This project would likely require starting at the confluence with Broadstreet Hollow and continuing on down to just past the Allaben Cemetery, although alternative strategies exist. This would be a large stream disturbance project and would likely have similar goals/objectives as the Esopus demonstration project. However, in light of the discussion to date on the demonstration project significantly more data, modeling, analysis, risk assessment and stipulation to demonstrate no effect down stream most likely precludes pursuing a project of such scale.

CCE is in the process of reforming a project advisory council (PAC) for the Ashokan Watershed Stream Management Program. The Program will be staffed by CCE and UCSWCD personnel and guided by the PAC and a set of working groups that report to the PAC. The proposed working group structure is centered on the goal categories presented in the Upper Esopus Creek Management Plan (CCE, 2007). There will be a flooding and erosion hazard assessment and response working group that will help guide the identification and prioritization of potential stream restoration and/or stabilization projects designed and constructed with the funds in the CCE and UCSWCD contracts with DEP. The composition of that group should include representatives from DEC, DEP, the local, county, and state highway departments, stakeholder groups such as Trout Unlimited and the whitewater recreation community, along with riparian landowners. The role of the group would be to ensure that proposed stream projects have merit, have clear and measureable (both quantitative and qualitative) goals/objectives, are well-planned, consider potential impacts beyond the primary project goals, and have a monitoring component for subsequent performance objective evaluation.

Recommendations

The following recommendations for future actions are proposed:

- Expand this document into a larger format that includes reporting on all previous monitoring activities with the intent to have a formal document that can be used to distribute an evaluation of this demonstration project.
- Form the Ashokan Watershed Stream Management Program working group that will deal with flooding and erosion hazard assessment and response. This group should meet at least once in the winter of 2009 to determine the optimal group composition and scope of the working group's activities.
- Continue status meetings with regulatory personnel to discuss stream management and restoration activities and calendars to assess the degree to which expectations are met and possible steps for improvement.
- Ensure that objective-setting discussions with stakeholders on future projects explicitly address the issue of potential influences of the project on adjacent properties.
- Where appropriate, initiate monitoring or research actions aimed at better understanding of river mechanics, including the potential for unanticipated adverse impacts from management actions. Use findings from these actions to better educate stakeholders, and to inform future program actions.

References

FIScH Engineering, October 25, 2000. Design for Stabilization and Reconstruction of Esopus Creek near the Woodland Bridge, Shandaken, New York. Prepared for NYCDEP.

Suro, T.P. and Firda, G.D., 2007, Flood of April 2-3, 2005, Esopus Creek Basin, New York: U.S. Geological Survey Open-File Report 2007-1036, 85 p.

Figures

Figure 1. Aerial photo of the Woodland Creek/Esopus Creek confluence. The project reach extends from the head of the bifurcated reach down to the Woodland bridge (2001, DOQQ)

Figure 2. Eroding stream bank/glacial till terrace (May, 2003)

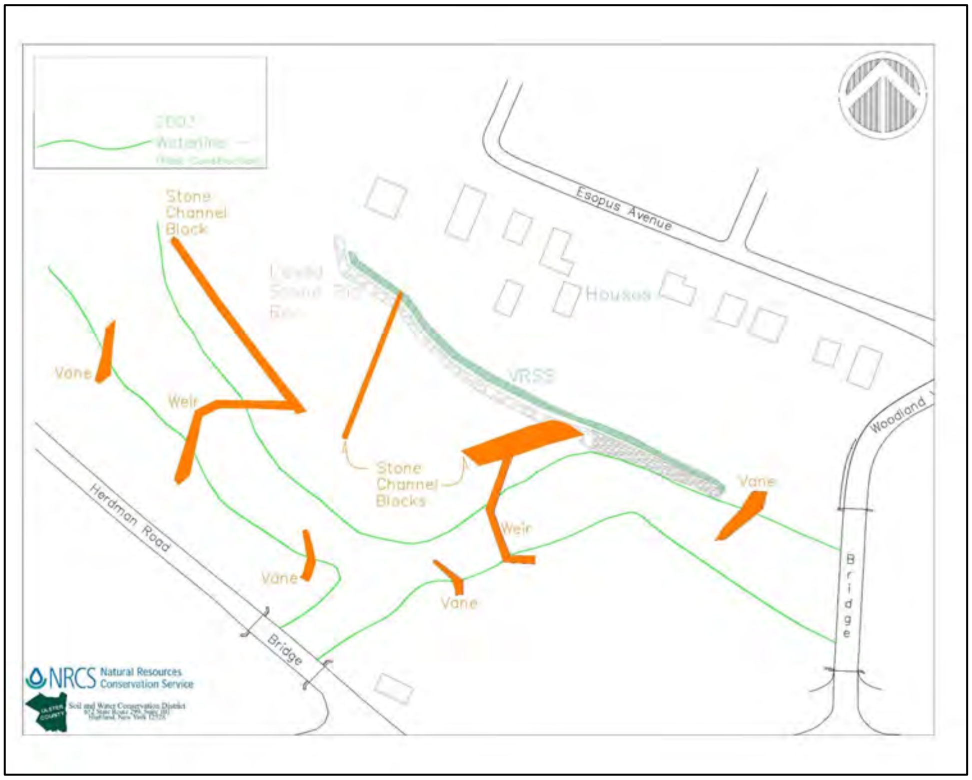

Figure 3. Schematic planform drawing of conceptual design (prepared by NRCS and FIScH Engineering)

Figure 4. Esopus Creek Restoration Demonstration Project - one year after completion (august, 2004)

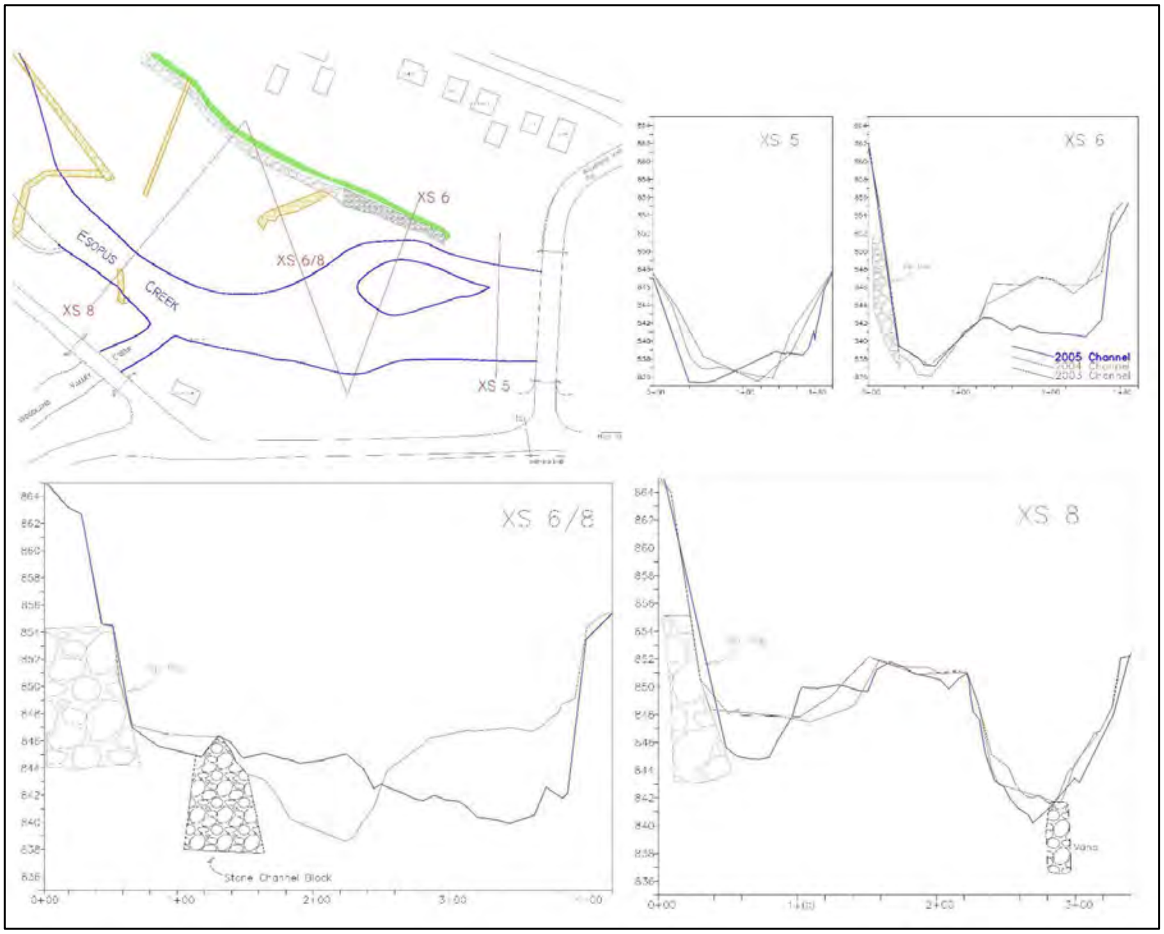

Figure 5. Example of post-flood monitoring by surveying monumented cross-sections.

Figure 6. Project site following April 2-3, 2005 flood. Aerial shot is from April 5 and ground shot of eroded bank is from April 3.

Figure 7. Post April 2005 flood topographic survey with schematics of remaining project features.