Title
Canasawacta Creek Project: Chenango County, New York

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Abstract: The Canasawacta Creek Watershed Initiative grew out of a desire to address the root causes of flooding, bank erosion, bridge scour and property damage that was a recurrent problem for both the New York State Department of Transportation (NYSDOT) and the inhabitants of the creek valley. Rather than continue with the old paradigm of fixing the problem spots NYSDOT, working through Region 9 office in Binghamton and its Main Office in Albany, requested the help of environmental specialists within the department as well as from other state and county agencies to address the problem more holistically and permanently. The first public meeting was held in the Town of Plymouth, Chenango County, in March of 2006. Over forty people attended; half were townspeople. The rest represented various entities including the New York State Department of Environmental Conservation (NYSDEC), the Chenango County Soil and Water Conservation District, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the Federal Highway Administration and the Upper Susquehanna Coalition. An interagency technical team was formed and an initial evaluation of a four mile stretch of the creek was performed in early June, 2006. Despite devastating flooding that occurred at the end of June, an action plan was developed and presented at a second public meeting at the end of August, 2006. NYSDOT began work in the stream in September and October of 2006. Additional work is planned for the summer of 2007. Armed with the findings of the interagency technical team, the residents of the watershed have organized themselves into a watershed committee that is working through the town to implement the parts of the plan that address private property. The watershed committee has spearheaded a town newsletter to keep everyone informed, and there is a watershed blog available on the Internet. The watershed committee has received a $179,000 grant from the NYSDEC. The grant requires a 50% match in funds which can be met by agencies such as NYSDOT and NYSDEC working in the watershed, as long as the work is in conformance with the overall watershed plan.

There are several interesting aspects of the watershed approach used in the Canasawacta Creek Project. The watershed approach requires cross-jurisdictional communication and cooperation, although there are unresolved issues such as funding and liability. The social and organizational skills necessary for a successful project are as important as the scientific and engineering expertise. The methodology used to prioritize various sites for remediation is supported by classic risk assessment methodology. Finally, because of the extensive baseline data recorded by NYSDOT during the past several decades, the project offers the opportunity to evaluate the effects of the interventions undertaken in the watershed.

Introduction and Background

Canasawacta Creek, located west and north of Norwich in central New York State, traverses a narrow valley and meanders along a two-lane rural state highway. A linear community of houses in the Town of Plymouth (population 2,070) has been established along this valley, often in the flood plain between the creek and the highway. Canasawacta Creek is one of the headwater watersheds of the Susquehanna River Basin. It flows into the Chenango River that, in turn, joins the Susquehanna River in Binghamton, New York. Once a high-quality trout stream, it has deteriorated in recent years as a result of its long history of manipulation which includes redirection, straightening, and channelization.

The Canasawacta Watershed covers approximately 61.7 square miles with 108 miles of stream including tributaries, and 139 miles of roads. Most of the watershed is forested or engaged in agriculture. Only about 4% of the surface area is currently impervious. The soils in the watershed are primarily heterogeneous, non-cohesive gravelly silt loam. Frequent flooding of these soils often results in the shifting of soil material from place to place (USDA, 1981). The stream rests on bedrock in some locations and has meandered across the entire valley floor during geologic time.

The problems that prompted this initiative are occurring in the upper part of the watershed, on the main branch of the creek upstream of the confluence with the East Branch of Canasawacta Creek. The East Branch seems to be relatively stable. The highway running through the valley of the East Branch is not as closely associated with the stream, and the highway itself is a Chenango County route. This means that the New York State DOT, a major player in the Initiative and a source of matching funding for grant eligibility, could have no direct involvement in that sub-watershed. Therefore, although problems downstream of the confluence will eventually be addressed, the initial focus has been upstream of the junction with the East Branch.

Hydrologic analysis indicates that the main branch of Canasawacta Creek, above the confluence, is 12.4 miles long and drains 25.4 square miles. The channel slope is moderately steep at 1.1%. The average daily stream flow is about 43 cubic feet per second (cfs), with a summertime average over the month of August about 1 cfs. Normal spring flooding exhibits stream flows of about 900 cfs. Estimated flows for a 50 year flood are about 2300 cfs.

Flashy mountain streams, such as the headwaters and tributaries to Canasawacta Creek, transport large amounts of coarse sediment (gravel and cobble) from the steep side valleys down to the main stream during floods. Some of this material then settles out in the form of alternating point bars as the flatter slopes of the valley floor make for slower flow velocities. The stream must then regain its lost cross sectional area by either flushing this sediment downstream, or by eroding the opposite bank. In Canasawacta Creek, the latter is often the case due to the valley's easily eroded

soils and general lack of woody vegetation. The eroding banks in turn supply more sediment to the channel, and the cycle of instability continues.

The valley was home to the Haudenesaunee for centuries before the first Europeans settled the area in the late 1700s. Although each group would have established their own paths, the earliest recorded highway plans in the valley date back to 1910. These plans describe a road from "Stewarts Corners westerly to the Hamlet of Kirk, a distance of 4.9 miles, in the town of Plymouth, Chenango County." Record plans indicate that construction of the current State Route 23 in 1931 also relocated and channelized Canasawacta Creek in several locations. Many of the locations where the creek was modified correspond to areas of concern today.

Several factors have converged to worsen problems that have been developing for the last hundred years including increased habitation of the valley, increased awareness of the adverse impact of engineering practices that were commonplace during the mid-twentieth century, climate changes that are associated with increased intensity of rainfall, and decreased manpower within the NYSDOT. During high water the highway is flooded in several locations and at least one bridge is inspected after each flooding event. When State Route 23 was built one accepted practice was to bulldoze the stream and remove any sediment that accumulated along the stream bed. This practice kept water flows moving quickly and prevented water from overflowing the banks of the stream. Unfortunately, this practice also prevented dissipation of the energy associated with flowing water and contributed to destruction of aquatic habitat.

There are no USGS gauging stations currently active in the Canasawacta Creek Watershed, although one did operate some 2.6 miles downstream of the confluence from 1945 to 1975. Records from gauging stations in adjacent watersheds indicate that annual flows in the area were 20-30% higher in 2003 and 2004. One of the effects predicted to accompany climate change in the northeast U.S. is not only an increase in the average annual rainfall but also an increase in the intensity of individual storm events. Without adequate and effective energy dissipation, the increased runoff associated with increased intensity of individual storms threatens both the homes of the people living in the valley and State Route 23. NYSDOT, being limited to working within the highway right-of-way, has neither the equipment nor the employees necessary to repair infrastructure every year, much less after every storm event.

The Problem

Recurrent flooding problems have resulted in ongoing maintenance issues for NYSDOT throughout the state, as well as along State Route 23. Maintenance forces return year after year to the same location and perform the same activity. At the same time that people in operations were identifying the ineffectiveness of such an approach, the regional hydraulics engineer was trying to engage the group designing and delivering capital projects to address the issue. NYSDOT did not really have a conceptual framework within which to place the problem. Furthermore, solution of the problem involved addressing watershed issues; something that NYSDOT had not done in the past. Because NYSDOT does not have the ability or the authority to address watershed issues unilaterally, it must form partnerships with others who have a stake in the watershed.

Materials and Methods

Canasawacta Creek is located in Region 9 of NYSDOT. Through Main Office staff in Albany, Region 9 staff in the Binghamton office and Chenango Residency staff, NYSDOT collects a tremendous amount of information but, unfortunately, the information is often disjointed. The NYSDOT resources that were used during this project included record plans, bridge inspection data, hydrology and hydraulic engineering expertise, and maintenance expertise. Methodologies employed by these disciplines were all used during the development of this project.

In addition, expertise in natural habitat, stream restoration, land use and community planning was incorporated by partnering with various agencies. Methodologies developed by these various agencies were also used during the development of this project. The partner agencies and organizations are as follows:

- New York State Department of Environmental Conservation (NYSDEC)
- Chenango County Soil and Water Conservation District (SWCD)
- Army Corps of Engineers (USACOE)
- U.S. Fish and Wildlife (USFWS)
- Federal Highway Administration (FHWA) and
- Upper Susquehanna Coalition (USC)

A team of experts, including hydraulics engineers, aquatic biologists, and stream geomorphologists, analyzed a four mile stretch of Canasawacta Creek. The stretch began just below the confluence of the east branch with the Creek's main stem and included two bridges that are part of State Route 23. The bridge at Moon Hill Road is downstream from the bridge at Chan Aldridge Road. Data collected included flow estimates, gravel bar volumetric estimates, stream cross sections, and identification of problem areas with photos. To assist in the analysis stations were marked every 500 feet on 2003 orthophotos scaled to 1 inch equal to 200 feet (figures 1 and 2). Station numbers increased from downstream to upstream. Left and right are referenced by looking downstream, with left facing north and right facing south.

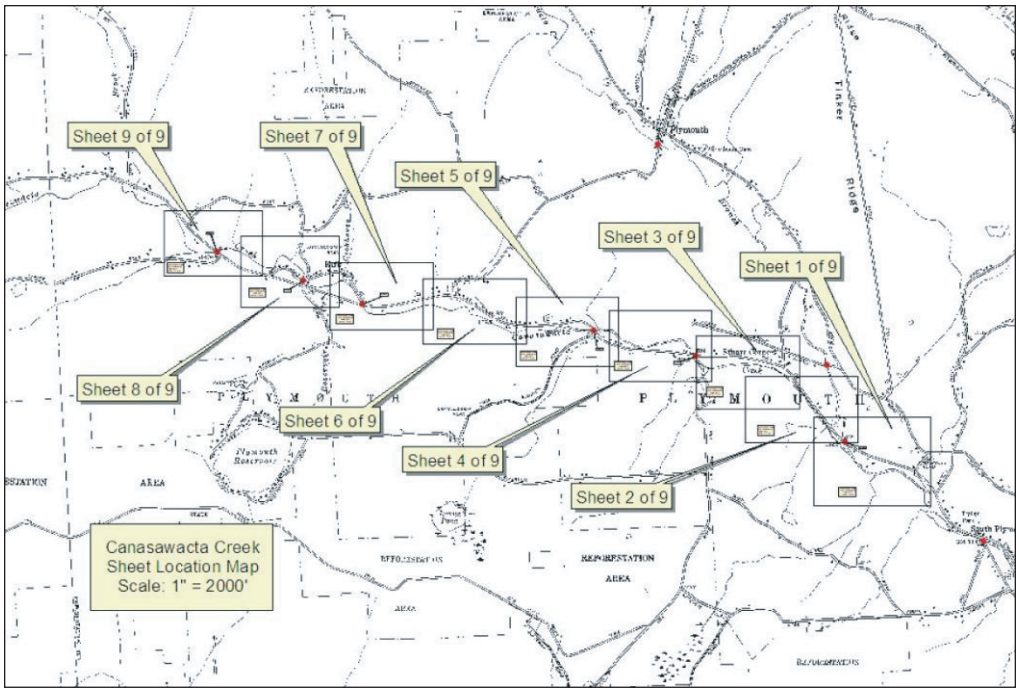

Figure 1. Reference map showing the location of the 9 individual orthophotos used in the stream evaluation.

Figure 2. 2003 orthophoto of Canasawacta Creek and Route 23. Ashcraft Road is perpendicular to Route 23 in the upper right quadrant of the photo. The white lines represent the stations that were located 500 feet apart.

Staff from the Department's Chenango Residency constructed stream intervention structures, guided by principles described by Rosgen (2004) and the Federal Highway Administration (2001). The work was performed under the guidance of an employee of the U.S. Fish and Wildlife Service and NYSDOT hydraulics engineers.

Results

Organizing Activities

NYSDOT held the first public meeting at the Town of Plymouth fire station on March 14, 2006, as a result of complaints, from people who lived along State Route 23, received by the NYSDOT Resident Engineer for Chenango County. The

meeting was to establish a cooperative framework among stakeholders in the Canasawacta Creek Watershed, to enable them to minimize flood damage to homes and infrastructure and to create a healthy watershed ecosystem/environment. Twenty townspeople and twenty-one people from seven government and non-government agencies attended the first meeting.

A smaller meeting with representatives from the NYSDOT, NYSDEC, USACOE and the SWCD was held on May 1 to plan how to implement the ideas discussed at the public meeting. The Stream Corridor Restoration Guide (1998), published by the Federal Interagency Stream Restoration Working Group, highlighted the following key points:

- Stream restoration is a multi-year process
- There needs to be an organizational decision structure and points of contact identified
- The problem needs to be investigated and identified and
- Consensus reached on the mission of the restoration initiative

One of the problems discussed at this meeting was identifying who would be responsible for implementing any project designed by the group. The Town of Plymouth was concerned because it does not have resources or experience in construction oversight. The town was also concerned about liability, if something went wrong. Other candidates to administer stream restoration projects included the Chenango County SWCD and the USC. The Pennsylvania Organization for Watershed and Rivers (POWR) publication, *How to Form Your Own Watershed Organization in Pennsylvania*, was discussed. Without resolving the issue, the group decided to plan the stream evaluation for early June and identified the participants that were essential to achieving this goal.

After a planning meeting on May 22, 2006, the stream evaluation team walked Canasawacta Creek on June 5 and 6. Field notes from the evaluation identified over 40 areas of varying degrees of degradation along the four-mile stretch of stream from just below the confluence of the East Branch with the main branch of Canasawacta Creek to almost a mile upstream from the bridge by Chan Aldridge Road (BIN 1053490). Hundreds of pictures were taken during the evaluation; figures 3 and 4 illustrate some of the detail that was captured during the stream evaluation.

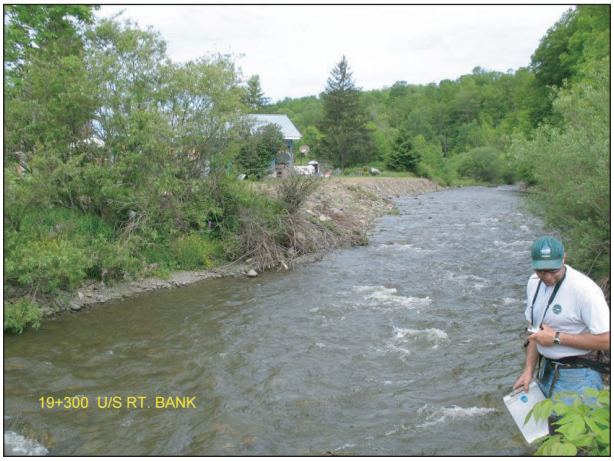

Figure 3. Looking upstream from the bridge at Moon Hill Road. The bridge is just out of the picture to the left. One of the houses located between Route 23 and Cansawacta Creek can be seen in the center of the photo.

Figure 4. Looking upstream from the Chan Aldrich bridge. The utility pole is located between Route 23 on the right and Canasawacta Creek.

At the end of June 2006, unprecedented flooding occurred throughout the Susquehanna River Basin, exceeding 500-year flood levels in numerous locations. Cannasawacta Creek was no exception. Areas identified as problematic in early June got worse. The back yard of the house and the trees along the south bank of the creek seen in Figure 3 were washed away. In some cases, erosion moved either upstream or downstream from where previous bank stabilization was located. No area of the stream was improved from the flooding. In some areas the stream formed new channels. The June 2006 flood highlighted the urgent need for intervention as well as the serious consequences of doing nothing.

In preparation for a second public meeting the technical team met on August 2, 2006, to discuss findings from the June stream evaluation and the impact of the flooding at the end of June. Each participant group, NYSDEC, Chenango County SWCD and NYSDOT, prepared lists of sites that required remediation. Each site on the lists was given a priority and an ease-of-fix ranking. The priority ranking was based on the amount of damage likely to occur to people, property and infrastructure if stability of the stream fails. In addition, the priority ranking took into consideration the overall health of the stream. The ease of fix ranking considers design simplicity, the site accessibility, and the cost of construction, technical solutions and maintenance. Sixteen sites were identified in total; seven were assigned high priority and one was assigned medium priority (Table 1). Low priority sites did not threaten homes or public safety. Of the seven high priority sites, four were identified as easy to fix. These four sites are being addressed by NYSDOT. Three of the sites ranked as high priority were also ranked as difficult or moderately difficult to fix.

The second public meeting took place on August 21, 2006. People were concerned about their homes and property. Several topics were discussed during the meeting including hydraulics, principles of stream restoration, and the summary of the findings. The idea of forming a watershed committee began to take shape at this meeting and community leaders stepped forward.

Soon after this August meeting the Canasawacta Creed Watershed Committee was formed. The group has spearheaded a town newsletter to keep staekholders informed. The newsletter is distributed to agencies as well as the towns residents. There is a watershed blog available on the internet. The watershed committee applied for funding and received a $179,000 grant from NYSDEC in March of 2007. The grant requires a 50% match in funds. This requirement can be met by agencies, such as NYSDOT and NYSDEC, working in the watershed as long as the work is in conformance with the overall watershed plan.

Stream Activity

The bridge by Moon Hill Road is on the flood watch list which means that the regional hydraulics engineer checks the bridge after every flood. This bridge was built in 1931. There are scour problems at the footings, which are not supported by piles. The stream bank is armored upstream and downstream from the bridge, but NYSDOT has not done any work in the stream in the vicinity of this bridge for many years. There is a 50 foot high eroding embankment upstream from the bridge on private property (figure 5). In addition several of the properties upstream from the bridge have lost significant portions of their backyards due to erosion during high water. Several homes have been repeatedly flooded during the past ten years.

Figure 5. Eroding south bank of Canasawacta Creek just upstream of the Moon Hill Road bridge. Material is continually sloughing off into the creek.

NYSDOT has intervened in the stream in three places:

1. By Ashcraft Road (below the confluence of the east and main branches)
2. Just above the confluence because of road flooding
3. The “new” bridge by Chan Aldrich Road

Area 1

Canasawacta Creek was eroding the south shoulder of State Route 23 in 2004. In the summer of 2004, stream bank between the stream and the road was armored with heavy stone to prevent further encroachment onto the shoulder of Route 23. At that time placement of rock vanes was considered but rejected because it required work off the DOT right-of-way and permission to work on private property was not forthcoming (figure 6). During the flooding of June 2006 the bank reinforcement held, but there was extensive damage to the stream bank further downstream (figure 7). This damage now threatens State Route 23.

Figure 6. Looking downstream at the bank stabilization installed in 2004 before the June flooding. Route 23 is seen in the photo. Ashcraft Road intersects Route 23 just out of view to the left in the photo.

Figure 7. This photo was taken just upstream from the rip-rap shown in Figure 6 after the June flooding. The creek has cut a new channel closer to Route 23. The vegetation blocks a clear view of the road but the location of Route 23 can be surmised by guide rail and highway sign.

Area 2

Record plans indicate that Canasawacta Creek was moved from the north to the south side of Route 23 during the 1931 construction project. This area of the road repeatedly floods during any high water event. The June 2006 flooding eroded the shoulder up to the edge of blacktop; the bed of the creek was almost at the same level as the top of the road (figure 8). NYSDOT personnel removed some of the sediment that was deposited in the bed of the creek. Further work is planned for the summer of 2007.

Figure 8. Canasawacta Creek is undermining Route 23. This is where the creek was moved from the north side of the road to its present location. Flooding occurs often in this location.

Area 3

The bridge by Chan Aldridge Road was initially built during the 1931 project. At that time the creek was straightened at the bridge location. In the 1990's a curve in Route 23 at the bridge was straightened and the new bridge built. The stream banks, both upstream and downstream from the bridge, have suffered from erosion during the past 10 years. Downstream from the bridge there are several homes on the south side of the creek. These homes have been repeatedly flooded.

Upstream from the bridge the utility pole between the north side of the creek and the south side of the highway was moved repeatedly because of bank erosion. In addition to threatening the utility pole the creek also threatens State Route 23 upstream from the bridge. Figure 9 shows the location of the utility pole before the June 2006 flood, after the June 2006 flood. Figure 10 shows a view of the same area from the bridge before and after the June flooding. The creek moved closer to the highway and cut a new channel that was closer to the original 1931 channel.

Figure 9. Looking downstream just above of the Chan Aldridge bridge in March 2006. Notice that the utility pole is several feet from the creek. It had already been moved once so that it was not engulfed by the stream.

Figure 10. Looking downstream just above the Chan Aldridge bridge (same location as figure 9) just after the June 2006 flood. The utility pole is now on the bank of the creek.

Figure 11 shows the south side of the creek near the Chan Aldridge bridge. A small tributary enters Canasawacta Creek from the south at this location. After the June flooding, the utility poles on the south side of the creek as well as a town road (Chan Aldrich) were also threatened.

Figure 11. South side of Canasawacta Creek looking upstream from the Chan Aldridge bridge after the June 2006 flooding.

In September of 2006, NYSDOT installed rock vanes and one cross vane upstream from the bridge. The design originally included three rock vanes (figure 12), but four were actually installed. The design included building a bench to increase the distance between Route 23 and the creek. The bench also acts as an overflow area during high water. The cross vane was installed immediately upstream from the bridge to direct energy away from both banks of the creek and direct the main flow towards the center of the bridge. Willows that were plentiful at the location were used to stabilize the rock structures.

Figure 12. One of the rock vanes built on the north bank of Canasawacta Creek. The photo was taken looking downstream.

Figure 13. The bench provides an area for high water between the creek and Route 23. The willows were planted and they are doing quite well. The utility pole is not shown but the bench protects it from the creek.

The Canasawacta Creek watershed experienced a second flood in November of 2006. Three of the rock vanes survived the flooding with minor damage; one had to be re-built. The cross vane was filled in with silt on one side.

Discussion

This project is interesting for several reasons. First, NYSDOT Region 9 had never done anything exactly like this before, perhaps because there was no framework for the project, or perhaps because it required considerable coordination. Maintenance forces have been well aware for a long time that they return to the same location year after year to perform the same work. It was clear to people in the field that the root causes of problems impacting roads and bridges were often removed from DOT infrastructure and out of the direct control of DOT. It was also clear that the interventions that DOT put in place affected areas removed from DOT ROW.

The watershed concept offers a format to deal with these concerns. It gives local people local control. The control, however, is based on consensus. Currently watersheds are governed by a patchwork of government entities and private landowners. Watershed boundaries do not respect political boundaries. No one entity is responsible for each watershed. Watershed committees fill that void, but there are many unresolved issues not the least of which are funding and liability.

Secondly, the social, organizational and administrative/budgeting skills required to progress this type of project are as important as scientific and engineering skills (Golet et al. 2007). During the course of the project many people, both from agencies and the town, were upset. None of the groups were completely satisfied with the outcomes. It was important to allow individuals to express their anger, frustration and opinion without loosing sight of the common goal. At first, county people were angry that NYSDOT did not step forward sooner. The townspeople were angry that the government did not just fix the problem. The NYSDEC wanted to restore the environment; NYSDOT wanted to maintain the roads and bridges. Everyone had to communicate and to compromise. In the end, it is rewarding to see the townspeople take control of their own lands and creek, and government agencies work with them to improve the situation. It is important to remember, however, that cooperation among people and groups with very different goals and missions requires continual effort. The story is not yet finished and the final outcome is not a given.

Because this is a new method of responding to a problem, it requires administrative and budgetary flexibility and innovation. An agency participating in a watershed partnership cannot disregard legal mandates for procurement or project design and construction. However, it can innovatively use existing organizations and administrative mechanisms to support common goals. For example, to address severe flooding problems in a timely manner, NYSDOT coordinated considerable expertise in its Main and Regional offices. Other agencies might have had to contract with consultants to receive the same expertise but NYSDOT was able to access this information in real time through intra-agency cooperation.

Once the watershed group developed suggested solutions, NYSDEC and USACE could approve required permits in a more timely manner because they were participating in the problem solving. They were not waiting in a remote office for a proposal to arrive.

NYSDOT's Chenango Residency provided another element of flexibility. The Residency has supplies, materials and staff who are highly trained in operating heavy equipment. As improvement plans were developed, the Residency staff could undertake improvements in real time. The watershed committee could evaluate the improvements as they went along and not have to wait until the end of a large construction contract.

Thirdly, the risk assessment methodology used to prioritize the sites for remediation is a simple, easy to use adaptation of classic risk assessment methodology. Typically, the risk severity and probability are used to make a table in which high risk-high probability events occupy one corner and low risk-low probability events occupy the opposite corner (Manuele, 2006; Mattson and Angermeier, 2007). In this case, the sites were ranked high, medium or low based on the amount of damage that failure of the site would cause to private homes or public infrastructure. They were also ranked high, medium or low based on how easily they could be fixed. The ease of fix took into account the design simplicity, site accessibility and the cost of construction, technical solutions and maintenance. The sites that had a high priority and were easy to fix occupied one corner of the table, and the sites that had a low priority and were hard to fix occupied to opposite corner of the table. Obviously, the high priority, easy to fix sites should be addressed first. The low priority, hard to fix sites may never get addressed. Eventually, however, it is necessary to address the high priority sites that are difficult to fix.

Finally, this project offers an opportunity to evaluate the effect of the practices that are used, as well as the structures that are installed, in the watershed. NYSDOT has detailed records of the two bridges in the project. These records have been kept for many years. Once the stream restoration efforts have been implemented the effect of these efforts on DOT infrastructure can be monitored and documented. This is important because, although there is an abundance of anecdotal evidence in support of environmental practices, fewer studies have been published in peer-reviewed journals.

The story of the Canasawacta Creek Project is one example of a watershed approach. The watershed approach provides a mechanism to solve problems on a smaller scale, and to break a big problem into bite size chunks. The approach requires expertise, dedication, hard work and a great deal of flexibility. It requires everyone to communicate and to cooperate. It offers an alternative to the status quo and the way things have been done in the past seventy-five years. Critical evaluation of the long term effect of the stream restoration techniques used in this project remains to be done.

Table 1: Summary of Findings - Summer 2006

location	priority	Ease of fix	Description of problem	Possible intervention	Actions
10 + 500 Ashcroft Rd	high	easy	Bank erosion threatens Route 23	Clear obstruction; armor bank upstream and downstream from work done in 2004; use rock vanes and/or stream bank plantings	DOT, 2007
11 + 500	low	Medium/ easy	6 to 12 foot high bank erosion		
15 + 000 to 15 + 500	high	easy	Flooding on Route 23	Deepen and narrow cross section to provide greater channel capacity and improve sediment transport; rock vanes to protect bank	DOT, 2006
18 + 500 Moon Hill Rd	high	Medium/ difficult	Right bank erosion, up to 10 feet high; gravel bar formation; drainage from small trib and pipe culvert	Re-grade rt bank (2:1); possibly protect with rock vane; vegetate bank;	Soil and Water District seeking funding
BIN 1017430 bridge	low	medium/ easy	Scour; top 2 feet of foundation at left abutment is exposed	Scour protection; possibly protect with rock vane upstream; leave vegetated bank downstream from bridge	
Bridge to 20 + 100	high	difficult	Rt bank erosion; very high left bank erosion (50 foot esker)	Move stream channel away from esker; rock vanes to maintain alignment and dissipate energy	
21 + 500 to 22 + 200	high	medium/ difficult	Grade control rock structure; backwater: flow.overflow right along back of houses	Remove dam-like structure to prevent backwater from causing excess deposition and flow divergence; install bank protection along rt bank	
BIN 1017420 "new" **bridge**	high	Easy	Streambed aggraded under the bridge; backwater downstream from bridge	Remove material from under bridge	DOT, 2006
Bridge to 24 + 000 telephone pole	high	easy	Rt bank erosion; left bank erosion; debris	Adjust upstream approach to bridge; grade left bank; create bankfull bench; rock vanes to relieve bank stress	DOT, 2006
24 + 200	low	easy	Right bank failure	Rock vanes and stream bank plantings	
24 + 700 to 25 + 000	medium	easy	Left bank failure	Rock vanes and stream bank plantings	
27 + 000 to 27 + 200	low	easy	Bank erosion	Rock vanes and stream bank plantings	
28 + 200	low	medium	Right bank erosion; potential for increased erosion	Rock vanes to direct flow away from right bank	
29 + 000	Low	Easy	Left bank erosion	Bankful bench and rock vanes	
32 + 000	low	Easy	Erosion due to cattle use	Cattle fencing; stream bank planting	
35 + 000	low	difficult	Tall eroding/slumping right bank	Willows on slope; bankful bench and rock vanes	

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Biographical Sketches: Mary O'Reilly, PhD, CIH, CPE, received her doctorate in Human Anatomy and Cell Biology from the University of Michigan. After completing her post doctoral work which addressed chemical-viral co-carcinogenicity, Mary worked as an environmental toxicologist at Syracuse Research Corporation. She has worked as an industrial hygienist for the New York State Department of Labor and currently works as an environmental specialist for the New York State Department of Transportation. She has served on the Board of Directors for the American Board of Industrial Hygiene and as a voting member of the AMSI Z-10 Committee, and currently serves on the Board of Directors for the American Conference of Governmental Industrial Hygienists. Mary is on the faculty of the SUNY School of Public Health as well as the advisory board of the Institute for Health and the Environment. Her current interests include phytoremediation, water quality, herbicide application, life cycle analysis, brownfields and risk assessment and has numerous publications. Outside of work she practices and teaches Tae Kwon Do and plays the Irish harp.

Brandon F. Greco, MS, is an Environmental Specialist in the Water/Ecology Section of NYSDOT's Environmental Analysis Bureau. Previous to his employment at NYSDOT, Brandon served as a Natural Resource Specialist and Field Manager at the Albany County (NY) soil and Water Conservation District, and as an Environmental Scientist at KCI Technologies, Inc., in Raleigh, NC. He has been involved with several geomorphic stream assessments and ecological restoration projects throughout the Southeast US and New York State. Brandon has completed the full suite of training offered by David Rosgen (Wildland Hydrology, Inc.). His formal education includes a Bachelor of Science degree from the New York State College of Environmental Science and Forestry at Syracuse, and a Master of Forestry degree from North Carolina State University.

David S. MacEwan is Geographic information Systems Coordinator for NYSDOPT Region 9, a position he has held for 12 years. He is responsible for software and application support, data collection efforts, and special mapping projects. Dave was honored with an NYSDOT Excellence in Engineering award for the development and publication of a multi-region bike route map, which he displayed at the 2002 ESRI User Conference. Dave has also been Regional Web Content Coordinator since 2001. He spearheaded a contemporary redesign of the regional intranet in 2002 and managed a highly successful public website for a major NYSDOT construction project in 2004-05. Dave is currently completing a Master degree in Geography at Binghamton University (SUNY). His MA project involves spatial analysis of emergency animal shelters in Broome County, New York, in light of record region-wide flood events in 2006.

John Rowen, MPA, is the vegetation and environmental program manager for NYSDOT's Office of Operations Management, a position he has held for three years. He oversees vegetation management and environmental stewardship programs, including the Green and Blur Highways Initiative, undertaken by operations forces throughout the State. The position includes budget preparation, training programs, contract management and helping operations staff advance environmental stewardship activities. Before taming this position, he worked on NYSDOT's High Speed Rail Program, special projects concerning transportation and the environment and served in the New York State Division of the Budget as a capital budget examiner for the Department of Environmental Conservation, statewide energy programs and several design and construction agencies. He is a free-lance writer and broadcaster who specializes in book review and features on authors, fishing and other outdoor topics.

George H. Long, MS, PE, is a professional engineer licensed in New York and works as a hydraulics engineer with the New York State Department of Transportation. He performs hydrologic and hydraulic analyses and provides oversight and assistance throughout the state. His work focuses on the development of engineering and operational policies to meet program needs including stream stabilization and restoration, slope protection and bridge hydraulic design issues. George has served on the Standards Subcommittee of the NYS Conference on Local Bridges since 1995. He received the NYSDOT Excellence in Engineering award in 2003 and has authored numerous papers.

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