Executive Summary

A meander analysis was developed to characterize the degree of streambank erosion on specific segments of the Genesee River in the Town of Caneadea, Allegany County, New York. This technique enabled the identification of river bank segments that should be considered for restoration. A project design and cost for each of the 17 segments evaluated was developed.

These designs and the use of an evaluation matrix allowed for the establishment of the priority order of restoration for each segment. The evaluation of these restoration projects will be used to select which projects should be brought forward for submittal to funding agencies.

The primary project attributes that provided distinctions between sites were whether or not the project was associated with an agricultural operation, the landowner had been contacted and was interested, and the project score on the decision matrix.

Five projects were identified as the top priority projects based upon the analysis conducted. One of those projects (Site 2A) was designed and estimated to the level necessary for submittal to a funding agency. A detailed project proposal was developed in anticipation of submittal to several funding agencies in the next six to eight months.

Introduction/Background

Streambank erosion is a major contributor to the sediment and nutrient loading in the Upper Genesee River. Given the steep topography and soils of the area, some streambank erosion and the associated sediment and nutrient load would be expected. However, human influences on the watershed and riparian areas exacerbate this erosion. Recent monitoring and modeling studies by SUNY Brockport (1) also suggest streambank erosion and the presence of agricultural lands without riparian buffers as causes of increased sediment and nutrient loading in this section of the river. The modeling studies suggest that a streambank stabilization program would effectively reduce the sediment and nutrient loads of the Upper Genesee River.

Streambank restoration projects are currently being investigated and funded on an ad-hoc basis. Genesee RiverWatch feels that we need to have a prioritized plan of projects to cover the whole upper watershed but agree we should start smaller with the section of the river near Houghton, NY (See map on Page 4.). This is a section that was identified in the SUNY Brockport (2013) study. In addition to the plan this project will result in the definition of several shovel-

ready projects that will be submitted in response to subsequent requests for proposals, including GLRI. Lessons learned here will also help us develop the larger watershed plan.

There are three overarching plans that recommend and support streambank stabilization as a means to reduce sediment and nutrient loads to the Genesee River. They are the:

- New York Great Lakes Basin: Interim Action Plan (2);
- Genesee River Watershed Plan (3); and
- Great Lakes Restoration Initiative Action Plan II (4).

New York Great Lakes Basin: Interim Action Plan: The New York State Department of Environmental Conservation (NYSDEC) established the *New York Great Lakes Basin: Interim Action Plan* in July 2014. Two of the ten goals in that document refer to streambank erosion/stabilization:

- *Goal 2*: Control sediment, nutrient and pathogen loadings so that water quality is protected, desired aquatic biotic communities flourish, humans and wildlife are protected from coastline health hazards, and natural processes are sustained.
- *Goal 3:* Conserve and restore native fish and wildlife biodiversity and habitats to achieve and sustain resilient ecosystems and vibrant economies. The sediment reduced by this project in the Genesee River supports the efforts to reintroduce sturgeon in the Lower portion of the Genesee River.

These goals have been established so that drinking water quality is protected, desired aquatic biotic communities flourish, humans and wildlife are protected from coastline health hazards, and natural processes are sustained. Although water quality in the open waters of the lakes has greatly improved in recent decades, it remains an ongoing concern in the nearshore environment, where most people interact with the water. Poor water quality in nearshore areas, including embayments (bays, river mouths and wetlands), impacts aquatic life, limits recreational use, and ultimately affects economic development in the region.

Genesee River Watershed Plan: In August 2014 NYSDEC published *Addressing Phosphorus and Sediment in the Genesee River Basin: A Synopsis of Existing Reports to Meet EPA's Nine Elements of a Watershed Plan.* This document outlines the work done and further actions necessary to reduce the sediment and phosphorus loadings in the Genesee River Basin in order to meet water quality goals in the Genesee River and nearshore areas of Lake Ontario.

SUNY College at Brockport also produced a series of reports which characterized the loads and sources of phosphorus and sediment for the entire Genesee River basin (Makarewicz J. C., et al., 2013). Those investigations were built upon flow measurements and an intensive water quality sampling and analysis program over several years. Calibrated Soil Water Assessment Tool (SWAT) models were developed using those data. Those models were then utilized to further identify and allocate sources of sediment and phosphorus and estimate potential load reductions from various management practice scenarios.

These recent studies by SUNY Brockport (2013) have shown that soil erosion in the Upper Genesee River Basin contributes to the excess sediment and phosphorus seen in the Genesee River and the nearshore water of Lake Ontario. Additionally, this project can act as a demonstration site for future streambank stabilization/riparian buffer projects in the watershed. Riparian buffers are currently underutilized in this area. Successful projects will help increase their implementation. This project will also contribute to achieving the goals of the three existing conservation plans discussed here.

Great Lakes Restoration Initiative Action Plan II: Under *GLRI Action Plan II* (Dated September 2014), federal agencies and their partners plan to focus on reducing nutrient runoff in watersheds targeted through the GLRI science-based adaptive management process. The work will:

- Advance drinking water source protection.
- Increase voluntary agricultural conservation practices to achieve downstream water quality improvements.
- Track nutrient and sediment reductions achieved through conservation practices.
- Use voluntary, incentive-based and existing regulatory approaches to reduce nutrient losses.
- Encourage producers and agribusinesses to adopt innovative technologies and approaches to reduce nutrient runoff and soil losses.
- Educate agricultural producers about the links between long-term productivity, nutrient conservation and water quality.

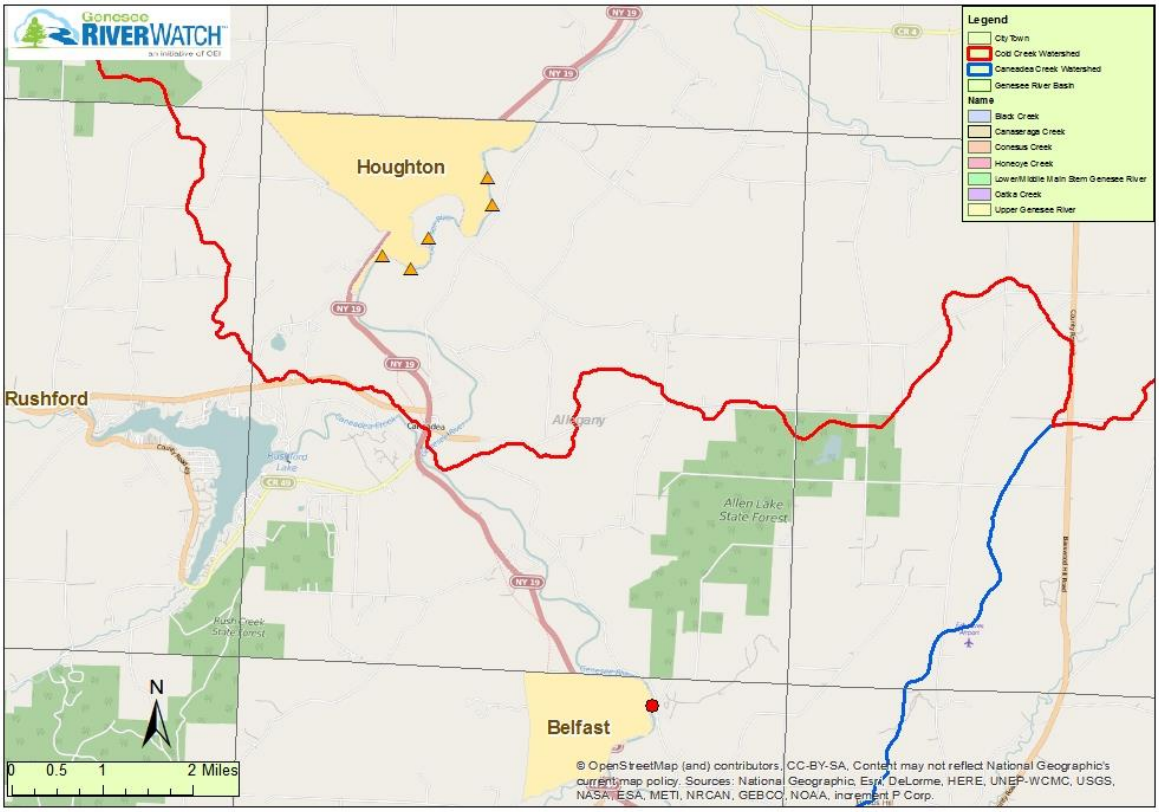
The USEPA has emphasized that nutrient runoff reduction projects should be evaluated on an annual basis to prioritize the type, location and longevity of future nutrient reduction work. In addition, GLRI partners should assess the extent to which harmful algal blooms are impacted by phosphorus loading, in-lake mixing, climate change and invasive species.

Approach

The objective of this study was to create a streambank restoration plan for the Upper Genesee River watershed for the study area described below. Our intent was to assess that section of the river to determine segments that had significant bank erosion, identify restoration options, estimate the cost and feasibility of those options, and create a plan document that recommends a priority for implementation.

The study area was defined as the portion of the Upper Genesee River Watershed within the borders of the Town of Caneadea. This was done to limit the scope of our investigation to a manageable area and to ensure the techniques we developed work and can be successfully applied to other portions of the river in the future.

Study Area – Town of Caneadea, Allegany County, New York



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NOTE: The yellow triangles in the above map indicate sites along the river that were identified in the SUNY 2013 study as those with significant streambank erosion.

The overall approach to this project was to:

1. *Build Partnerships* – Work with stakeholders to discuss the scope of this plan and their involvement in the process of developing the plan.
2. *Identify Critical Areas* – Use aerial imaging, GIS, work of others, and site visits to identify the sections of the river that need restoration.
3. *Solicit Landowner Interest* – Solicit landowners associated with the critical areas identified above to participate in the investigation of alternatives.
4. *Select Best Restoration Options* – Identify technically and economically feasible bank stabilization and riparian buffer restoration options for each section of the river.
5. *Prepare Plan* – Create an Upper Genesee River Bank Stabilization Plan.

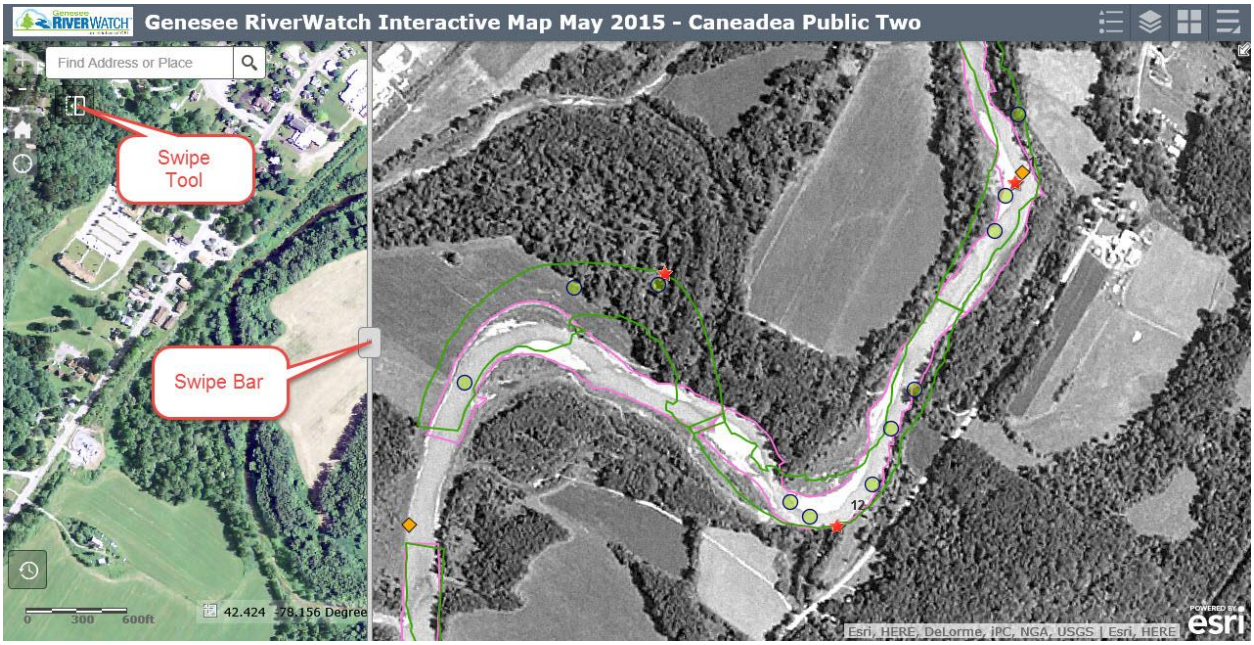
Build Partnerships: CEI initially established a working agreement with the Allegany County Soil and Water Conservation District (ACS&WCD). They are a key resource for understanding soil erosion and streambank issues for the Genesee River. After that we made contact with the US Army Corps of Engineers (USACE) and the Natural Resource Conservation Service (NRCS) to inform them as to the scope of this study and solicit their interest in being involved. Both agreed to participate. NRCS offered to provide an individual to help farmers we identified as having priority streambank stabilization opportunities with access to their program of agricultural best management practices funding available via the Great Lakes Restoration Initiative. USACE offered their expertise on streambank restoration and sediment modeling.

Identify Critical Areas: The previous work of SUNY Brockport, our own knowledge of the area, and the extensive knowledge of the ACS&WCD and USACE led us to focus on study area within the town of Caneadea. To refine that information we decided to use a "swipe tool" in ArcGIS developed by ESRI to help us identify segments of the river in the study area that had seen the most loss of land. This tool enabled our team to quantify and visualize the number of acres of land that were lost by erosion.

ESRI describes their Swipe widget as a tool that enables the user to easily compare the content of different layers in a map. It provides horizontal, vertical and spyglass view modes. You can slide the swipe tool or move mouse around to reveal the content of another layer. They suggest that you may want to use it to show before-and-after imagery of a flood, or display two related thematic layers in a map. We chose to use it to show the before and after of the relative position of the river bank from 2003 and 2013.

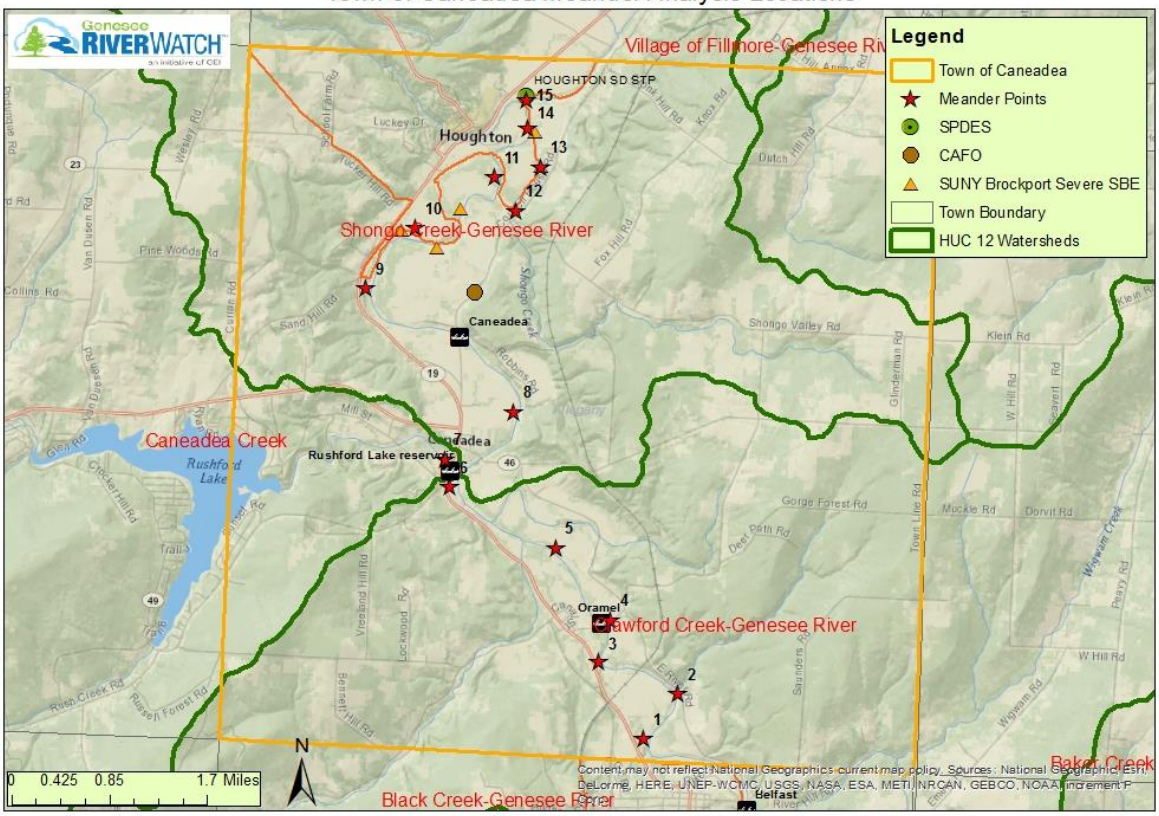
The analysis was based upon a ten-year period from 2003 to 2013. All of the analysis is stored on our website in a restricted access section. All team members had access to this information which facilitated their understanding and analysis of the meanders in the study area. Provided below is a screen shot of the output of that analysis for site 10. The results of the complete analysis will posted on our website in the near future.

Screen Shot of Swipe Tool Output for Site 10



Once that analysis was complete and reviewed by the team, we took a paddle trip on the river to see first-hand and photograph the erosion at each site. The detailed results of that trip can be found on our limited-access webpage. This working group portion of our Genesee RiverWatch website is also the archive location for the detailed results of this analysis. The map below shows the location (red stars) of all of the sites that were evaluated.

Town of Caneadea Meander Analysis Locations



<u>Solicit Landowner Interest:</u> When this project was originally envisioned we felt that a major aspect of the prioritization of each site would be landowners interested and willing to consent to the restoration of their portions of streambank along the river. Our ACS&WCD partners felt that all landowners would be interested in restoring their streambanks especially since we were going to apply for funding to implement those projects. We were able to make direct contact with three landowners in the study area:

- Houghton College (Site 14);
- Town of Caneadea (Sites 6, 7 & 15);
- Edelweiss Land, LLC (Sites 11 & 15); and
- Marshacres, LLC. (Sites 2A, 4, 5 & 10)

These landowners expressed a keen interest in the segments in which they had a stake in the reduction of erosion.

Select Best Restoration Options: Our team brainstormed a list of criteria we felt might be used to decide which streambank restoration opportunities to pursue. That list (below) provided us with an initial indication of the important issues involved with making such a decision.

1. Landowner consent
2. Farmland saved
3. Severity of erosion
4. Ease of implementation
5. Degree of impact of restoration
6. Degree of difficulty to mobilize
7. Amount of habitat generated
8. Size of buffer
9. Degree of difficulty to permit
10. Percent match by landowner
11. Pounds of sediment
12. Pounds of phosphorus
13. Cost
14. Probability that it will last
15. Potential infrastructure impact
16. Complexity of project

This list was consolidated to include the following criteria:

Criteria	Description	Units
Ease of Implementation	How easily could the project be implemented?	Low, Medium, High
Land Lost	The amount of land lost over 10 year period	Acres
Restoration Cost	The cost to restore the streambank	$
Poor Riparian Area	Portion of riparian area that is poor or non-existent	%
Infrastructure Impact	Potential future impact on infrastructure	Low, Medium, High
Cost Effectiveness	Cost of effectiveness of restoration	$/acre
Phosphorus Reduced	Phosphorus reduced by restoration per year	Pounds
Sediment Reduced	Sediment reduced by restoration per year	Tons

Each decision criteria needed to be scored for each site. The table below provides an explanation as to where each value was derived.

Criteria	Value
Ease of Implementation	Professional judgment by design engineer as to the degree of difficulty associated with the restoration of each site based upon a site visit and meander analysis.
Land Lost	Number of acres of land lost as calculated from meander analysis using ArcGIS data.
Restoration Cost	The total cost to design, permit, construct and monitor the restoration of each site as estimated by design engineer.
Poor Riparian Area	The percentage of cultivated riparian area along the entire meander using areal imaging and site visits.
Infrastructure Impact	Team judgement as to the degree to which infrastructure (house, road, bridge, etc.) may be impacted from continued erosion at each site.
Cost Effectiveness	Dollars per acre of land lost as calculated by dividing the "Restoration Cost" by the "Land Lost".
Phosphorus Reduced	Pounds of phosphorus reduced per year as estimated from EPA's STEPL* model.
Sediment Reduced	Tons of sediment reduced per year as estimated from EPA's STEPL* model.

* The USEPA describes their Spreadsheet Tool for Estimating Pollutant Load (STEPL) as tool comprised of simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). It provides a user-friendly interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies

Restoration Costs: Most of the values for the parameters in the table above are self-explanatory. However, the "Restoration Costs" warrant further description. The actual costs estimated for each site are shown in APPENDIX A and were based upon several considerations including:

- Specific geomorphological considerations at each site;
- Knowledge of various streambank stabilization techniques with emphasis on bioengineering techniques;
- Previous work by others in the Genesee River Basin;
- Specific cost information obtained from local suppliers based upon the site design;
- Previous work published by others on similar projects; and
- Review by our team.

The major components of cost for each site restoration estimate were:

- Project Management – Reporting, meetings, notes, dissemination and collection of bid packages, and cost control.
- Engineering Design – Restoration design, materials selection and drawing creation.
- Environmental Permitting – Regulatory review, preparation of permit, review with regulatory agencies, and final documentation.
- Bid Packages – Preparation of bid packages, review, and selection of contractors.
- Construction – Field work to complete construction as designed and permitted.
- Post Construction Monitoring – Prepare post-construction monitoring plan and conduct monitoring as agreed.

Our design engineer has established a preliminary design for each streambank segment based upon field measurements, conversation with the landowner, and review of the GIS information from our meander analysis. He estimated the cost of his design based upon his previous experience on restoration projects, obtaining materials and excavation estimates from local providers, and similar work by others in the region. His design includes the use of bioengineering technologies including: riparian zones, tree plantings, etc.

Bioengineering techniques use natural materials and certain riparian vegetation as a strategy to control bank erosion and promote longer-term stability of the river channel and banks, while attempting to minimize the adverse effects of stabilization when possible. Riparian vegetation is used as a means of erosion control. Vegetative growth reduces local velocities against the bank, thereby reducing near bank shear stress. After time, as the vegetation grows and matures, the hard mass provided by plant roots can provide protection from erosion and collapse and increase internal bank strength.

Techniques designed to increase a bank's resistance to the force of water function in much the same way as traditional hardening techniques, such as gabions, riprap and concrete, by "armoring" a riverbank with materials that are more resistant to the force of water than native, in situ soil. Natural materials, such as coir (coconut husk) fiber, provide flow resistance while also serving as a substrate for plant growth, or incorporate interstitial space to provide ground contact for rooting plants. Bioengineering techniques and traditional hardening methods are not exclusive of each other and can be used in conjunction with traditional hardening methods to provide the most effective strategy for bank stability.

In this study area bank stabilization methods were applied to only discrete portions of the banks along a given stretch of a river, which reduces the adverse ecological impacts compared to stabilizing the banks throughout the entire stretch of a river. This partial or intermittent bank stabilization approach focuses on the areas with the greatest need for stabilization. Since many bioengineering techniques are specifically designed to reduce flow velocities, dissipate energy, and reduce erosional forces along the banks on which they are applied rather than simply deflecting the river's energy upstream or downstream, they are consistent with intermittent

bank stabilization because they mean that the stabilization design for particular sections of riverbank can minimize energy displacement that could affect nearby riverbank segments.

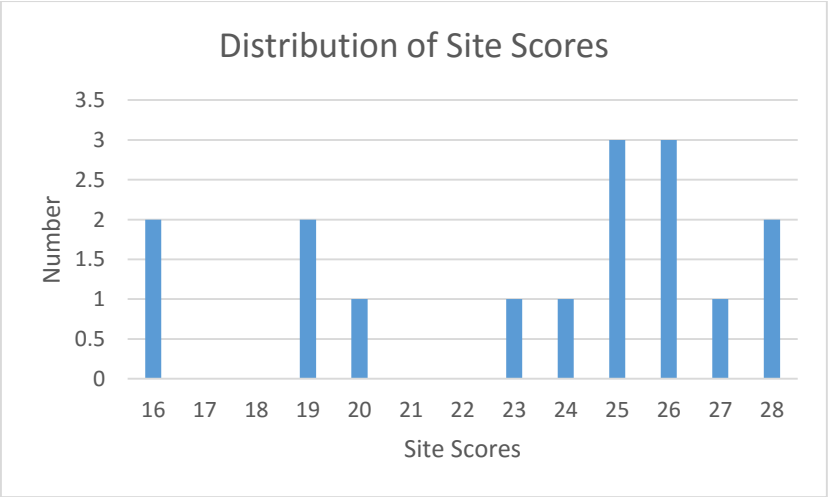
The team assembled for this project consists of the following people:

> Scott Fonte, PE – Professional engineer with extensive experience designing and building streambank stabilization projects.
> Wayne Howard – GIS analyst/environmental scientist with significant experience with GIS mapping and watershed modeling.
> Peter Lent – Retired NYSDEC permit administrator, Oatka Creek Watershed Committee Chairmen, and aquatic biologist.
> Ryan Paulsen – District Technician, Allegany County Soil and Water Conservation District.
> George Thomas – Senior environmental engineer with experience in environmental permitting, watershed plan development, restoration scenario evaluation, and project management.

Results and Analysis

All of the values for each site evaluation criteria are shown in **APPENDIX A**. The matrix score for each site is provided in **APPENDIX B**.

The site scores were looked at in a variety of ways and the histogram below provided the most useful distinction between sites. It shows that there is a grouping of project sites with a score greater than 24 that should be given closer consideration and higher priority. The sites with scores greater than 24 are: 1, 2A, 4, 5, 6, 7, 8, 10, 10A & 11.



In addition to the matrix scores our project team extensively reviewed the meander analysis, photographs, GIS data, and local knowledge. Ultimately, the primary project attributes that provided distinctions between projects were:

- Was the project associated with an agricultural operation?;
- Had landowner been contacted and were they interested?; and
- Did the project score relatively high on the decision matrix?

The site score was used in part of the analysis but other criteria were used to make distinctions between projects. Each of the projects were placed into the six priority categories described below.

1. Priority 1 projects are those that are on agricultural land, have landowner commitment, and have a high score (>22) on the decision matrix (This is due to the fact that most of the available funding for streambank restorations projects is allocated for agricultural operations.)
2. Priority 2 projects are those that are on non-agricultural land, have landowner commitment, and have a high score (>22) on the decision matrix
3. Priority 3 projects are those that are on agricultural land, do not have landowner commitment, and have a high score (>22) on the decision matrix
4. Priority 4 projects are those that are on non-agricultural land, have landowner commitment, and have a low score (≤22) on the decision matrix
5. Priority 5 projects are all the rest

This table summarizes where each site fits within this prioritization scheme.

Priority	Agricultural	Owner Interested	Score >22	Sites
1	X	X	X	2A, 4, 5, 10, 11
2		X	X	6
3			X	1, 7, 8, 10A
4		X		14 & 15
5				5B, 9A, 12, 13, 14A

As Priority 3 project site landowners are contacted in the future they will be moved to the first priority category depending upon their interest. Site 7 could become a Priority 1 because it has the potential to impact the Route 19 Bridge south of the village of Caneadea. In this case the Town of Caneadea and the NYS Department of Transportation could become interested stakeholders on this project in addition to the actual landowners. Follow up with the Department of Transportation and Town of Caneadea will clarify the priority of this site. Most

of the erosion that occurs at this site is the result of the annual draining of Rushford Lake when the stream runs fast and high for a few weeks in the fall.

Conclusions

A meander analysis was developed to characterize the degree of streambank erosion on specific segments of the Genesee River in the Town of Caneadea, Allegany County, New York. This technique enabled the identification of river bank segments that should be considered for restoration. A project design and cost for each of the 17 segments evaluated was developed.

These designs and the use of an evaluation matrix allowed for the establishment of the priority order of restoration for each segment. The evaluation of these restoration projects will be used to select which projects should be brought forward for submittal to funding agencies.

The primary project attributes that provided distinctions between sites were whether or not the project was associated with an agricultural operation, the landowner had been contacted and was interested, and the project score on the decision matrix.

Five projects were identified as the top priority projects based upon the analysis conducted. One of those projects (Site 2A) was designed and estimated to the level necessary for submittal to a funding agency. A detailed project proposal was developed in anticipation of submittal to several funding agencies in the next six to eight months.

Upon completion of this plan Genesee RiverWatch will provide the results of our meander analysis on our website at: www.geneseeriverwatch.org .

References

(1) Makarewicz, Joseph C.; Lewis, Theodore W.; Snyder, Blake; and Smith, William B., "Genesee River Watershed Project. Volume 2. Water Quality Analysis of the Upper Genesee River Watershed: Nutrient Concentration and Loading, Identification of Point and Nonpoint Sources of Pollution, Total Maximum Daily Load, and an Assessment of Management Practices using the Soil Water Assessment Tool (SWAT) Model. A report to the USDA." (2013). *Technical Reports.* Paper 125.
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http://www.dec.ny.gov/docs/water_pdf/geneseeninelement.pdf

(4) "Great Lakes Restoration Initiative Action Plan II, United States Environmental Protection Agency, September 2014
http://greatlakesrestoration.us/actionplan/pdfs/glri-action-plan-2.pdf

(5) USEPA Spreadsheet Tool for Estimating Pollutant Load (STEPL)
http://it.tetratech-ffx.com/steplweb/

APPENDIX A: Decision Matrix

Criteria	1	2	3	4	5	Value
Ease of Implementation	Low		Medium		High	
Land Lost (Acres)	< 1	>1	>2	>3	> 4	
Restoration Cost ($)	> 400,000	300,000	200,000	100,000	< 100,000	
Poor Riparian Area (%)	< 20%	20	40	60	> 80%	
Infrastructure Impact Potential	Little		Medium		High	
Cost Effectiveness ($/acre)	>200,000	175,000	150,000	125,000	<100,000	
Phosphorus Reduced (#/yr)	<50	50	100	1500	>200	
Sediment Reduced (TPY)	<50	100	200	300	>400	
					Project Score:	

APPENDIX B: Decision Matrix Raw Data to Support Scoring

DECISION CRITERIA	Site 1	Site 2A	Site 4	Site 5	Site 5B	Site 6	Site 7	Site 8	Site 9A	Site 10	Site 10A	Site 11	Site 12	Site 13	Site 14	Site 14A	Site 15
Ease of Implementation:	5	4	1	1	5	5	4	2	3	5	3	3	3	2	4	3	4
Land Lost (Acres):	2.8	0.76	2.7	4.92	1.78	4.01	1.91	5.69	1.26	2.58	4.33	15.58	1.64	3	1.08	1.64	1.3
Soil Lost (k-ft3):	488	331	1176	1715	310	873	499	2479	164	562	1132	4072	286	653	188	286	340
Restoration Cost ($k):	165	148.5	330	345	75	187.5	123.7	330	87.5	270	429	330	300	200	60	120	63.8
Poor Riparian Area (%):	50	90	90	90	20	50	80	20	50	90	90	50	30	20	20	50	30
Infrastructure Impact Potential:	4	1	1	1	3	4	5	3	4	1	1	1	3	2	3	1	2
Cost Effectiveness ($/acre):	59	195	122	70	42	47	65	58	69	105	99	21	183	67	56	73	49
Phosphorus Reduced (#/yr):	44	99	241	201	22	68	49	241	23	99	171	236	66	55	18	35	33
Sediment Reduced (tons/yr):	84	188	460	385	42	131	94	460	44	188	326	451	125	105	33	67	63

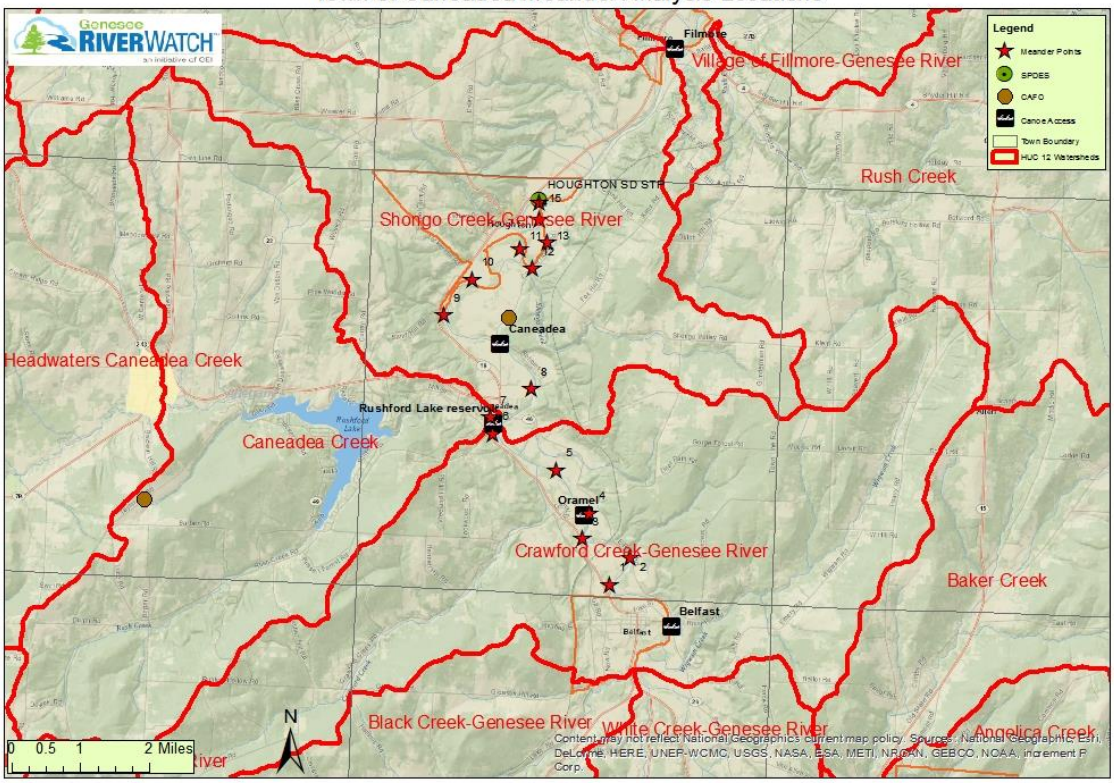
APPENDIX C: Decision Matrix Scores

DECISION CRITERIA	Site 1	Site 2A	Site 4	Site 5	Site 5B	Site 6	Site 7	Site 8	Site 9A	Site 10	Site 10A	Site 11	Site 12	Site 13	Site 14	Site 14A	Site 15
Ease of Implementation:	5	4	1	1	5	5	4	2	3	5	3	3	3	2	4	3	4
Land Lost (Acres):	3	1	3	5	2	5	2	5	2	3	5	5	2	3	2	2	2
Restoration Cost ($):	2	5	2	1	3	1	4	2	5	3	2	1	2	2	2	2	2
Poor Riparian Area (%):	3	5	5	5	1	3	4	1	3	5	5	3	2	2	2	3	2
Infrastructure Impact Potential:	4	1	1	1	3	4	5	3	3	1	1	1	3	2	3	1	2
Cost Effectiveness ($/acre):	4	4	4	5	4	3	4	5	5	4	5	5	3	4	1	3	1
Phosphorus Reduced (#/yr):	1	3	5	4	1	2	1	5	1	2	2	5	2	2	1	1	1
Sediment Reduced (tons/yr):	2	2	5	4	1	2	2	5	1	2	4	5	2	2	1	2	2
TOTAL SCORE:	24	25	26	26	20	25	26	28	23	25	27	28	19	19	16	17	16

APPENDIX D – Site Descriptions

Site	Comments	Description
1	Good candidate segment: easy access, simple	Sandy upper bank, sandy gravel base
2	Bendway wiers have helped this location. Eliminate from further consideration.	Has held up well for 10 years
2A	Owner is very interested in doing something with this site	Sandy upper bank, sandy gravel base
3	Bendway wiers have helped this location. Eliminate from further consideration.	Has held up well for 10 years
4	Clay section, channel is deep, lots of material to move, easy access	Sandy upper bank, sandy gravel base
5	Clay toe,	Sandy upper bank, sandy gravel base
5B	Near Rt. 19	Sandy upper bank, sandy gravel base
6	Town owns, canoe access spot	Check right bank downstream of site 5
7	Rushford Lake drainage annually could be a problem, bridge impact in future	Left bank Caneadea Creek
8	60 foot drop to river in one section, road washed our partially	Sandy upper bank, sandy gravel base
9	No signs of erosion. Eliminate from further consideration.	Sandy upper bank, sandy gravel base
9A	Warrants a closer look	Sandy upper bank, sandy gravel base
10	No clay, good access	Sandy upper bank, sandy gravel base
10A	Some clay, looks doable	Sandy upper bank, sandy gravel base
11	Largest amount of land lost over study period.	Sandy upper bank, sandy gravel base, one section mostly woody debris
12	Town may be interested, crack in soil	Mostly clay soil
13	Multiple landowners.	Steep sandy bank, clay at base
14	Houghton College interested in this site	
14A	East side of river opposite HC site 14	Right bank across from site 14
15	Upgrade of WWTP included some stabilization. Downstream field unprotected.	After stone at treatment plant site

Town of Caneadea Meander Analysis Locations



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