Ludlowville Stormwater Control Project

Tompkins County Planning Department

Technical Report 2: Alternatives Analysis

October 2010
Revision 1: November 2010

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Prepared for:

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Executive Summary

On behalf of the Ludlowville Stormwater Control Project Team, the Tompkins County Planning Department retained the services of Barton & Loguidice, P.C. (B&L) to prepare a Drainage Study for the Ludlowville area in response to resident requests to address the historical flooding which has impacted the area for many years. The project is sponsored by the Tompkins County Planning Department on behalf of the County's Highway Department and Soil & Water Conservation District, and the Town of Lansing's Highway Department and Zoning/Code Enforcement Office. The focus of this Technical Report #2 is to evaluate drainage improvement alternatives to address the issues that were identified in Technical Report #1 (Existing Ludlowville Stormwater Conditions - March 2009).

Stormwater modeling was conducted in Technical Report #1 to determine the limiting components of the existing drainage system and to provide focus areas for potential remedial alternatives. Technical Report #1 identified several culvert crossings with limited carrying capacities along with areas of severe streambank erosion. The following design alternatives were evaluated:

- **Upstream Detention Analysis** – installation of detention ponds to reduce peak runoff rates throughout the watershed. The ponds would attenuate peak flows and decrease the hydraulic demand on downstream structures.
- **Streambank Stabilization Practices** – to address ongoing stream erosion occurring in proximity to Culvert 12 on Ludlowville Road.
- **Culvert Analyses** –including Culvert 12 (Ludlowville Road), Culvert 18 (intersection of Salmon Creed/Ludlowville Roads), and the Salmon Creek Road Culvert. Each of these culverts was modeled to overtop during existing conditions under specific design storms. The culvert analyses

takes into account upstream watershed modifications (i.e., upstream detention and streambank stabilization practices).

- **Over Bank Flood Protection (Old School House Road) -** Technical Report 1 identified channel overtopping behind the property at 138 Ludlowville Road. The channel is reduced to an 8-foot bottom width by 1-foot deep section just above the waterfall, and is modeled to overtop during the 5-year storm event. This overtopping was evaluated in conjunction with the upstream watershed modifications.

Following a review of alternatives to address each of the above drainage issues, our recommendation is for construction of an upstream detention facility, along with streambank stabilization within the unnamed tributary below Ludlowville Road. While these projects independently provide a number of benefits, when combined together, they provide tremendous flood protection and water quality benefits throughout the study area watershed. The drainage modeling developed as part of Technical Report 1 was reanalyzed based on the recommended alternatives. The updated modeling results of these alternatives indicate a substantial reduction on the hydraulic demand of existing infrastructure. These improvements will reduce peak flows throughout the drainage system, and will minimize the need for downstream drainage structure improvements. To maximize benefits, the upstream detention would contain between 2 to 3 million gallons of storage volume, and the streambank stabilization would consist of hybrid bank stabilization with installation of channel step pools. These recommendations will have to be evaluated in consideration of several additional factors including cost, land use availability, physical and construction feasibility, ease of maintenance, community acceptance and safety.

Following final approval and selection of the improvement alternatives we will progress with Final Design, which will be presented as Technical Report 3.

1.0 Introduction

1.1 Background

Residents of the Hamlet of Ludlowville in the vicinity of Salmon Creek Road, Ludlowville Road, Ridge Road (New York State Route 34B) and Lansingville Road have experienced recurring flood events over the past several years. Flooding has primarily been attributed to spring thaws combined with significant rainfall events that produce stormwater flows that exceed the capacity of the existing drainage system. Flooding has caused damage to public infrastructure (roads and culverts), basements, landscapes, driveways and other personal and public property. In addition, there is ongoing streambank erosion in the unnamed tributary of Salmon Creek that is conveyed below Ludlowville Road. This erosion has caused significant private property loss and sediment loading directly to Salmon Creek and ultimately Cayuga Lake.

Technical Report 1 (March 2009) evaluated the existing drainage conditions within the study area watershed and should be reviewed for additional background information. The attached Figure 1 depicts the basin areas within the overall watershed study area. Technical Report 1 identified the following key findings:

- Basins A and B (Lansingville Road) overtop during a 5-year storm event. Excess flows are routed down Ludlowville Road (Basin C). This, in turn, causes overtopping of the Ludlowville Road culvert (Culvert 12).
- The lower portion of the unnamed tributary also overtops during the 5-year storm event at the crest of the waterfall above the 138 Ludlowville Road property.

- The closed drainage system along the north side of Ludlowville Road overtops during a 5-year storm event.
- The culvert at the downstream end of the Drainage Basin C (Culvert 18) overtops during a 10-year storm event.
- The culvert at the downstream end of the Drainage Basin D overtops during a 25-year storm event. Excess flows are routed onto private property and Salmon Creek Road.
- Streambank erosion continues to progress below the Ludlowville Road culvert leading to annual loss of private property and increased sediment loads to Salmon Creek and Cayuga Lake.

The following alternatives were evaluated to address the drainage issues:

- Upstream detention (installation of stormwater ponds) to reduce peak runoff rates throughout the watershed.
- Streambank stabilization along the unnamed tributary to Salmon Creek (adjacent to Ludlowville Road).
- Hydraulic analyses at three culvert locations including Culvert 12 (Ludlowville Road), the Salmon Creek Road Culvert, and Culvert 18 (intersection of Salmon Creed/Ludlowville Roads).
- Analysis of over bank flood protection at the Old School House Road waterfall behind the property at 138 Ludlowville Road.

Technical Report 2 provides a summary of these alternatives, along with a recommended drainage improvement plan. Technical Report 3 will be prepared following selection of the preferred alternatives by the Ludlowville Stormwater Control Project Team. Technical Report 3 will include the final project design.

2.0 Upstream Detention

2.1 Upstream Detention Alternatives

Currently there are no stormwater detention basins in the study area watershed. The primary study area (Basins A, B and C) totals 183-acres with areas of steep slopes (greater than 20%). Without stormwater detention facilities, there is no control of the runoff rates within the watershed. Stormwater detention facilities, or ponds, can hold stormwater flows and release them gradually over extended periods of time. The ponds are equipped with outlet control structures to regulate the discharge. The detention facilities can reduce peak flow rates, which can assist downstream drainage structures (i.e., pipes or drainage swales) by safely conveying storm flows.

Example Dry Detention Pond
(from fairfaxcounty.g**ov)**

Two alternatives were considered for upstream detention. Both alternatives assumed installation of a stormwater detention pond in Basin B; near the intersection of Lansingville and Ridge Roads. It should be noted that property acquisition for detention ponds has not yet been conducted, and that there are no predetermined locations for pond construction. The location in Basin B was selected solely based on the hydraulic benefit that it provides throughout the watershed. Actual location, if pursued, would be subject to land acquisition.

2.1.1 Upstream Detention Alternative 1: Deep Pond

This option includes construction of a 5.5 acre-feet pond (approximately 1.8 million gallons). The top of berm elevation for this pond scenario is 778 feet with a bottom elevation of 769 feet. The surface area of this pond would be approximately 2.6-acres, and it would be 9 feet deep. The primary outlet was modeled as a 21-inch culvert set at the bottom of the pond, which would convey flow across Lansingville Road to the existing drainage system along Ridge Road. This drainage system ultimately discharges through the Ludlowville Road culvert (culvert 12). Under normal conditions the pond would be dry. During rainfall events the outlet structure would regulate discharges and the pond would temporarily detain water. Based on this configuration, Table 1 summarizes the key drainage characteristics of this pond.

Table 1.
Upstream Detention Alternative 1: Deep Pond

Storm Event	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Pond Elevation (ft)
1	32.0	14.0	771.1
10	128.4	40.9	775.2
50	193.6	80.7	777.8

This pond will provide an approximate 58% reduction in peak flows for a 50-year storm event. The stormwater modeling for this scenario is provided in Appendix A. The constructability of this pond, however, will be a challenge given the available land and grading requirements.

2.1.2 Upstream Detention Alternative 2: Shallow Pond

This pond configuration was selected based upon a more feasible constructability. This option includes construction of a 3.7 acre-feet pond (approximately 1.2 million gallons). The top of berm elevation for this pond scenario is the same as the previous option; 778 feet. The bottom elevation under this scenario is 773 feet. The surface area of this pond would still be approximately 2.6-acres, but it would only be 5 feet deep. The primary outlet was again modeled as a 21-inch culvert set at the bottom of the pond, which again would discharge into the existing drainage system along Ridge Road. Based on this configuration, Table 2 summarizes the key drainage characteristics of this pond.

Table 2.
Upstream Detention Alternative 2: Shallow Pond

Storm Event	PeakInflow (cfs)	Peak Outflow (cfs)	Peak Pond Elevation (ft)
1	32.0	7.8	774.5
10	128.4	56.4	777.7
50	193.6	133.8	overtops

Note: Actual pond volumes and outlet structures would likely be modified during Final Design based on available land use. Outlet structures would be sized to safely pass storm flows.

This pond provides a greater feasibility of constructability given the shallower depths. The stormwater modeling for this scenario is provided in Appendix B. The pond, however, does not provide as much downstream protection as Alternative 1 due to less storage volume provided.

2.2 Downstream Benefits of Upstream Stormwater Detention

The stormwater modeling that was developed as part of Technical Report 1 was reassessed to incorporate the two upstream detention scenarios. Key design points throughout the watershed were reviewed to determine the potential benefits that the upstream detention would provide. The design points included the Ludlowville Road culvert (culvert 12), the Salmon Creek culvert 18, and the Old School House Road waterfall. Table 3 summarizes the impacts at these locations with the two upstream detention scenarios.

Table 3.
Comparison of Peak Discharge Rates with Upstream Detention

Storm Event	Peak Inflow at Culvert 12 (cfs)			Peak Inflow at Culvert 18 (cfs)			Peak Inflow at Old School House Road Waterfall (cfs)		
	Existing	Deep Pond	Shallow Pond	Existing	Deep Pond	Shallow Pond	Existing	Deep Pond	Shallow Pond
1	38.1	16.2	9.8	5.3	5.3	5.3	37.5	16.1	9.8
10	140.7	49.9	61.6	50.8	23.5	23.5	108.0	49.6	59.8
50	236.6	98.1	182.0	130.8	38.2	82.4	108.0	92.6	92.6

Table 4 summarizes the benefits provided by upstream detention in comparison to existing conditions.

Table 4.
Comparison of Downstream Structure Failure with Upstream Detention

Structure Limitations	Frequency of Occurrence		
	Existing	Deep Pond	Shallow Pond
Overtopping of Ludlowville Road Culvert	5-year Event	50-year Event	25-Year Event
Culvert 18 Surcharge	10-year Event	50-year Event	25-Year Event
Old Schoolhouse Road Waterfall Overtopping	5-year Event	Passes the 50-year Event	

2.3 Upstream Detention Permitting Conditions

Since greater than one-acre of soil will be disturbed with either pond alternative, a NYSDEC SPDES Permit for Construction Activities would be required. This permit would require development of an erosion and sediment control plan documented in a site specific Stormwater Pollution Prevention Plan (SWPPP). The SWPPP would be subject to State and Local review. The SWPPP would be limited to erosion and sediment control measures since this would be an environmental enhancement project.

3.0 Streambank Stabilization

Erosion below the Ludlowville Road Culvert

Ideally, the construction of the upstream detention systems would precede the implementation of stream stabilization measures in downstream areas such as the tributary below the Ludlowville Road Culvert. Installation of upstream detention systems will decrease peak flows and erosive velocities in the lower reaches of the watershed, so stabilization requirements may be lessened. However, the land acquisition requirements necessary for construction of the detention facilities and funding logistics may delay installation. The current erosion of the unnamed tributary below Ludlowville Road would continue until the detention facilities could be built. Therefore, we have identified interim measures to be evaluated to limit further erosion and provide immediate stability to this drainage. Streambank stabilization in its own right will provide benefits both in terms of water quantity and quality that flows through the Hamlet to Salmon Creek.

Several site constraints were incorporated into our streambank stabilization analysis. Usually when developing an approach to correcting a stream of this type, the plan would include the design and imposition of a stable stream form which provides appropriate roughness, channel length and size to eliminate excessive erosion. In this instance, this approach is constrained; which required a hybridized approach to addressing the existing, highly erosive condition. These constraints include:

- The drainage flows through several private properties with nearby structures and appurtenant facilities such as septic systems.

- The drainage has eroded the channel down to the bedrock and created severely steep and unstable bank slopes (in some cases steeper than 1 on 1).
- The drainage possesses a steep gradient (approximately 12.5%)

In consideration of the above, the following alternatives were analyzed for remedying the current condition in the unnamed tributary below Lulowville Road:

- Create a Stable Channel Using Natural Stream Channel Design Principles;
- Closed Conveyance;
- Hard Armoring of Drainage Bed and Banks; and
- Hybrid Bank Stabilization with Shaping of Existing Banks and Installation of Step Pools.

The analysis was conducted for the area approximately 360 feet below the Ludlowville Road culvert. Final design would also include limited rip-rap stabilization and analysis of check dam installation above the Ludlowville Road culvert. These additional approaches would provide further reduction of peak flows throughout the watershed, and specifically reduce velocities upgradient from Culvert 12.

3.1 Streambank Stabilization Alternatives

3.2.1 Stabilization Alternative 1: Create a Stable Channel Using Natural Stream Channel Design Principles

Typically, the remedy for an over-steepened, erosive channel such as the tributary below the Ludlowville Road culvert would be to construct a stable channel form with substantial sinuosity to reduce the gradient, reduce flow velocities, and allow for a more controlled movement of bed load. This remedy would require considerable lateral area to accomplish this approach. In this instance the drainage path (total drainage distance) would have to be lengthened by a factor of three to achieve a reasonable gradient. Such a lengthening would demand a wide belt width (distance from one curve apex to the next) and highly compressed curvature to achieve. Earthmoving quantities would be large and encroachment on adjacent structures would likely exceed that which would be acceptable to the landowners. Additionally, the inclusion of a floodplain bench would also increase the width of disturbance resulting in additional losses of usable property by adjacent landowners.

This alternative would also require the highest design and construction costs. Given the extensive loss of private property, coupled with the highest costs, this alternative was not considered for additional analysis.

3.2.2 Stabilization Alternative 2: Closed Conveyance

It is possible to place this drainage into a pipe which would eliminate further erosion. Velocities would be increased and would likely require that this piped conveyance be extended all the way to Salmon Creek to avoid damage to receiving areas. Permitting of such a solution may be problematic as it would result in the loss of existing waters and natural drainage under both Federal and State regulatory frameworks. This approach would also place a high demand on long-term maintenance. This analysis was not further evaluated given the lack of regulatory acceptance it would receive coupled with the maintenance burden.

3.2.3 Stabilization Alternative 3: Hard Armoring of Drainage Bed and Banks

This alternative consists of the placement of rock rip-rap on the bottom and sides of the existing channel to increase channel roughness and limit further erosion of the banks. Some excavation would be necessary to provide room for the stone. No re-vegetation of the banks would be done in this alternative. This alternative may have to be extended downgradient nearly to the confluence with Salmon Creek as it would have little effect on velocities and therefore the potential for additional erosion would be shifted from one location of the tributary to another. While this alternative is the cheapest of the options evaluated here, it may not achieve correction of downstream conditions and may therefore be unacceptable to the stakeholders.

Example of Rip Rap Channel
(from fairfaxcounty.gov)

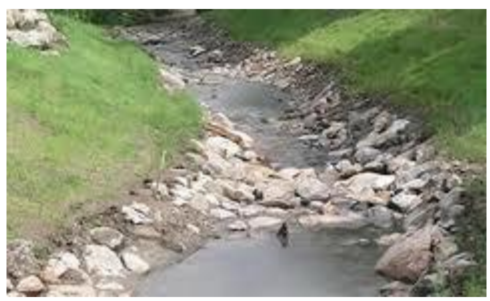
3.2.4 Stabilization Alternative 4: Hybrid Stabilization with Shaping of Existing Banks and Installation of Step Pools

This alternative makes reduced use of rock and increased use of bioengineered techniques for bank stabilization to create a stable channel which would mimic a natural channel and result in a partially vegetated bank. Under this alternative, the existing over-steepened banks would be shaved back to achieve a 2:1 slope. These shaped slopes would be vegetated with a ground cover and potentially other vegetation to prevent further excessive erosion of these soils during periods of high flow. Existing trees and vegetation would be maintained where possible.

Given the high velocities that will continue to be present in this drainage until the upstream detention facilities are constructed, it is necessary to place heavy rock fill in the bottom of the drainageway and on the sides to a height corresponding to that reached by the 50-year rainfall event. The use of this rock will limit erosion, add roughness, and improve the channel geometry by raising the elevation of the channel bottom. This approach will provide water quantity and quality improvements down gradient of culvert 12, including significant benefits at the Old Schoolhouse Road waterfall.

Because the stream cannot be lengthened it is necessary to implement measures to attenuate the high gradient possessed by this drainage. Step pools achieve this by creating “flattened” gradients with hydraulic drops to step the flow down the slope. These step pools allow sediment to drop out of the flow by slowing the water down. They also dissipate energy in the drop pools. This system will help to manage bedload more effectively thereby reducing erosive pressure on the downstream segment of this drainage.

The step pools would be spaced approximately 36 feet apart and would consist of a double row of extra heavy stone fill which will be pinned to the underlying bedrock. Each step would result in a drop of approximately 3.5



Example of Partial Rip-Rap and Vegetated Channel with Step Pools
(from mda.state.mn.us)

feet. The gradient within each pool would be reduced to between 1 and 2 percent and the stream channel would be widened. This would result in shallower, slower flows. This approach would check the current erosion being experienced by the system. The details of this alternative are provided in Appendix C.

This alternative is not the least expensive as it requires additional labor and materials to install the step pool features and has higher material removal quantities to shape the banks, tie-in the structures and provide room for the rock fill. It does have the benefit of being low-maintenance and provides a more natural channel which will support vegetation and improve the aesthetics of the drainage.

3.2 Streambank Stabilization Permitting Considerations

Implementation of the selected alternative will require both NYSDEC and US Army Corps of Engineers permits. The Corps permitting will likely be in the form of a Nationwide Permit 13 – Bank Stabilization. The maximum timeframe for acquiring such a permit is 45 days. The drainage in question is not mapped by the NYSDEC as a stream therefore Article 15 permitting would likely not be necessary for this project. There may be a need for permitting under the NYSDEC stormwater SPDES program if the total disturbance exceeds 1 acre for the project. This permit, if applicable, may require development of a SWPPP as outlined above.

4.0 Culvert Analysis

Technical Report 1 identified three (3) main culverts within the watershed study area that were unable to pass design storm flows (refer to Figure 1). These culverts included the following:

- Culvert 12 (Ludlowville Road): surcharges during a 5-year storm event;
- Culvert 18 (Ludlowville/Salmon Creek Road Intersection): surcharges during a 10-year storm event; and
- Salmon Creek Culvert: surcharges during a 25-year storm event.

The traditional approach to culvert hydraulics would be to create a larger opening to pass the design flows, or reroute drainage away from the undersized culvert. Larger diameter culverts, however, will pass elevated peak flows downstream and exasperate the existing drainage impacts and streambank erosion that is currently occurring. We therefore are not recommending installation of larger culverts within the existing drainage system.

Ludlowville Road Culvert

Culverts are typically designed to pass the 50-year storm in accordance with the NYS Highway Design Manual. Dependent upon the final upstream detention pond configuration, the Salmon Creek culvert may meet this requirement. In addition, excess flows that occur when this culvert surcharges are routed directly to Salmon Creek. Future analysis of culvert modifications at this location, therefore, were not conducted at this time.

Culvert 12 (Ludlowville Road) and Culvert 18 (Ludlowville/Salmon Creek Road Intersection) currently do not meet the NYS Highway Design Manual requirements. Increasing the hydraulic capacity of these culverts, however, will simply cause additional downgradient drainage issues. It has also been determined that rerouting of drainage may not be possible given that the natural drainage paths would require acquisition and drainage easements from the New York State Department of Transportation.

Installation of either of the upstream detention pond scenarios evaluated, would reduce the hydraulic carrying demand on both Culverts 12 and 18. Based on the 1.8 million gallon upstream detention pond, Culverts 12 and 18 will pass the 25-year storm event. It is feasible that both culverts will pass the 50-year storm event with slightly expanded upstream detention. Further evaluation of Culverts 12 and 18 will be conducted during final design after the upstream detention design is complete.

5.0 Old Schoolhouse Road Waterfall

Waterfall at 138 Ludlowville Road.

Under exisiting conditions the Old School House Road waterfall (located behind 138 Ludlowville Road) overtops during a 5-year storm event. With inclusion of the revised drainage model inputs for the potential upstream detention and streambank stabilization improvements, the waterfall was modeled without overtopping during the 50-year event. This is an example of how upstream improvements impact the hydraulics throughout the entire drainage basin. Additional improvements were not evaluated at the Old Schoolhouse Road waterfall, as modeling indicates substantial improvements at this location assuming the installation of upstream detention and streambank stabilization.

6.0 Recommended Stormwater Infrastructure Improvements

Several stormwater improvement alternatives were assessed. The alternatives have significant effects on one another, so they can not be evaluated independently. For example increased upstream detention volume minimizes peak flows, which in turn would decrease the streambank stabilization required and would increase the effectiveness of the existing cross culverts and closed drainage system. Alternatively, without the construction of upstream detention the erosive velocities within the streambank and peak flows encountered at culverts and closed drainage systems would continue. Under this scenario, additional hard armoring of the streambank would be required, and cross culverts and closed drainage systems would need to be upsized to pass peak flows. Our analysis took the interconnectedness of the drainage issues into account. The following recommendations maximize the hydraulic benefit within the drainage system. These recommendations need to be assessed against additional factors as outlined in Section 8.0.

6.1 Upstream Detention Recommendation

Maximum upstream detention is recommended to attenuate peak flows throughout the drainage system. Upstream metering will assist roadside culverts and closed drainage systems in passing storm event flows. Our analyses included evaluation of two pond sizes: a 9 foot deep pond with 5.5 acre-feet of volume (1.8 million gallons) and a 5 foot deep pond with 3.7 acre-feet of volume (1.2 million gallons). Actual pond sizing would be dependent upon available land, depth to groundwater and/or bedrock, and grading limitations where the pond is to be sited.

Currently the main culverts in the drainage system overtop during the 5 and 10-year storm events. The larger of the two ponds attenuated flows throughout the drainage system to the point where downstream culverts (including the Ludlowville Road Culvert 12) nearly pass the 50-year design storm. This attenuation minimizes culvert overtopping that historically routed excess flows to private properties, or to undersized closed drainage systems along Ludlowville Road. The shallower pond analyzed reduced downstream structure overtopping to a 25-year frequency.

The New York State Highway Design Manual bases new culvert sizing on passing the 50-year storm event. To pass these flows, it is estimated that approximately a 2-million gallon storage pond would be required for upstream detention. It is recommended that maximum upstream detention be provided to reduce downstream flooding. Storage should be less than 3 million gallons to prevent dam permitting. Again, actual storage volume and pond configuration will depend on available land use acquisition. It is recommended that a dry pond (no normal standing water) be installed to maximize pond storage volumes. The pond should also be equipped with a forebay (plunge pool at the inlet for sediment deposition) to minimize the long-term maintenance demand.

6.2 Streambank Stabilization Recommendation

The recommended practice for streambank restoration is hybrid stabilization with shaping of the existing banks and installation of step pools. Ideally the streambank stabilization would be conducted after installation of the upstream detention, which may downsize the needed restoration. Given the extreme and ongoing erosion within the channel, along with the understanding that land acquisition may postpone upstream detention, we selected this hybrid approach to provide immediate and long-term benefits within the channel. The streambank stabilization project alone will provide long-term benefits within the immediate area, as well as provide protection and water quality benefits downstream throughout the watershed. This project also has the benefit of being able to be implemented in a short timeframe.

The bank stabilization will create a stable channel under existing conditions which would mimic a natural channel and result in a vegetated bank. When upstream detention is added to the watershed, it will further reduce erosive velocities within the channel. Shaving will be required to the existing banks which will create additional loss of private property. Without the shaving, these embankments would continue to erode and this land (and additional lands) would ultimately be lost to erosion. The shaving will also provide a measure of safety that is currently not present. The embankments would consist of a mix of rock at lower elevations, and vegetation above high water elevations. The details of this alternative are provided in Appendix C.

The step pools will flatten the hydraulic gradient of the existing channel, which will slow the velocity and erosivity of the tributary. This will benefit downstream properties, including the Old Schoolhouse Road waterfall, throughout the tributary to the confluence with Salmon Creek. This alternative will also provide sediment deposition behind the step pools, which will be a water quality benefit to Salmon Creek and Cayuga Lake. Once installed this is a low-maintenance drainage improvement with substantial water quality and land use benefits.

6.3 Culvert Recommendations

Three culverts within the main watershed study area were analyzed including:

- Culvert 12 (Ludlowville Road), Culvert 18 (Ludlowville/Salmon Creek Road Intersection) and the Salmon Creek Culvert. We are not recommending increasing the hydraulic capacity of any of these culverts at this time. Increasing the size of the existing culverts will simply shift the drainage issues further downstream, and increase the ongoing erosion of the main tributary below Ludlowville Road. Although the culverts currently do not pass elevated storm events, the recommended upstream detention will reduce the demand on each of the three culverts analyzed. It is recommended that the culvert hydraulics be reassessed following final design and sizing of the upstream detention facility.

6.4 Old Schoolhouse Road Waterfall Recommendations

With inclusion of the revised drainage model inputs for the potential streambank stabilization improvements, the waterfall was modeled without overtopping during the 50-year event. The modeling inputs were revised to reflect a different manning's roughness coefficient of the channel with the restoration complete. This roughness coefficient slows peak flows and benefits the hydraulics at the Old Schoolhouse Road waterfall. This is a vast improvement from existing conditions where the waterfall is modeled to overtop during a 5-year event. It is recommended that the Old Schoolhouse Road waterfall hydraulics be reassessed following final streambank stabilization design. The additional design and sizing of the upstream detention facility will further reduce flows.

7.0 Potential Benefits of Recommended Stormwater Improvements

The following two watershed improvements which work in concert though operate independently are recommended based on the alternative analysis:

- Installation of upstream detention (ideally between 2 and 3 million gallons of storage volume) combined with;
- Hybrid streambank stabilization with installation of channel step pools.

The following table from Technical Report 1 has been updated to reflect the impact of these two projects on drainage issues throughout the watershed.

Table 5. Summary of Drainage Improvements with Upstream Detention		
Design Location	Existing Conditions (Technical Report 1)	Modeled Conditions with Recommended Improvements
	Design Storm Structure Limitation	
Culvert 12 (Ludlowville Road)	5-year Event	50-year event
Culvert 18 (Salmon Creek Road)	10-year Event	50-year event

[1]Results based on 1.8 million gallon upstream detention facility. Actual results dependent upon upstream storage volumes available (to be determined during final design).

Table 6. Summary of Drainage Improvements with Streambank Stabilization		
Design Location	Existing Conditions (Technical Report 1)	Modeled Conditions with Recommended Improvements
	Design Storm Structure Limitation	
Old Schoolhouse Road	5-year Event	50-year event

8.0 Estimated Costs of Recommended Stormwater Improvements

This report has identified recommended improvements to alleviate the recurring downstream flooding and streambank erosion occurring in the Ludlowville area. These recommendations are demonstrated to provide a water quality and flood control benefit. The recommendations, however, also need to be evaluated against additional factors including cost, land use availability, physical and construction feasibility, ease of maintenance, community acceptance and safety. To assist with this evaluation we have provided the following general cost estimate for installation of each recommended practice. Final costs would vary depending on which portions of the project were conducted by municipal forces, and which percentage was bid as a public works project. Typically, municipal force account work can be conducted cheaper than publically bid projects. More detailed costs will be provided at final design.

Table 7.
Preliminary Estimate of Improvement Costs

Recommended Improvement	Design	Construction	Construction Administration	Contingency	Total Capital Cost	Annual Maintenance Cost
Upstream Detention[1]	$13,600	$170,000	$10,200	$17,000	$210,800	$5,100
Streambank Stabilization[2]	$13,500	$90,000	$5,400	$9,000	$117,900	$1,800

[1]Assumes 1.8 million gallon pond. Costs do not include land acquisition. Design costs assume 8% of construction. Construction administration costs assumed as 6% of construction. Contingency is 10% of construction cost. Annual maintenance assumed as 3% of construction.

[2]Assumes 360 feet of streambank stabilization (hybrid bank armoring with step pools). Design costs assume 15% of construction. Construction administration costs assumed as 6% of construction. Contingency is 10% of construction cost. Annual maintenance assumed as 2% of construction.

9.0 Final Design Considerations

The recommendations outlined herein are based on the information obtained during the data acquisition phase of Technical Report 1. Additional detailed information will be needed to prepare the final design. Specifically for the upstream detention, land acquisition and right-of-way permitting will likely be required. Final Design will require detailed survey of the proposed detention area, along with subsurface soil borings to determine depth to bedrock and groundwater. The project will also require stakeholder acceptance, specifically from landowners along the tributary where embankment cutbacks will be required.

10.0 Next Steps

The results of the analyses contained herein, along with the proposed recommendations, were presented at a public meeting on October 19, 2010. Comments generated at the meeting were incorporated into this revised report. We will continue to solicit stakeholder involvement and participation prior to moving to the next phase of the project. Once selected alternatives are identified we will approach the specific landowners whose land is directly impacted by alternatives and progress with final design including collection of additional data as needed to complete the Design Report. Detailed construction estimates will be provided as part of the final design and we will determine which portions of the project will be completed by municipal forces and which will be bid as a public works project. Final design will be presented at another public meeting prior to soliciting bids.

Written comments regarding the subject of this report should be directed to:

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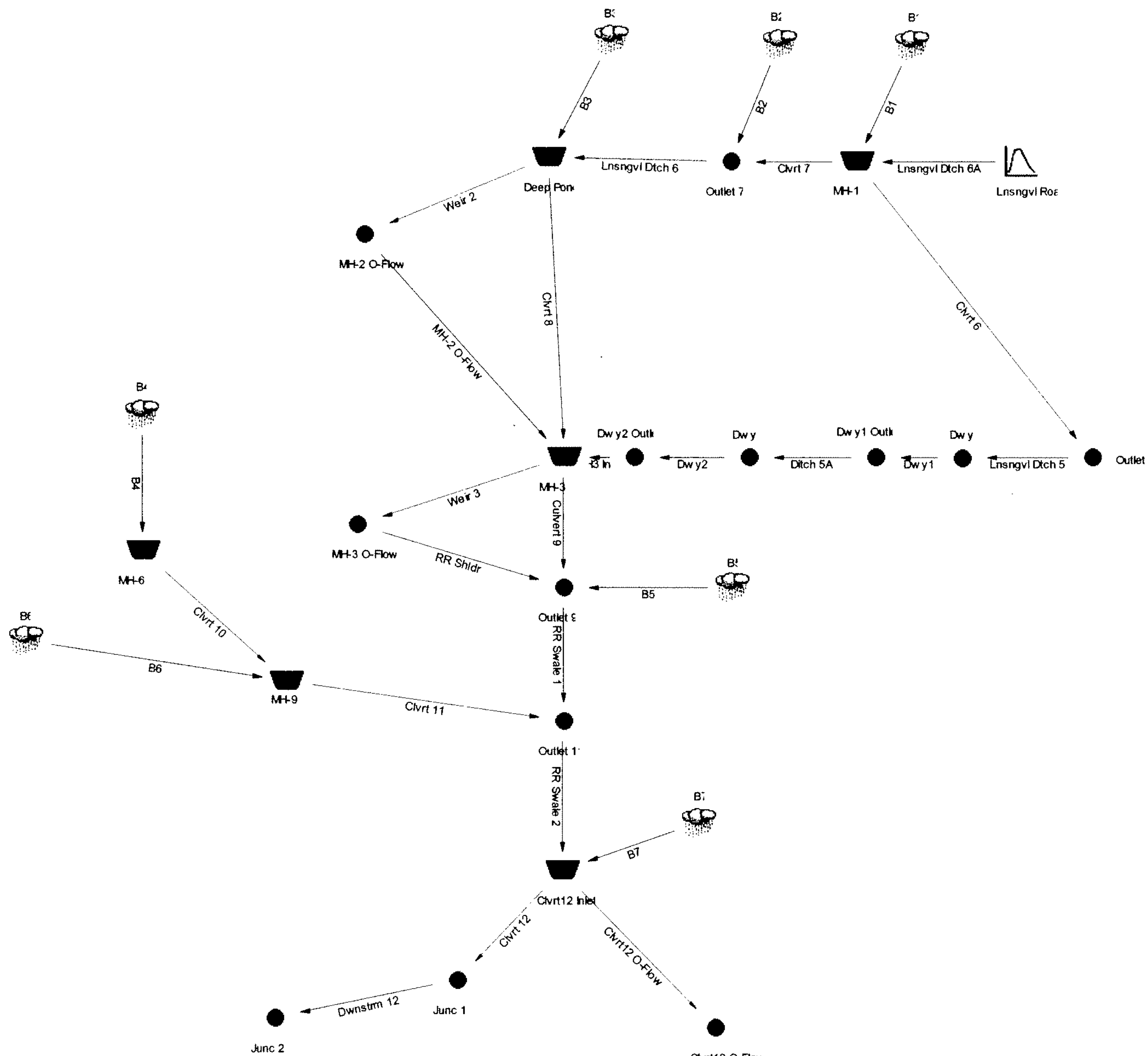
Appendices

Appendix A

Deep Pond Hydraulic Modeling



B3
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Clvrt 8
MH-2 O-Flow
Clvrt 6
B4
Dwy2 Outl
Dwy
Dwy1 Outl
Dwy
Dwy2
Ditch 5A
Dwy1
Lnsngvl Dtch 5
Outlet
MH-3
Weir 3
Culvert 9
MH-3 O-Flow
RR Shldr
B5
MH-6
Outlet 9
Clvrt 10
B6
RR Swale 1
B6
MH-9
Clvrt 11
Outlet 1
RR Swale 2
B7
B7
Clvrt12 Inlet
Clvrt 12
Clvrt12 O-Flow
Dwnstrm 12
Junc 1
Junc 2
Clvrt12 O-Flow

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Tompkins County

Return Event	Total Depth in	Rainfall Type	RNF ID
1	2.3000	Synthetic Curve	TypeII 24hr
5	3.4000	Synthetic Curve	TypeII 24hr
10	3.9000	Synthetic Curve	TypeII 24hr
25	4.6000	Synthetic Curve	TypeII 24hr
50	4.9000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
B1	AREA	1	.900		12.1000	8.55		
B1	AREA	5	2.416		12.1000	29.86		
B1	AREA	10	3.246		12.1000	41.44		
B1	AREA	25	4.515		12.1000	58.94		
B1	AREA	50	5.090		12.1000	66.81		
B2	AREA	1	1.348		12.1000	15.35		
B2	AREA	5	3.163		12.1000	40.38		
B2	AREA	10	4.113		12.1000	53.27		
B2	AREA	25	5.534		12.1000	72.33		
B2	AREA	50	6.169		12.1000	80.77		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
B3	AREA	1	.801		12.1000	9.54		
B3	AREA	5	1.837		12.1000	23.89		
B3	AREA	10	2.375		12.1000	31.21		
B3	AREA	25	3.176		12.0500	42.22		
B3	AREA	50	3.533		12.0500	47.14		
B4	AREA	1	.348		12.0000	5.63		
B4	AREA	5	.680		12.0000	11.11		
B4	AREA	10	.843		12.0000	13.73		
B4	AREA	25	1.079		12.0000	17.46		
B4	AREA	50	1.182		12.0000	19.07		
B5	AREA	1	.132		12.0000	2.03		
B5	AREA	5	.262		12.0000	4.14		
B5	AREA	10	.326		12.0000	5.16		
B5	AREA	25	.420		12.0000	6.62		
B5	AREA	50	.461		12.0000	7.25		
B6	AREA	1	.339		12.0500	4.96		
B6	AREA	5	.701		12.0500	10.48		
B6	AREA	10	.882		12.0500	13.18		
B6	AREA	25	1.146		12.0500	17.07		
B6	AREA	50	1.263		12.0500	18.75		
B7	AREA	1	.149		11.9500	2.69		
B7	AREA	5	.298		11.9500	5.37		
B7	AREA	10	.371		11.9000	6.69		
B7	AREA	25	.477		11.9000	8.63		
B7	AREA	50	.523		11.9000	9.47		
CLVRT12 INLETIN	POND	1	4.338		12.4500	16.19		
CLVRT12 INLETIN	POND	5	9.841		12.4500	38.77		
CLVRT12 INLETIN	POND	10	12.857		12.3500	49.93		
CLVRT12 INLETIN	POND	25	17.428		12.3000	67.49		
CLVRT12 INLETIN	POND	50	19.742		12.3000	98.10		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
+CLVRT12 INLETOUT	POND	1	4.338		12.5000	16.18	667.82	.002
+CLVRT12 INLETOUT	POND	5	9.841		12.5000	38.74	668.93	.004
+CLVRT12 INLETOUT	POND	10	12.857		12.4000	49.84	669.39	.005
+CLVRT12 INLETOUT	POND	25	17.428		12.3500	67.30	670.06	.006
+CLVRT12 INLETOUT	POND	50	19.742		12.3000	95.52	670.62	.007
*CLVRT12 O-FLOW	JCT	1	.000		.0500	.00		
*CLVRT12 O-FLOW	JCT	5	.000		.0500	.00		
*CLVRT12 O-FLOW	JCT	10	.000		.0500	.00		
*CLVRT12 O-FLOW	JCT	25	.000		.0500	.00		
*CLVRT12 O-FLOW	JCT	50	.216		12.3000	12.85		
DEEP POND IN	POND	1	3.049		12.1500	32.00		
DEEP POND IN	POND	5	7.570		12.1500	94.31		
DEEP POND IN	POND	10	10.020		12.1000	128.35		
DEEP POND IN	POND	25	13.595		12.1000	174.62		
DEEP POND IN	POND	50	15.160		12.1000	193.60		
+DEEP POND OUT	POND	1	3.366	L	12.4000	14.01	771.12	.889
+DEEP POND OUT	POND	5	7.887	L	12.4500	33.58	773.77	2.341
+DEEP POND OUT	POND	10	10.337	L	12.4500	40.90	775.24	3.320
+DEEP POND OUT	POND	25	13.912	L	12.5000	43.93	777.31	4.926
+DEEP POND OUT	POND	50	15.477	L	12.4000	80.65	777.75	5.311
DWY1	JCT	1	.000		.0500	.00		
DWY1	JCT	5	.009		12.1500	.76		
DWY1	JCT	10	.094		12.1500	6.00		
DWY1	JCT	25	.390		12.1500	21.03		
DWY1	JCT	50	.574		12.1500	29.01		
DWY1 OUTLET	JCT	1	.000		.0500	.00		
DWY1 OUTLET	JCT	5	.009		12.2000	.75		
DWY1 OUTLET	JCT	10	.094		12.2000	5.87		
DWY1 OUTLET	JCT	25	.390		12.2000	20.25		
DWY1 OUTLET	JCT	50	.689		12.1500	49.76		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
DWY2	JCT	1	.000		.0500	.00		
DWY2	JCT	5	.009		12.2000	.64		
DWY2	JCT	10	.094		12.2000	5.45		
DWY2	JCT	25	.390		12.2000	19.58		
DWY2	JCT	50	.689		12.2000	41.24		
DWY2 OUTLET	JCT	1	.000		.0500	.00		
DWY2 OUTLET	JCT	5	.009		12.2500	.64		
DWY2 OUTLET	JCT	10	.094		12.2500	5.37		
DWY2 OUTLET	JCT	25	.390		12.2500	19.00		
DWY2 OUTLET	JCT	50	.832		12.2000	69.95		
JUNC 10	JCT	1	4.338		12.5000	16.18		
JUNC 10	JCT	5	9.841		12.5000	38.74		
JUNC 10	JCT	10	12.857		12.4000	49.84		
JUNC 10	JCT	25	17.428		12.3500	67.30		
JUNC 10	JCT	50	19.526		12.3000	82.66		
*JUNC 20	JCT	1	4.338		12.5000	16.14		
*JUNC 20	JCT	5	9.841		12.5000	38.71		
*JUNC 20	JCT	10	12.857		12.4500	49.55		
*JUNC 20	JCT	25	17.428		12.3500	66.57		
*JUNC 20	JCT	50	19.863		12.2500	92.56		
LNSNGVL ROAD	HYG	1	.000		11.9000	.00		
LNSNGVL ROAD	HYG	5	.163		12.1000	10.60		
LNSNGVL ROAD	HYG	10	.381		12.1000	19.83		
LNSNGVL ROAD	HYG	25	.761		12.1000	33.43		
LNSNGVL ROAD	HYG	50	.942	R	12.1000	39.43		
MH-1 IN	POND	1	.900		12.1000	8.55		
MH-1 IN	POND	5	2.579		12.1000	36.26		
MH-1 IN	POND	10	3.627		12.1000	56.93		
MH-1 IN	POND	25	5.276		12.1000	88.24		
MH-1 IN	POND	50	6.032		12.1000	102.18		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
+MH-1	OUT POND	1	.900		12.1500	8.44	804.81	.001
+MH-1	OUT POND	5	2.579		12.1500	36.12	806.58	.003
+MH-1	OUT POND	10	3.627		12.1500	56.22	807.41	.003
+MH-1	OUT POND	25	5.276		12.1500	86.32	808.70	.004
+MH-1	OUT POND	50	6.032		12.1500	99.68	809.29	.005
MH-2 O-FLOW	JCT	1	.000		.0500	.00		
MH-2 O-FLOW	JCT	5	.000		.0500	.00		
MH-2 O-FLOW	JCT	10	.000		.0500	.00		
MH-2 O-FLOW	JCT	25	.000		.0500	.00		
MH-2 O-FLOW	JCT	50	.522		12.4000	35.83		
MH-3	IN POND	1	3.374		12.4000	14.01		
MH-3	IN POND	5	7.904		12.4000	33.60		
MH-3	IN POND	10	10.439		12.3000	43.94		
MH-3	IN POND	25	14.310		12.2500	60.89		
MH-3	IN POND	50	16.317		12.2000	112.06		
+MH-3	OUT POND	1	3.374		12.4500	13.99	766.04	.001
+MH-3	OUT POND	5	7.904		12.4500	33.59	767.08	.002
+MH-3	OUT POND	10	10.439		12.3000	43.67	767.56	.003
+MH-3	OUT POND	25	14.310		12.2500	59.97	768.31	.003
+MH-3	OUT POND	50	16.317		12.2500	96.29	770.24	.005
MH-3 O-FLOW	JCT	1	.000		.0500	.00		
MH-3 O-FLOW	JCT	5	.000		.0500	.00		
MH-3 O-FLOW	JCT	10	.000		.0500	.00		
MH-3 O-FLOW	JCT	25	.000		.0500	.00		
MH-3 O-FLOW	JCT	50	.000		.0500	.00		
MH-6	IN POND	1	.348		12.0000	5.63		
MH-6	IN POND	5	.680		12.0000	11.11		
MH-6	IN POND	10	.843		12.0000	13.73		
MH-6	IN POND	25	1.079		12.0000	17.46		
MH-6	IN POND	50	1.182		12.0000	19.07		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
MH-6	OUT POND	1	.348		12.0500	5.48	733.52	.001
MH-6	OUT POND	5	.680		12.0000	10.78	734.01	.001
MH-6	OUT POND	10	.843		12.0000	13.37	734.21	.001
MH-6	OUT POND	25	1.079		12.0000	17.07	734.48	.002
MH-6	OUT POND	50	1.182		12.0000	18.68	734.58	.002
MH-9	IN POND	1	.687		12.0500	10.44		
MH-9	IN POND	5	1.381		12.0500	21.17		
MH-9	IN POND	10	1.725		12.0000	26.40		
MH-9	IN POND	25	2.225		12.0000	34.07		
MH-9	IN POND	50	2.445		12.0000	37.40		
MH-9	OUT POND	1	.683		12.5000	1.58	704.85	.285
MH-9	OUT POND	5	1.378		12.4000	3.98	705.68	.595
MH-9	OUT POND	10	1.721		12.4000	4.71	706.09	.762
MH-9	OUT POND	25	2.222		12.4000	5.58	706.67	1.013
MH-9	OUT POND	50	2.441		12.4500	5.92	706.92	1.124
OUTLET 11	JCT	1	4.189		12.4500	15.90		
OUTLET 11	JCT	5	9.543		12.4500	38.22		
OUTLET 11	JCT	10	12.487		12.3500	49.35		
OUTLET 11	JCT	25	16.951		12.3000	67.07		
OUTLET 11	JCT	50	19.219		12.2500	100.79		
OUTLET 6	JCT	1	.000		.0500	.00		
OUTLET 6	JCT	5	.009		12.1500	.96		
OUTLET 6	JCT	10	.094		12.1500	6.50		
OUTLET 6	JCT	25	.390		12.1500	21.71		
OUTLET 6	JCT	50	.574		12.1500	29.60		
OUTLET 7	JCT	1	2.248		12.1000	23.28		
OUTLET 7	JCT	5	5.733		12.1000	73.49		
OUTLET 7	JCT	10	7.645		12.1000	101.06		
OUTLET 7	JCT	25	10.419		12.1000	135.94		
OUTLET 7	JCT	50	11.627		12.1000	150.08		

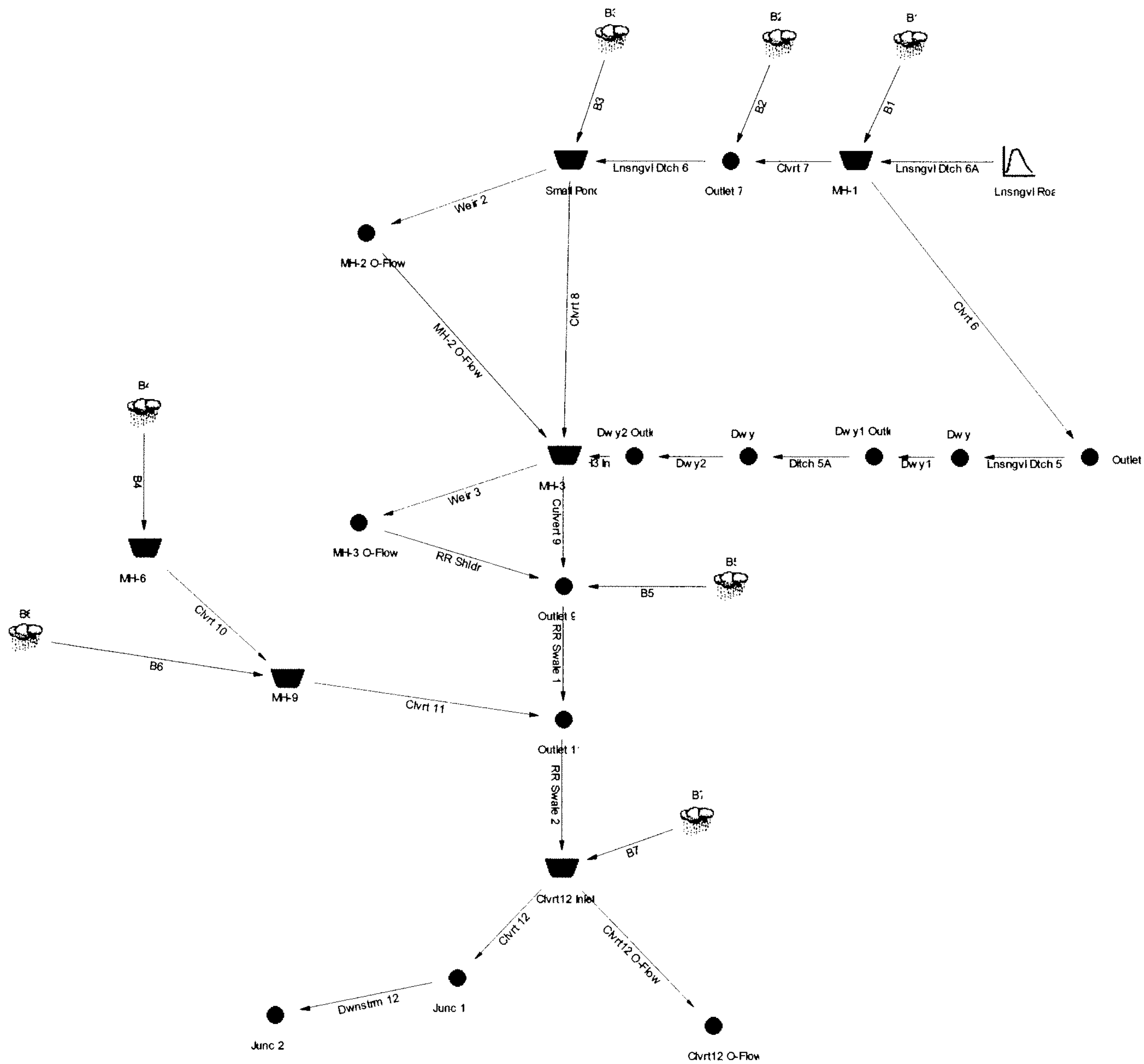
MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
OUTLET 9	JCT	1	3.505		12.4500	14.33		
OUTLET 9	JCT	5	8.166		12.4000	34.25		
OUTLET 9	JCT	10	10.766		12.3000	44.84		
OUTLET 9	JCT	25	14.730		12.2500	61.80		
OUTLET 9	JCT	50	16.778		12.2500	98.28		

Appendix B

Shallow Pond Hydraulic Modeling



B3
B2
B1
B3
B2
B1
Lnsngvl Dtch 6
Clvrt 7
Lnsngvl Dtch 6A
Small Pond
Outlet 7
MH-1
Lnsngvl Roa
Weir 2
MH-2 O-Flow
Clvrt 8
MH-2 O-Flow
Clvrt 6
B4
Dw y2 Outle
Dw y
Dw y1 Outle
Dw y
Outlet
B3 In
Dw y2
Ditch 5A
Dw y1
Lnsngvl Dtch 5
B4
MH-3
Weir 3
Culvert 9
MH-3 O-Flow
RR Shldr
B5
MH-6
B5
Outlet 9
Clvrt 10
B6
B6
MH-9
RR Swale 1
Clvrt 11
Outlet 11
RR Swale 2
B7
B7
Clvrt12 Inlet
Clvrt 12
Clvrt12 O-Flow
Dwnstrm 12
Junc 1
Junc 2
Clvrt12 O-Flow

MASTER DESIGN STORM SUMMARY

Network Storm Collection: Tompkins County

Return Event	Total Depth in	Rainfall Type	RNF ID
1	2.3000	Synthetic Curve	TypeII 24hr
5	3.4000	Synthetic Curve	TypeII 24hr
10	3.9000	Synthetic Curve	TypeII 24hr
25	4.6000	Synthetic Curve	TypeII 24hr
50	4.9000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY

SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
B1	AREA	1	.900		12.1000	8.55		
B1	AREA	5	2.416		12.1000	29.86		
B1	AREA	10	3.246		12.1000	41.44		
B1	AREA	25	4.515		12.1000	58.94		
B1	AREA	50	5.090		12.1000	66.81		
B2	AREA	1	1.348		12.1000	15.35		
B2	AREA	5	3.163		12.1000	40.38		
B2	AREA	10	4.113		12.1000	53.27		
B2	AREA	25	5.534		12.1000	72.33		
B2	AREA	50	6.169		12.1000	80.77		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
B3	AREA	1	.801		12.1000	9.54		
B3	AREA	5	1.837		12.1000	23.89		
B3	AREA	10	2.375		12.1000	31.21		
B3	AREA	25	3.176		12.0500	42.22		
B3	AREA	50	3.533		12.0500	47.14		
B4	AREA	1	.348		12.0000	5.63		
B4	AREA	5	.680		12.0000	11.11		
B4	AREA	10	.843		12.0000	13.73		
B4	AREA	25	1.079		12.0000	17.46		
B4	AREA	50	1.182		12.0000	19.07		
B5	AREA	1	.132		12.0000	2.03		
B5	AREA	5	.262		12.0000	4.14		
B5	AREA	10	.326		12.0000	5.16		
B5	AREA	25	.420		12.0000	6.62		
B5	AREA	50	.461		12.0000	7.25		
B6	AREA	1	.339		12.0500	4.96		
B6	AREA	5	.701		12.0500	10.48		
B6	AREA	10	.882		12.0500	13.18		
B6	AREA	25	1.146		12.0500	17.07		
B6	AREA	50	1.263		12.0500	18.75		
B7	AREA	1	.149		11.9500	2.69		
B7	AREA	5	.298		11.9500	5.37		
B7	AREA	10	.371		11.9000	6.69		
B7	AREA	25	.477		11.9000	8.63		
B7	AREA	50	.523		11.9000	9.47		
CLVRT12 INLETIN	POND	1	3.954		12.7000	9.80		
CLVRT12 INLETIN	POND	5	9.457		12.5500	32.03		
CLVRT12 INLETIN	POND	10	12.473		12.4500	61.60		
CLVRT12 INLETIN	POND	25	17.236		12.4000	156.26		
CLVRT12 INLETIN	POND	50	19.780		12.3500	181.99		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
+CLVRT12 INLETOUT	POND	1	3.954		12.7000	9.79	667.39	.002
+CLVRT12 INLETOUT	POND	5	9.457		12.5500	32.02	668.63	.003
+CLVRT12 INLETOUT	POND	10	12.473		12.5000	60.47	669.80	.005
+CLVRT12 INLETOUT	POND	25	17.236		12.4000	155.01	670.88	.008
+CLVRT12 INLETOUT	POND	50	19.780		12.3500	181.63	670.97	.008
*CLVRT12 O-FLOW	JCT	1	.000		.0500	.00		
*CLVRT12 O-FLOW	JCT	5	.000		.0500	.00		
*CLVRT12 O-FLOW	JCT	10	.000		.0500	.00		
*CLVRT12 O-FLOW	JCT	25	1.304		12.4000	65.45		
*CLVRT12 O-FLOW	JCT	50	2.343		12.3500	89.66		
DWY1	JCT	1	.000		.0500	.00		
DWY1	JCT	5	.009		12.1500	.76		
DWY1	JCT	10	.094		12.1500	6.00		
DWY1	JCT	25	.390		12.1500	21.03		
DWY1	JCT	50	.574		12.1500	29.01		
DWY1 OUTLET	JCT	1	.000		.0500	.00		
DWY1 OUTLET	JCT	5	.009		12.2000	.75		
DWY1 OUTLET	JCT	10	.094		12.2000	5.87		
DWY1 OUTLET	JCT	25	.390		12.2000	20.25		
DWY1 OUTLET	JCT	50	.689		12.1500	49.76		
DWY2	JCT	1	.000		.0500	.00		
DWY2	JCT	5	.009		12.2000	.64		
DWY2	JCT	10	.094		12.2000	5.45		
DWY2	JCT	25	.390		12.2000	19.58		
DWY2	JCT	50	.689		12.2000	41.24		
DWY2 OUTLET	JCT	1	.000		.0500	.00		
DWY2 OUTLET	JCT	5	.009		12.2500	.64		
DWY2 OUTLET	JCT	10	.094		12.2500	5.37		
DWY2 OUTLET	JCT	25	.390		12.2500	19.00		
DWY2 OUTLET	JCT	50	.832		12.2000	69.95		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID		Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
JUNC 10		JCT	1	3.954		12.7000	9.79		
JUNC 10		JCT	5	9.457		12.5500	32.02		
JUNC 10		JCT	10	12.473		12.5000	60.47		
JUNC 10		JCT	25	15.932		12.4000	89.56		
JUNC 10		JCT	50	17.437		12.3500	91.96		
*JUNC 20		JCT	1	3.954		12.7500	9.79		
*JUNC 20		JCT	5	9.457		12.6000	32.00		
*JUNC 20		JCT	10	12.473		12.5000	59.76		
*JUNC 20		JCT	25	16.278		12.2500	92.56		
*JUNC 20		JCT	50	17.804		12.2500	92.56		
LNSNGVL ROAD		HYG	1	.000		11.9000	.00		
LNSNGVL ROAD		HYG	5	.163		12.1000	10.60		
LNSNGVL ROAD		HYG	10	.381		12.1000	19.83		
LNSNGVL ROAD		HYG	25	.761		12.1000	33.43		
LNSNGVL ROAD		HYG	50	.942	R	12.1000	39.43		
MH-1	IN	POND	1	.900		12.1000	8.55		
MH-1	IN	POND	5	2.579		12.1000	36.26		
MH-1	IN	POND	10	3.627		12.1000	56.93		
MH-1	IN	POND	25	5.276		12.1000	88.24		
MH-1	IN	POND	50	6.032		12.1000	102.18		
+MH-1	OUT	POND	1	.900		12.1500	8.44	804.81	.001
+MH-1	OUT	POND	5	2.579		12.1500	36.12	806.58	.003
+MH-1	OUT	POND	10	3.627		12.1500	56.22	807.41	.003
+MH-1	OUT	POND	25	5.276		12.1500	86.32	808.70	.004
+MH-1	OUT	POND	50	6.032		12.1500	99.68	809.29	.005
MH-2 O-FLOW		JCT	1	.000		.0500	.00		
MH-2 O-FLOW		JCT	5	.000		.0500	.00		
MH-2 O-FLOW		JCT	10	.370		12.4000	23.26		
MH-2 O-FLOW		JCT	25	2.674		12.2500	98.99		
MH-2 O-FLOW		JCT	50	3.741		12.1500	98.99		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID		Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
MH-3	IN	POND	1	2.990		12.6500	7.78		
MH-3	IN	POND	5	7.519		12.5000	27.08		
MH-3	IN	POND	10	10.055		12.3500	58.71		
MH-3	IN	POND	25	14.118		12.2500	152.81		
MH-3	IN	POND	50	16.355		12.2000	203.75		
+MH-3	OUT	POND	1	2.990		12.7000	7.78	765.80	.001
+MH-3	OUT	POND	5	7.519		12.5000	27.04	766.97	.002
+MH-3	OUT	POND	10	10.055		12.4000	58.07	768.42	.003
+MH-3	OUT	POND	25	14.118		12.3000	151.30	770.81	.005
+MH-3	OUT	POND	50	16.355		12.2500	187.38	770.94	.005
MH-3 O-FLOW		JCT	1	.000		.0500	.00		
MH-3 O-FLOW		JCT	5	.000		.0500	.00		
MH-3 O-FLOW		JCT	10	.000		.0500	.00		
MH-3 O-FLOW		JCT	25	.874		12.3000	49.16		
MH-3 O-FLOW		JCT	50	1.696		12.2500	83.20		
MH-6	IN	POND	1	.348		12.0000	5.63		
MH-6	IN	POND	5	.680		12.0000	11.11		
MH-6	IN	POND	10	.843		12.0000	13.73		
MH-6	IN	POND	25	1.079		12.0000	17.46		
MH-6	IN	POND	50	1.182		12.0000	19.07		
MH-6	OUT	POND	1	.348		12.0500	5.48	733.52	.001
MH-6	OUT	POND	5	.680		12.0000	10.78	734.01	.001
MH-6	OUT	POND	10	.843		12.0000	13.37	734.21	.001
MH-6	OUT	POND	25	1.079		12.0000	17.07	734.48	.002
MH-6	OUT	POND	50	1.182		12.0000	18.68	734.58	.002
MH-9	IN	POND	1	.687		12.0500	10.44		
MH-9	IN	POND	5	1.381		12.0500	21.17		
MH-9	IN	POND	10	1.725		12.0000	26.40		
MH-9	IN	POND	25	2.225		12.0000	34.07		
MH-9	IN	POND	50	2.445		12.0000	37.40		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID		Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
MH-9	OUT	POND	1	.683		12.5000	1.58	704.85	.285
MH-9	OUT	POND	5	1.378		12.4000	3.98	705.68	.595
MH-9	OUT	POND	10	1.721		12.4000	4.71	706.09	.762
MH-9	OUT	POND	25	2.222		12.4000	5.58	706.67	1.013
MH-9	OUT	POND	50	2.441		12.4500	5.92	706.92	1.124
OUTLET 11		JCT	1	3.805		12.7000	9.56		
OUTLET 11		JCT	5	9.159		12.5000	31.54		
OUTLET 11		JCT	10	12.103		12.4500	61.54		
OUTLET 11		JCT	25	16.759		12.3500	157.08		
OUTLET 11		JCT	50	19.257		12.3000	187.45		
OUTLET 6		JCT	1	.000		.0500	.00		
OUTLET 6		JCT	5	.009		12.1500	.96		
OUTLET 6		JCT	10	.094		12.1500	6.50		
OUTLET 6		JCT	25	.390		12.1500	21.71		
OUTLET 6		JCT	50	.574		12.1500	29.60		
OUTLET 7		JCT	1	2.248		12.1000	23.28		
OUTLET 7		JCT	5	5.733		12.1000	73.49		
OUTLET 7		JCT	10	7.645		12.1000	101.06		
OUTLET 7		JCT	25	10.419		12.1000	135.94		
OUTLET 7		JCT	50	11.627		12.1000	150.08		
OUTLET 9		JCT	1	3.121		12.6500	8.00		
OUTLET 9		JCT	5	7.782		12.5000	27.62		
OUTLET 9		JCT	10	10.381		12.4000	58.94		
OUTLET 9		JCT	25	14.538		12.3000	152.69		
OUTLET 9		JCT	50	16.816		12.2500	186.40		
SMALL POND	IN	POND	1	3.049		12.1500	32.00		
SMALL POND	IN	POND	5	7.570		12.1500	94.31		
SMALL POND	IN	POND	10	10.020		12.1000	128.35		
SMALL POND	IN	POND	25	13.595		12.1000	174.62		
SMALL POND	IN	POND	50	15.160		12.1000	193.60		

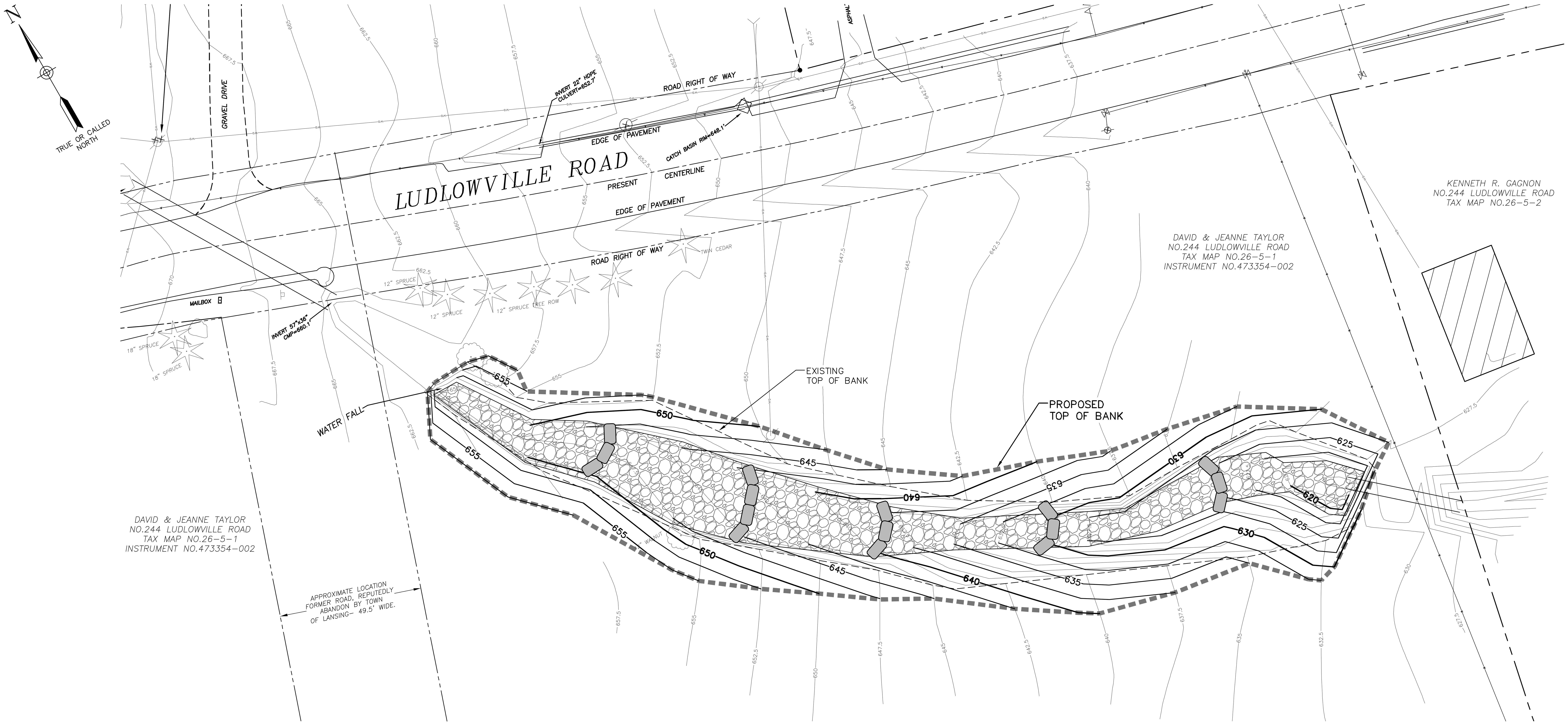
MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method
Hydrograph File Import Option Used For 1 node(s)

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
+SMALL POND	OUT POND	1	2.990		12.6500	7.78	774.46	.908
+SMALL POND	OUT POND	5	7.511		12.5000	27.08	776.70	2.551
+SMALL POND	OUT POND	10	9.961		12.4000	56.37	777.69	3.379
+SMALL POND	OUT POND	25	13.731	R	12.2500	133.81	778.00	3.654
+SMALL POND	OUT POND	50	15.526	R	12.1500	133.81	778.00	3.654

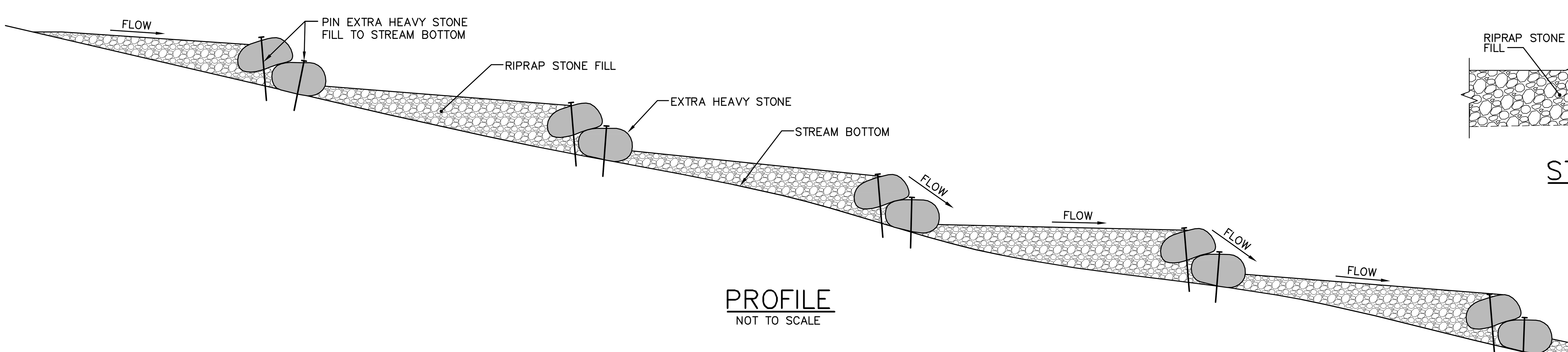
Appendix C

Streambank Stabilization Details



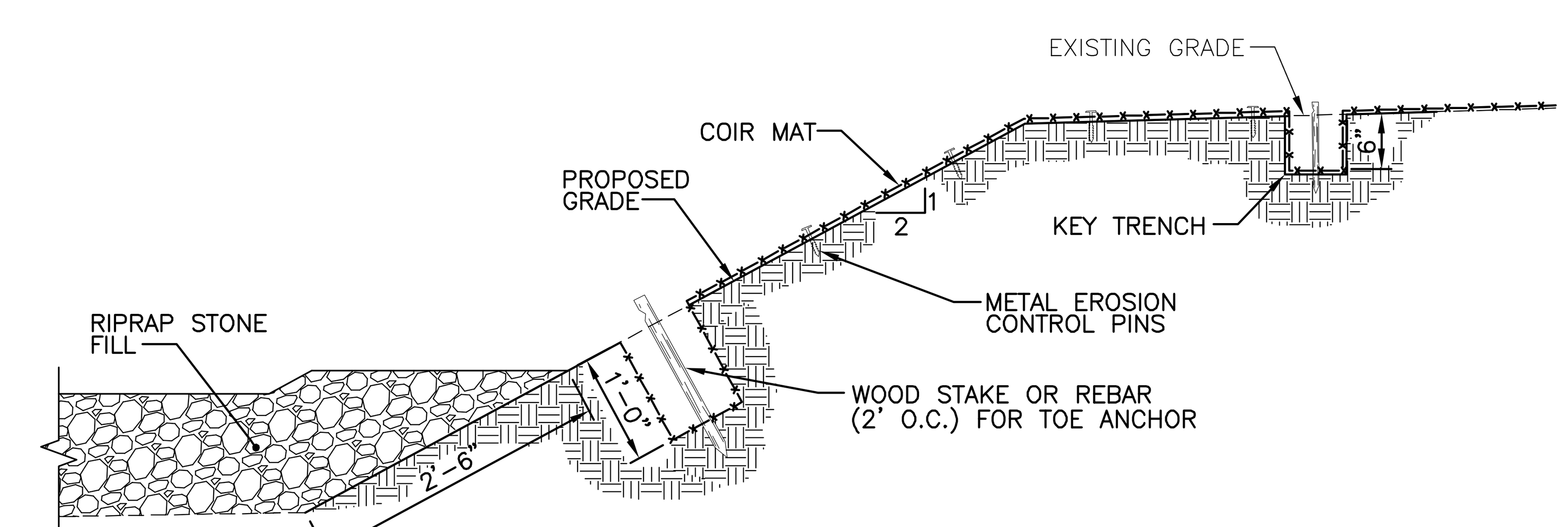
PLAN VIEW

SCALE: 1" = 20'-0"



PROFILE

NOT TO SCALE



STREAM BANK TREATMENT DETAIL

NOT TO SCALE

1"=20' 20' 0 20' 40'

NO ALTERATION PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

COMPLETED CONSTRUCTION

Significant Construction Changes Are Shown

By ______ Date ______

Ck'd ______ Date ______

REVISIONS

TOMPKINS COUNTY
LUDLOWVILLE STORMWATER CONTROL

CONCEPTUAL STREAM RESTORATION PLAN

TOWN OF LANSING TOMPKINS COUNTY, NEW YORK

Barton & Loguidice, P.C.

NOT FOR CONSTRUCTION
10/14/10

Date
OCTOBER, 2010

Scale
1" = 20'

Sheet Number
1

File Number
560.013

Plotted: Oct 14, 2010 - 3:36PM
I:\Shared\500\560013\560013_SP.DWG
SYR By: jgs

Checked by ______ Drawn by JGS Designed by JJS In charge of SDN