CITY OF SUPERIOR, WISCONSIN
Public Works Department

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Faxon Creek Watershed Study
Final Report

CITY OF SUPERIOR, WISCONSIN
REVISED November 2016

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Donohue Project No.: 12452

Final Report – Faxon Creek Watershed Study
City of Superior, Wisconsin

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CHAPTER I – EXECUTIVE SUMMARY

This study has been performed in conjunction with and/or for the benefit of the City of Superior, the University of Wisconsin, the Railroad Crossing North of N 21st Street, and the general public.

In June 2012, approximately 8-10 inches of rain fell on the City of Superior. Widespread surface and basement flooding ensued. Faxon Creek, which drains approximately 3,500 acres through a 10-foot brick sewer that discharges to the Bay of Superior, overtopped its banks. Faxon Creek interceptor, a sanitary sewer artery, parallels much of the creek. The high creek levels overtopped several roadways and submerged sanitary manholes along the Faxon Creek interceptor. Water from the creek found its way into the basements of many homes that drain into the interceptor. On August 2, 2012 President Obama declared a major disaster (DR-4076) for the counties of Ashland, Bayfield, and Douglas and the Red Cliff Band of Lake Superior Chippewa.

This study has evaluated a series of potential improvement scenarios to identify the most cost-effective alternative to lowering the base flood elevation of the creek thereby mitigating the risk of basement flooding. To do so, a model of the Faxon Creek watershed was developed to evaluate a range of potential conveyance and stormwater detention alternatives and the corresponding reduction in flood risk each provides. These risks were compared to corresponding estimates of improvement costs to assess the cost-effectiveness of each combination of system improvements.

Increasing the creek's hydraulic capacity to maximize the conveyance of stormwater to Central Park and through the K-Street sewer to the Bay of Superior was found to be most cost-effective at reducing the risk of flooding. K-Street sewer is structurally unsound and must be repaired. Major repairs completed in 2014 will stop the deterioration of the sewer while increasing its capacity by 30%.

It should be noted that the City has already completed several improvements to the K-Street sewer including replacing the most downstream section of the sewer with a smooth coated CMP, extending the sewer past Marina Drive, and replacing the culverts under the Osaugie Trail.

In addition, by improving the crossings at Hill Avenue, Railroad Crossing North of N 21st Street, North 21st Street, and Catlin Avenue, the risk of widespread flooding could be reduced to a 1% chance of occurrence in any given year at a cost of approximately $2,300,000. However improving the Railroad Crossing North of N 21st Street may prove challenging as it is on railroad property.

Other alternatives were analyzed, but rejected. These included less cost-effective options that might mitigate the need for all four crossings by constructing detention ponds at Heritage Park, on property owned by the University of Wisconsin, and property adjacent to and owned by the railroad. However detention can only eliminate the need for the N 21st Street crossing. For example, a pond at the Heritage Park site would eliminate the need for this crossing while reducing the risk of flooding to a 1% annual probability of occurrence at a total cost of $4.7M. This pond could also provide TSS reduction. The Railroad Crossing North of N 21st Street pond could reduce the risk of flooding to 0.75% per year at a total cost of $5M, but would not provide TSS reduction.

Since the Hill Avenue and Railroad crossings are the furthest downstream and need to be improved under all scenarios, these should receive top priority. The N 21st Street culvert is the next upstream structure that warrants improvement, however this need could be negated by detention at Heritage

Park and/or the University of Wisconsin, albeit at a much higher total cost. The arch culvert under the old Grand Ave alignment south of N 21st is no longer needed and should be removed. While the Catlin Avenue crossing needs to be improved regardless, it should not be improved until all downstream improvements are complete.

CHAPTER II – INTRODUCTION

Faxon Creek is an urban stream that collects stormwater from a variety of watershed types with varying degrees of development. Changes in land use and increase in imperviousness within the watershed have greatly increased stormwater runoff rates. The stream itself has been piped for long sections and has numerous road crossings. Wet weather flows routinely exceed the design capacities of the creek itself and several road and railroad crossings resulting in increased flood elevations. Development adjacent to the stream is now affected on a recurrent basis by significant storm events and damage to the aging conveyance infrastructure is accelerating.

The K-Street storm sewer, a 2,400-foot stretch of 10-foot diameter brick sewer, originates in Central Park and discharges into Superior Bay. This sewer was constructed in 1891 and is in poor condition. All of the Faxon Creek watershed drains through this critical pipe. Over the years since this pipe was constructed and wet weather flows have increased, the level of protection provided by this pipe has declined. Its deteriorating structural condition may further reduce its capacity while placing it at risk for structural failure.

This stormwater management plan for the watershed recommends a series of improvement alternatives that, once implemented, will cost-effectively mitigate the risk of flooding. This plan includes a recommended set of conveyance improvements and detention storage, sequenced in a manner that enables the City to improve the level of protection as quickly and cost-effectively as possible.

2.1 JUNE 2012 RAINFALL

During a massive storm in June 2012, 8-10 inches of rain on Superior over 24 hours (Figure 1), an event with only a 0.25% annual probability of occurrence in any given year (400-year storm). To make matters worse, approximately 3 inches of rain had fallen over the preceding week, so soils were saturated and stream baseflow was elevated at the start of the event. However, the storm was a “slow soaker”; over the peak 1-3 hours of the storm it was no more than a 10-year event (Figure 2). It is the peak 12+ hours of the storm that it approached the 500-year recurrence interval. Storms of this nature create the greatest challenge for large downstream components, like creeks, rivers, and detention basins, rather than smaller collector sewers, which are typically designed for shorter more intense rainfalls.

Widespread surface and basement flooding ensued. Faxon Creek overtopped its banks. The high creek levels overtopped several roadways and submerged sanitary manholes along the Faxon Creek interceptor. Water from the creek found its way into the basements of many homes that drain into the interceptor. On August 2, 2012 President Obama declared a major disaster (DR-4076) for the counties of Ashland, Bayfield, and Douglas and the Red Cliff Band of Lake Superior Chippewa.

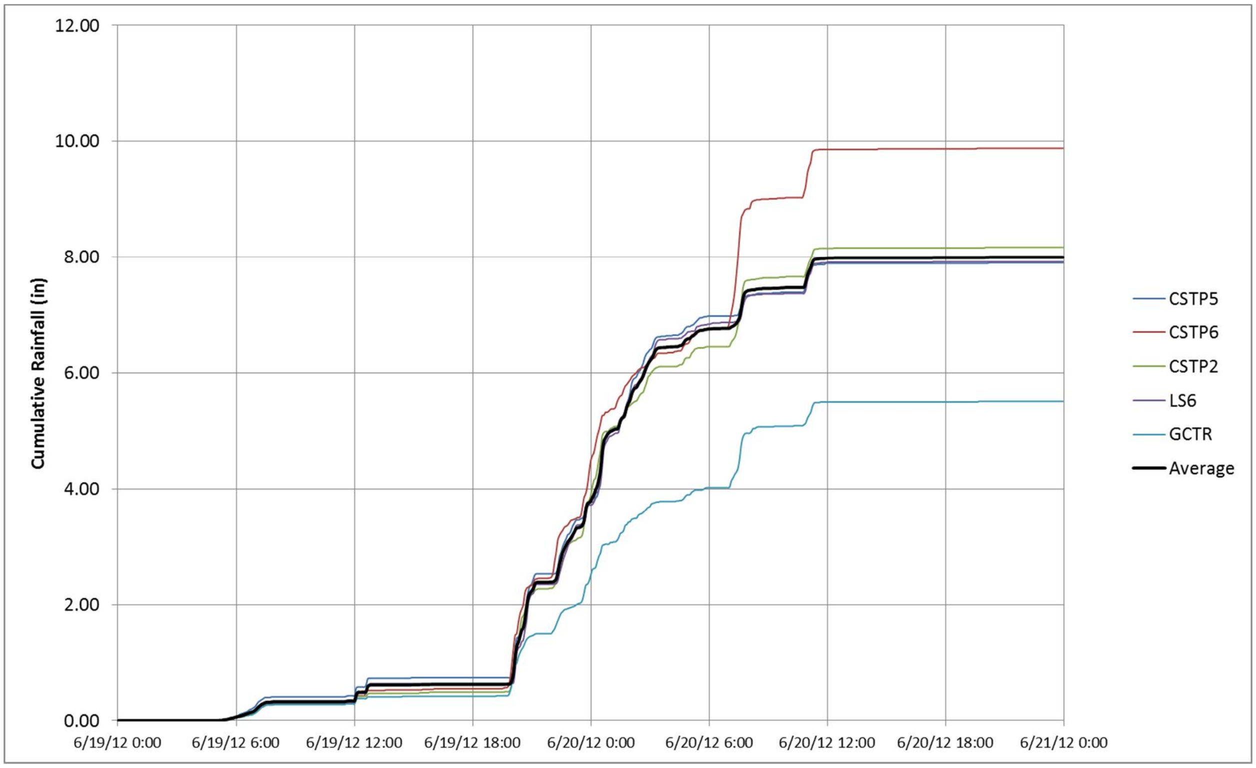

Figure 1 – June 2012 Storm Cumulative Rainfall

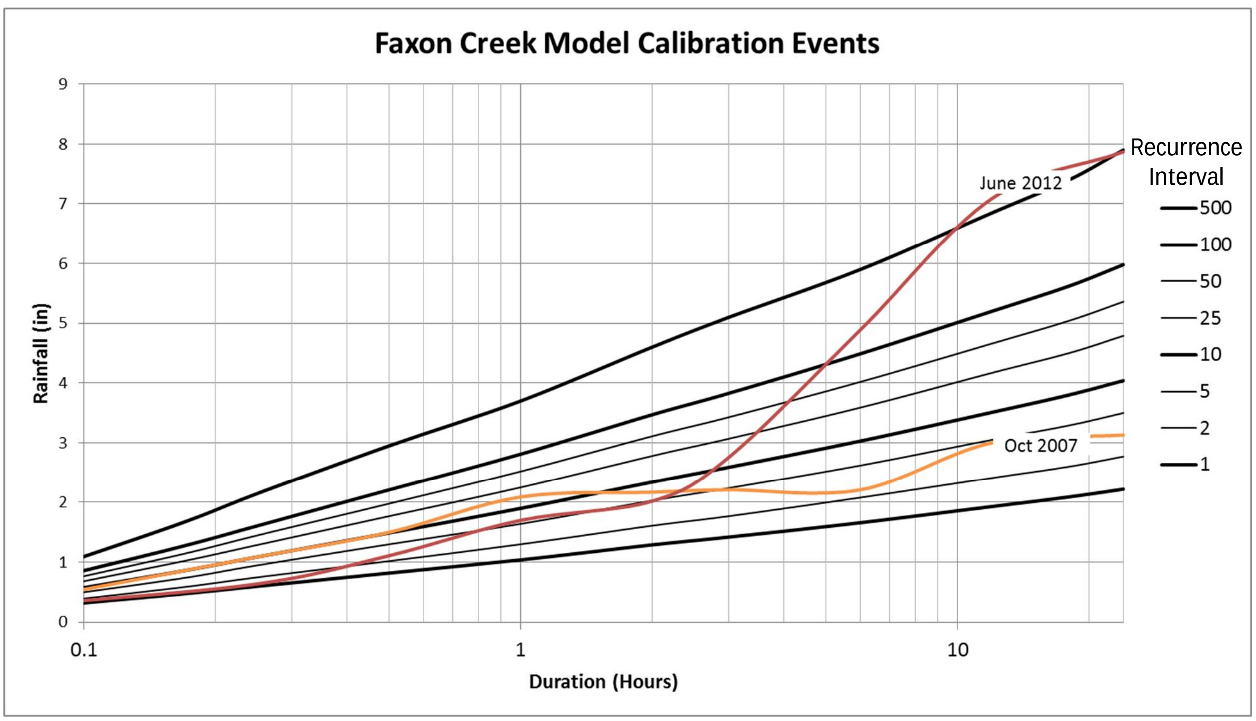

Figure 2 – Model Calibration Storms Frequency Analysis

During the June 2012 rainfall event, basement flooding was severe. The University of Wisconsin – Superior experienced flooding in 14 of their 16 buildings with damages estimated to be between $15 and $20 million. They had approximately seven feet of water in the Jim Dan Hill Library and 27 feet in

the sub-basement, basement and main floor of the power plant. The causes of University flooding have been addressed in the report, *Flooding Evaluation of the UW-Superior Campus Superior, Wisconsin In Response to the 2012 Flooding*[1]. 750 homes in Superior were reported to have experienced flood damage costing $2,000 - $40,000. 25 roads were closed due to standing water.[2]

There was no flow data collected during this event; however Superior staff made several observations of high water levels and extents of flooding including taking several photos during the peak of the storm. Section 1.5.2 of the *Existing Conditions Report*[3], compares XP-SWMM model results to photos taken during the event.

2.2 SURFACE FLOODING

Not surprisingly during a storm of this magnitude, there was significant and widespread surface flooding. Faxon Creek overtopped its banks in several locations and overtopped several roads including Catlin Ave, North 21st Street, and Hill Ave. Parts of Faxon St and Poplar Ave were also submerged.

2.3 BASEMENT FLOODING

Basement flooding was widespread as indicated in Figure 3. Superior is served by a combined sewer system, so in many parts of the city basement flooding would be expected during an event of this magnitude. The City has significantly reduced the severity of basement backups in areas served by combined sewers such as Billings Park and South Superior by constructing storm sewers to direct surface runoff away from combined sewers. The Faxon Creek watershed, has already been completely separated.

Prior to this event widespread basement flooding had not occurred in the Faxon Creek watershed and was not generally associated with Faxon Creek itself. However, during this event, almost every basement in the neighborhood just south of North 21st Street flooded. The peak water levels in the creek were sufficient to submerge several sanitary manholes near the creek under several feet of water. There is a high probability that, despite efforts to make the sanitary sewer system “water tight”, stormwater from the creek inundated and surcharged the sanitary sewer system causing it to back up into basements, many of which are below the creek’s peak flood elevation.

City personnel have made every effort to remove potential sources of inflow into the sanitary sewer, and continue to do so. However, unless creek water levels are lowered, there will always be a risk that the creek may find alternate pathways into the sanitary sewer. The most reliable means of preventing this sort of catastrophic flooding from occurring again is to lower creek flood elevations.

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[1] Aon Risk Solutions, University of Wisonsin-Superior, and the Division of State Facilities, 2013.
[2] Northland News Center, June 21, 2012.
[3] Donohue & Associates, *Existing Conditions Report,* January 2014.

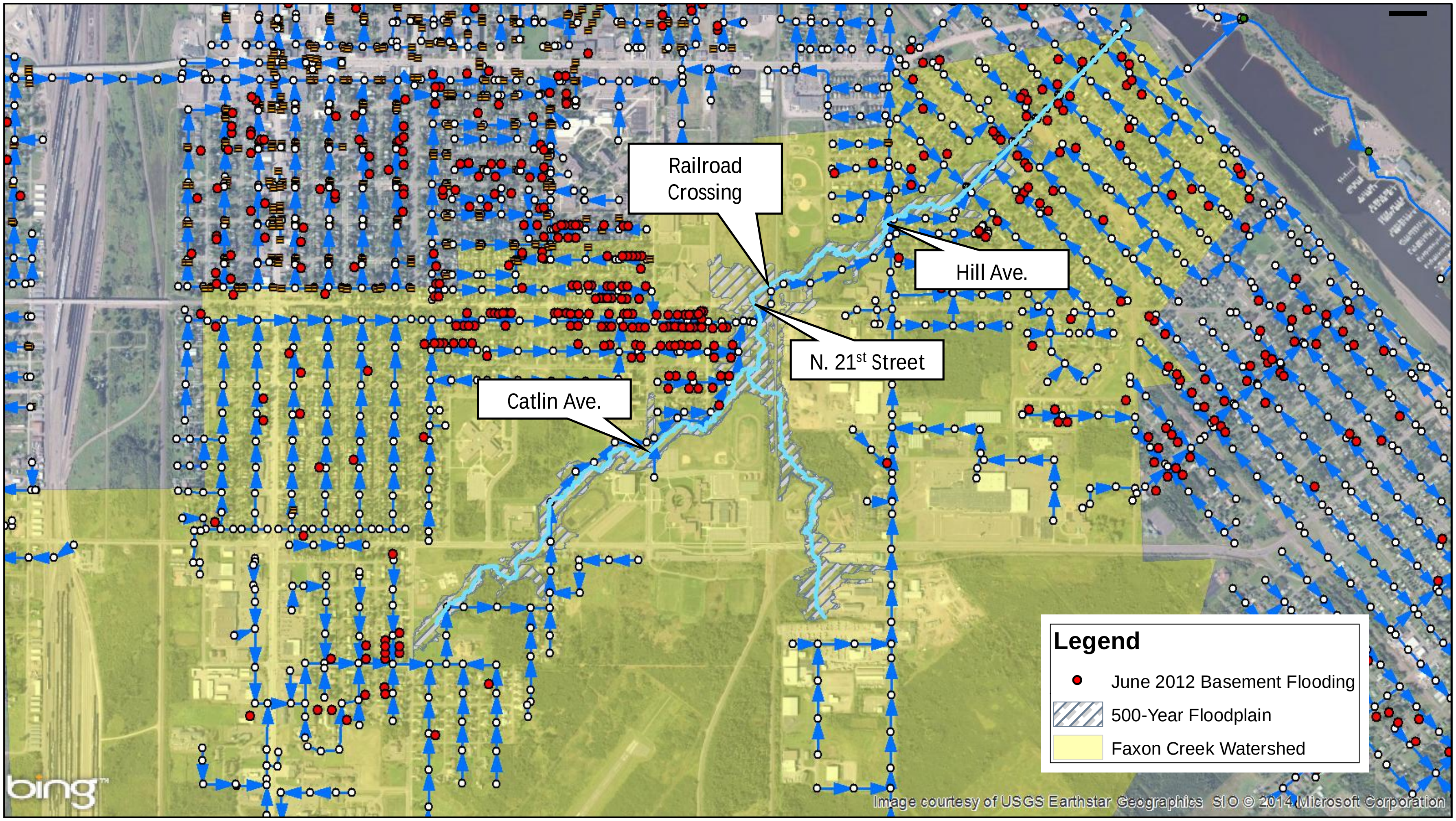

Figure 3 – June 2012 Basement Flood Complaints

2.4 K-STREET SEWER

All flow from the Faxon Creek watershed must pass through the K-Street sewer. This 10-foot brick sewer, constructed in 1891 as a combined sewer, originates in Central Park and flows approximately 2,400 feet before discharging into Superior Bay.

As the sewers have aged and flows have increased, this vital piece of infrastructure has become increasingly unable to provide a suitable level of service. Being the most downstream conveyance link along Faxon Creek, its hydraulic limitations can propagate upstream contributing to the basement flooding described in Section 2.3.

Several improvements have been made to improve this deteriorating sewer. The upper portion of the sewer through Central Park was removed. This opens up the substantial detention volume of the park to attenuate storm flows.

Originally the pipe discharged into Superior Bay just past E 2nd Street. As fill moved the shoreline, the most downstream section of the sewer was removed and it discharged into a pond in a park just before passing under Marina Drive to the bay. Pipe flow velocities typically increase near a free outfall. Over several decades, this acceleration of flow likely contributed to accelerated degradation of the lower reaches of this sewer. This 120-foot section has been replaced with smooth-lined CMP and extended and additional 223 feet to the bay and the pond has been filled. The coating provides a smooth interior surface that increases hydraulic capacity while eliminating corrosion.

Approximately 500 feet of the sewer has been rehabilitated with Shotcrete. This repair has proved reliable with the repaired sections in good condition after several decades. Several tuckpointing spot repairs have also been made.

During the storm of June 2012, high flows further accelerated the rate of degradation, with large sections of brick peeling away and washing downstream. Superior personnel, recognizing the risk of failure, requested that plans to repair the sewer be made as soon as possible. In 2014 the first 700 feet of the sewer was repaired with circumferential Shotcrete. The surface was hand-troweled to provide a smoother surface, reducing the Manning's roughness coefficient, and increasing pipe capacity.

In addition, there are two locations where other conduits pass through the crown of the K-Street sewer. During large storms and high water levels, these conduits can collect debris and significantly reduce pipe capacity. Donohue recommends those conduits no longer in service be removed and the others be re-routed. Hydraulic analyses indicated these improvements will increase the peak capacity of the sewer from 440 mgd to 570 mgd, a 30% increase. (See Section 5.2.1.)

CHAPTER III – SUMMARY OF PREVIOUS SUBMITTALS

3.1 STRUCTURAL COMPONENT ANALYSIS

In February 2014 Donohue submitted the *Faxon Creek Structural Component Analysis*[4] a detailed report of the inspections of the K-Street sewer and upstream road crossings.

3.1.1 K-STREET SEWER INSPECTIONS

LHB, Inc. performed a detailed inspection of the entire interior surface of the K-Street Sewer. Stationing was established, defects logged, and photos taken. On August 4, 2013, LHB submitted a six-page memo summarizing their inspection. LHB also provided stationing, photos, field notes, and a defect table. All of these were incorporated into a GIS utility geodatabase that was submitted to the City.

3.1.2 CROSSING INSPECTIONS

Donohue inspected the following crossings along the Faxon Creek and its tributary:

- Faxon Creek
    - K-Street sewer entrance in Central Park
    - Hill Avenue
    - Railroad north of N 21st Street
    - N 21st Street & Grand Avenue
    - Arch culvert near U of W steam plant on Grand Avenue
    - N 24th Street & Catlin Avenue
- Tributary
    - Railroad Crossing south of N 21st Street
    - N 28th Street & Weeks Ave
    - N 28th Street & Railroad split
    - N 28th Street at Villa Rita

3.2 K- STREET SEWER REHABILITATION PLANS & SPECIFICATIONS

In October 2013, Donohue submitted final plans and specifications for the rehabilitation of the K-Street sewer. A pre-bid meeting for the construction contract was held in Superior on May 28, 2014. As of the publication of this report repair work was completed on November 20, 2014.

3.3 EXISTING CONDITIONS REPORT

In January 2014 Donohue submitted the *Faxon Creek Existing Conditions Report*[5]. This report detailed the development of the XP-SWMM model including field surveys, hydrologic and hydraulic model configuration and parameters, 2D model development, model calibration, existing floodplain boundaries from model results, and peak hydraulic grade lines (HGLs) for the 10, 50, 100, and 500-year storms.

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[4] Donohue & Associates, *Faxon Creek Structural Component Analysis*, February 2014.
[5] Donohue & Associates, *Faxon Creek Existing Conditions Report*, January 2014.

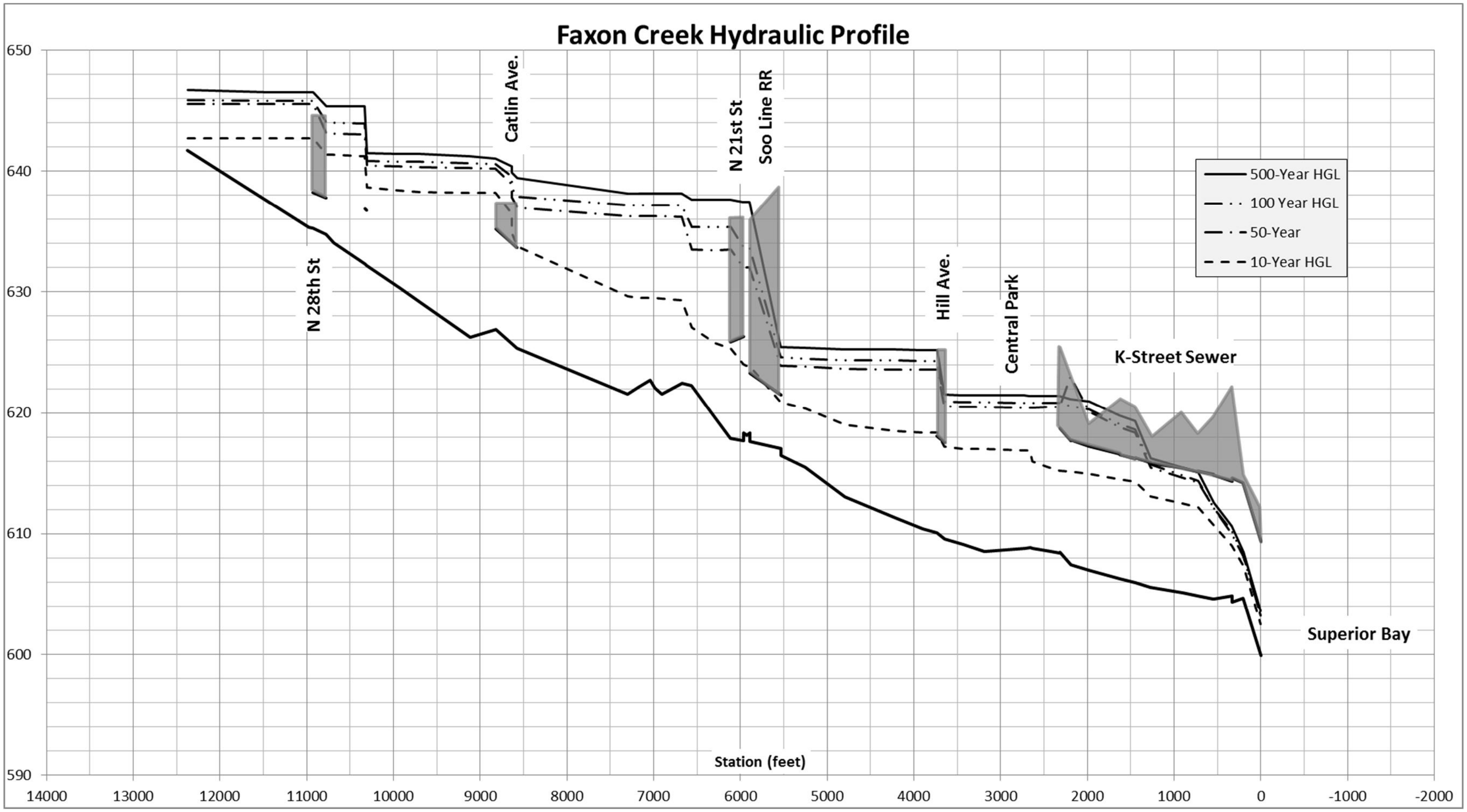

Figure 4 – 10, 50, 100, and 500-Year Peak HGL (Existing Conditions)

3.4 FEMA Flood Plain Boundaries

The *Existing Conditions Report* delineated the 100 and 500 year floodplain boundaries approximated by the model. These represent the extent of flooding with a 1% and 0.2% probability of occurrence during any given year. These boundaries are indicated in Figure 5.

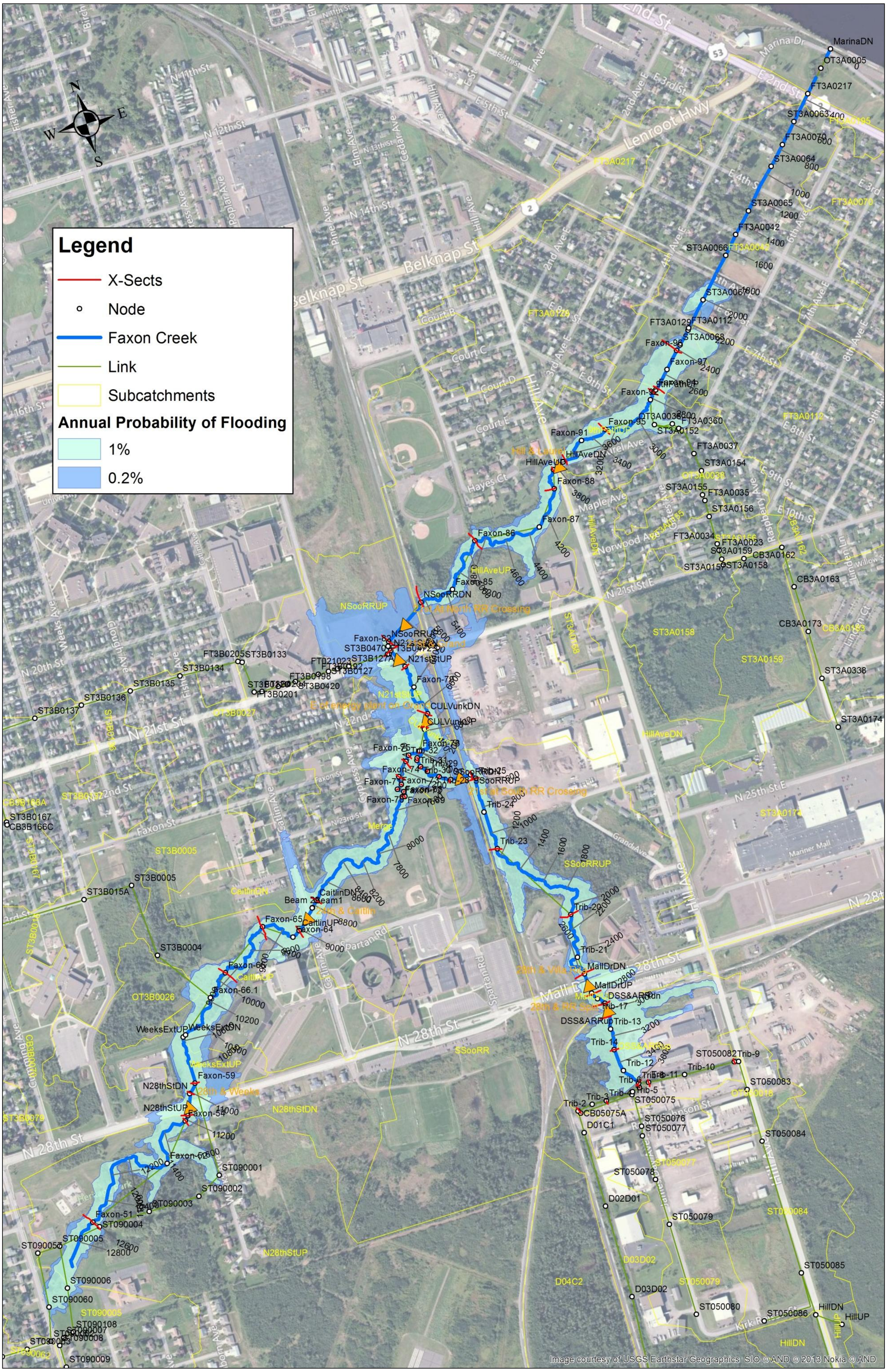

Figure 5 – Faxon Creek Model Configuration & Floodplain Boundaries

CHAPTER IV – XP-SWMM MODEL DEVELOPMENT

The development of the model was largely documented in the *Existing Conditions Report.* Superior desired to evaluate the risk of flooding for storms up to the 0.2% annual probability of recurrence including calibrating to the storm of June 2012. During events of this magnitude, the storm sewers that convey surface runoff to Faxon Creek are likely to surcharge to grade. When this occurs, overland flows can determine the rate at which runoff is conveyed to the creek. In some cases, surface topography actually directs storm runoff to the watershed north of the Faxon Creek watershed, and likely contributed to flooding of the University of Wisconsin. In addition, the creek has been observed to overtop its banks causing significant surface flooding. To accurately replicate these phenomena, XP-SWMM 2D was the selected modeling platform.

Of particular concern to COS is the manner in which the outfall of the K-Street sewer was replicated in the model. During calibration, every attempt was made to simulate this sewer as accurately as possible. Sediment and debris were replicated to match survey and inspection data. Excessive head losses during high flows due to other utilities crossing near the crown of the sewer were replicated. The outlet into the pond past East 2nd Street and the culverts under Marina Drive were included. The model boundary condition at the Osaugie Trail was the estimate bay water level at the time of the 2012 flood (601.71). The culverts under Marina Drive were twin 7-foot concrete pipes with high Manning's coefficients (0.03).

In the *Existing Conditions Report,* the June 2012 flood was used as a calibration event. Since there was no flow data and relatively little water level data available, calibration to this event primarily involved comparing model results to the observed extent of flooding from photographs and eye-witness accounts. The outlet to the Bay was simulated as described above. However, during this event, overland flows from outside the watershed drained into the pond in the park; the model could not account for this. In addition, the culverts under Marina drive failed and the entire road washed away. Therefore it was not possible to accurately replicate the water level during the course of this event. Nevertheless, further upstream from the impacts of the outfall and the failure of Marina Drive, the observed and simulated height and breadth of flooding are in agreement.

CHAPTER V – ALTERNATIVE ANALYSIS

5.1 EVALUATION OBJECTIVES / DESIGN CRITERIA

The RFP and project plan specified that the City desired to provide the 100-year level-of-service (LOS). The City of Superior (COS) analyzed costs associated with various levels of protection/service. In other words, the COS desired to provide adequate conveyance and/or detention so as to protect homes and businesses from widespread flooding for a storm with a 1% probability of occurring in any given year. However, as alternative analysis progressed, it became apparent that providing the desired LOS might be cost prohibitive. Therefore a sensitivity analysis was performed to provide a range of detention options, costs, and corresponding LOS.

5.2 CONVEYANCE IMPROVEMENTS

Roadway crossings can create significant head loss along a stream. As a result, water levels upstream of these crossings can reach flood stage, preventing attainment of the desired LOS. Alleviating these bottlenecks is often the most cost-effective means of reducing the risk of flooding. While the conveyance capacity of the K-Street sewer has been increased by about 30%, it still has insufficient capacity to provide the desired 100-year LOS. Central Park, which has significant detention capacity, lies at the upstream end of this sewer. Therefore one objective was to maximize the amount of flow that could be conveyed to the park, which required making a series of improvements to upstream crossings.

5.2.1 K-STREET SEWER

AS one might expect with a sewer over 100 years old, portions of the K-Street sewer were in need of repair. In addition to significant loss of brick, debris, etc. there are several locations where other utilities pass through the sewer near the invert and crown of the pipe. During large storm events, these crossings can collect debris, further increasing head loss and reducing pipe capacity as reflected in the model. In coordination with Superior Water Light & Power, the COS removed and/or relocated those crossings that create the greatest head loss.

Figure 6 is a profile of the K-Street sewer derived from LHB's field survey. It generally has a consistent positive slope towards the bay. However, the investigation has identified several sections where minor improvements can significantly increase capacity.

Improvements already made to the K-Street sewer include filling in the pond in the park between E 2nd Street and Marina Dr and extending the sewer all the way to Superior Bay. With the completion of the Shotcrete repairs, the reduction in head loss through the pipe during peak flows has increased the 100-year capacity of the sewer from 680 cfs (440 mgd) to 880 cfs (570 mgd) (Figure 7). During alternative analyses, the boundary condition of the K-Street sewer was a free outfall to the bay, with a fixed water surface elevation of 601.71.

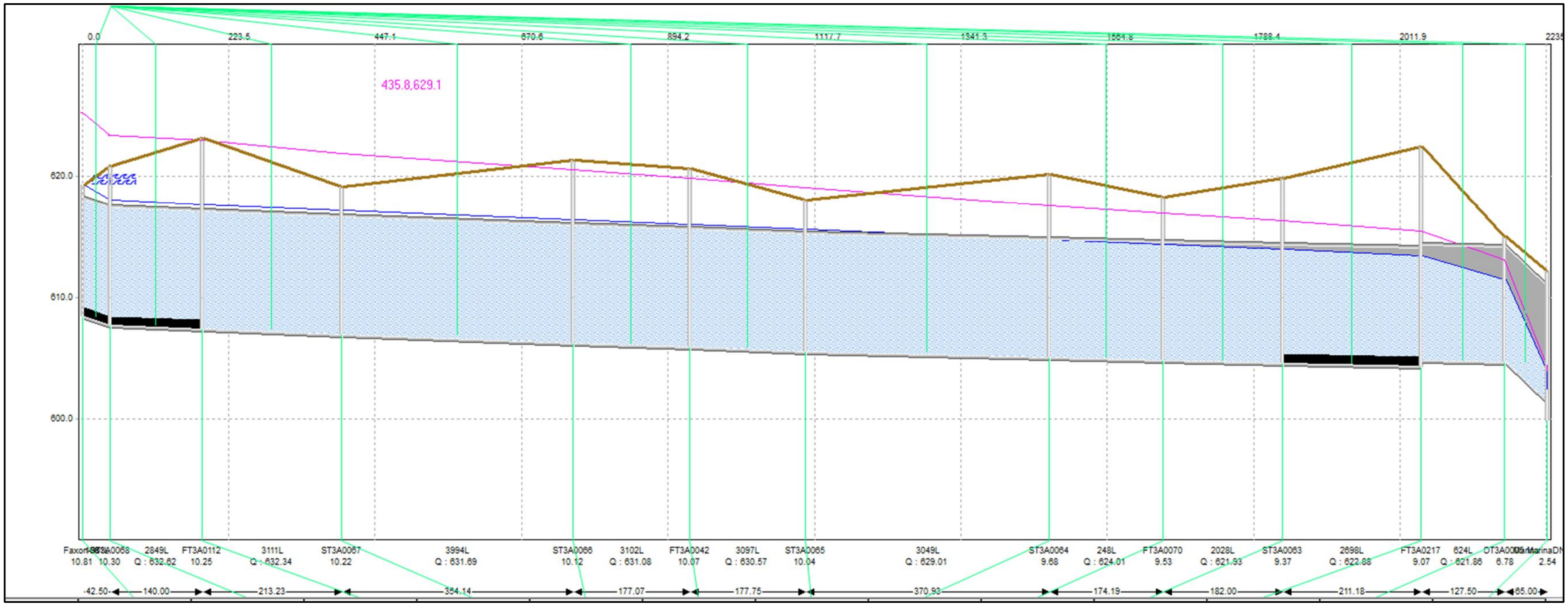

Figure 6 – K-Street Sewer Profile

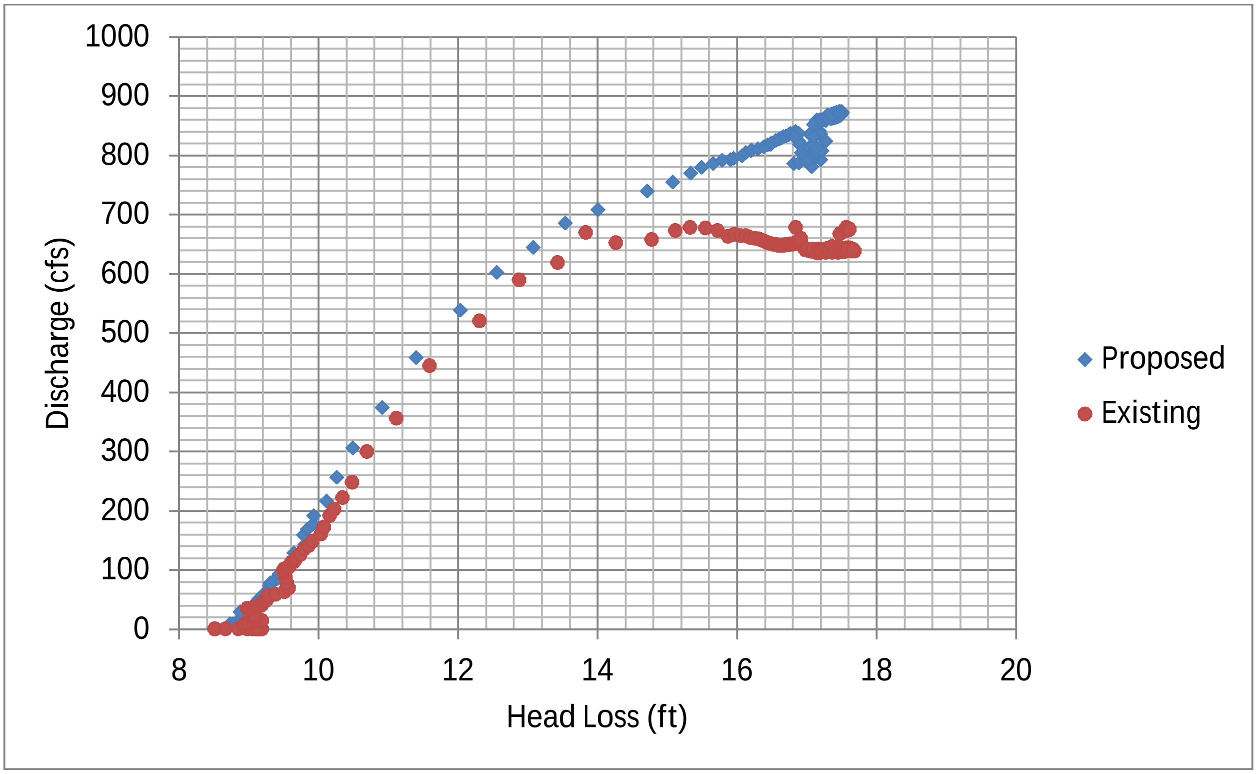

Figure 7 – K Street Sewer Hydraulic Analysis

5.2.2 HILL AVENUE

During the storm of June 2012, Faxon Creek flows, at approximately 715 cfs (462 mgd), overtopped the roadway at Hill Ave. Creek flows normally pass under Hill Ave. through a reinforced concrete arch conduit. During inspections, this aging piece of infrastructure was found to be in poor condition, with spalling, exposed rebar, etc. While spot repairs have prolonged the life of this crossing, it may be approaching the end of its useful life. Furthermore, it lacks sufficient capacity to provide an adequate LOS for peak flows that have likely increased since the crossing was constructed.

As a result of this crossing's limited capacity, it acts as a bottleneck, elevating the upstream water levels, contributing to flooding. The initial recommendation was to replace this crossing with twin box culverts. This was intended to pass the peak design flow with a minimum of head loss. Subsequent hydraulic analyses, however, have determined that this culvert can be replaced with a single 9' X 12' box culvert.

A hydraulic evaluation of this crossing was made using HY-8 Culvert Analysis Program (Figure 8) to estimate the head loss for a range of flows and configurations. The Hill Ave crossing in the XP-SWMM model was replaced with a single 9' X 12' box culvert. The resultant HGL is depicted in Figure 22. While replacing the arch culvert with a single box culvert rather than two increases the HGL between the Railroad Crossing North of N 21st Street and Hill Ave by about two feet, there are no buildings in this area, so it does not increase the risk of flood damage. The increased HGL does not propagate to upstream of N 21st Street, therefore the single culvert does not increase the risk of basement backups as compared to dual box culverts.

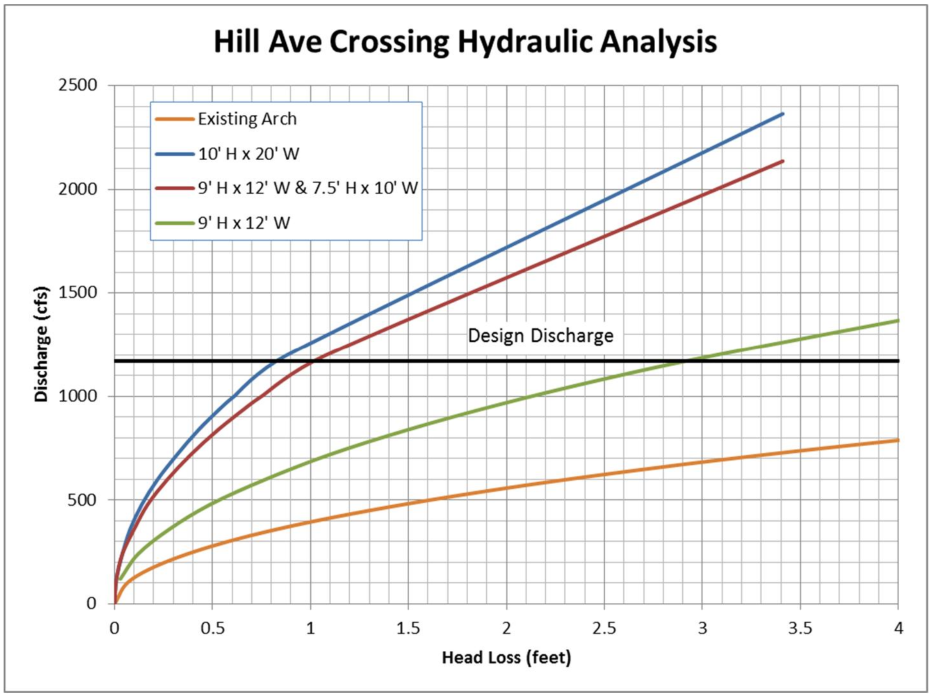

Figure 8 – Hill Ave Crossing HY-8 Analysis

Table 1 compares the effect of the proposed improvements to the Hill Ave crossing along Faxon Creek using the flows and tailwater elevations from both the XP-SWMM model and the Flood Insurance Study. The HY-8 model was used to evaluate the reduction in the HGL for various culvert configurations and flows. Replacing the existing arch culvert with a single 9' x 12' box culvert reduces the head loss across the culvert during the 100-year and 500-year storms from 2.5 feet to 1.10 feet and from 3.00 feet to 2.19 feet respectively. (During design, the size of the culvert was increased to 10' x 12'.)

Table 1 – Hill Ave Crossing HY-8 Analysis

Design Storm (Years)	Scenario	Discharge (cfs)	100-Year HGL	Upstream	Downstream	Head Loss (feet)
100	Existing	720[1]	1977 Flood Insurance Study	621.5	619.00[1]	2.50
			HY-8	622.33		3.33
		625[2]	XP-SWMM	624.29	620.95[2]	3.34
			HY-8	623.47		2.52
	Proposed		HY-8 (9' x 12')	621.79		0.84
		720[1]		622.05		1.10
500	Existing	1,150[1]	1977 Flood Insurance Study	626.00	623[1]	3.00
			HY-8	626.06		3.06
	Proposed		HY-8 (9' x 12')	625.19		2.19

Notes:

1. From 1977 Flood Insurance Study
2. From XP-SWMM Model

5.2.3 RAILROAD CROSSING NORTH OF N 21ST STREET

There are three conduits, each approximately 350 feet in length, that convey flow from just downstream of N 21st Street under the Railroad Crossing North of N 21st Street (the Railroad). The lower two of these conduits are 60-inch RCP while the largest, and highest, of the three is a 72-inch CMP. Internal inspections of these conduits, detailed in the *Faxon Creek Structural Component Analysis*, determined that the two 60-inch RCPs are in poor condition. Several joints are significantly offset, creating excessive head-loss and further contributing to upstream flooding.

The following six alternatives with several sub-alternatives were considered for reducing the head loss through this crossing so as to lower the HGL:

- <u>Alternative 1</u> – Replace the two 60-inch RCP conduits with 84-inch pipes with a low roughness coefficient, such as smooth-lined polycoated CMPs. The old pipes would be replaced using the consumption method. As the new pipe is jacked, the old pipes are "consumed", or manually removed from the inside. The new pipe is jacked as personnel remove the existing culvert from within the protective shield. The shield has the steering capability to maintain grade. The jacking unit is substantial and requires a sizeable work pit. The unit must also have a stable backstop to push against. If the Railroad requires a steel casing pipe the carrier pipe can be of virtually any material including HOBAS.
- <u>Alternative 2</u> – After the 2012 storm, the Railroad installed two new 48-in CMP culverts under the tracks to mitigate the risk of flows overtopping and washing out the berm. These might be used to provide additional capacity to reduce the HGL south of N 21st Street. Doing so will require re-grading the cross-hatched area in Figure 9 to permit water to flow from the creek to the culverts.
- <u>Alternative 3</u> – Replace the 3 existing culverts with a single box culvert and filling in the "hole" just north of N 21st Street (Figure 10). Doing so would reduce exit and entrance losses, potentially lowering the HGL. Two sub-alternatives were considered, an 8'x8' box culvert and an 8'x10' box culvert. Either would extends all the way to the east side of the Railroad.
- <u>Alternative 5</u> – This is similar to Alternative 2, but involves more excavation. Rather than a modest about of re-grading to divert high flows to the new 48" CMPs, this alternative excavates down to the elevation of the creek bed while removing the three culverts until just west of the Railroad.
- <u>Alternative 6</u> – This alternative included Alternatives 2. It also added a fourth culvert to the existing 3 culverts. Several sub-alternatives with fourth culverts of varying sizes were given consideration. This alternative also assumed new headwalls would be constructed at the upstream and downstream ends of the crossing to reduce entrance and exit losses.

The results of the alternative analysis are summarized in Table 2. Highlighted peak HGLs are those less than the level-of-service (LOS), or risk of flooding, specified in the column heading. Each alternative provides at least a 25-year LOS. Only Alternatives 3A and 6D provide the 100-year LOS. At about $45K, Alternative 2 is the cheapest alternative to provide the 25-year LOS, while at a cost of approximately $754K, 6D is the lowest cost option to provide the 100-year LOS. Figure 11 is a cost-benefit analysis of all of the alternatives.

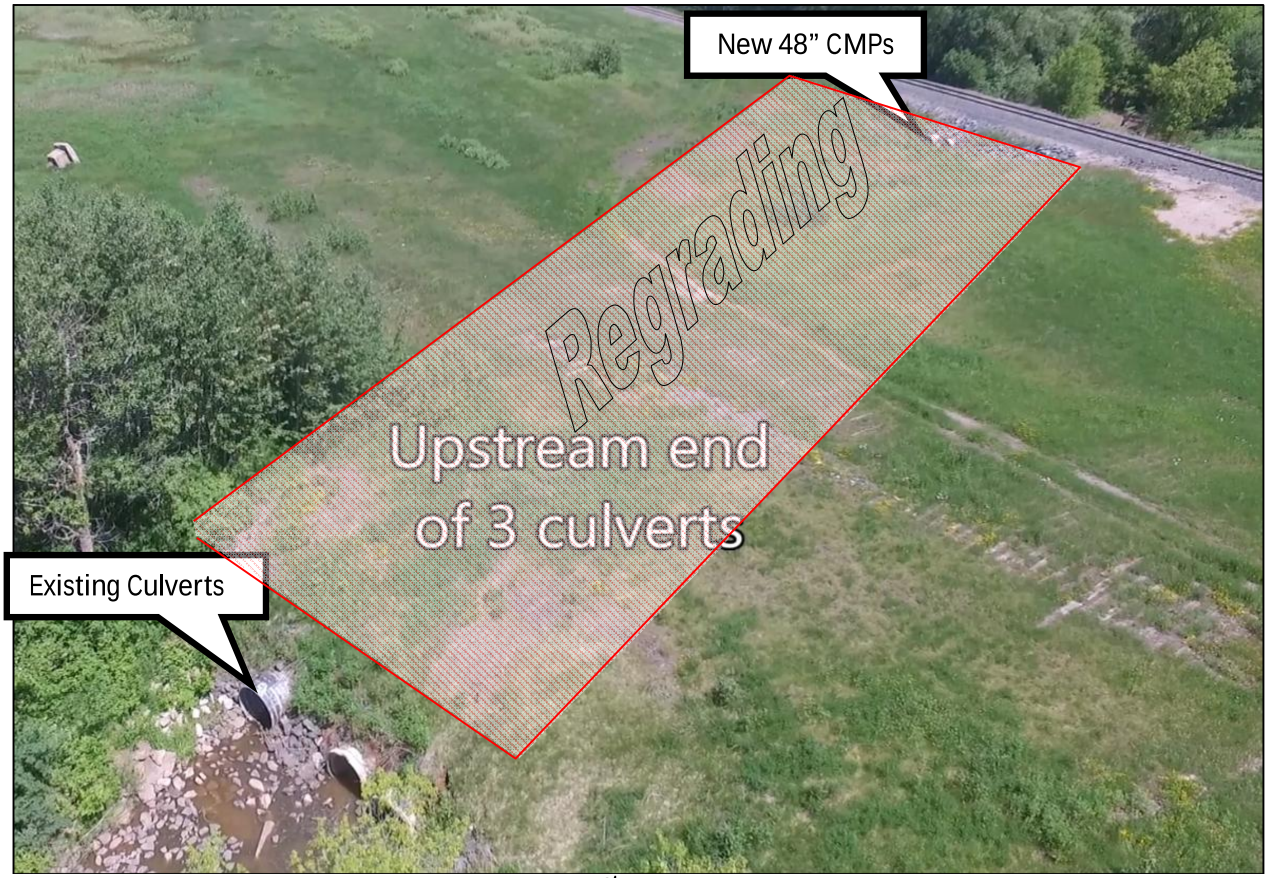

Figure 9 – Railroad Crossing North of N 21st St, Alternative 2

Figure 10 – "Hole" North of N. 21st Street

Table 2 – Railroad Crossing Improvement Alternatives

Alternative	Description	Peak HGL		Level of Service	Cost Estimate
		25-Year	100-Year		
	Target Peak HGL	631.61			
	2016 Conditions			16	$ -
1	Replace 60-in RCPs with 84-in CMPs	626.47	630.75	100	$ 991,460
2	Re-grading	631.59	635.21	26	$ 44,476
3A	Single 8x10 Culvert	627.29	630.98	125	$ 1,821,966
3B	Single 8X8 Culvert	628.87	633.21	60	$ 1,770,935
5	Open Upstream End of 3 Culverts	628.2	632.71	69	$ 807,903
6A	Alt 2 + Add 4th Culvert (60-inch)	628.75	632.92	63	$ 548,395
6B	Alt 2 + Add 4th Culvert (72-in)	627.72	632.28	78	$ 593,029
6C	Alt 2 + Add 4th Culvert (48-in)	629.90	633.62	48	$ 520,256
6D	Alt 2 + Add 4th Culvert (84-in)	626.65	630.98	134	$ 754,317

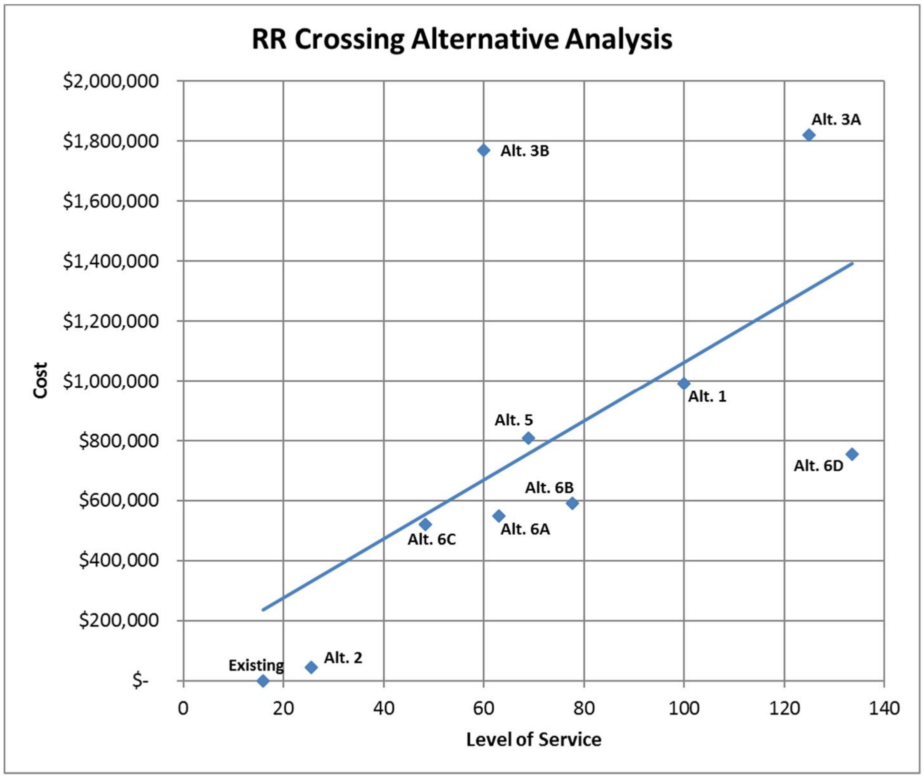

Figure 11 – Railroad Crossing Alternatives Cost-Benefit Analysis

5.2.4 NORTH 21ST STREET

This 8-foot concrete box culvert was replaced in 2009. It lies just downstream of some of the worst basement flooding (Figure 3) that occurred during the June 2012 flood. This conduit appears to have been appropriately sized to match the capacity of the Railroad crossing just downstream. However, with potential improvements to the Railroad and Hill Ave crossings, and a potential storage pond north of the crossing adjacent to the Railroad, it will no longer have adequate capacity to take advantage of downstream capacity improvements and most cost-effectively provide the desired LOS.

Donohue evaluated the following 3 alternatives for this crossing:

Table 3 – N 21st Street Crossing Alternatives

Description	Cost Estimate	Comments
Do nothing	$0	Would only be sufficient for the 25-year level-of-service.
Install 8x8 box culvert alongside existing culvert	$264,500	Could provide the 90-100 year LOS should the Railroad crossing do likewise
Replace existing 8x8 box culvert with 8X10 box culvert	$290,950	

Constructing a second 8-foot box culvert parallel the existing crossing would improve the hydraulics of the crossing as indicated in Figure 12.

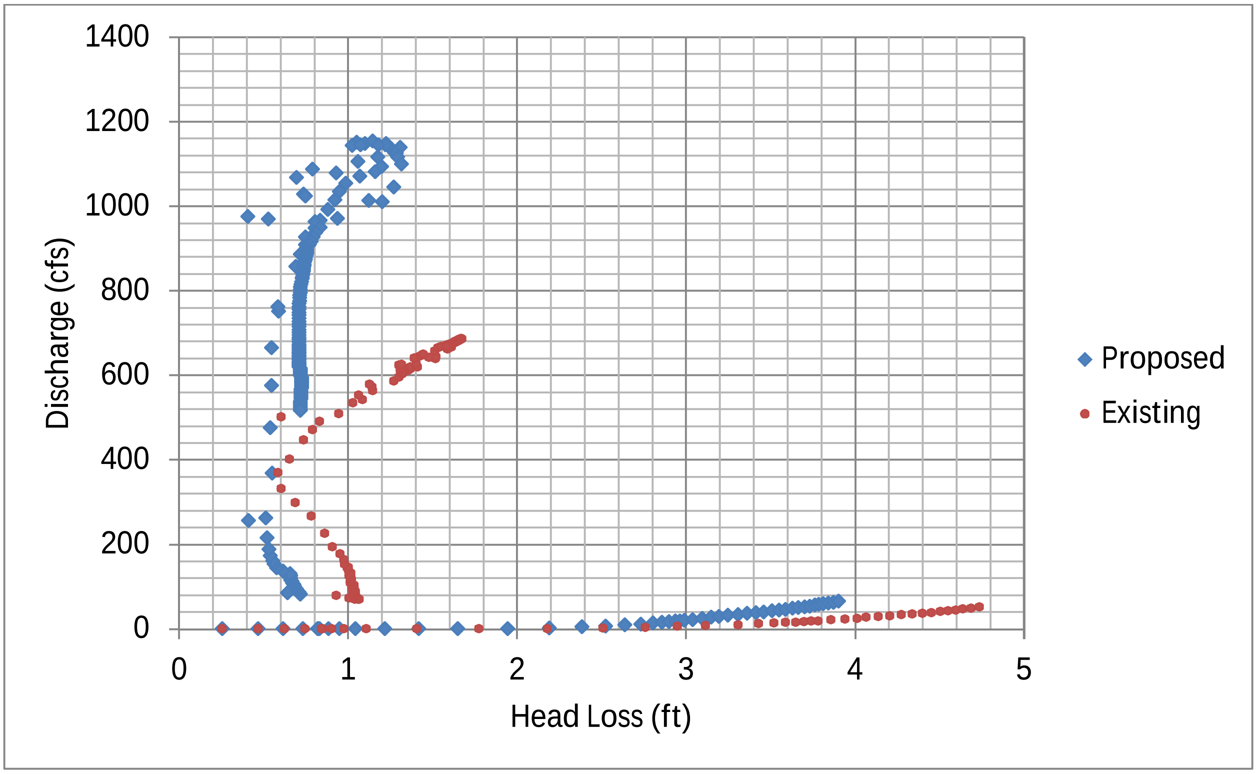

Figure 12 – N 21st Street Crossing Hydraulics

In order for this improvement to be effective, the arch culvert under the old Grand Ave alignment south of N 21st would need to be removed. This conduit passes under what had been Grand Avenue and is no longer required. It prevents peak flows from being conveyed downstream and contributes to some of the worst basement flooding in the Faxon Creek watershed.

5.2.5 Catlin Avenue

Model runs of existing conditions indicated that this 100-inch culvert experiences excessive head loss. This is, in part, caused by a 12-inch concrete "beam", believed to be an active UWS steam line, penetrating the crown of the pipe. Donohue recommends that a parallel 84-inch RCP culvert be constructed under Catlin Ave. This would reduce the head loss (Figure 13) such that the crossing no longer contributes significantly to risk of flooding.

5.3 Detention Storage

Five (5) locations (Figure 14) were given consideration as potential storage sites. However preliminary analyses determined that two sites, particularly those near airport property, were too far upstream to provide even a modest amount of flow attenuation and benefit flood prone areas further downstream. Ultimately three sites were evaluated during alternative analyses. The detention ponds described in this section are shown with their maximum footprints. They need not necessarily be constructed to this size.

5.3.1 RAILROAD CROSSING NORTH OF N 21ST STREET DETENTION POND

Some of the highest flooding during the storm of June 2012 occurred just upstream of the Railroad Crossing North of N 21st Street and the N 21st Street culvert. Faxon Road was submerged, and the basement levels of the university's steam plant, located adjacent to the river, were completely flooded causing extensive damage. Basement flooding in the adjacent neighborhood was severe (Figure 3).

While placing detention ponds further upstream in the watershed can reduce downstream flooding by attenuating peak flows, it is far more effective to locate detention storage nearest the flooding. This provides more passive control over the timing of flows into and out of storage in a manner that best mitigates nearby flooding.

This potential storage site is located on property owned by the railroad. While the site is currently vacant, and used primarily as a snow dump, consideration has been given to converting it to a commercial corridor.

Figure 15 is a schematic of this pond's recommended configuration, at its maximum potential size. This pond would function as off-line storage for creek floodwaters. Water would flow into and out of the pond through the same 7-foot conduit.

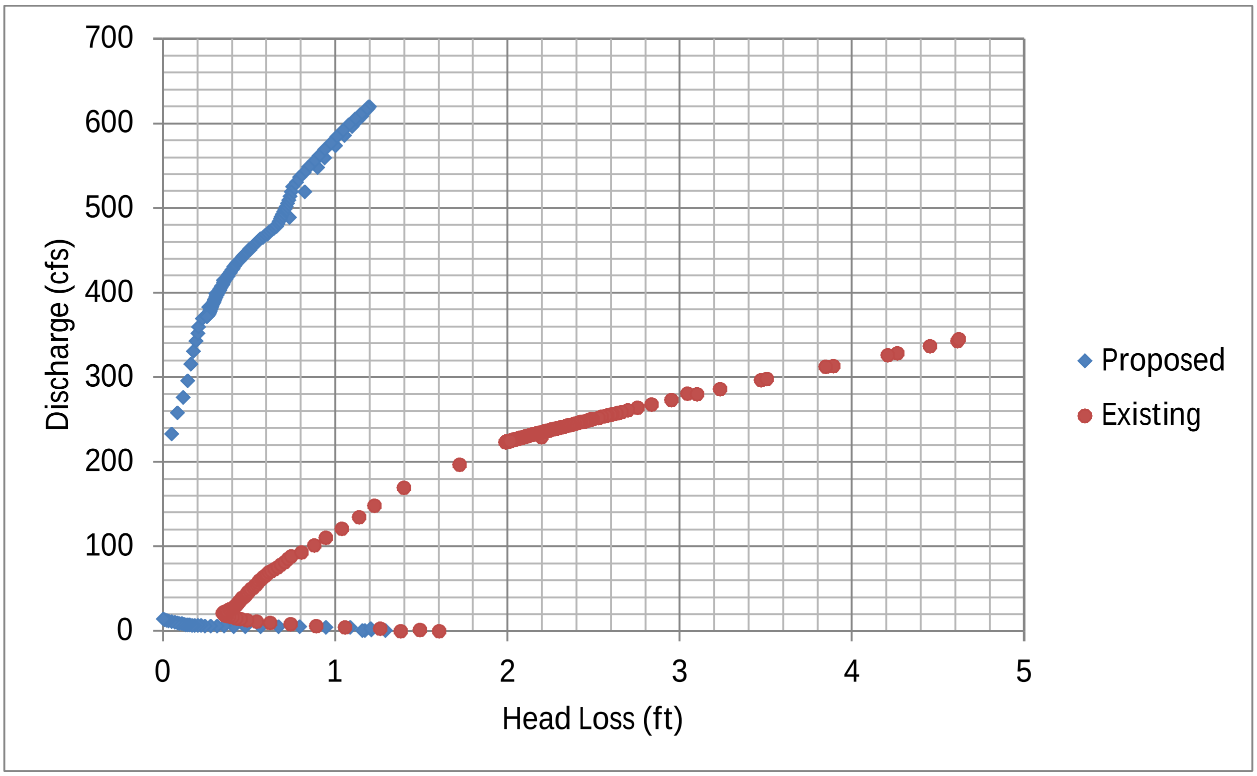

Figure 13 – Catlin Avenue Crossing Hydraulic Analysis

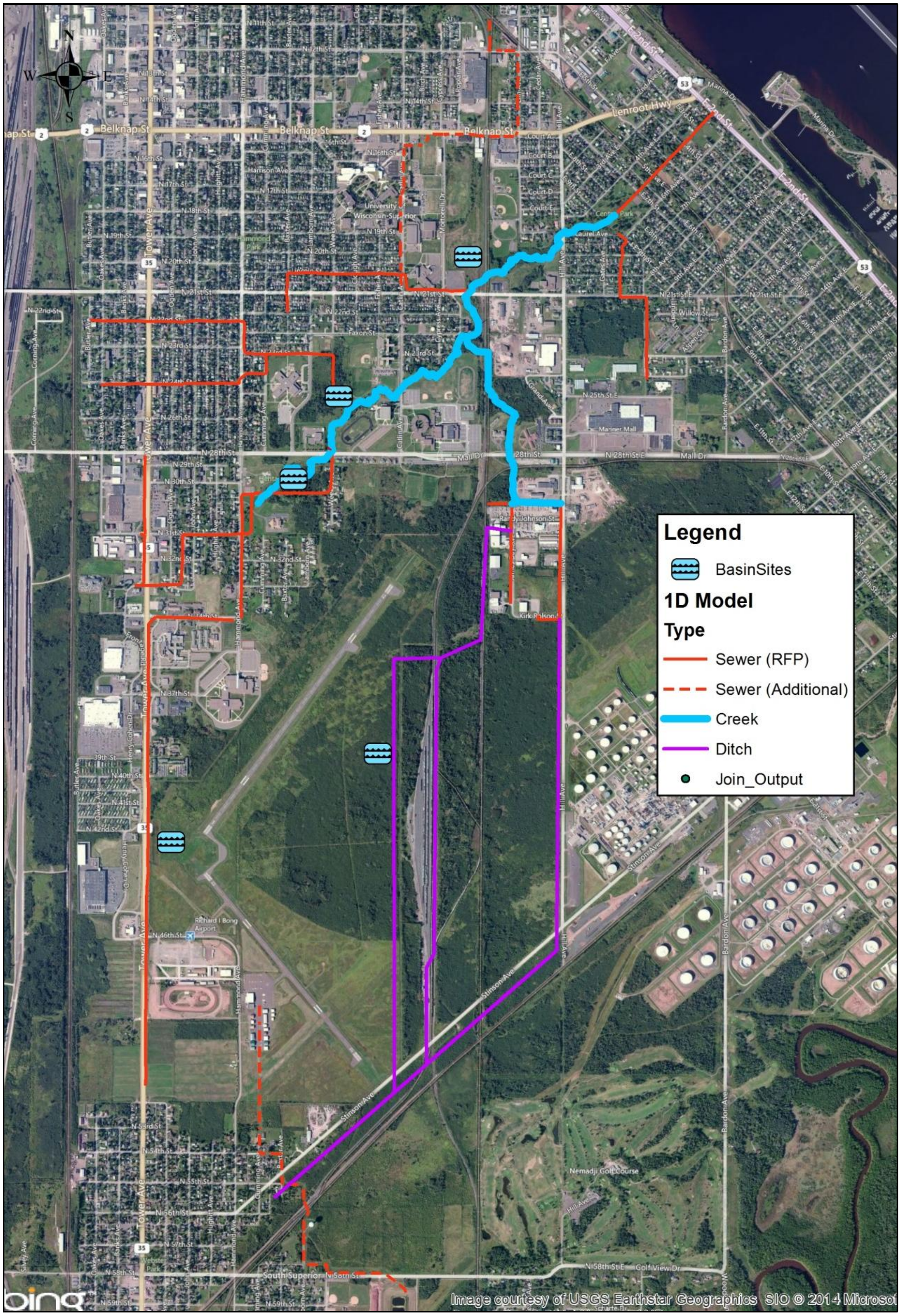

Figure 14 – Potential Detention Basin Sites

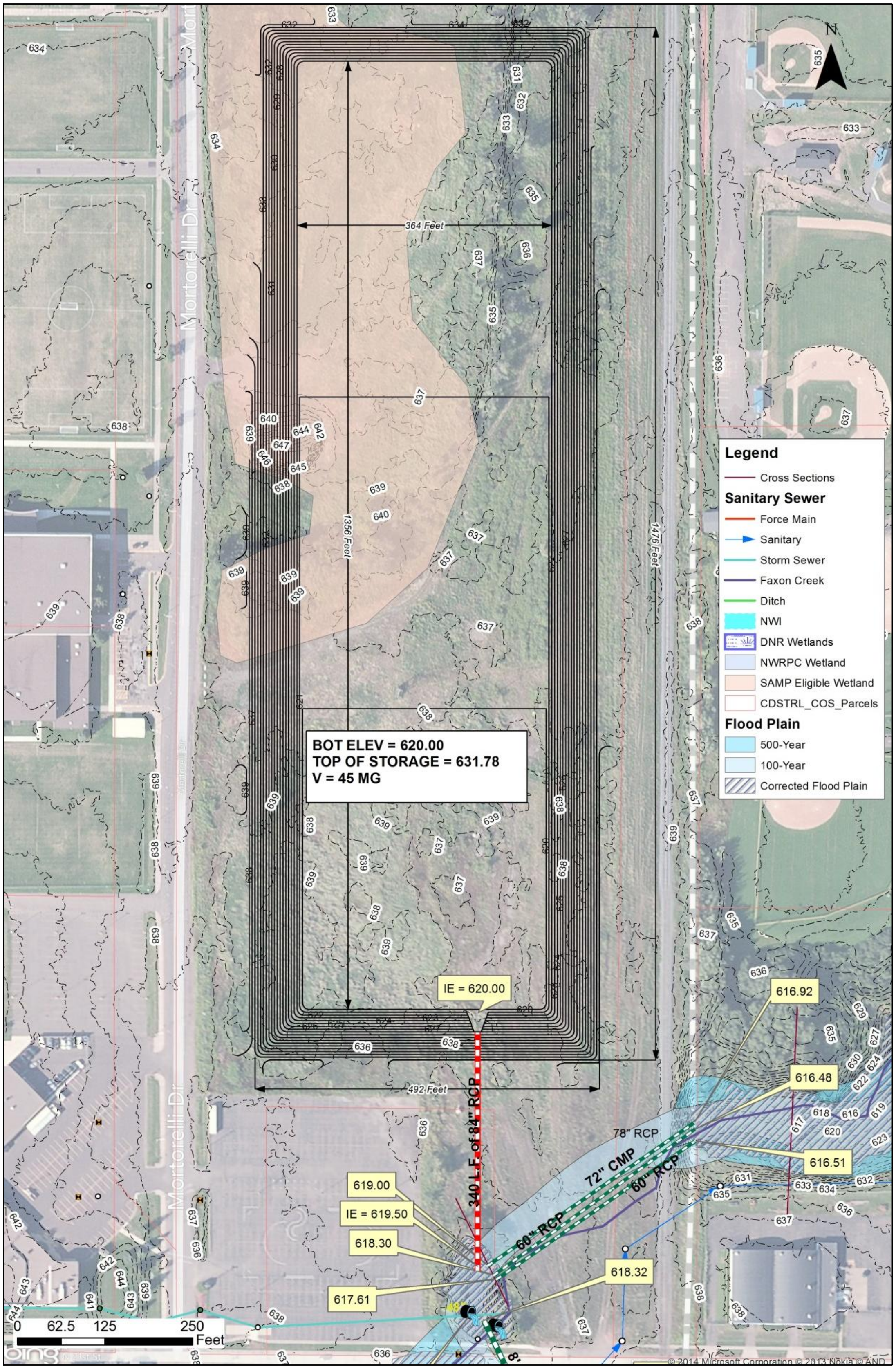

Figure 15 – Railroad Crossing North of N 21st Street Detention Pond Schematic

The cost per usable storage gallon for this pond is high as compared to the other potential storage sites. Grade elevation at the site is approximately 638.00 while the bottom of the pond would be approximately 620.00, giving it a depth of 18 feet. However, in order to keep water levels low enough so as to mitigate nearby basement flooding, only the first 9 feet of the pond's depth can be used for storage. While water levels above 629.00 are certainly possible, at that point the HGL of the creek upstream of N. 21st Street is at risk of flooding the sanitary sewers, resulting in basement backups.

This pond would be located between the crossings at N 21st Street and the Railroad Crossing North of N 21st Street. The majority of 2012 basement flooding occurred upstream of the N 21st Street crossing. This 8-foot concrete box culvert was replaced in 2009. The culvert was appropriately sized for the conditions at the time, which are no downstream pond and the Railroad Crossing with inadequate capacity. However, it will act as a bottleneck in the future, creating excessive head loss and rendering the detention pond ineffective to reduce basement flooding. Therefore a second 8-foot box culvert under N. 21st Street will be required.

The pond need not necessarily be the full size indicated in Figure 15. A smaller pond footprint or no pond at all may cost-effectively provide the desired LOS. A cost-benefit evaluation of pond sizes and configurations has been provided in Section 5.3.4.

5.3.2 UNIVERSITY OF WISCONSIN POND

Figure 16 is a schematic of a detention pond given consideration on a property owned by the University of Wisconsin. This schematic is what the pond might look like at its maximum footprint. The pond need not necessarily be the full size indicated. A smaller pond footprint may cost-effectively provide the desired LOS. A cost-benefit evaluation of pond sizes and configurations has been provided in Section 5.3.4.

A 54-inch storm sewer currently flows through the site. This sewer would continue to function to convey flows into and out of the pond. A section of pipe where the pond is located would be removed during construction. A headwall would be constructed at the pond inlet, and an outlet control structure at the pond outlet would regulate flows leaving the site.

This pond provides an opportunity for TSS reduction. By excavating 2-3 feet below the outlet structure, a pool would be created to settle TSS during small to modest rainfall events.

The outlet structure would likely be a form of stand pipe with multiple outlets. The lowest outlet would establish the pool elevation and regulate flows during smaller events to promote settling of solids. A second, larger opening, just above the first, would serve to regulate discharge rates during larger storms and mitigate downstream flooding along Faxon Creek. At the top of the stand pipe would be a large opening that would act as a spillway, permitting flows that enter the site once the pond is full to pass directly to the outlet pipe.

5.3.3 HERITAGE PARK POND

Figure 18 is a schematic of a detention pond given consideration on property owned by the COS and the Central Assembly of God church. This schematic is what the pond might look like at its maximum footprint. The pond need not necessarily be the full size indicated. A smaller pond footprint may cost-effectively provide the desired LOS. A cost-benefit evaluation of pond sizes and configurations has been provided in Section 5.3.4.

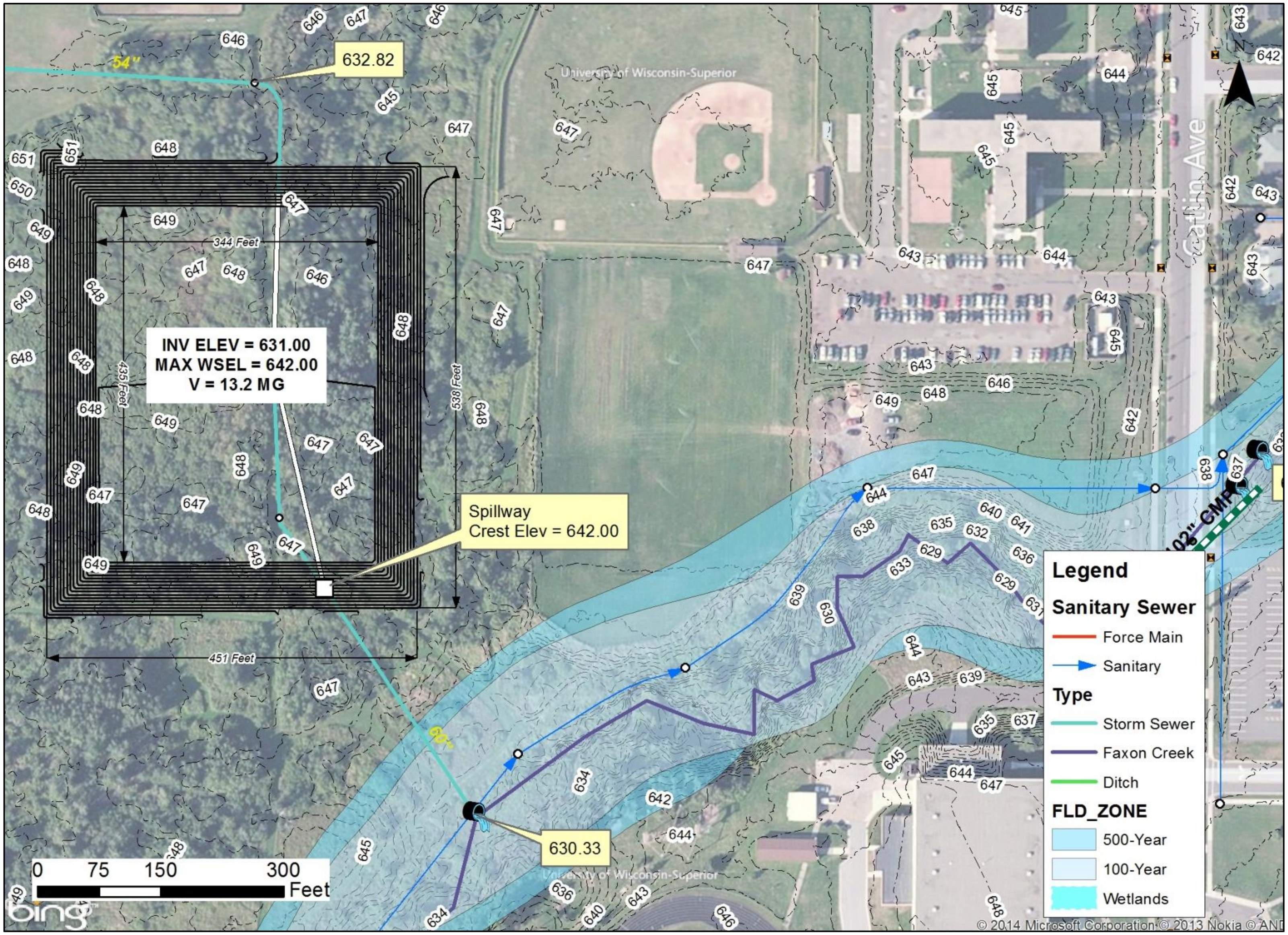

Figure 16 – U of W Detention Pond Schematic

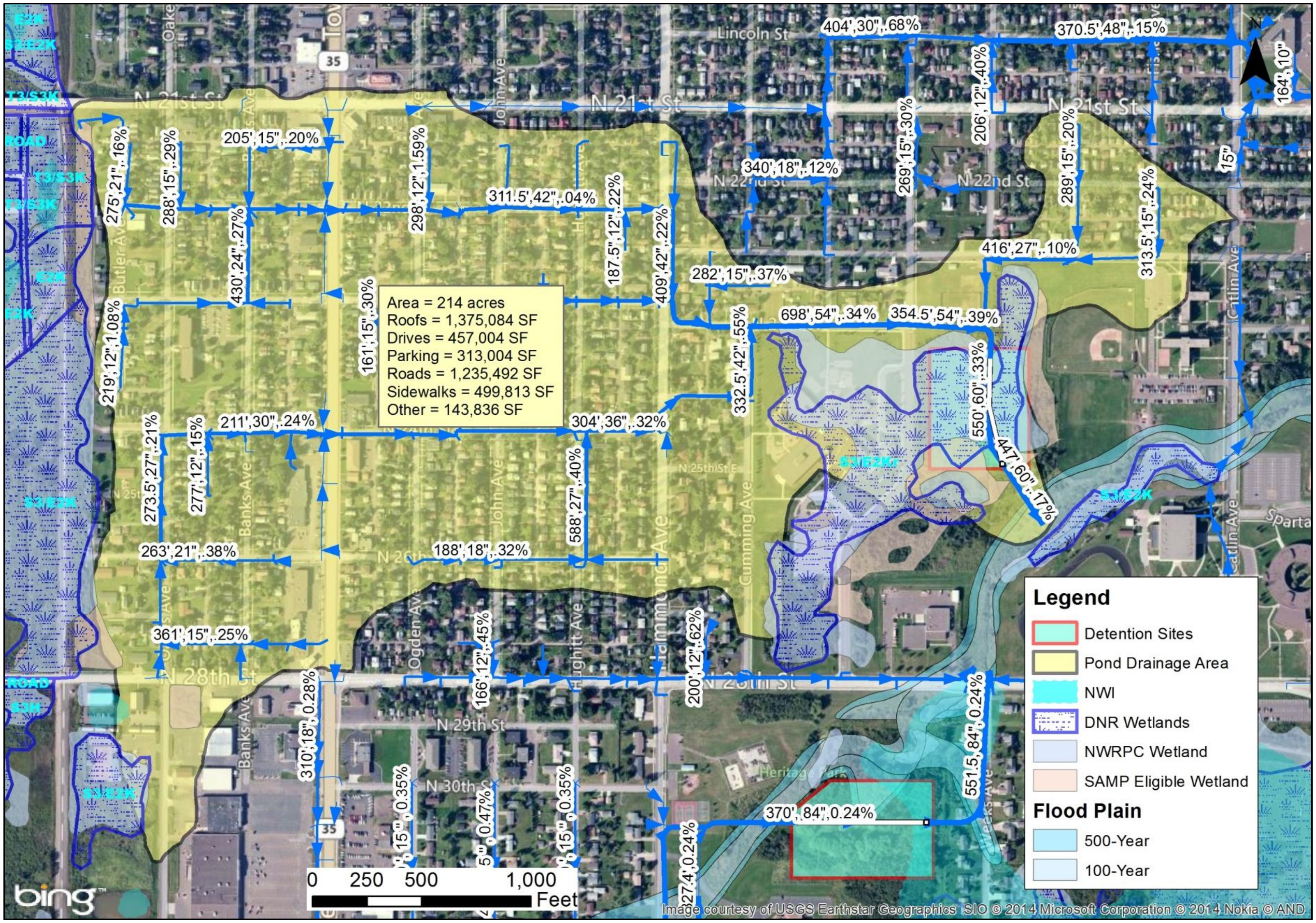

Figure 17 – U of W Detention Pond Drainage Area

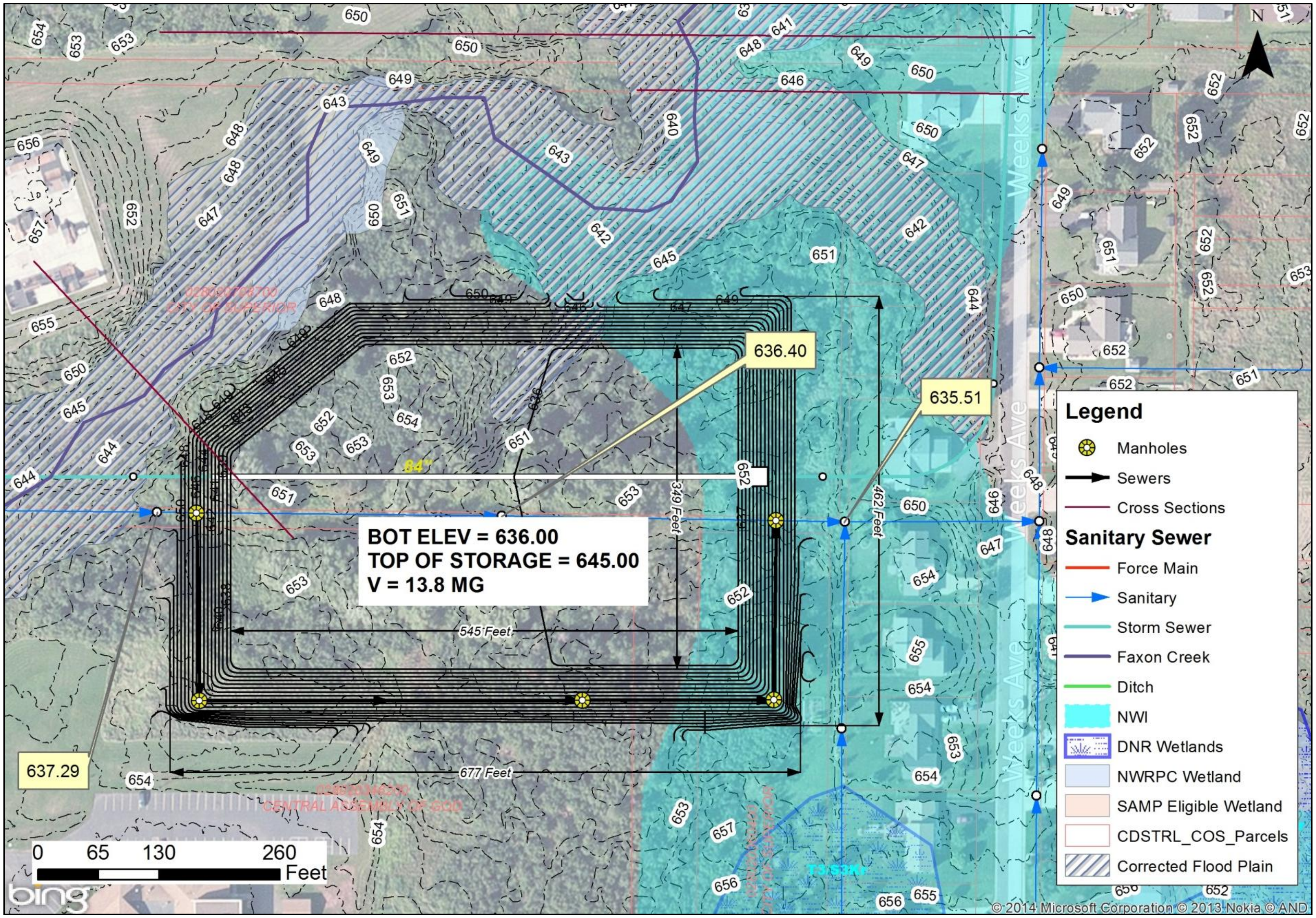

Figure 18 – Heritage Park Pond Schematic

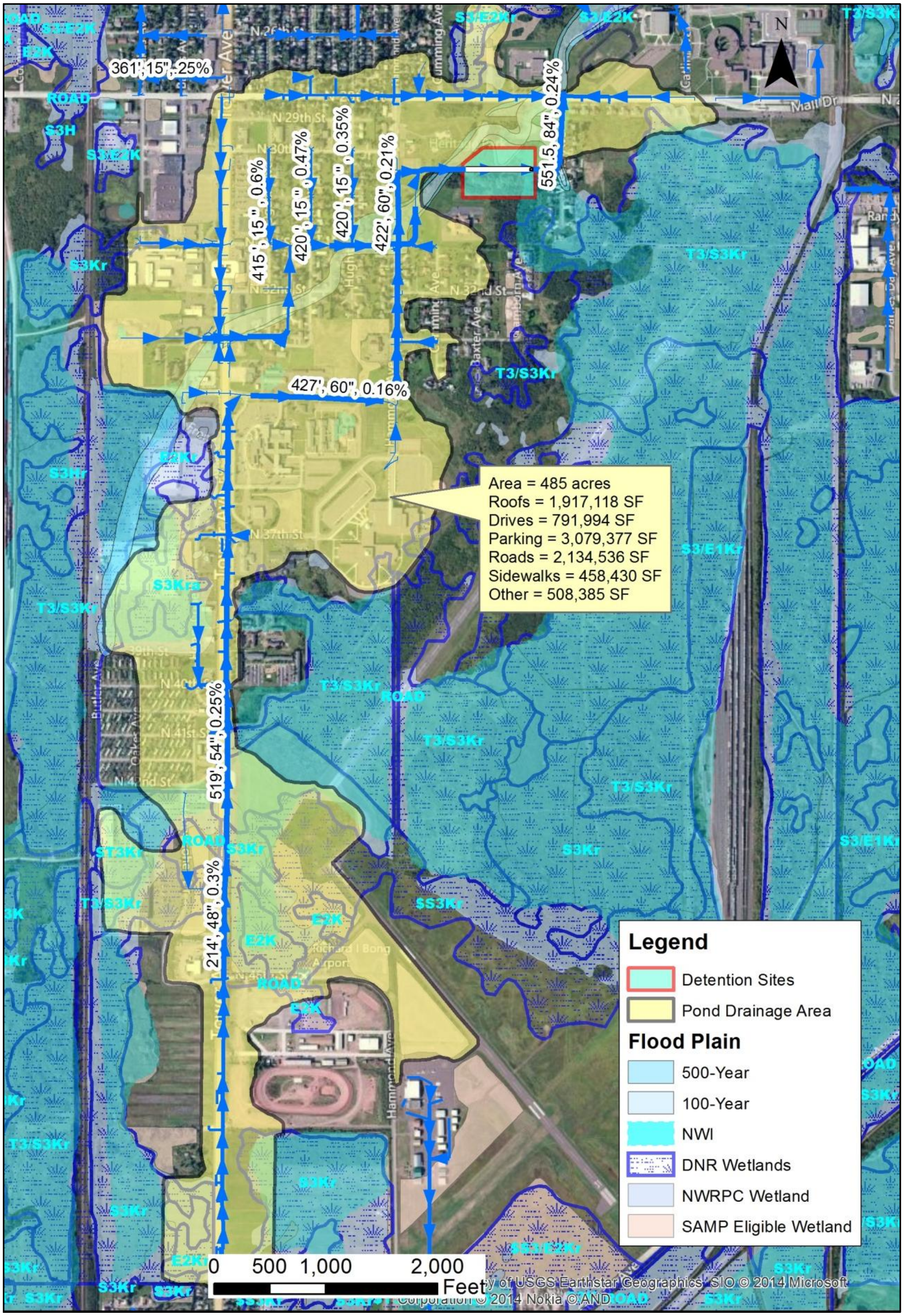

Figure 19 – Heritage Park Pond Service Area

An 84-inch storm sewer currently conducts flow through the site. This sewer would continue to function to convey flows into and out of the pond. A section of pipe where the pond is located would be removed during construction. A headwall would be constructed at the pond inlet, and an outlet control structure at the pond outlet would regulate flows leaving the site.

An 18-inch sanitary sewer currently passes through the pond site. This sewer would have to be relocated around the south side of the pond during construction.

This pond provides an opportunity for TSS reduction. By excavating 2-3 feet below the outlet structure, a pool would be created to settle TSS during small to modest rainfall events.

The outlet structure would likely be a form of stand pipe with multiple outlets. The lowest outlet would establish the pool elevation and regulate flows during smaller events to promote settling of solids. A second, larger opening, just above the first, would serve to regulate discharge rates during larger storms and mitigate downstream flooding along Faxon Creek. At the top of the stand pipe would be a large opening that would act as a spillway, permitting flows that enter the site once the pond is full to pass directly to the outlet pipe.

5.3.4 POND SELECTION / SIZING COST-BENEFIT ANALYSIS

There is a vast number of combinations of potential pond sizes and crossing improvements providing a range of reductions in flood elevations, i.e. levels of service. In order to provide the COS with a variety of options from which to select an alternative that provides the desired LOS, a cost-benefit analysis was performed by evaluating 6 system scenarios with a range of pond sizes over a range of design storms. A total of 42 model runs were made in conducting the analysis.

Table 4 describes the crossing and pond improvements that were made for each of the 6 unique system configurations, or scenarios.

Table 4 – Cost-Benefit Analysis Scenarios

	Crossing Improvements				Detention Ponds		
Scenario	Catlin	N 21st St	Soo	Hill	Heritage Park	U of W	Railroad Crossing North of N 21st Street
1	•		•	•	•	•	
1B	•		•	•			
2	•		•	•	•		
3	•		•	•	•		•
4	•	•	•	•	•		•
5	•	•	•	•			•
5B*	•	•	•	•			
6	•	•					•

*Most cost-effective alternative

For each scenario, the model was run with a range of pond sizes and design storms to quantify the benefit in terms of the LOS. Cost estimates were adjusted for the ranges of pond sizes and total costs summed. Table 5 and Figure 20 indicate numerically and graphically the result of this analysis. This analysis indicates that Scenario 5 is the most cost-effective. By improving the Catlin, N 21st St / Grand Ave., Railroad Crossing North of N 21st Street, and Hill Ave crossings, the 97-year LOS can be achieved without any detention. While Table 4 indicates a pond near the Railroad Crossing North of N 21st Street, the 97-year LOS is attained with a pond size of 0 MG. Ponds of 8.5 acres and 12.8 acres increase the LOS to 130 years and 140 years respectively. Making the pond any larger has a negligible benefit in terms of increasing the LOS.

For each scenario, the LOS was determined by evaluating the peak water surface elevation at station 73+00 along the creek. At this location, there is a sanitary manhole with a rim elevation of 632.19. This manhole was found to be at the greatest risk for inundation with creek flood waters. It was presumed that if the creek could be kept below this elevation at this location, the risk of basement flooding in the adjacent neighborhood would be adequately mitigated.

Table 5 – Alternative Analysis Cost-Benefit Evaluation

Scenario	Crossing Improvements	Fraction of Max. Footprint	U of W Area (acres)	U of W Volume (MG)	U of W Cost ($M)	Heritage Park Area (acres)	Heritage Park Volume (MG)	Heritage Park Cost ($M)	Soo Line Area (acres)	Soo Line Volume (MG)	Soo Line Max Depth (ft)	Soo Line Cost ($M)	Total Volume (MG)	Crossings ($M)	Total Cost ($M)	Storm Probability (STA 73+00) 2%	Storm Probability (STA 73+00) 1%	Design Storm (Years)
															Critical Elevation:	632.19		
1	Catlin, Soo, Hill	100%	5.76	14.8	$ 2.02	6.29	14.3	$ 2.66	No Pond				29.1	$ 2.10	$ 6.78	629.84	631.45	123
		75%	4.32	9.5	$ 1.27	4.72	9.4	$ 1.80					18.9		$ 5.17	630.52	632.34	96
		50%	2.88	4.4	$ 0.68	3.15	4.5	$ 1.10					8.9		$ 3.88	631.41	633.14	73
1B		0%	0	0.0	$ -	0.00	0.0	$ -					0.0		$ 2.10	632.03	633.75	55
2		100%	No Pond			6.29	14.3	$ 2.66					14.3		$ 4.76	630.25	632.25	99
		75%				4.72	9.4	$ 1.80					9.4		$ 3.90	630.97	632.85	82
		50%				3.15	4.5	$ 1.10					4.5		$ 3.20	631.59	633.39	67
3		100%				6.29	14.3	$ 2.66	17.0	29.0		$ 7.43	43.3		$ 12.19	631.31	633.24	66
		75%				4.72	9.4	$ 1.80					38.4		$ 11.33	631.38	633.36	62
		50%				3.15	4.5	$ 1.10					33.5		$ 10.63	631.47	633.52	55
4	Catlin, Soo, Hill, N 21st St	100%				6.29	14.3	$ 2.66	17.0	27.5	6.62	$ 7.40	41.8	$ 2.38	$ 12.44	629.56	630.61	175
		75%				4.72	9.4	$ 1.80	12.8	20.9	7.50	$ 4.45	30.3		$ 8.63	629.97	631.03	155
		50%				3.15	4.5	$ 1.10	8.5	13.4	8.96	$ 2.73	17.9		$ 6.21	630.56	631.58	130
5	Catlin, Soo, Hill, N 21st St	100%				No Pond			17.0	29.0	6.97	$ 7.40	29.0		$ 9.78	630.41	631.38	142
		75%							12.8	22.3	7.90	$ 4.45	22.3		$ 6.83	630.49	631.43	140
		50%							8.5	13.4	8.96	$ 2.73	13.4		$ 5.11	630.56	631.58	130
5B		0%							No Pond				0.0		$ 2.38	630.86	632.29	97
6	Catlin, N 21st St	100%	No Pond						17.0	27.5	6.62	$ 7.40	27.5	$ 0.51	$ 7.91	631.12	633.49	73
		75%							12.8	20.9	7.50	$ 4.45	20.9		$ 4.96	632.19	634.72	50

Cost-Effective Alternative

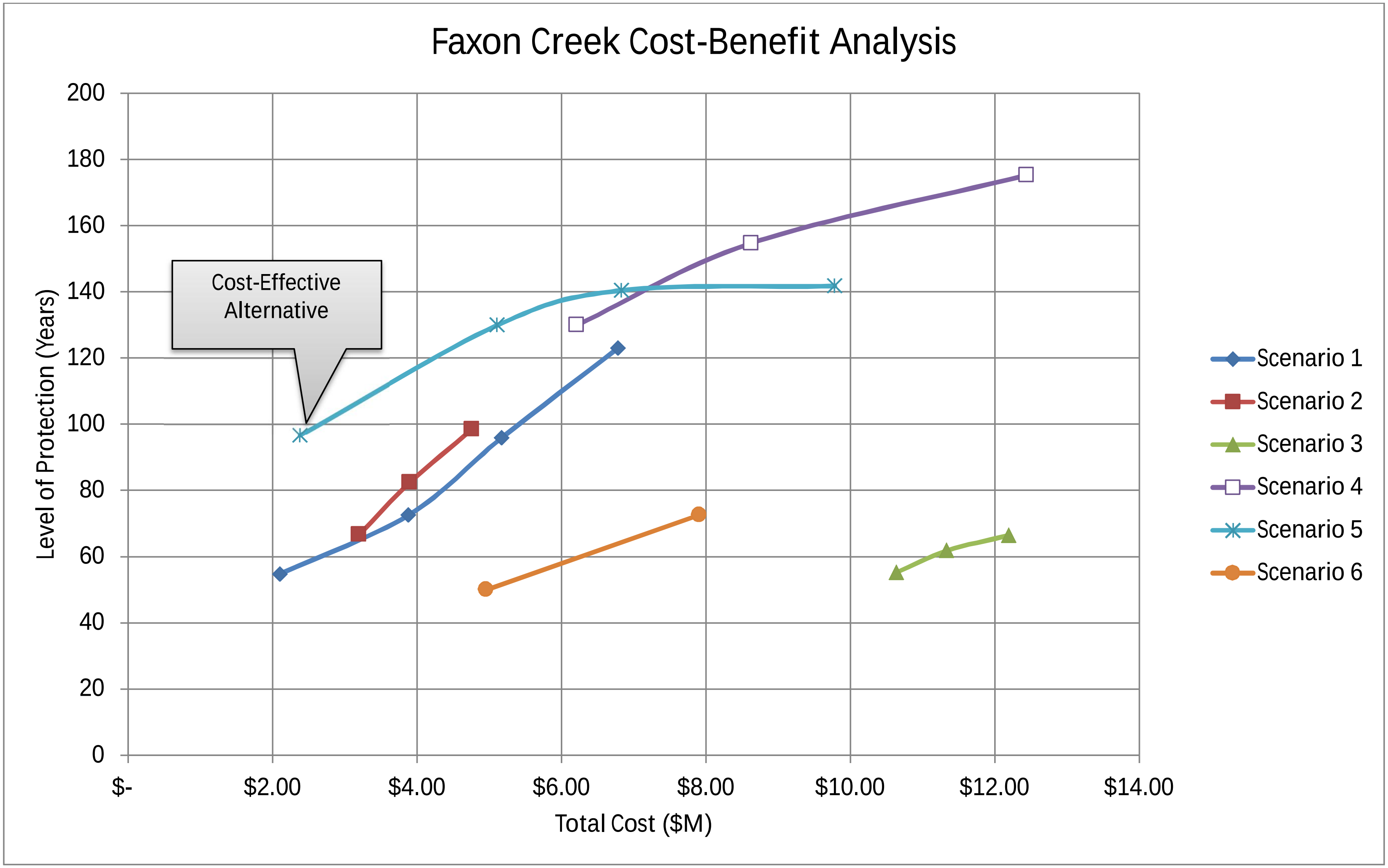

Figure 20 – Alternative Analysis Cost-Benefit Evaluation

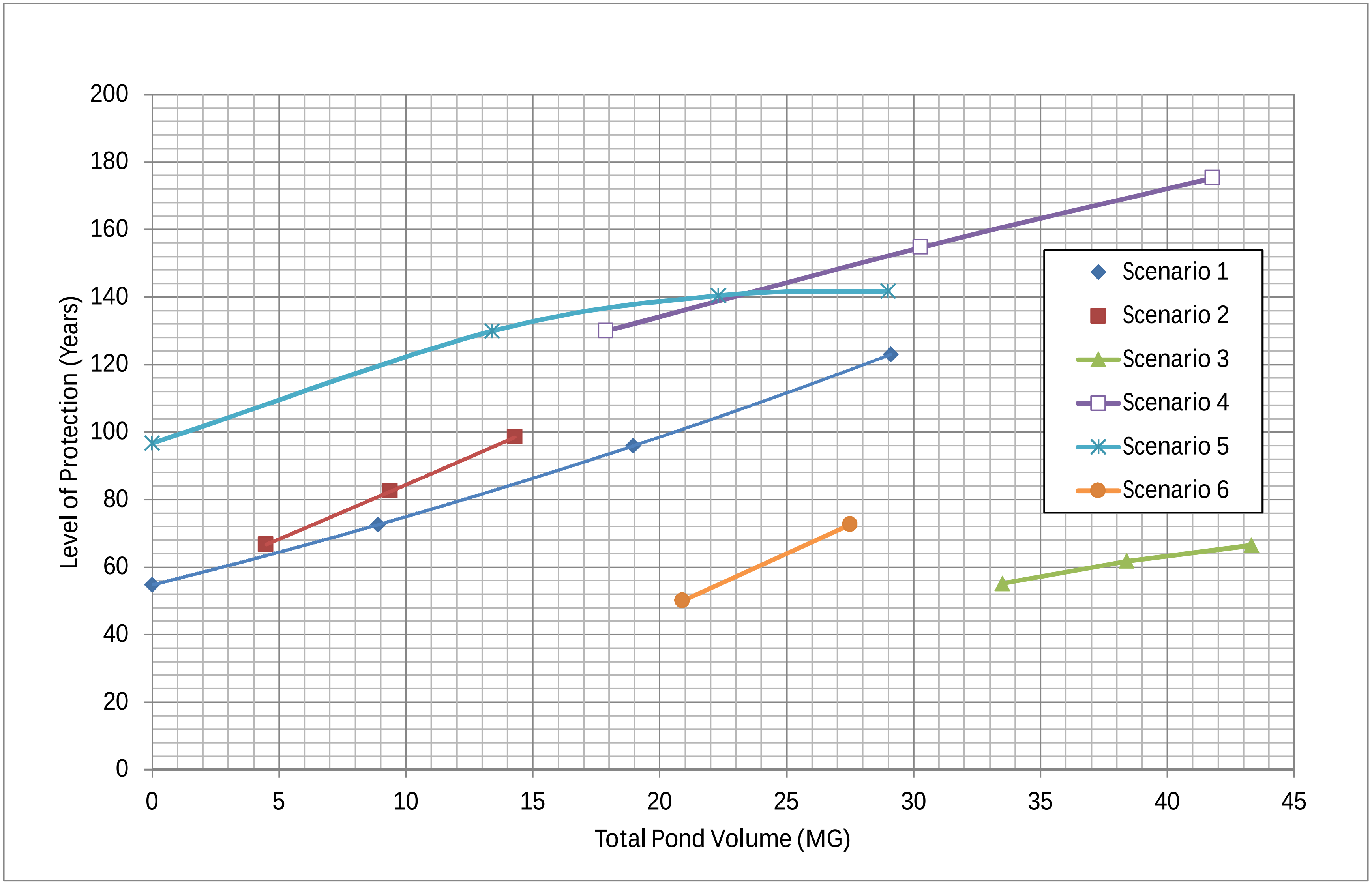

Figure 21 – Pond Size Sensitivity Analysis

5.4 Opinions of Probable Construction Costs

Table 6 is a summary of opinions of probable construction costs. The pond costs are for ponds at maximum potential size. Detailed cost opinions are provided in the Appendix. Please note that all cost estimates are for design and construction only, and do not account for real estate acquisition.

Table 6 – Summary of Opinions of Probable Construction Costs

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

SUMMARY

INITIAL CONSTRUCTION COST ESTIMATE

General Description

ALTERNATIVE NO. AND NAME	Cost ($)
Hill Avenue Crossing	866,510
Railroad Crossing North of N 21st Street	991,460
N 21st Street Crossing	262,313
Grand Ave. Culvert Removal	15,853
Catlin Crossing	242,755
Pond No. 2 / UW Superior	2,018,094
Pond No. 3 / Heritage Park	2,664,237
Pond No. 1 / Soo Line RR	7,428,525

Notes:
1. Estimates do not include the cost of real estate acquisition.
2. The Hill Avenue Crossing has since been bid. The winning bid was for $727,171.15

5.5 RECOMMENDED IMPROVEMENTS

As a result of the cost-benefit analysis described in Section 5.3.4, Donohue recommends an alternative based on Scenario 5. This would improve the Catlin, N 21st, the Railroad Crossing North of N 21st Street, and Hill Ave crossings; no detention storage is required. These improvements would provide the 97-year LOS for approximately $2.5M. The LOS could be increased to the 140-year LOS by constructing a pond adjacent to the Railroad Crossing North of N 21st Street.

Donohue recommends prioritizing the improvements by starting the furthest downstream, and working upstream. As of the date of this report, the two most downstream improvements, the rehabilitation of the K-Street sewer and the replacement of the Hill Ave crossing, were already complete. Donohue recommends next improving the Railroad Crossing North of N 21st Street, N. 21st Street / Grand Ave, and finally the Catlin Avenue crossing.

Figure 22 depicts the lowering of the peak HGL. This assumes the RR crossing is improved so as to provide the 100-year level of service. If, on the other hand, the re-grading option (Alternative 2 from Table 2) is selected, the hydraulic profile would be as indicated in Figure 23.

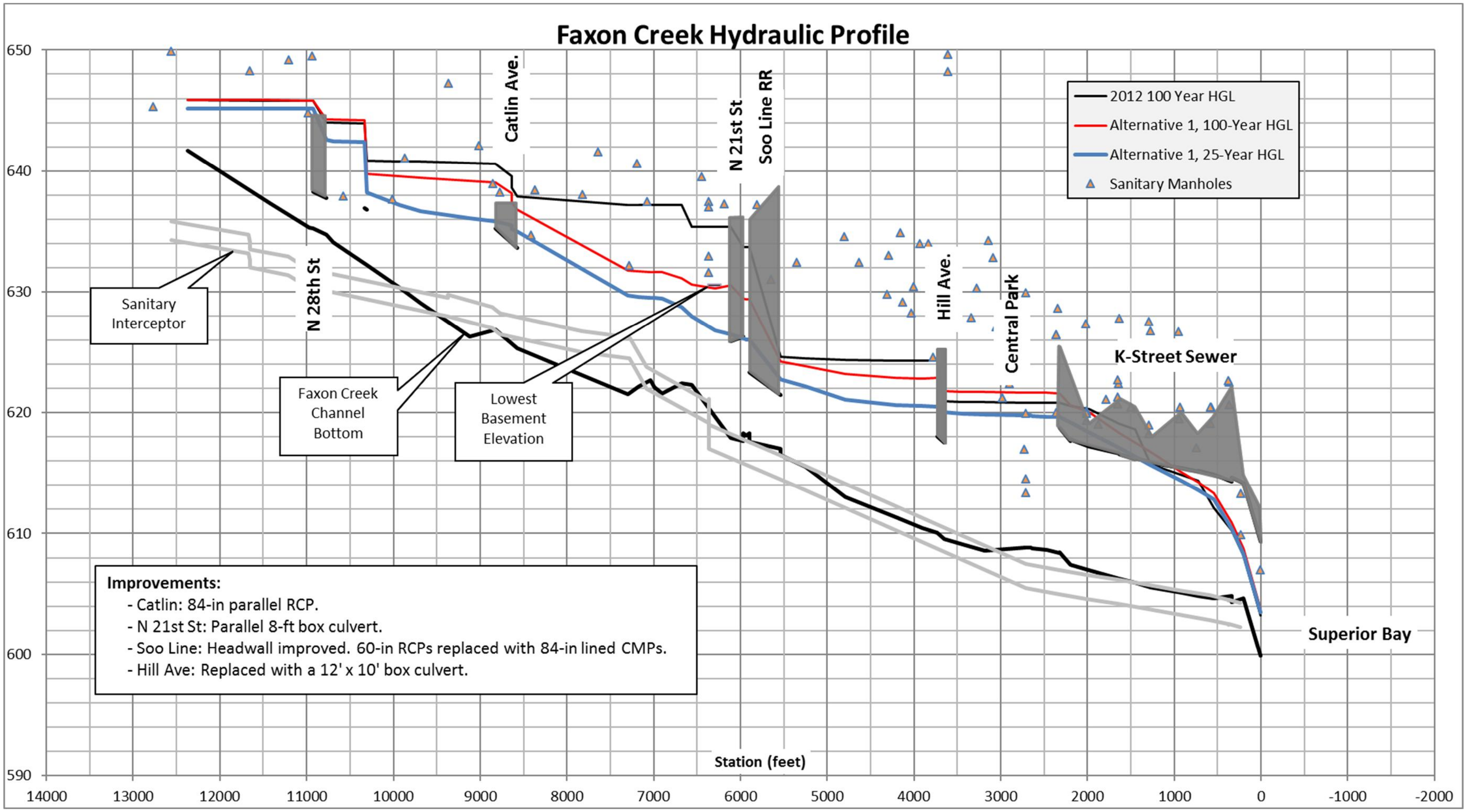

Figure 22 – Existing & Proposed Peak Hydraulic Grade Lines (Recommended Improvements)

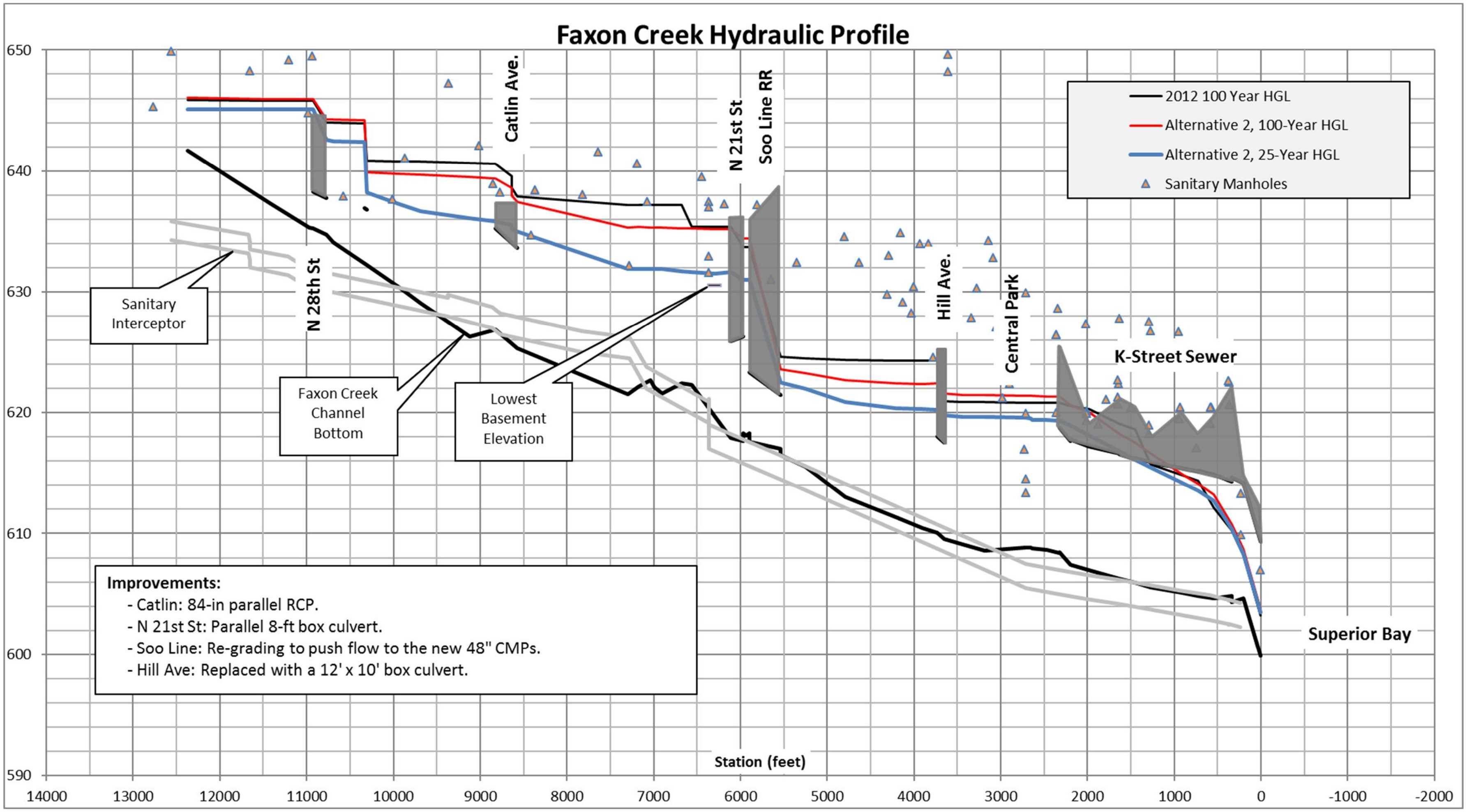

Figure 23 – Existing & Proposed Peak Hydraulic Grade Lines (Re-Grading Option)

5.6 OTHER IMPROVEMENTS CONSIDERED

5.6.1 STORMWATER DETENTION

Other detention storage sites were given consideration. These include expanding an existing detention pond on Tower Avenue and constructing a new pond on the air field. However these sites are too far upstream to show even a slight reduction in the risk of downstream flooding.

5.6.2 NEMADJI RIVER DIVERSION

The Nemadji River basin is adjacent to the Faxon Creek basin. Superior requested that Donohue evaluate the potential benefit of constructing a sewer to divert stormwater from Faxon Creek to the Nemadji River. As indicated in Figure 25, a diversion 48-inch sewer would originate in a ditch near the intersection of Stinson Avenue and Hill Ave and flow approximately 2500 feet south and east before discharging into a drainage swale which flows towards the Nemadji River. Figure 24 is a profile of the proposed sewer and overland flow profile to the Nemadji River outlet.

This system modification would only divert a relatively minor amount of storm flow from the tributary to Faxon Creek. Being so far up in the watershed, it would have a negligible effect on the severity of flooding along Faxon Creek.

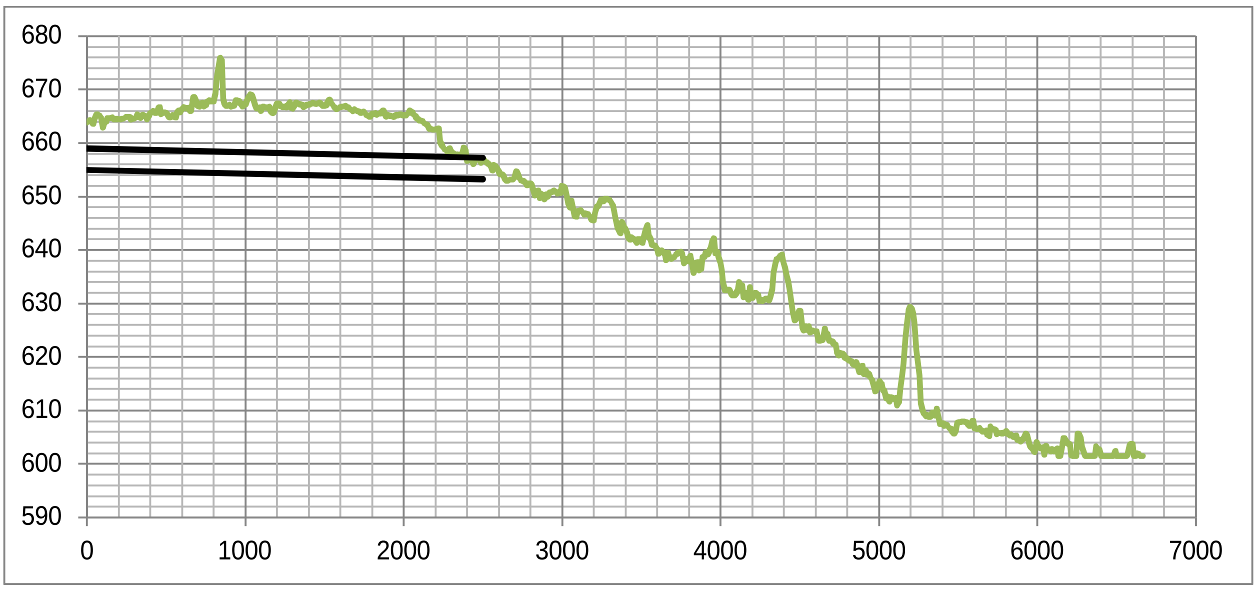

Figure 24 – Nemadji Diversion Profile

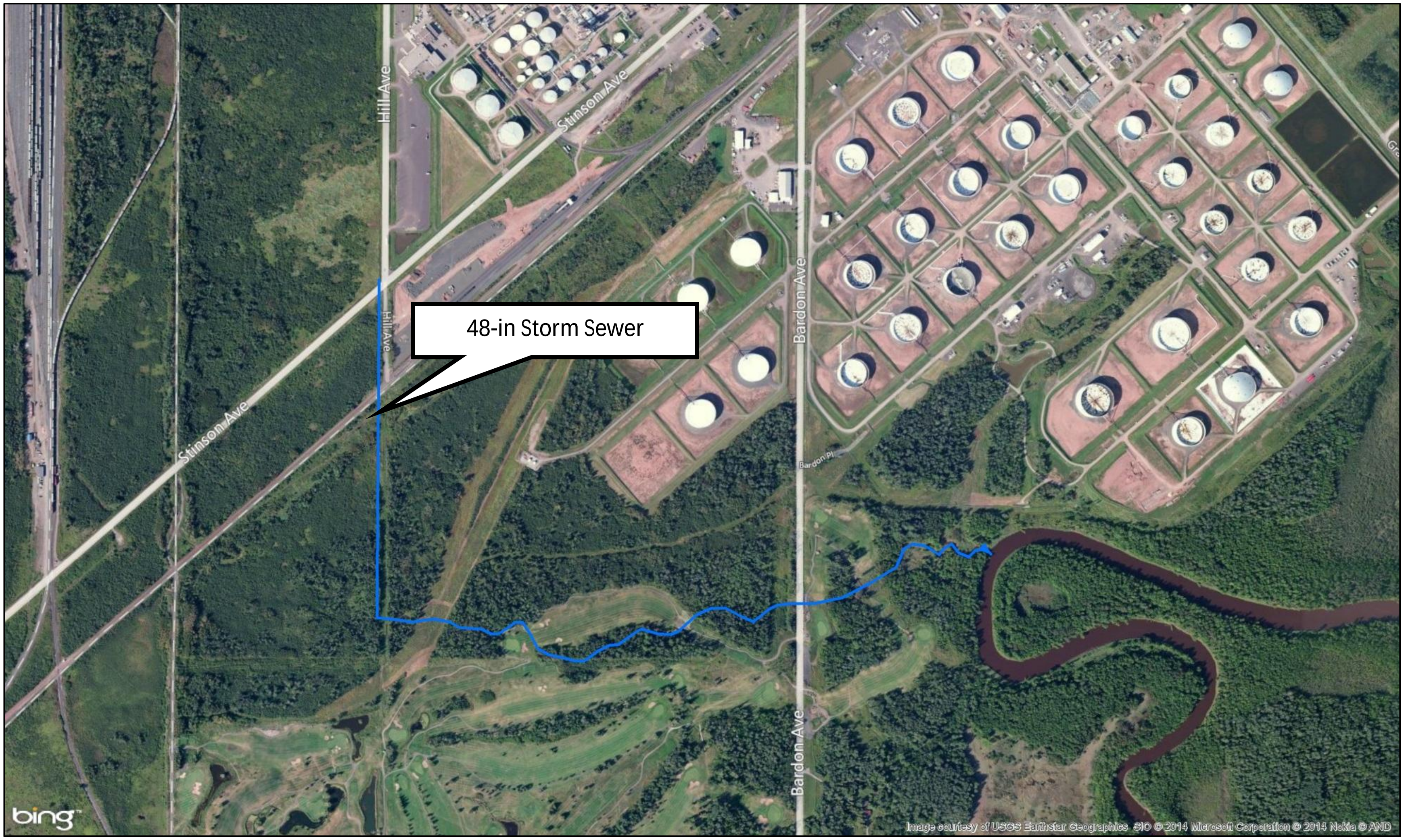

Figure 25 – Nemadji River Diversion

CHAPTER VI – BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs), in this context, are typically referred to as "Green Infrastructure" (GI). Conventional "grey infrastructure" generally involves storage and conveyance structures designed to route storm runoff to the nearest body of water. GI, on the other hand, attempts to mimic the natural hydrologic process by maximizing infiltration of rain that falls on both pervious and impervious surfaces as groundwater recharge. Doing so reduces the size and cost of conventional grey infrastructure while reducing peak flows and flooding of receiving streams. It also improves water quality by capturing pollutants in the soil matrix. However it generally only serves to reduce the impact of minor event and TSS removal.

While GI may be able to eliminate a substantial portion of runoff on a total annual average volumetric basis, it is often inadequate for flood control as it is cannot sufficiently reduce runoff rates during large storm events, and needs to be supplemented with conventional grey infrastructure. However, it may reduce the size and cost of such infrastructure. Unfortunately, Superior sits on primarily clay soils with low permeability. For flood-type events in the once every 50+ year range, rainfall intensities greatly exceed the saturated hydraulic permeability of the soil, and very little of the peak rainfall can infiltrate into the soil. Therefore these sorts of stormwater BMPs will do little to reduce the scope of the Faxon Creek flood control projects. Furthermore, permitting of such projects can be an obstacle.

Referring to Figure 26, the majority of the developed area in the Faxon Creek watershed where GI might be implemented is of soil type 262B—Amnicon-Cuttre complex. This soil is mostly clay and of hydrologic soil group D. At the surface, this soil has a saturated hydraulic conductivity (Ksat) of 3.667 micrometers/second (0.53 inches/hour) (Table 7). Referring to Table 8, the limiting Ksat values are often much lower. With peak hour intensities of 2.43 in/hr and 2.75 in/hr during the 50 and 100-year storms respectively, little of the rainfall that might be directed towards GI would infiltrate into the soil. Therefore this analysis presumes that GI can only mitigate the size of grey infrastructure via distributed storage and peak flow attenuation.

The following GI technologies, sorted from generally highest to least cost, were evaluated for cost-effectiveness in mitigating the size of larger centralized detention facilities:

- Green Roofs
- Bioretention/Bioswales/Greenways
- Swales/Strip
- Stormwater Trees
- Cisterns
- Underground Storage (RCP)
- Rain Gardens
- Porous Pavement
- Rain Barrels
- Underground Storage (CMP)
- Soil Amendments
- Native Landscaping

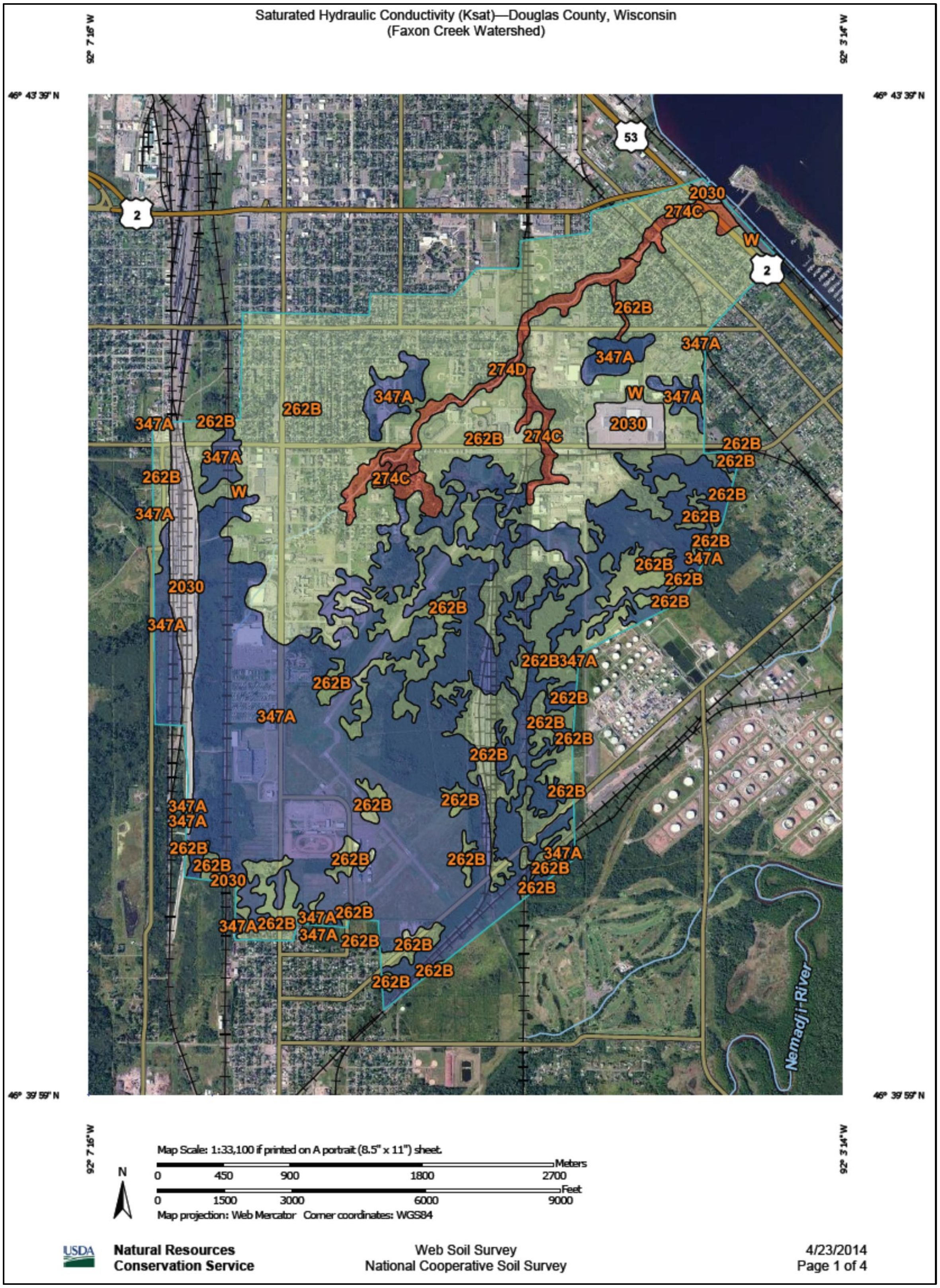

Figure 26 – Soil Saturated Hydraulic Conductivity

Table 7 – Soil Saturated Hydraulic Conductivity (Ksat)

Saturated Hydraulic Conductivity (Ksat)— Summary by Map Unit — Douglas County, Wisconsin (WI031)				
Map unit symbol	**Map unit name**	**Rating (micrometers per second)**	**Acres in AOI**	**Percent of AOI**
262B	Amnicon-Cuttre complex, 0 to 4 percent slopes	3.7667	1,815.5	50.3%
274C	Miskoaki clay loam, 6 to 12 percent slopes	2.1867	74.4	2.1%
274D	Miskoaki clay loam, 12 to 25 percent slopes	2.1867	46.7	1.3%
347A	Bergland-Cuttre complex, 0 to 3 percent slopes	11.8488	1,533.7	42.5%
2030	Udorthents and Udipsamments, cut or fill		128.9	3.6%
W	Water		7.6	0.2%
Totals for Area of Interest			**3,606.8**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Weighted Average

Component Percent Cutoff: *None Specified*

Tie-break Rule: Slowest

Interpret Nulls as Zero: No

Table 8 – Soil Properties

Douglas County, Wisconsin

262B—Amnicon-Cuttre complex, 0 to 4 percent slopes

Map Unit Setting

Elevation: 600 to 1,000 feet
Mean annual precipitation: 28 to 33 inches
Mean annual air temperature: 36 to 43 degrees F
Frost-free period: 90 to 120 days

Map Unit Composition

Amnicon and similar soils: 50 percent
Cuttre and similar soils: 40 percent
Minor components: 10 percent

Description of Amnicon

Setting

Landform: Till plains
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey till

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 12 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water capacity: Moderate (about 6.3 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance
Land capability (nonirrigated): 3e
Hydrologic Soil Group: D
Other vegetative classification: Unnamed (G092XY005WI)

Typical profile

0 to 2 inches: Silty clay loam
2 to 5 inches: Silty clay loam
5 to 10 inches: Silty clay loam
10 to 16 inches: Clay
16 to 24 inches: Clay
24 to 43 inches: Clay
43 to 67 inches: Clay

Description of Cuttre

Setting

Landform: Till plains
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Clayey till

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water capacity: Moderate (about 6.0 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance
Land capability (nonirrigated): 3w
Hydrologic Soil Group: D
Other vegetative classification: Unnamed (G092XY004WI)

Typical profile

0 to 3 inches: Clay
3 to 6 inches: Clay loam
6 to 12 inches: Clay
12 to 25 inches: Clay
25 to 41 inches: Clay
41 to 80 inches: Clay

Minor Components

Miskoaki

Percent of map unit: 5 percent

Bergland

Percent of map unit: 3 percent
Landform: Depressions, drainageways

Sedgwick

Percent of map unit: 2 percent

Data Source Information

Soil Survey Area: Douglas County, Wisconsin
Survey Area Data: Version 10, Dec 23, 2013

Table 9 – BMP Capital Unit Costs ($/gal)

	MMSD[1]	Contech[2]	HSD LTCP[3]	High	Low	Average
Green Roofs	$ 4.72		$ 18.00	$ 18.00	$ 4.72	$ 11.36
Bioretention/Bioswales/Greenways	$ 2.24		$ 8.77	$ 8.77	$ 2.24	$ 5.51
Cisterns	$ 4.51			$ 4.51	$ 4.51	$ 4.51
Underground Storage (RCP)		$ 1.80		$ 1.80	$ 1.80	$ 1.80
Rain Gardens	$ 1.59		$ 1.56	$ 1.59	$ 1.56	$ 1.58
Porous Pavement	$ 2.34		$ 0.58	$ 2.34	$ 0.58	$ 1.46
Rain Barrels	$ 1.99		$ 0.91	$ 1.99	$ 0.91	$ 1.45
Underground Storage (CMP)		$ 0.67		$ 0.67	$ 0.67	$ 0.67
Soil Amendments	$ 0.28			$ 0.28	$ 0.28	$ 0.28
Detention Ponds / Infiltration Basins		$0.24		$ 0.27	$ 0.22	$ 0.24
Native Landscaping	$ 0.19			$ 0.19	$ 0.19	$ 0.19
Swales/Strip				$ -	$ -	$ -

Notes:

1. Milwaukee Metropolitan Sewerage District
2. Contech Engineered Solutions (Design firm specializing in GI)
3. Hammond Sanitary District's CSO Long Term Control Plan

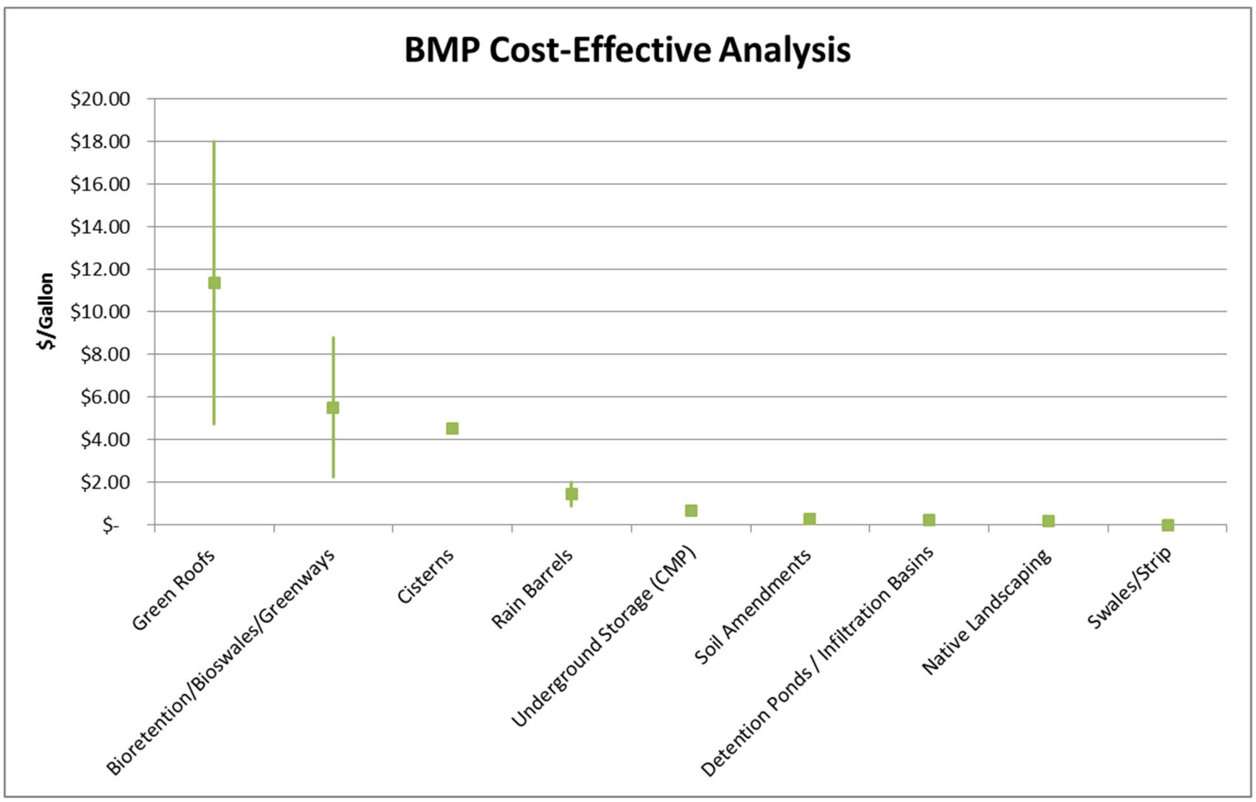

Figure 27 – BMP Capital Unit Costs ($/gal)

Porous pavement is the GI technology with the greatest potential in Superior. Table 10 details how the unit cost of $0.58/gallon in Table 9 was derived. This assumes that four feet of soil below the street will be replaced with porous aggregate with a 40% void space. This void space will act as detention for stormwater directed to the porous pavement. The cost is approximately 2.4X that of centralized detention.

Table 10 – Derivation of HSD LTCP GI Unit Costs

Permeable Pavement

From HSD unit costs, $7.00/SF (From EPA's LTCP-EZ Instructions, Appendix C)

- Assume 40% void space.
- Depth of storage = 4 feet.
- Storage per SF = 1.6 ft^3/ft^2
- ($7/SF) / (1.6 ft^3/ft^2) = $4.38/ft^3 = $0.58/gal

Green Roofs

- $25/SF (MMSD)
- Average Depth = 7.5"
- Void Space = 30%
- Storage per SF = 0.19 ft^3/ft^2
- ($25/SF) / (0.19 ft^3/ft^2) = $132/ft^3 = $18/gal

Rain Gardens

From HSD unit costs, $7.00/SF (From EPA's LTCP-EZ Instructions, Appendix C)

- Average Depth = 24"
- Void Space = 30%
- Storage per SF = 0.60 ft^3/ft^2
- ($7/SF) / (0.60 ft^3/ft^2) = $12/ft^3 = $1.56/gal

Rain Barrels

- Barrel retail cost = $50 (MMSD)
- Storage per barrel = 55 gallons
- ($55/barrel) / (55 gallons/barrel) = $0.91/gal

The maintenance of GI is often overlooked. However these costs can be substantial, and without proper planning and budgeting, a lack of maintenance may render GI largely ineffective. While there is little published data on GI maintenance costs, a report presented at the 2012 Water Environment Federation annual conference evaluated 20-year whole life cycle costs for select BMP's. The results of this study are summarized in Table 11 and Figure 28. While there are wide ranges of estimates, this study determined that the 20-year whole life cycle cost of centralized infiltration basins, or grass-lined detention ponds, is significantly less than for that of porous pavement.

On the other hand, many Superior streets have roadside ditches rather than curb & gutter and storm sewers. These ditches provide distributed storage, flow attenuation, and an opportunity for stormwater to infiltrate following a rainfall event. It is recommended that Superior endeavor to maintain these ditches and resist replacing them with curb & gutter wherever possible.

Table 11 – Whole Life Cycle Costs for Selected BMPs[6]

Stormwater Control	Whole Life Cost ($/m^3)		
	Low Maintenance	Medium Maintenance	High Maintenance
Swales/Strip	500	660	2200
Wet Ponds/Wetlands	520	600	925
Dry Extended Detention	330	375	575
Sand Filter	450	520	670
Bioretention	1900	2200	5100
Infiltration Trench	1200	1600	2700
Infiltration Basin	330	400	700
Permeable Pavement	570	640	1400

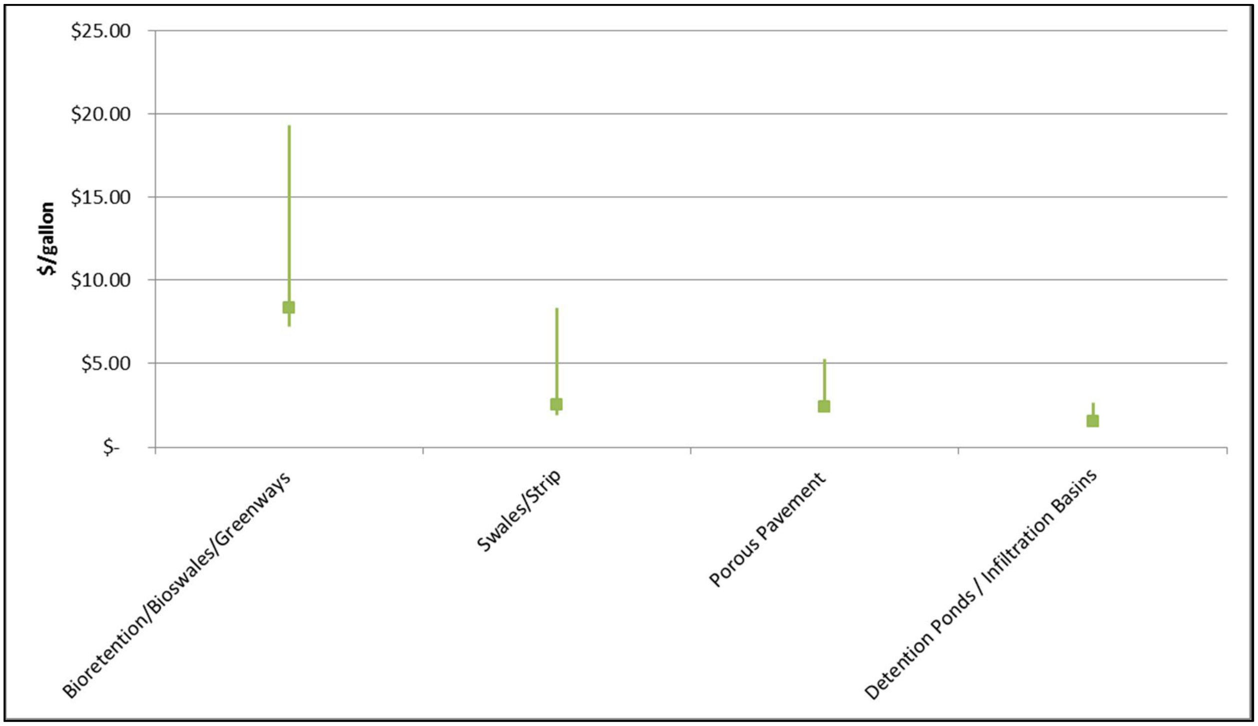

Figure 28 – BMP Whole Life Cycle Costs

[6] Michael Barrett and Christine Pomeroy, *Assessment of Whole Life Costs for Green Infrastructure*, WEFTEC 2012

CHAPTER VII – TOTAL SUSPENDED SOLIDS (TSS)

Donohue analyzed the potential TSS reduction of constructing the U of W and Heritage Park ponds as wet-bottom detention facilities. Incorporating water quality features into the ponds may also make these projects eligible for grant money, potentially moving the cost curves for scenarios including these ponds to the left (Figure 20). The configuration of the Soo Pond inlet/outlet does not provide opportunity for suspended particles to "settle out" in the pond; therefore this pond was not considered for TSS reduction benefits.

7.1 PRELIMINARY POND SIZE REQUIREMENTS

Wet bottom ponds can provide both peak flow attenuation and effective TSS reduction if properly designed. The Wisconsin Department of Natural Resources *Conservation Practice Standard 1001: Wet Detention Pond* guidance was used to estimate the permanent pool area required to provide 60% and 80% TSS reduction based on drainage area and land use. Land use information was extracted from existing stormshed data provided by the COS for Outfalls OT090000 and OT3B0026. Table 12 summarizes the land use for the Heritage Park and UW Superior pond drainage basins.

Table 12 – Land Use

Land Use (acres)		
	Heritage Park	U of W
Commercial, Institutional, Industrial	324	62
Residential	124	151
Open Space/Parks	37	0
Total Tributary Area	485	214
% Impervious	19%	43%

Table 13 and Table 14 show the Heritage Park and UW Superior watershed areas, corresponding *WDNR Wet Detention Pond* factors, and the resulting minimum permanent pool surface areas for 60% and 80% TSS reduction. For drainage areas with multiple categories of land use, the drainage areas are pro-rated.

Table 13 – Heritage Park Pond Minimum Pond Permanent Pool Surface Area

(a) Land Use	(b) Watershed Area (acres)	c) Minimum Pond Surface Area, (as % of Watershed Area)		Minimum Pond Surface Area, (acres) Column (b) x Column (c)	
		60% Removal	80% Removal	60% Removal	80% Removal
Commercial	324	0.6	1.8	1.944	5.832
Residential	124	0.3	0.7	0.372	0.868
Open Space	37	0.2	0.6	0.074	0.222
Total	485	---	---	2.39	6.92

Table 14 – UW Superior Pond Minimum Pond Permanent Pool Surface Area

(a) Land Use	(b) Watershed Area (acres)	c) Minimum Pond Surface Area, (as % of Watershed Area)		Minimum Pond Surface Area, (acres) Column (b) x Column (c)	
		60%	80%	60%	80%
Commercial	62	0.6	1.8	0.372	1.116
Residential	152	0.3	1.0	0.456	1.520
Total	214	---	---	0.83	2.64

7.2 SLAMM Modeling Methodology

To quantify the amount of TSS being generated and transported from the project area, the Windows Version 9.4 Source Loading and Management Model ® (SLAMM) was used. WinSLAMM was also used to quantify TSS reductions from the Heritage Park and UW Superior detention ponds. WinSLAMM is accepted by the WDNR as a suitable pollutant loading model for evaluating the reduction of total suspended solids according to NR 151.12(5)5.

WinSLAMM calculates runoff volumes and urban and freeway pollutant loads from individual storms and aggregates them to determine annual loads. For this analysis the following data files were used:

- Rain file name: WisReg – Duluth MN 1975.RAN (January 2 – December 29)
- Particulate Solids Concentration file name: WI_AVG01.psc
- Runoff Coefficient file name: WI_SL06 Dec06.rsv
- Particulate Residue Delivery file name: WI_DLV01.prr
- Institutional Street Delivery file name: WI_Com Inst Indust Dec06.std
- Commercial Street Delivery file name: WI_Com Inst Indust Dec06.std
- Industrial Street Delivery file name: WI_Com Inst Indust Dec06.std
- Other Urban Street Delivery file name: WI_Res and Other Urban Dec06.std
- Freeway Street Delivery file name: Freeway Dec06.std
- Pollutant Relative Concentration file name: WI_GEO01.ppd
- Particle Size Distribution File: NURP.CPZ

Model output files are in Appendix B.

The project was modeled as follows:

1. Standard Land Use types for residential and commercial areas were used to define modeling parameters for roofs, roadways, alleys, sidewalks, parking lots, etc.
2. The Heritage Park site was modeled using the maximum pond size that fits into the area. This pond has 3.9 acres of surface area, which is smaller than the estimated requirement for 80% reduction. Even this size would require purchasing a portion of the adjacent church property. We also modeled a pond with 2.39 acres of surface area based on the WDNR guideline for 60% TSS removal, which would fit more readily into the City-owned property.

3. The UW-Superior site was modeled using the maximum pond size that fits into the area, 3.17 acres of surface area. A 2.64 acre pond was modeled to provide 80% TSS removal and a 0.83 acre pond to provide 60% TSS removal, based on the WDNR Wet Pond Guidance.
4. The ponds' outlet structures were modeled with a small orifice (8-inch diameter) at the permanent pool elevation and a larger orifice (15-inch diameter) 1 to 1.5 feet above the smaller orifice. A 20-foot long, 10-foot wide spillway provided for peak overflow.

A Soil Resource Report for the project area was obtained from the Natural Resources Conservation Service (NRCS) Web Soil Survey for Douglas County. Chapter 5 includes copies of the soil mapping. Soil borings performed throughout the COS for previous projects confirm that site soils are predominantly clay. Infiltration rates for the soil types present were taken from Wisconsin Department of Natural Resources Conservation Practice Standard 1002: Site Evaluation for Stormwater Infiltration. The "dynamic infiltration rate" was assumed to be 50% or less, of Standard 1002 values, as shown in Table 15.

Table 15 – Project Soils Information

Location	Soil Map Unit	Soil Name	Std. 1002 Design Infiltration Rate (in/hr)	Dynamic Infiltration Rate (in/hr)
UW Superior Pond Heritage Park Pond	262B	Amnicon Cuttre complex Typical profile: 0 to 10 inches – Silty Clay Loam 10 to 67 inches – Clay	0.07	0.035
UW Superior Pond	374A	Bergland-Cutter complex Typical profile: 0 to 49 inches – Clay 49 to 60 inches – Silty Clay	0.07	0.035
Heritage Park Pond	274D	Miskoaki Clay Loam Typical profile: 0 to 10 inches – Clay Loam 10 to 67 inches – Clay	0.07	0.035

7.3 TOTAL SUSPENDED SOLIDS SUMMARY

WinSLAMM modeling results show that 213,330 lbs/year of TSS are generated from the Heritage Park pond watershed area, and 78,702 lbs/year are generated from the US Superior pond watershed area, based on standard land use files. In reality, the amount of TSS that would actually reach the ponds is likely lower because of treatment provided by vegetated swales, rain gardens, other detention ponds, and catch basin sumps upstream of the pond. These devices were not modeled for this conceptual TSS analysis. The percent TSS removal accomplished by the various pond configurations is shown in Table 16. WinSLAMM modeling output files are included in Appendix B.

Table 16 – Total Suspended Solids (TSS) Summary

	Heritage Pond		UW Superior Pond		
Watershed Area	485 acres		214 acres		
TSS Generated (Annualized)	213,330 lbs.		78,702 lbs.		
Surface Area	3.90 acres	2.39 acres	3.17 acres	2.64 acres	0.83 acres
TSS Removal	75.64%	66.46%	86.31%	83.65%	63.65%

CHAPTER VIII – GRANT OPPORTUNITIES & TIMELINES

As part of this Study, Donohue reviewed the recommended improvements at the crossings at Hill Avenue, Railroad Crossing North of N 21st Street, North 21st Street, and Catlin Avenue (Faxon Creek watershed improvements) in light of Facility Planning Technical Memorandum #15 (TM #15) - Funding, dated December 27, 2013. The 2012 having received a Presidential Disaster Declaration (Section 2.1) may improve the chances of Faxon Creek improvements receiving Federal funding assistance.

TM #15 provided a general summary of the capital funding programs for both wastewater and stormwater projects. The idea was to create a list of funding programs that could be evaluated as projects completed their planning. In addition, a meeting was held with the COS on July 17, 2014, to review use of the Wisconsin Clean Water Fund Program for wastewater projects and to discuss outside funding for the Faxon Creek watershed improvements.

The meeting led to a recommendation to attempt to secure a U.S. Congressional earmarked grant for the Faxon Creek watershed improvements. As discussed in detail in Chapter II, Section 2.3 and Chapter III, Section 3.3 of TM #15, preparing to use this funding option requires that a number of non-technical activities be completed before the funding request is made.

Below is a checklist of things that the COS can do at this time to begin the process of elevating the Faxon Creek watershed improvements to national funding attention and to help provide a solid basis for requesting a traditional U.S. Congressional earmarked grant:

1. Securing support of the Mayor and/or another elected official. Experience has shown that an elected official is in the best position to speak to the Member's constituents.
2. Working with the elected official's office to secure written funding request support from a variety of area supporters. This is normally a two to four paragraph letter sent to the elected official providing a short and simple narrative explaining the project and why the person/organization supports the funding request. Preparing and providing potential supporters with an example support letter tends to help secure the needed letters.
3. Preparing a one-page funding request fact sheet as discussed in Chapter III, Section 3.3.2 of TM #15. This fact sheet generally contains (1) a clear funding request, (2) reference to the appropriate funding bill, (3) concise need and compliance information, (4) project cost, schedule and status (5) parallels to past funded projects, (6) local affordability issues, (7) a written support summary, and (8) several contacts to insure that Member staff can quickly address last minute questions.

Since TM #15 was written, the U.S. Congress has passed the FY14 Federal Budget and began working through a traditional Federal Appropriations process. The Federal Appropriations process sets up the mechanism that allows for direct project grant earmarking. Based on the traditional Federal Appropriations cycle, it is recommended that these three items be completed by the beginning of November 2014, with an eye towards meeting face-to-face with the COS's Congressional Members and/or their offices between the fall elections and the end of the year.

Appendix A – Opinions of Probable Construction Costs

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Catlin Crossing

INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	11,048	11,048
Traffic Control	LS	1	7,000	7,000
Removing Existing Structure	Each	1	18,000	18,000
Excavation for Structure	Each	1	9,000	9,000
84-inch lined CMP culvert	Lineal Foot	245	360	88,200
84-inch Apron Endwalls	Each	2	4,000	8,000
Stream re-route/bypass	LS	1	20,000	20,000
Structure Backfill	CY	450	12.50	5,625
Restoration	Each	1	1,000	1,000
Erosion Control	LS	1	1,000	1,000
Concrete retaining wall				
Subtotal				168,873
Contingency			25%	42,218
Subtotal				211,091
Total Construction Cost				**211,091**
Engineering			15%	31,664
Total Initial Cost				**242,755**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Soo Line Railroad Crossing

INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	45,121	45,121
Railroad Flagger	Days	10	900	9,000
Removing Existing Structure	Each	1	30,000	30,000
84-inch culvert - Open Cut	Lineal Foot	494	360	177,840
84-inch RCP culvert - Bore and jack	Lineal Foot	200	1,860	372,000
84-inch Apron Endwalls/Headwall	LS	1	16,000	16,000
Stream re-route/bypass	LS	1	25,000	25,000
Structure Backfill	CY	900	12.50	11,250
Restoration	Each	1	2,500	2,500
Erosion Control	LS	1	1,000	1,000
Subtotal				689,711
Contingency			25%	172,428
Subtotal				862,139
Total Construction Cost				**862,139**
Engineering			15%	129,321
Total Initial Cost				**991,460**

City of Superior, Wisconsin

Project No. 12452

Faxon Creek Culvert Regrading Between N 21st St & Railroad Crossing

ALTERNATIVE 2

INITIAL COST ESTIMATE

General Description

Install 8'H x 8'W precast concrete box culvert at the 21st St Crossing (Alt 1). The existing box culvert will remain inplace. Channel grading will be done to connect the down stream end of the box culvert to the upstream side of the twin 48" metal culvert pipes installed in 2012 at the Soo line rail crossing.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	1,500	1,500
Channel Grading	CY	1,600	16	25,600
Topsoil, Seeding	SY	480	8	3,840
Alternative 1 Cost				184,000
Subtotal				214,940
Contingency			25%	53,735
Subtotal				268,675
Total Construction Cost				**268,675**
Engineering			15%	40,301
Total Cost				**308,976**

City of Superior, Wisconsin

Project No. 12452

Replace Railroad Crossing North of N 21st St

ALTERNATIVE 3A

INITIAL COST ESTIMATE

General Description

Install 8'H x 10'W precast concrete box culvert under the Soo rail line starting south of N. 21st St. and ending east of the tracks. Existing culverts at Soo rail line w ill be removed.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	115,000	115,000
Removing Storm Sew er 60-inch	LF	554	40	22,160
Removing Storm Sew er 72-inch	LF	277	50	13,850
8-ft H x 10-ft W Culvert (Opencut)	LF	352	1,200	422,400
8-ft H x 10-ft W Culvert (Bore & Jack) (60-ft)	LF	60	10,000	600,000
Concrete Headw all (Dow nstream Soo Rail Line)	SF	410	140	57,400
Rip Rap (DS)	CY	50	120	6,000
Topsoil, Seeding	SY	1,956	8	15,644
Remove Existing Box Culvert	LS	1	15,000	15,000
8'H x 10'W Precast Concrete Box Culvert (N 21st St.)	LS	1	202,400	202,400
Subtotal				1,469,854
Contingency			25%	367,464
Subtotal				1,837,318
Total Construction Cost				**1,837,318**
Engineering			15%	275,598
Total Cost				**2,112,916**

City of Superior, Wisconsin

Project No. 12452

Replace Railroad Crossing North of N 21st St

ALTERNATIVE 3B

INITIAL COST ESTIMATE

General Description

Install 8'H x 8'W precast concrete box culvert under the Soo rail line starting north of N. 21st St. and ending east of the tracks. Existing culverts at Soo rail line w ill be removed.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	101,500	101,500
Removing Storm Sew er 60-inch	LF	554	40	22,160
Removing Storm Sew er 72-inch	LF	277	50	13,850
8-ft H x 8-ft W Culvert (Opencut)	LF	352	1,000	352,000
8-ft H x 8-ft W Culvert (Bore & Jack) (60-ft)	LF	60	10,000	600,000
Concrete Headw all (Upstream Soo Rail Line)	SF	410	140	57,400
Concrete Headw all (Dow nstream Soo Rail Line)	SF	410	140	57,400
Rip Rap (US & DS)	CY	100	120	12,000
Topsoil, Seeding	SY	1,956	8	15,644
Subtotal				1,231,954
Contingency			25%	307,989
Subtotal				1,539,943
Total Construction Cost				**1,539,943**
Engineering			15%	230,991
Total Cost				**1,770,935**

City of Superior, Wisconsin

Project No. 12452

Restore Portion of Railroad Crossing North of N 21st St To Open Channel

ALTERNATIVE 5A

INITIAL COST ESTIMATE

General Description

Install 8'H x 8'W precast concrete box culvert at the 21st St Crossing (Alt 1). The existing box culvert will remain inplace. Existing culverts at Soo rail line crossing to remain. Remove upstream portion of culverts and construct channel with 25 ft wide bottom and 4:1 side slopes. Construct headwall on upstream side of Soo Rail Line.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	26,000	26,000
Removing Storm Sewer 60-inch	LF	554	40	22,160
Removing Storm Sewer 72-inch	LF	277	50	13,850
Channel Grading	CY	22,000	16	352,000
Concrete Headwall (Upstream Soo Rail Line)	SF	550	140	77,000
Rip Rap (Headwall)	CY	100	120	12,000
Topsoil, Seeding	SY	5,126	8	41,010
Alternative 1 Cost				184,000
Subtotal				728,020
Contingency			25%	182,005
Subtotal				910,025
Total Construction Cost				**910,025**
Engineering			15%	136,504
Total Cost				**1,046,528**

City of Superior, Wisconsin

Project No. 12452

Restore Portion of Railroad Crossing North of N 21st St To Open Channel

ALTERNATIVE 5B

INITIAL COST ESTIMATE

General Description

Install 8'H x 10'W precast concrete box culvert at the 21st St Crossing. The existing box culvert w ill be removed. Existing culverts at Soo rail line crossing to remain. Remove upstream portion of culverts and construct channel w ith 25 ft w ide bottom and 4:1 side slopes. Construct headw all on upstream side of Soo Rail Line.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	27,000	27,000
Removing Storm Sew er 60-inch	LF	554	40	22,160
Removing Storm Sew er 72-inch	LF	277	50	13,850
Channel Grading	CY	22,000	16	352,000
Concrete Headw all (Upstream Soo Rail Line)	SF	550	140	77,000
Rip Rap (Headw all)	CY	100	120	12,000
Topsoil, Seeding	SY	5,126	8	41,010
Stream re-route/channelize	LS	1	20,000	20,000
Remove Exisitng Box Culvert	LS	1	15,000	15,000
8'H x 10'W Precast Concrete Box Culvert	LS	1	202,400	202,400
Subtotal				782,420
Contingency			25%	195,605
Subtotal				978,025
Total Construction Cost				**978,025**
Engineering			15%	146,704
Total Cost				**1,124,728**

City of Superior, Wisconsin

Project No. 12452

Add Additional Culvert To Railroad Crossing North of N 21st St

ALTERNATIVE 6A

INITIAL COST ESTIMATE

General Description

Install 8'H x 8'W precast concrete box culvert at the 21st St Crossing (Alt 1). The existing box culvert will remain inplace. Channel grading will be done to connect the down stream end of the box culvert to the upstream side of the twin 48" metal culvert pipes installed in 2012 at the Soo line rail crossing. Install 60-inch culvert under the Soo rail line. Existing culverts at Soo rail line to remain.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	15,750	15,750
Grading	CY	1,000	16	16,000
60-Inch Culvert (Opencut)	LF	287	300	86,100
60-Inch Culvert (Bore & Jack)	LF	60	1,800	108,000
60-Inch Apron Endwall	LS	1	11,000	11,000
Concrete Headwall (Upstream Soo Rail Line)	SF	590	140	82,600
Rip Rap (US & DS)	CY	50	120	6,000
Topsoil, Seeding	SY	638	8	5,102
Stream re-route/channelize	LS	1	20,000	20,000
Alternative 2 Cost				214,940
Subtotal				565,492
Contingency			25%	141,373
Subtotal				706,865
Total Construction Cost				**706,865**
Engineering			15%	106,030
Total Cost				**812,895**

City of Superior, Wisconsin

Project No. 12452

Add Additional Culvert To Railroad Crossing North of N 21st St

ALTERNATIVE 6B

INITIAL COST ESTIMATE

General Description

Install 8'H x 8'W precast concrete box culvert at the 21st St Crossing (Alt 1). The existing box culvert will remain inplace. Channel grading will be done to connect the down stream end of the box culvert to the upstream side of the twin 48" metal culvert pipes installed in 2012 at the Soo line rail crossing. Install 72-inch culvert under the Soo rail line. Existing culverts at Soo rail line to remain.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	18,050	18,050
Grading	CY	1,000	16	16,000
72-Inch Culvert (Opencut)	LF	287	350	100,450
72-Inch Culvert (Bore & Jack)	LF	60	2,000	120,000
72-Inch Apron Endwall	LS	1	12,000	12,000
Concrete Headwall (Upstream Soo Rail Line)	SF	600	140	84,000
Rip Rap (US & DS)	CY	50	120	6,000
Topsoil, Seeding	SY	638	8	5,102
Stream re-route/channelize	LS	1	20,000	20,000
Alternative 2 Cost				214,940
Subtotal				596,542
Contingency			25%	149,136
Subtotal				745,678
Total Construction Cost				**745,678**
Engineering			15%	111,852
Total Cost				**857,529**

City of Superior, Wisconsin

Project No. 12452

Add Additional Culvert To Railroad Crossing North of N 21st St

ALTERNATIVE 6C

INITIAL COST ESTIMATE

General Description

Install 8'H x 8'W precast concrete box culvert at the 21st St Crossing (Alt 1). The existing box culvert will remain inplace. Channel grading will be done to connect the down stream end of the box culvert to the upstream side of the twin 48" metal culvert pipes installed in 2012 at the Soo line rail crossing. Install 48-inch culvert under the Soo rail line. Existing culverts at Soo rail line to remain.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	14,750	14,750
Grading	CY	1,000	16	16,000
48-Inch Culvert (Opencut)	LF	287	275	78,925
48-Inch Culvert (Bore & Jack)	LF	60	1,650	99,000
48-Inch Apron Endwall	LS	1	10,000	10,000
Concrete Headwall (Upstream Soo Rail Line)	SF	580	140	81,200
Rip Rap (US & DS)	CY	50	120	6,000
Topsoil, Seeding	SY	638	8	5,102
Stream re-route/channelize	LS	1	20,000	20,000
Alternative 2 Cost				214,940
Subtotal				545,917
Contingency			25%	136,479
Subtotal				682,397
Total Construction Cost				**682,397**
Engineering			15%	102,359
Total Cost				**784,756**

City of Superior, Wisconsin

Project No. 12452

Add Additional Culvert To Railroad Crossing North of N 21st St

ALTERNATIVE 6D

INITIAL COST ESTIMATE

General Description

Install 8'H x 8'W precast concrete box culvert at the 21st St Crossing (Alt 1). The existing box culvert will remain inplace. Channel grading will be done to connect the down stream end of the box culvert to the upstream side of the twin 48" metal culvert pipes installed in 2012 at the Soo line rail crossing. Install 84-inch culvert under the Soo rail line. Existing culverts at Soo rail line to remain.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	21,800	21,800
Grading	CY	1,000	16	16,000
84-Inch Culvert (Opencut)	LF	287	500	143,500
84-Inch Culvert (Bore & Jack) (Microtunnel?)	LF	60	3,000	180,000
84-Inch Apron Endwall	LS	1	16,000	16,000
Concrete Headwall (Upstream Soo Rail Line)	SF	610	140	85,400
Rip Rap (US & DS)	CY	50	120	6,000
Topsoil, Seeding	SY	638	8	5,102
Stream re-route/channelize	LS	1	20,000	20,000
Alternative 2 Cost				214,940
Subtotal				708,742
Contingency			25%	177,186
Subtotal				885,928
Total Construction Cost				**885,928**
Engineering			15%	132,889
Total Cost				**1,018,817**

City of Superior, Wisconsin

Project No. 12937

Faxon Creek Culvert Replacement at Hill Avenue

INITIAL COST ESTIMATE

General Description

Install 12'W x 10'H precast concrete box culvert at the Hill Avenue Crossing. The existing arch culvert will be removed. The retaining wall at Laurel Avenue and the existing 36" RCP storm sewer will remain. The existing "viaduct" on the west side of Hill Avenue will be removed as necessary to construct a replacement sanitary sewer. New headwalls, endwalls, and foundations will be cast-in-place concrete. Hill Avenue will be reconstructed to improve the vertical alignment. Laurel Avenue will be reconstructed as needed to match at the Hill Avenue intersection. Sidewalk will be added, along with curb and gutter.

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	48,000	48,000
Traffic Control	LS	1	7,000	7,000
By-Pass Pumping	LS	1	15,000	15,000
Stream re-route/bypass	LS	1	50,000	50,000
Pavement Removal	SY	1,636	8	13,088
Removing Existing Culvert	LS	1	10,000	10,000
12 x 10 ft. Box Culvert	LF	100	1,300	130,000
End wall, head wall, foundations	LS	1	170,000	170,000
Form liner for pattern concrete	SF	700	13	9,100
Storm sewer replacement (12-inch)	LF	150	60	9,000
Catch Basins	EA	3	1,500	4,500
Sanitary Sewer (15-inch)	LF	420	60	25,200
Curb and Gutter	LF	526	30	15,780
Asphalt Pavement	Tons	360	90	32,400
Sidewalk	SF	2,550	5	12,750
Erosion Control, Topsoil, Seed	LS	1	30,000	30,000
Remove Portion of Existing Viaduct	LS	1	20,000	20,000
Asphalt Driveways	SY	13	200	2,600
Select Crushed	Tons	1,290	16	20,640
Base Aggregate Dense 1 1/4"	Tons	725	16	11,600
Railing	LF	50	120	6,000
Drain Tile	LF	1,040	5	5,200
Subtotal				647,858
Contingency			25%	161,965
Subtotal				809,823
Total Construction Cost				**809,823**
Engineering during Construction			7%	56,688
Total Cost				**866,510**

This project has since been bid. The winning bid was $727,171.15.

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 2 / UW Superior

INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	91,843	91,843
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	2,000	2.00	4,000
Clear and Grub	LS	1	5000.00	5,000
Remove, stockpile and place Topsoil	Square Yard	27,000	1.25	33,750
Remove Existing Pipe, 60-inch	Lineal Foot	600	56.00	33,600
Pond Excavation and haul material offsite	Cubic Yard	117,000	10.00	1,170,000
Rip Rap	Cubic Yard	34	42.00	1,428
Erosion Control Mat	Square Yard	9,000	2.25	20,250
Outlet Structure	Each	1	15000.00	15,000
Storm Sewer Pipe, 60-inch	Lineal Foot	30	279.00	8,370
Seed	Square Yard	27,000	0.35	9,450
Landscaping Allowance	LS	1	10,000	10,000
Land Acquisition??				
Subtotal				1,403,891
Contingency			25%	350,973
Subtotal				1,754,864
Total Construction Cost				**1,754,864**
Engineering			15%	263,230
Total Initial Cost				**2,018,094**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 2 / UW Superior

(75% of Maximum Footprint)
INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	0	
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	2,000	2.00	4,000
Clear and Grub	LS	1	5000.00	5,000
Remove, stockpile and place Topsoil	Square Yard	20,250	1.25	25,313
Remove Existing Pipe, 60-inch	Lineal Foot	600	56.00	33,600
Pond Excavation and haul material offsite	Cubic Yard	74,880	10.00	748,800
Rip Rap	Cubic Yard	34	42.00	1,428
Erosion Control Mat	Square Yard	9,000	2.25	20,250
Outlet Structure	Each	1	15000.00	15,000
Storm Sewer Pipe, 60-inch	Lineal Foot	30	279.00	8,370
Seed	Square Yard	20,250	0.35	7,088
Landscaping Allowance	LS	1	10,000	10,000
Land Acquisition??				
Subtotal				880,048
Contingency			25%	220,012
Subtotal				1,100,060
Total Construction Cost				**1,100,060**
Engineering			15%	165,009
Total Initial Cost				**1,265,069**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 2 / UW Superior

(50% of Maximum Footprint)
INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	0	
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	2,000	2.00	4,000
Clear and Grub	LS	1	5000.00	5,000
Remove, stockpile and place Topsoil	Square Yard	13,500	1.25	16,875
Remove Existing Pipe, 60-inch	Lineal Foot	600	56.00	33,600
Pond Excavation and haul material offsite	Cubic Yard	35,100	10.00	351,000
Rip Rap	Cubic Yard	34	42.00	1,428
Erosion Control Mat	Square Yard	9,000	2.25	20,250
Outlet Structure	Each	1	15000.00	15,000
Storm Sewer Pipe, 60-inch	Lineal Foot	30	279.00	8,370
Seed	Square Yard	13,500	0.35	4,725
Landscaping Allowance	LS	1	10,000	10,000
Land Acquisition??				
Subtotal				471,448
Contingency			25%	117,862
Subtotal				589,310
Total Construction Cost				**589,310**
Engineering			15%	88,397
Total Initial Cost				**677,707**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 3 / Heritage Park

INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	121,249	121,249
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	1,500	2.00	3,000
Clear and Grub	LS	1	10000.00	10,000
Remove, stockpile and place Topsoil	Square Yard	29,718	1.25	37,147
Remove Existing Pipe, 84-inch	Lineal Foot	677	56.00	37,912
Pond Excavation/Haul/Dump	Cubic Yard	137,000	10.00	1,370,000
Rip Rap	Cubic Yard	44	42.00	1,848
Erosion Control Mat	Square Yard	4,589	2.25	10,325
Outlet Structure	Each	1	15000.00	15,000
Storm Sewer Pipe, 84-inch	Lineal Foot	50	511.00	25,550
Seed	Square Yard	29,718	0.35	10,401
Wetland Restoration	Acre	1		
Landscaping Allowance	LS	1	20,000	20,000
18" Sanitary Sewer	LF	1,150	135	155,250
Sanitary Manholes	EA	4	6,750	27,000
Bypass Pumping	LS	1	7,500	7,500
Subtotal				1,853,382
Contingency			25%	463,346
Subtotal				2,316,728
Total Construction Cost				**2,316,728**
Engineering			15%	347,509
Total Initial Cost				**2,664,237**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 3 / Heritage Park
(75% of Maximum Footprint)
INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	0	
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	1,500	2.00	3,000
Clear and Grub	LS	1	10000.00	10,000
Remove, stockpile and place Topsoil	Square Yard	22,288	1.25	27,860
Remove Existing Pipe, 84-inch	Lineal Foot	677	56.00	37,912
Pond Excavation/Haul/Dump	Cubic Yard	90,420	10.00	904,200
Rip Rap	Cubic Yard	44	42.00	1,848
Erosion Control Mat	Square Yard	4,589	2.25	10,325
Outlet Structure	Each	1	15000.00	15,000
Storm Sewer Pipe, 84-inch	Lineal Foot	50	511.00	25,550
Seed	Square Yard	22,288	0.35	7,801
Wetland Restoration	Acre	1		
Landscaping Allowance	LS	1	20,000	20,000
18" Sanitary Sewer	LF	1,150	135	155,250
Sanitary Manholes	EA	4	6,750	27,000
Bypass Pumping	LS	1	7,500	7,500
Subtotal				1,254,446
Contingency			25%	313,612
Subtotal				1,568,058
Total Construction Cost				**1,568,058**
Engineering			15%	235,209
Total Initial Cost				**1,803,266**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 3 / Heritage Park
(50% of Maximum Footprint)
INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	0	
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	1,500	2.00	3,000
Clear and Grub	LS	1	10000.00	10,000
Remove, stockpile and place Topsoil	Square Yard	14,859	1.25	18,574
Remove Existing Pipe, 84-inch	Lineal Foot	677	56.00	37,912
Pond Excavation/Haul/Dump	Cubic Yard	42,470	10.00	424,700
Rip Rap	Cubic Yard	44	42.00	1,848
Erosion Control Mat	Square Yard	4,589	2.25	10,325
Outlet Structure	Each	1	15000.00	15,000
Storm Sewer Pipe, 84-inch	Lineal Foot	50	511.00	25,550
Seed	Square Yard	14,859	0.35	5,201
Wetland Restoration	Acre	1		
Landscaping Allowance	LS	1	20,000	20,000
18" Sanitary Sewer	LF	1,150	135	155,250
Sanitary Manholes	EA	4	6,750	27,000
Bypass Pumping	LS	1	7,500	7,500
Subtotal				763,059
Contingency			25%	190,765
Subtotal				953,824
Total Construction Cost				**953,824**
Engineering			15%	143,074
Total Initial Cost				**1,096,897**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 1 / Soo Line RR

INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	338,072	338,072
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	750	2.00	1,500
Clear and Grub	LS	1	1000.00	1,000
Remove, stockpile and place Topsoil	Square Yard	82,280	1.25	102,850
Pond Excavation, Haul	Cubic Yard	448,000	10.00	4,480,000
Rip Rap	Cubic Yard	25	42.00	1,050
Erosion Control Mat	Square Yard	22,222	2.25	50,000
Storm Sewer Pipe, 84-inch	Lineal Foot	340	480.00	163,200
Seed	Square Yard	82,280	0.35	28,798
Wetland Restoration	Acre	5	0.00	
Subtotal				5,167,670
Contingency			25%	1,291,917
Subtotal				6,459,587
Total Construction Cost				**6,459,587**
Engineering			15%	968,938
Total Initial Cost				**7,428,525**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 1 / Soo Line RR

(75% of Maximum Footprint)
INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	0	
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	750	2.00	1,500
Clear and Grub	LS	1	1000.00	1,000
Remove, stockpile and place Topsoil	Square Yard	61,710	1.25	77,138
Pond Excavation, Haul	Cubic Yard	277,000	10.00	2,770,000
Rip Rap	Cubic Yard	25	42.00	1,050
Erosion Control Mat	Square Yard	22,222	2.25	50,000
Storm Sewer Pipe, 84-inch	Lineal Foot	340	480.00	163,200
Seed	Square Yard	82,280	0.35	28,798
Wetland Restoration	Acre	5	0.00	
Subtotal				3,093,886
Contingency			25%	773,471
Subtotal				3,867,357
Total Construction Cost				**3,867,357**
Engineering			15%	580,104
Total Initial Cost				**4,447,460**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Pond No. 1 / Soo Line RR

(50% of Maximum Footprint)
INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	0	
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	750	2.00	1,500
Clear and Grub	LS	1	1000.00	1,000
Remove, stockpile and place Topsoil	Square Yard	41,140	1.25	51,425
Pond Excavation, Haul	Cubic Yard	160,000	10.00	1,600,000
Rip Rap	Cubic Yard	25	42.00	1,050
Erosion Control Mat	Square Yard	22,222	2.25	50,000
Storm Sewer Pipe, 84-inch	Lineal Foot	340	480.00	163,200
Seed	Square Yard	82,280	0.35	28,798
Wetland Restoration	Acre	5	0.00	
Subtotal				1,898,173
Contingency			25%	474,543
Subtotal				2,372,716
Total Construction Cost				**2,372,716**
Engineering			15%	355,907
Total Initial Cost				**2,728,624**

City of Superior, Wisconsin
Stormwater Facility Improvements
Faxon Creek Watershed

Culvert Removal

INITIAL COST ESTIMATE

General Description

ITEM	Units	Quantity	Unit Cost ($)	Initial Cost ($)
Contract Admin/Mobilization/Demobilization	LS	1	1,500	1,500
Tracking Pad	Each	1	1,200	1,200
Silt Fence	Each	4	200.00	800
Remove, stockpile and place Topsoil	Square Yard	450	1.25	563
Remove Existing Culvert, 8.6' x 9.4' arch	Lineal Foot	84	62.00	5,208
Grading	Cubic Yard	200	8.00	1,600
Seed	Square Yard	450	0.35	158
Subtotal				11,028
Contingency			25%	2,757
Subtotal				13,785
Total Construction Cost				**13,785**
Engineering			15%	2,068
Total Initial Cost				**15,853**

Appendix B – WinSLAMM Model Output

Heritage Pond Basin no detention - Output Summary.txt

SLAMM for Windows Version 9.4.0

Data file name: L:\Home\skimmler\Faxon Creek\Pond Design\Heritage Pond Basin no detention.dat
Data file description: SLU/CLAY-MDRNA-Medium Density Residential, No Alleys, fair Curb & Gutter
Rain file name: C:\Program Files\WinSLAMM\Rain Files\WisReg - Duluth MN 1975.RAN
Particulate Solids Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
Runoff Coefficient file name: C:\Program Files\WinSLAMM\WI_SL06 Dec06.rsv
Particulate Residue Delivery file name: C:\PROGRAM FILES\WINSLAMM\WI_DLV01.PRR
Residential Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name: C:\Program Files\WinSLAMM\Freeway Dec06.std
Pollutant Relative Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance: False
Model Run Start Date: 01/02/75 Model Run End Date: 12/29/75
Date of run: 09-23-2014 Time of run: 09:08:08
Total Area Modeled (acres): 485
Years in Model Run: 0.99

	Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Source Area Total without Controls:	2.848E+07	0 %	118.7	210993	0 %
Total Before Drainage System:	2.848E+07	0.00%	118.7	210992	0.00%
Total After Drainage System:	2.848E+07	0.00%	118.7	210992	0.00%
Total After Outfall Controls:	2.848E+07	0.00%	118.7	210992	0.00%
Annualized Total After Outfall Controls:	2.880E+07			213330	

Heritage Basin Max Pond - Output Summary.txt

SLAMM for Windows Version 9.4.0

Data file name: L:\Home\skimmler\Faxon Creek\Pond Design\Heritage Basin Max Pond.dat
Data file description: SLU/CLAY-MDRNA-Medium Density Residential, No Alleys, fair Curb & Gutter
Rain file name: C:\Program Files\WinSLAMM\Rain Files\WisReg - Duluth MN 1975.RAN
Particulate Solids Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
Runoff Coefficient file name: C:\Program Files\WinSLAMM\WI_SL06 Dec06.rsv
Particulate Residue Delivery file name: C:\PROGRAM FILES\WINSLAMM\WI_DLV01.PRR
Residential Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name: C:\Program Files\WinSLAMM\Freeway Dec06.std
Pollutant Relative Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance: False
Model Run Start Date: 01/02/75 Model Run End Date: 12/29/75
Date of run: 09-23-2014 Time of run: 11:04:19
Total Area Modeled (acres): 485
Years in Model Run: 0.99

	Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Source Area Total without Controls:	2.848E+07	0 %	118.7	210993	0 %
Total Before Drainage System:	2.848E+07	0.00%	118.7	210992	0.00%
Total After Drainage System:	2.848E+07	0.00%	118.7	210992	0.00%
Total After Outfall Controls:	2.848E+07	0.00%	28.91	51406	75.64%
Annualized Total After Outfall Controls:	2.880E+07			51976	

Heritage Basin 60 Percent - Output Summary.txt

SLAMM for Windows Version 9.4.0

Data file name: L:\Home\skimmler\Faxon Creek\Pond Design\Heritage Basin 60 Percent.dat
Data file description: SLU/CLAY-MDRNA-Medium Density Residential, No Alleys, fair Curb & Gutter
Rain file name: C:\Program Files\WinSLAMM\Rain Files\WisReg - Duluth MN 1975.RAN
Particulate Solids Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
Runoff Coefficient file name: C:\Program Files\WinSLAMM\WI_SL06 Dec06.rsv
Particulate Residue Delivery file name: C:\PROGRAM FILES\WINSLAMM\WI_DLV01.PRR
Residential Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name: C:\Program Files\WinSLAMM\Freeway Dec06.std
Pollutant Relative Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance: False
Model Run Start Date: 01/02/75 Model Run End Date: 12/29/75
Date of run: 09-23-2014 Time of run: 14:21:02
Total Area Modeled (acres): 485
Years in Model Run: 0.99

	Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Source Area Total without Controls:	2.848E+07	0 %	118.7	210993	0 %
Total Before Drainage System:	2.848E+07	0.00%	118.7	210992	0.00%
Total After Drainage System:	2.848E+07	0.00%	118.7	210992	0.00%
Total After Outfall Controls:	2.848E+07	0.00%	39.80	70764	66.46%
Annualized Total After Outfall Controls:	2.880E+07			71548	

UW Pond Basin no detention - Output Summary.txt

SLAMM for Windows Version 9.4.0

Data file name: L:\Home\skimmler\Faxon Creek\Pond Design\UW Pond Basin no detention.dat
Data file description: SLU/CLAY-MDRNA-Medium Density Residential, No Alleys, fair Curb & Gutter
Rain file name: C:\Program Files\WinSLAMM\Rain Files\WisReg - Duluth MN 1975.RAN
Particulate Solids Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
Runoff Coefficient file name: C:\Program Files\WinSLAMM\WI_SL06 Dec06.rsv
Particulate Residue Delivery file name: C:\PROGRAM FILES\WINSLAMM\WI_DLV01.PRR
Residential Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name: C:\Program Files\WinSLAMM\Freeway Dec06.std
Pollutant Relative Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance: False
Model Run Start Date: 01/02/75 Model Run End Date: 12/29/75
Date of run: 09-23-2014 Time of run: 09:26:16
Total Area Modeled (acres): 214.002
Years in Model Run: 0.99

	Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Source Area Total without Controls:	8.847E+06	0 %	140.9	77841	0 %
Total Before Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Outfall Controls:	8.847E+06	0.00%	140.9	77840	0.00%
Annualized Total After Outfall Controls:	8.945E+06			78702	

UW Basin Max Pond - Output Summary.txt

SLAMM for Windows Version 9.4.0

Data file name: L:\Home\skimmler\Faxon Creek\Pond Design\UW Basin Max Pond.dat
Data file description: SLU/CLAY-MDRNA-Medium Density Residential, No Alleys, fair Curb & Gutter
Rain file name: C:\Program Files\WinSLAMM\Rain Files\WisReg - Duluth MN 1975.RAN
Particulate Solids Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
Runoff Coefficient file name: C:\Program Files\WinSLAMM\WI_SL06 Dec06.rsv
Particulate Residue Delivery file name: C:\PROGRAM FILES\WINSLAMM\WI_DLV01.PRR
Residential Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name: C:\Program Files\WinSLAMM\Freeway Dec06.std
Pollutant Relative Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance: False
Model Run Start Date: 01/02/75 Model Run End Date: 12/29/75
Date of run: 09-23-2014 Time of run: 10:35:58
Total Area Modeled (acres): 214.002
Years in Model Run: 0.99

	Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Source Area Total without Controls:	8.847E+06	0 %	140.9	77841	0 %
Total Before Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Outfall Controls:	8.847E+06	0.00%	19.29	10655	86.31%
Annualized Total After Outfall Controls:	8.945E+06			10773	

UW Basin 80Percent Pond - Output Summary.txt

SLAMM for Windows Version 9.4.0

Data file name: L:\Home\skimmler\Faxon Creek\Pond Design\UW Basin 80Percent Pond.dat
Data file description: SLU/CLAY-MDRNA-Medium Density Residential, No Alleys, fair Curb & Gutter
Rain file name: C:\Program Files\WinSLAMM\Rain Files\WisReg - Duluth MN 1975.RAN
Particulate Solids Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
Runoff Coefficient file name: C:\Program Files\WinSLAMM\WI_SL06 Dec06.rsv
Particulate Residue Delivery file name: C:\PROGRAM FILES\WINSLAMM\WI_DLV01.PRR
Residential Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name: C:\Program Files\WinSLAMM\Freeway Dec06.std
Pollutant Relative Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance: False
Model Run Start Date: 01/02/75 Model Run End Date: 12/29/75
Date of run: 09-23-2014 Time of run: 10:41:38
Total Area Modeled (acres): 214.002
Years in Model Run: 0.99

	Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Source Area Total without Controls:	8.847E+06	0 %	140.9	77841	0 %
Total Before Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Outfall Controls:	8.847E+06	0.00%	23.04	12724	83.65%
Annualized Total After Outfall Controls:	8.945E+06			12865	

UW Basin 60Percent Pond - Output Summary.txt

SLAMM for Windows Version 9.4.0

Data file name: L:\Home\skimmler\Faxon Creek\Pond Design\UW Basin 60Percent Pond.dat
Data file description: SLU/CLAY-MDRNA-Medium Density Residential, No Alleys, fair Curb & Gutter
Rain file name: C:\Program Files\WinSLAMM\Rain Files\WisReg - Duluth MN 1975.RAN
Particulate Solids Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
Runoff Coefficient file name: C:\Program Files\WinSLAMM\WI_SL06 Dec06.rsv
Particulate Residue Delivery file name: C:\PROGRAM FILES\WINSLAMM\WI_DLV01.PRR
Residential Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name: C:\Program Files\WinSLAMM\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name: C:\Program Files\WinSLAMM\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name: C:\Program Files\WinSLAMM\Freeway Dec06.std
Pollutant Relative Concentration file name: C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance: False
Model Run Start Date: 01/02/75 Model Run End Date: 12/29/75
Date of run: 09-23-2014 Time of run: 10:44:26
Total Area Modeled (acres): 214.002
Years in Model Run: 0.99

	Runoff Volume (cu ft)	Percent Runoff Volume Reduction	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Source Area Total without Controls:	8.847E+06	0 %	140.9	77841	0 %
Total Before Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Drainage System:	8.847E+06	0.00%	140.9	77840	0.00%
Total After Outfall Controls:	8.847E+06	0.00%	51.23	28296	63.65%
Annualized Total After Outfall Controls:	8.945E+06			28609	