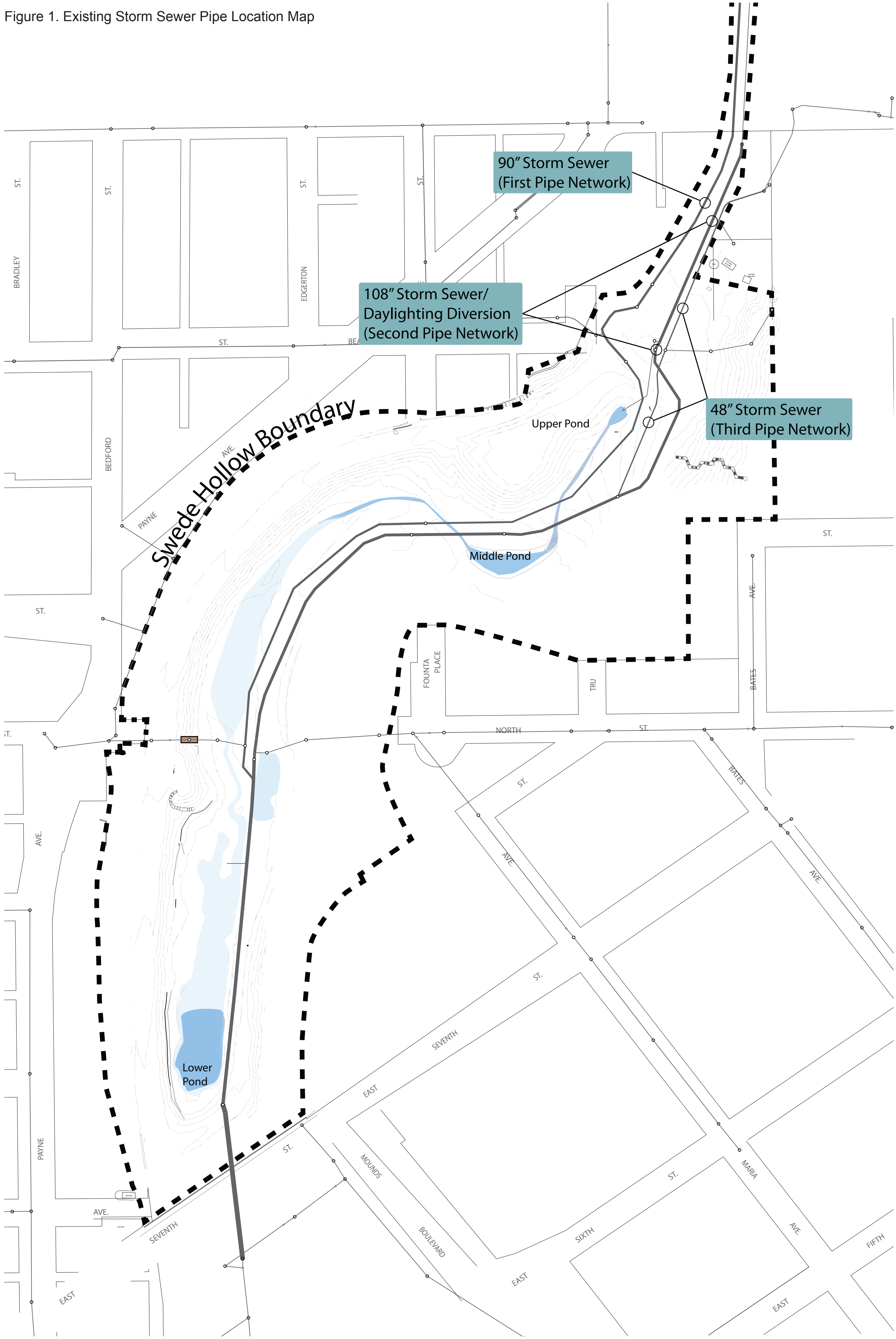
Figure 1. Existing Storm Sewer Pipe Location Map



memo

651 Hale Avenue North Oakdale, Minnesota 55128 telephone: 651.770.8448 facsimile: 651.770.2552 www.eorinc.com

Date |	~~October 29, 2012~~ (*Updated August 18, 2013)*
To |	Brian Tourtelotte (City of St. Paul) Bob Fossum (Capitol Region Watershed District)
From |	Meghan Jacobson, PhD, and Cecilio Olivier, PE
Regarding |	Swede Hollow Water Quality Monitoring Data Analysis

This memo summarizes results from a water quality and groundwater seepage assessment conducted in association with the Swede Hollow Daylighted Stream Analysis and Feasibility Study. We performed water quality monitoring of the groundwater seepage areas within the Swede Hollow study area on August 10 and September 4, 2012, under baseflow conditions at select sites along the creek for phosphorus, nitrogen ions, fluoride, and *Escherichia coli E (E. coli)*. The objective of this sampling was to identify a potential source of nutrients linked to algal blooms observed in the ponding areas of the Swede Hollow study area.

Key conclusions from this study were:

1. High *E. coli* and high total dissolved phosphorus (TDP) to total phosphorus (TP) ratios in the Upper Discharge and Stream sites indicate a potential source of dissolved nutrients and *E. coli* to the stream.

2. Low fluoride and phosphorus concentrations in the Upper Discharge and Stream suggest that potential wastewater contributions to the Upper Discharge site are very diluted with groundwater inputs.

3. Lower TDP/TP ratios and nitrate/nitrite levels below detection limit in the Lower Pond site suggests that these nutrients provided by the Upper Discharge are taken up for algal or other plant growth.

4. The TP concentration and dominance of duck weed in the Lower Pond indicate that the overall water quality of the Lower Pond was within the expected range for its size and depth.

All data considered, the harvesting of Quaternary groundwater to augment creek flows would not appear to have a detrimental effect on water quality. Nevertheless, further investigation of the groundwater seeping areas is recommended as part of an additional study not part of this project.

Water Quality Monitoring Sites

Water quality samples were collected from four sites on August 10 and from three sites on September 4, 2012 (Figure 1):

- Upper Pond:[1] Outlet of the Upper Pond

[1] *The "Upper Pond" referred to in this memo is the "Middle Pond" referred to in the Final Report.*

- Upper Discharge: Outlet of a pipe under the walking path at the base of the east hillside (groundwater seepage discharge)
- Creek: Within the Creek near a gravel path leading off the paved walking path
- Lower Pond

No samples were collected from the Lower Pond on September 4. The last major rainfall event prior to the sampling dates occurred on August 4 with 0.68 inches of rainfall recorded at a Metropolitan Mosquito Control District precipitation station located approximately 2 miles from Swede Hollow. All monitoring samples were taken under baseflow conditions. There was no surface water entering the Upper Pond, indicating that the main source of water to the Upper Pond is groundwater seepage. In addition, water was flowing through the pipe underneath the walking path on both sample dates. This water appeared to originate from groundwater seepage that collected at the base of the east hillside in a ditch and drained through the pipe to the Creek. The depth of the Creek at the "Creek" location on both sample dates was approximately 8 inches. A large algal bloom was not observed in the Lower Pond on the date of sample collection (August 10). Rather, the surface of the Lower Pond was covered in duck weed, a small floating aquatic plant which can be mistaken for an algal bloom.

Water Quality Monitoring Results
The following parameters were analyzed for water samples collected at all sites:

- Fluoride
- Total dissolved phosphorus (TDP)
- Total phosphorus (TP)
- Nitrate and nitrite
- *Escherichia coli* (*E. coli*)

Individual summaries of the spatial and temporal trends of each parameter are included below, and in Table 1 and Figure 2 through Figure 6.

Fluoride
Fluoride was measured as a potential indicator of municipal wastewater in the Creek. Fluoride is naturally found in the environment from igneous rock weathering. The overall median concentration of fluoride in Minnesota aquifers was 0.30 mg/L (range 0.27 – 0.45 mg/L; Minnesota Pollution Control Agency May 1999 Environmental Outcomes Division Factsheet: *Chloride and Fluoride in Minnesota's Ground Water*). None of the fluoride concentrations measured as part of this study was greater than natural background concentrations typically found in Minnesota groundwater (Table 1). Additional fluoride is added to the water supply system during water treatment to prevent tooth decay. Average concentrations of fluoride in Saint Paul drinking water are 1.08 mg/L (range 1.0 – 1.1 mg/L), with a federal drinking water quality standard of 4.0 mg/L (Saint Paul Regional Water Services *Water Quality Report 2012*).

E. coli
E. coli was measured as another potential indicator of municipal wastewater in the creek. High *E. coli* concentrations in surface waters are typically associated with sources of human or animal waste. The *E. coli* levels in the Upper Discharge and Creek sites were higher than either pond

site, and exceeded the State surface water quality standard (126 organisms/ 100 mL) on a single occasion in August for the Upper Discharge site and on a single occasion in September for the Creek site (Table 1). However, a minimum of 5 samples in the same month should be taken to determine an accurate geometric mean *E. coli* level. [2]

Phosphorus

Total dissolved phosphorus (TDP) and total phosphorus (TP) were measured as potential nutrient sources for the observed algal blooms in the creek. TP includes both dissolved and particulate (phosphorus incorporated into living tissue or adsorbed to sediments) forms. TDP typically comprises a greater fraction of the TP in municipal wastewater, due to leaching of dissolved nutrients from human waste, than the TP in surface waters, where P is found in plant or algae tissues or bound to sediment. Typical TP concentrations in Minnesota wastewater are 5.86 mg/L (range 1.17 mg/L – 25.05 mg/L; MPCA report wq-qqtp9-06a *Appendix A: Phosphorus Removal by Minnesota Municipal Wastewater Treatment Facilities*), compared to 0.07 mg/L in Minnesota groundwater (Minnesota Pollution Control Agency, May 1999, Environmental Outcomes Division Factsheet: *Phosphorus in Minnesota's Ground Water*). TDP comprised nearly all of the TP found in the groundwater seepage discharge and creek sites, however at concentrations much lower than typical raw municipal wastewater and similar to typical groundwater. The TP concentrations in the Upper Discharge and Creek were similar to the overall median concentration of TP in Minnesota wells (0.07 mg/L). TP concentrations were higher in the Pond sites with smaller fractions of TDP indicating that more TP may be found in algal tissues. However, the TP concentration in the lower pond (0.065 mg/L) was near the Minnesota shallow lake water quality standard of 0.06 mg/L, indicating that the overall water quality of the Lower Pond was within the expected range for its size and depth. Moreover, the pond surface was covered in duck weed, a small floating aquatic plant, which can be mistaken for an algal bloom.

Nitrate and Nitrite

Nitrate and nitrite were measured as other potential nutrient sources for the observed algal blooms in the creek. Nitrate and nitrite are dissolved forms of nitrogen that can be taken up directly by plants and algae for growth. Nitrate and nitrite concentrations were highest in the groundwater seepage Discharge and Creek site. Nitrate and nitrite concentrations were below detection limit at both Pond sites suggesting that these forms of nitrogen were being taken up quickly from surface waters for algal growth.

Conclusions

High *E. coli* and high TDP/TP ratios in the Upper Discharge and Creek sites indicate a potential source of dissolved nutrients and *E. coli* to the creek. However, low fluoride and phosphorus concentrations in the Upper Discharge and Creek suggest that potential wastewater contributions to the Upper Discharge site are very diluted with groundwater inputs. In addition, lower TDP/TP ratios and nitrate/nitrite levels below detection limit in the Lower Pond site suggest that these nutrients were taken up for algal or other plant growth. But the TP concentration and dominance of duck weed in the Lower Pond indicate that the overall water quality of the lower pond was within the expected range for its size and depth.

All data considered, the harvesting of Quaternary groundwater to augment creek flows would not appear to have a detrimental effect on water quality. Nevertheless, further investigation of the groundwater seeping areas is recommended as part of an additional study not part of this project.

Table 1. Summary of water quality monitoring in the Swede Hollow study area, 2012

	Upper Pond		**Upper Discharge**		**Creek**		**Lower Pond**	
Parameter	*10-Aug*	*4-Sep*	*10-Aug*	*4-Sep*	*10-Aug*	*4-Sep*	*10-Aug*	*4-Sep*
Fluoride (mg/L)	0.14	0.16	0.076	0.079	0.083	0.093	0.14	--
TDP (mg/L)	0.029	0.067	0.028	0.034	0.054	0.055	0.029	--
TP (mg/L)	0.065	0.1	0.026	0.034	0.057	0.054	0.065	--
TDP:TP	0.45	0.67	~1	~1	0.95	~1	0.45	
Nitrate-nitrite (mg/L)	<DL	<DL	1.3	1.4	0.63	0.67	<DL	--
E. coli (MPN/ 100mL)[2]	3	11	240	115	32	225	3	--

<DL = below detection limit

[2] *Minnesota Rules Chapter 7050.0222 Specific Water Quality Standards for Class 2 Waters of the State: Aquatic Life and Recreation; Subpart 2. Class 2A Waters: Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31. (Geometric mean is used in place of arithmetic mean in order to measure the central tendency of the data, dampening the effect that very high or very low values have on arithmetic means. Since bacteria data sets often contain a few very high values, the geometric mean more appropriately characterizes the central tendency of the data.)*

Figure 1. Water quality monitoring sites in the Swede Hollow study area, 2012

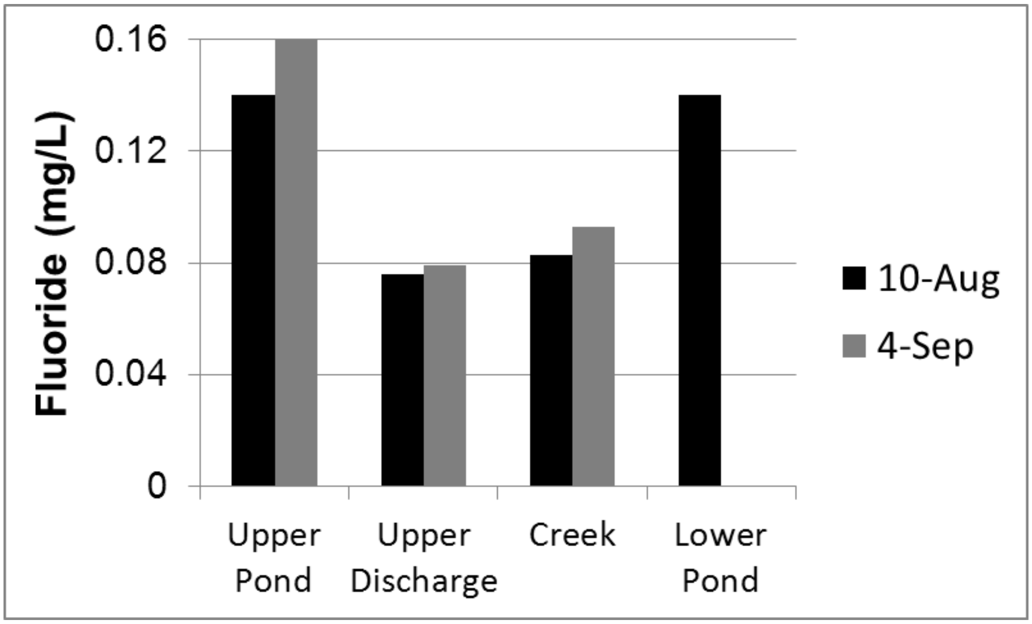


Figure 2. Bar graphs of fluoride concentrations in the Swede Hollow study area, 2012

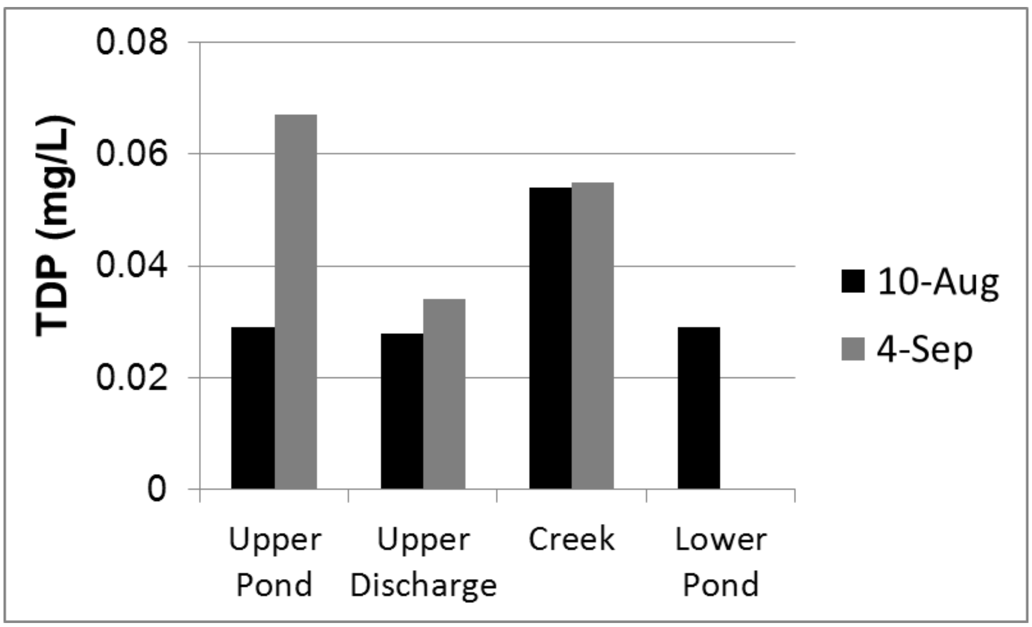


Figure 3. Bar graphs of total dissolved phosphorus (TDP) concentrations in the Swede Hollow study area, 2012

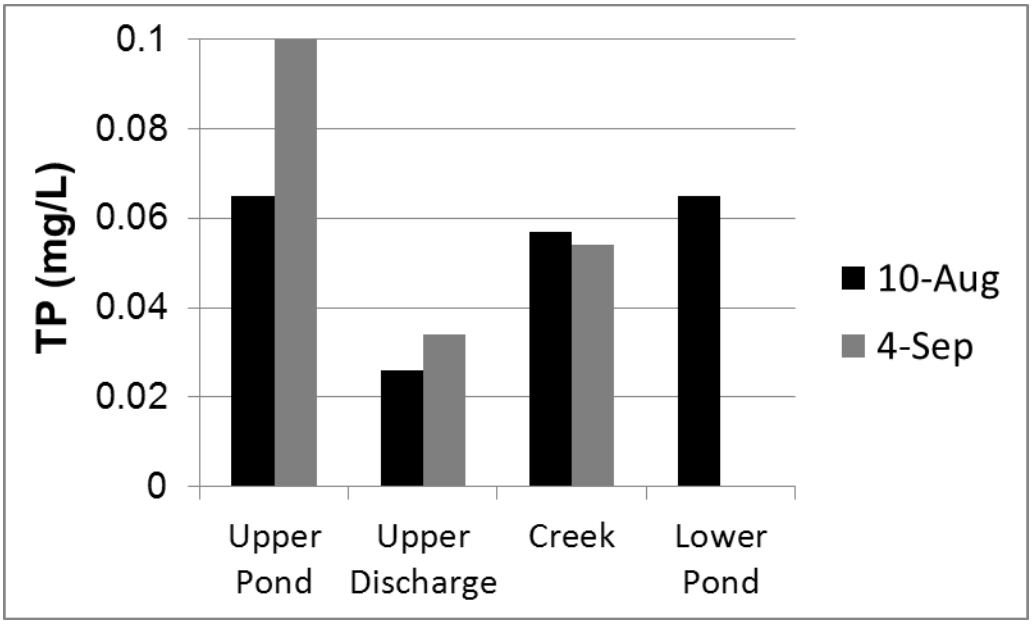


Figure 4. Bar graphs of total phosphorus (TP) concentrations in the Swede Hollow study area, 2012

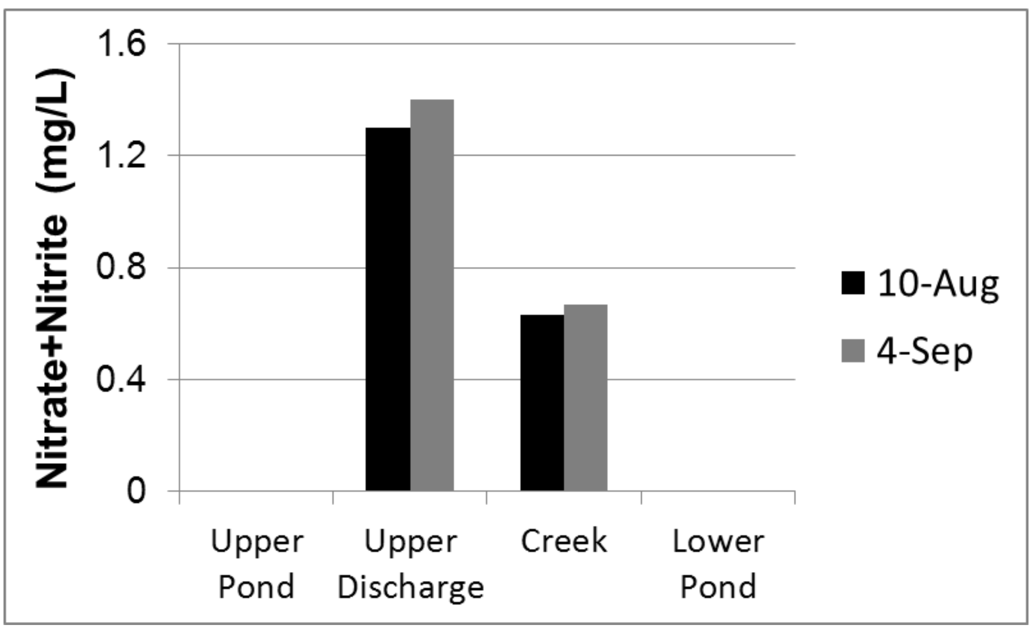


Figure 5. Bar graphs of nitrate and nitrite concentrations in the Swede Hollow study area, 2012

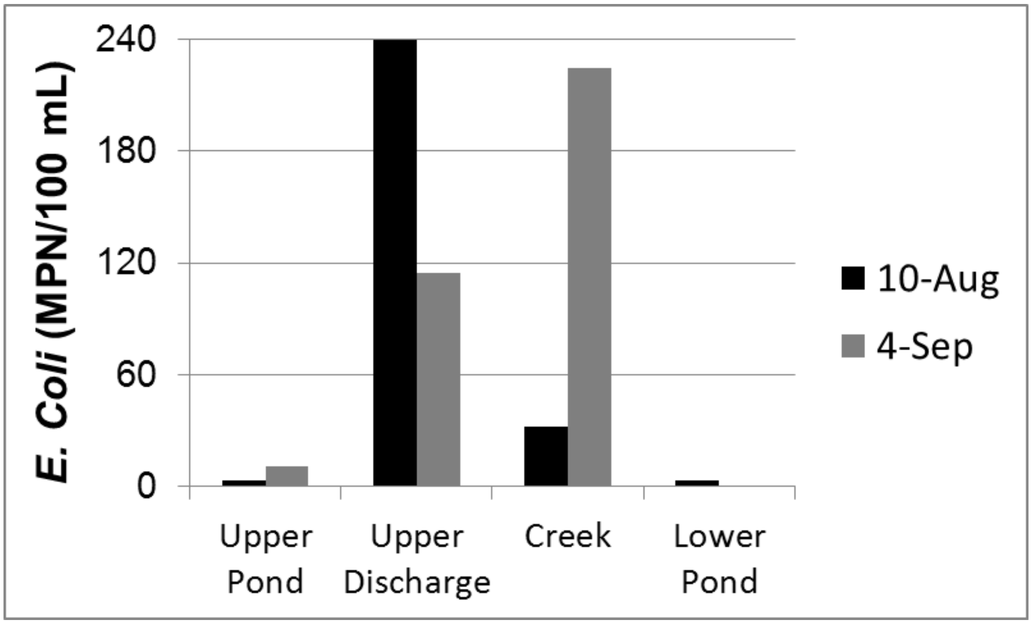
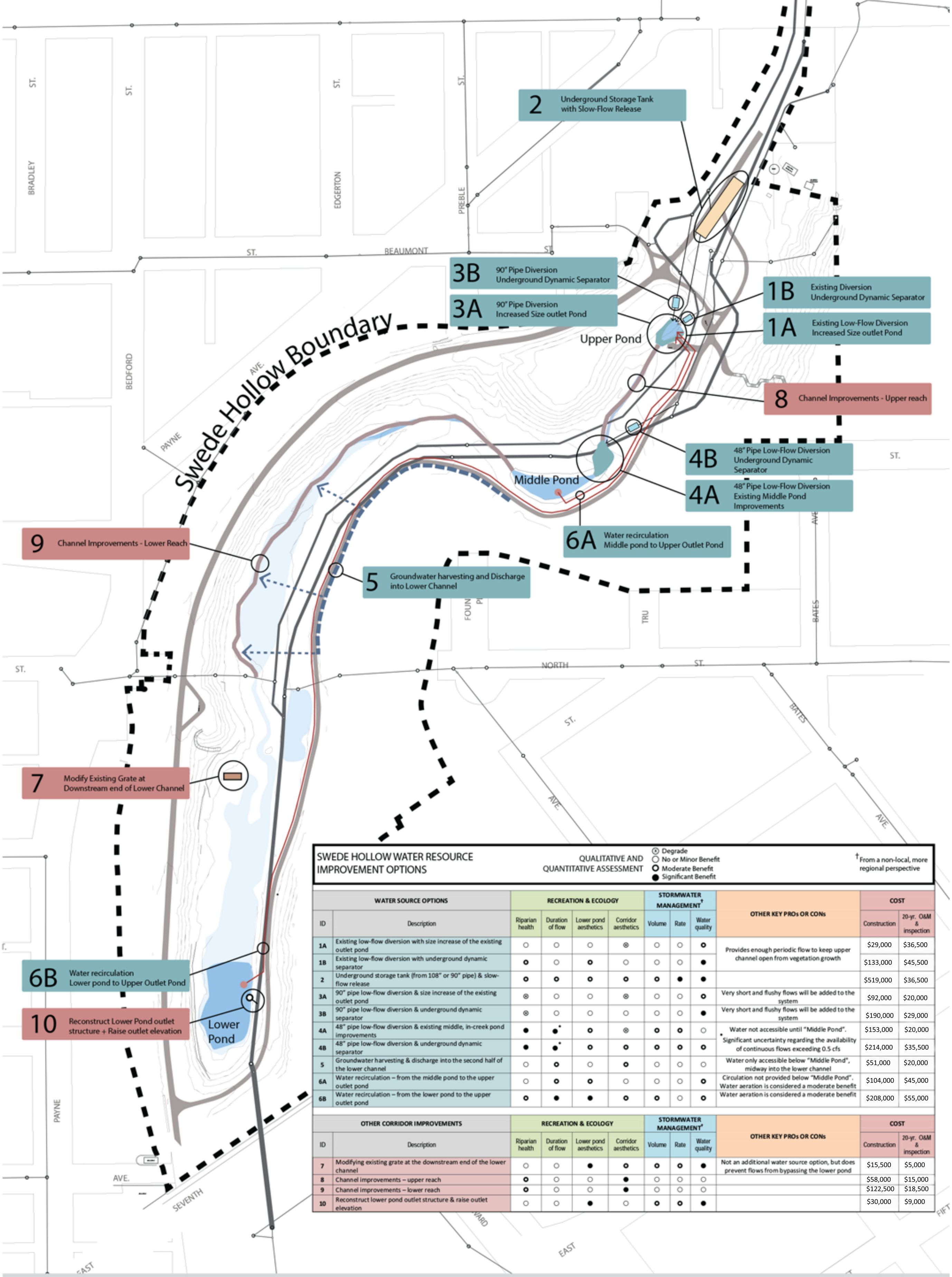


Figure 6. Bar graphs of *Escherichia coli* (*E. coli*) concentrations in the Swede Hollow study area, 2012

Figure 3. Swede Hollow Water Resource Improvements - Water Source Options



SWEDE HOLLOW WATER RESOURCE IMPROVEMENT OPTIONS

QUALITATIVE AND QUANTITATIVE ASSESSMENT

⊗ Degrade
○ No or Minor Benefit
O Moderate Benefit
● Significant Benefit

† From a non-local, more regional perspective

WATER SOURCE OPTIONS		RECREATION & ECOLOGY				STORMWATER MANAGEMENT†			OTHER KEY PROs OR CONs	COST	
ID	Description	Riparian health	Duration of flow	Lower pond aesthetics	Corridor aesthetics	Volume	Rate	Water quality		Construction	20-yr. O&M & inspection
1A	Existing low-flow diversion with size increase of the existing outlet pond	○	○	○	⊗	○	○	**O**	Provides enough periodic flow to keep upper channel open from vegetation growth	$29,000	$36,500
1B	Existing low-flow diversion with underground dynamic separator	**O**	○	**O**	○	○	○	●		$133,000	$45,500
2	Underground storage tank (from 108" or 90" pipe) & slow-flow release	**O**	**O**	**O**	**O**	**O**	●	●		$519,000	$36,500
3A	90" pipe low-flow diversion & size increase of the existing outlet pond	⊗	○	○	⊗	○	○	**O**	Very short and flushy flows will be added to the system	$92,000	$20,000
3B	90" pipe low-flow diversion & underground dynamic separator	⊗	○	○	○	○	○	●	Very short and flushy flows will be added to the system	$190,000	$29,000
4A	48" pipe low-flow diversion & existing middle, in-creek pond improvements	●	●•	**O**	⊗	**O**	**O**	○	Water not accessible until "Middle Pond". • Significant uncertainty regarding the availability of continuous flows exceeding 0.5 cfs	$153,000	$20,000
4B	48" pipe low-flow diversion & underground dynamic separator	●	●•	**O**	**O**	**O**	**O**	**O**		$214,000	$35,500
5	Groundwater harvesting & discharge into the second half of the lower channel	○	**O**	○	**O**	○	○	○	Water only accessible below "Middle Pond", midway into the lower channel	$51,000	$20,000
6A	Water recirculation – from the middle pond to the upper outlet pond	○	**O**	**O**	○	○	○	**O**	Circulation not provided below "Middle Pond". Water aeration is considered a moderate benefit	$104,000	$45,000
6B	Water recirculation – from the lower pond to the upper outlet pond	**O**	●	●	**O**	**O**	○	**O**	Water aeration is considered a moderate benefit	$208,000	$55,000

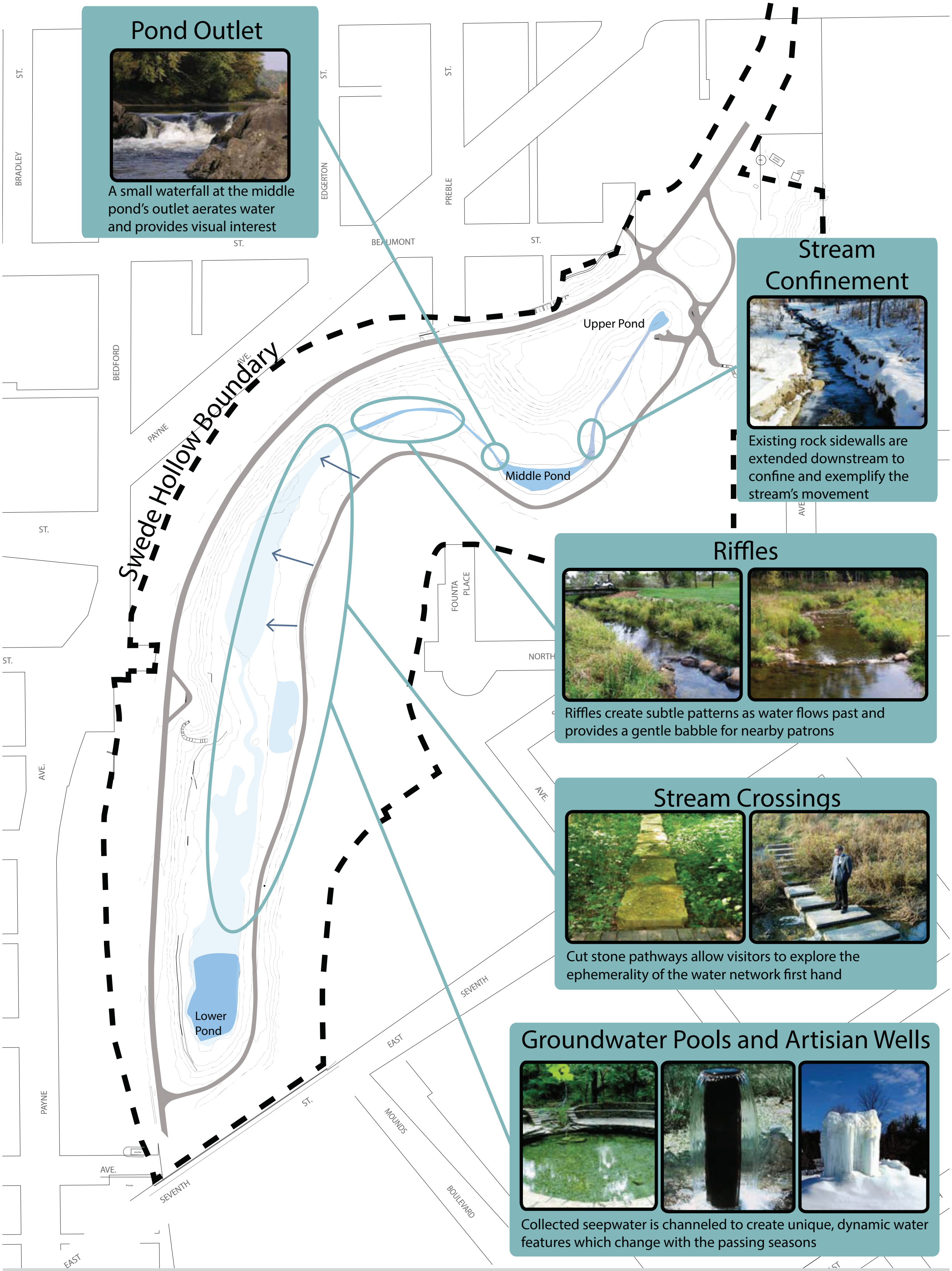
OTHER CORRIDOR IMPROVEMENTS		RECREATION & ECOLOGY				STORMWATER MANAGEMENT†			OTHER KEY PROs OR CONs	COST	
ID	Description	Riparian health	Duration of flow	Lower pond aesthetics	Corridor aesthetics	Volume	Rate	Water quality		Construction	20-yr. O&M & inspection
7	Modifying existing grate at the downstream end of the lower channel	○	○	●	**O**	**O**	**O**	●	Not an additional water source option, but does prevent flows from bypassing the lower pond	$15,500	$5,000
8	Channel improvements – upper reach	**O**	○	○	●	○	○	○		$58,000	$15,000
9	Channel improvements – lower reach	**O**	○	○	●	○	○	○		$122,500	$18,500
10	Reconstruct lower pond outlet structure & raise outlet elevation	○	○	●	○	**O**	**O**	●		$30,000	$9,000

EOR water ecology community

Swede Hollow Water Resource Improvements: Water Source Options

10jan13 - Stakeholder Engagement

Figure 4. Swede Hollow Water Resource Improvements - Recreational Water Features



Swede Hollow Water Resource Improvements:
Recreational Water Features

EOR water ecology community

10jan13 - Stakeholder Engagement

Figure 5. Televising Investigation Location Map

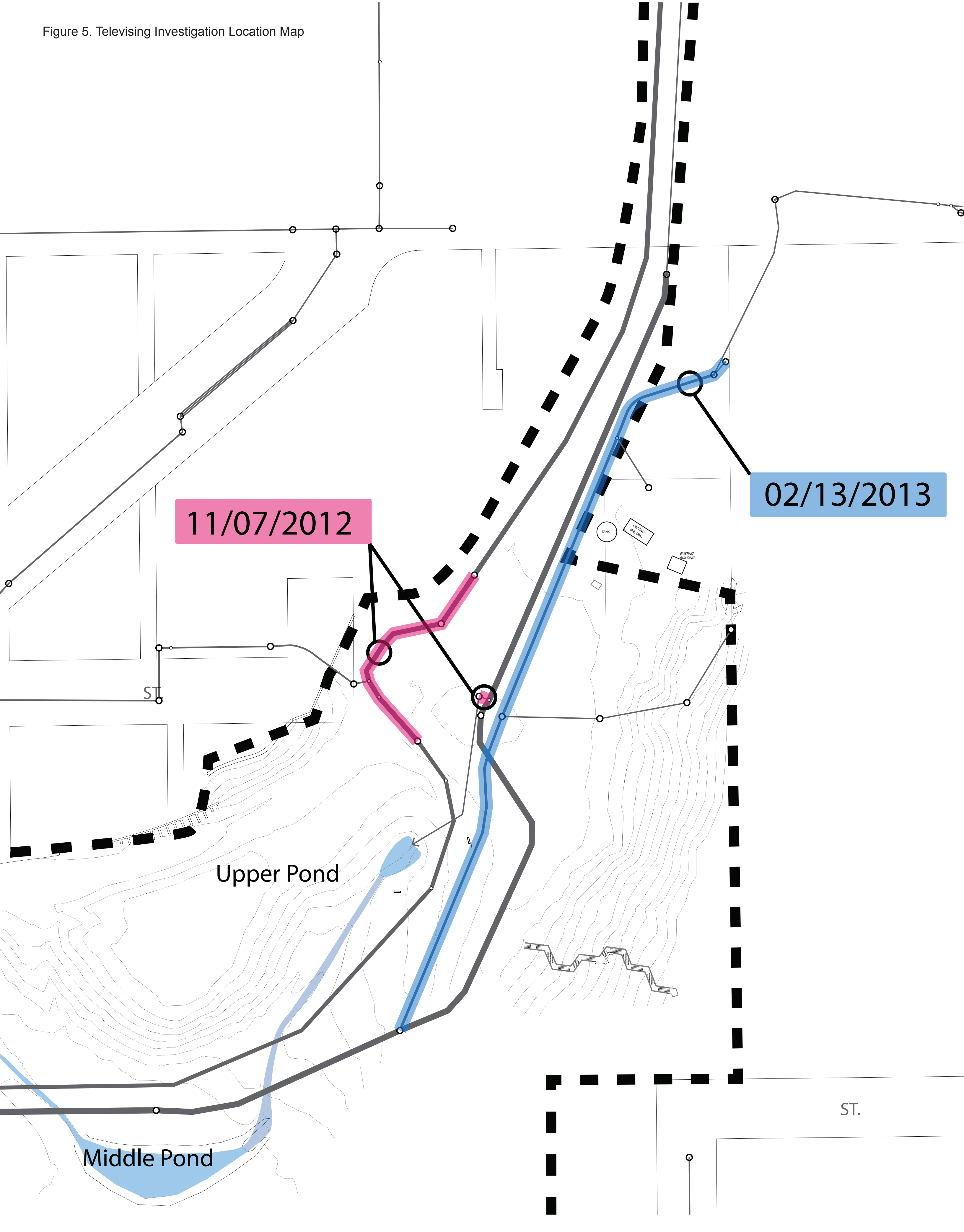


Figure 6. Televising Investigation Diagram - Pipe Network 1 (90” and 72”)')

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Upstream MH	Downstream MH
90" MH	JUNCTION BOX

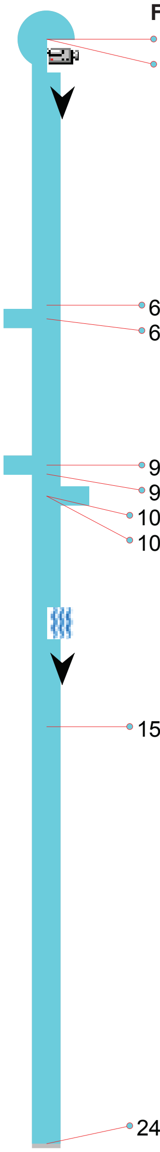
Date	Time	Location (Street)	Job Number
11/7/2012	8:54 AM	EASMT SWEDE HOLLOW	12316 M01

Use of Sewer	Pipe Size	Material	Jt. Spacing	Shape	Survey Direction
Stormwater	90	Reinforced Concrete Pipe	8	Circular	Downstream

Pre-Cleaning	Weather	Surface	US MH Depth	DS MH Depth	Flow Direction
Jetting	Dry	Dirt	8	0	S

Media No.	Surveyed Length	Total Length	Surveyor	Certificate No.	Truck No.
	250	155	BJ	U-509-8014	257

Comments



Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			Starting Manhole: US 90" MH
0.0	MWL	Water Level			
60.0	MGO	General Observation			LOOKING UP LINE THAT GOES UP HILL
63.0	TF	Tap, Factory Made	1		LINE GOES UP HILL TOWARDS ROAD
96.0	TB	Tap, Break-in / Hammer	3		MH APROX. 10' UP LINE
98.0	MGO	General Observation			LOOKING UP 36"
103.0	TB	Tap, Break-in / Hammer	9		GOES TO DROP INLET IN DITCH
103.0	MGO	General Observation			LOOKING UP DROP INLET
155.0	MMC	Material Change			PIPE SIZE CHANGE IN JUNCTION BOX
249.0	MSA	Survey Abandoned			END OF INSPECTION

Snapshot

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CCTV

Upstream MH	Downstream MH
90" MH	JUNCTION BOX

Date	Time	Location (Street)	Job Number
11/7/2012	8:54 AM	EASMT SWEDE HOLLOW	12316 M01

MGO - General Observation @ 60.0 ft.
LOOKING UP LINE THAT GOES UP HILL

MGO - General Observation @ 98.0 ft.
LOOKING UP 36"

MGO - General Observation @ 103.0 ft.
LOOKING UP DROP INLET

Figure 8. Televising Investigation Diagram - Pipe Network 2 (108” and Clearwater Diversion)

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Upstream MH	Downstream MH
DROP HOLE	SLUCE GATE

Date	Time	Location (Street)	Job Number
11/7/2012	7:46 AM	EASMT SWEDE HOLLOW	12316 M01

Use of Sewer	Pipe Size	Material	Jt. Spacing	Shape	Survey Direction
Stormwater	21	Reinforced Concrete Pipe	8	Circular	Upstream

Pre-Cleaning	Weather	Surface	US MH Depth	DS MH Depth	Flow Direction
Jetting	Dry	Dirt	25	25	W

Media No.	Surveyed Length	Total Length	Surveyor	Certificate No.	Truck No.
	17.3	17.3	BJ	U-509-8014	257

Comments

Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			DS SLUCE GATE
17.3	AMH	Access Point - Manhole			DROP GATE
0.5	MWL	Water Level			3" OF SEDIMENT IN LINE

Snapshot

Figure 9. Televising Investigation Photos - Pipe Network 2 (108" and Clearwater Diversion)

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Upstream MH	Downstream MH
DROP HOLE	SLUCE GATE

Date	Time	Location (Street)	Job Number
11/7/2012	7:46 AM	EASMT SWEDE HOLLOW	12316 M01

AMH - Access Point - Manhole @ 0.0 ft.
DS SLUCE GATE

AMH - Access Point - Manhole @ 17.3 ft.
DROP GATE

Figure 10A. Televising Investigation Diagram - Pipe Network 3 (48")

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Upstream MH	Downstream MH
1	2

Date	Time	Location (Street)	Job Number
02/13/2013	10:52 AM	SWEDE HOLLOW	13035M-01

Use of Sewer	Pipe Size	Material	Jt. Spacing	Shape	Survey Direction
Stormwater	48	Reinforced Concrete Pipe	8	Circular	Downstream

Pre-Cleaning	Weather	Surface	US MH Depth	DS MH Depth	Flow Direction
No Pre-Cleaning	Dry	Grass	0	0	S

Media No.	Surveyed Length	Total Length	Surveyor	Certificate No.	Truck No.
1-2	337.5	0	MR	U-303-638	258

Comments
PHALEN CREEK

Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			Starting Manhole: 1
0.0	MWL	Water Level			MINOR FLOW < 1/2"
3.0	FC	Fracture Circumferential	12 to 12		OPEN FRACTURE AT INVERT
3.0	SAV	Surface: Aggregate Visible	5 to 7	S01	
8.0	CL	Crack Longitudinal	12	S02	
35.4	CL	Crack Longitudinal	3		
84.6	LL	Line - Left			TRANSITIONAL BEND TO 96'
97.3	CL	Crack Longitudinal	12	F02	
117.5	LR	Line - Right			
286.6	MWLS	Water Level: Sag			
337.5	MSA	Survey Abandoned			DROPS INTO LARGER PIPE

Figure 10B. Televising Investigation Diagram - Pipe Network 3 (48")

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Upstream MH	Downstream MH
3	2

Date	Time	Location (Street)	Job Number
02/13/2013	9:25 AM	SWEDE HOLLOW	13035M-01

Use of Sewer	Pipe Size	Material	Jt. Spacing	Shape	Survey Direction
Stormwater	48	Reinforced Concrete Pipe	8	Circular	Upstream

Pre-Cleaning	Weather	Surface	US MH Depth	DS MH Depth	Flow Direction
No Pre-Cleaning	Dry	Grass	0	0	S

Media No.	Surveyed Length	Total Length	Surveyor	Certificate No.	Truck No.
1-2	420	0	MR	U-303-638	258

Comments
PHALEN CREEK

Ftg.	Code	Description	Position	Cont.	Comment
420.0	AMH	Access Point - Manhole			US STRUCTURE 3 (LOCATION UNK)
419.7	CL	Crack Longitudinal	12	F02	
419.7	SRI	Surface: Roughness Increased	5 to 7	F01	
384.0	LL	Line - Left			< 5%
378.2	MGO	General Observation			FACED JT WITH CONC 3 TO 9
357.5	CL	Crack Longitudinal	12	S02	HAIR LINE CRACK
322.8	DAE	Deposits Attached: Encrustation	6 to 7		< 5%
322.8	LR	Line - Right			START OF BENDTO RIGHT TO 366'
306.0	MGO	General Observation			FLOW MARKS AT 50%
298.9	DAE	Deposits Attached: Encrustation	6 to 8		VERY MINOR BUILDUP JUST OFF JT
289.9	MGO	General Observation			FACED JT--POSSIBLE WEEPING THRU CONC (4 TO 8)
288.4	DAE	Deposits Attached: Encrustation	7 to 8		POSSIBLE MD AT FLOW LINE
151.0	MWL	Water Level			SLIGHT FLAT SPOT IN PIPE
73.6	CC	Crack Circumferential	3 to 4		
10.2	SRI	Surface: Roughness Increased	6	S01	
0.0	MWL	Water Level			< 5%
0.0	AMH	Access Point - Manhole			Starting Manhole: 2

Figure 10C. Televising Investigation Diagram - Pipe Network 3 (48")

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Upstream MH	Downstream MH
4	3

Date	Time	Location (Street)	Job Number
02/13/2013	10:41 AM	SWEDE HOLLOW	13035M-01

Use of Sewer	Pipe Size	Material	Jt. Spacing	Shape	Survey Direction
Stormwater	48	Reinforced Concrete Pipe	8	Circular	Upstream

Pre-Cleaning	Weather	Surface	US MH Depth	DS MH Depth	Flow Direction
No Pre-Cleaning	Dry	Grass	0	0	S

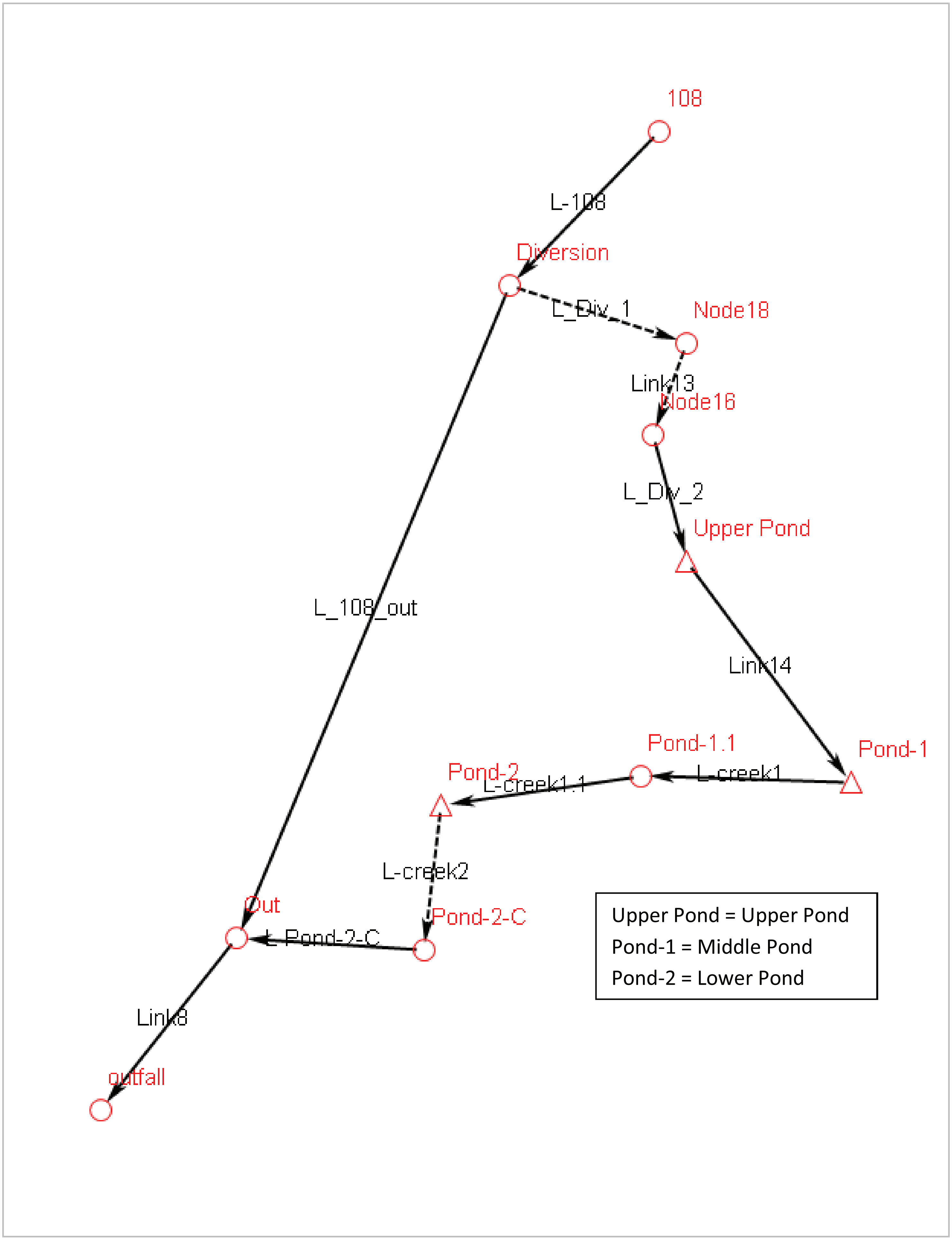
Media No.	Surveyed Length	Total Length	Surveyor	Certificate No.	Truck No.
1-2	4.1	0	MR	U-303-638	258

Comments
PHALEN CREEK

Ftg.	Code	Description	Position	Cont.	Comment
4.1	MSA	Survey Abandoned			CAMERA ON ITS SIDE
0.0	MWL	Water Level			
0.0	AMH	Access Point - Manhole			

Starting Manhole: 3

Figure 11. XP-SWMM Model Diagram



XP-SWMM – Swede Hollow Stormwater Model Network of Pipes and Ponds

Figure 12. Duration of Flow for L-creek1.1

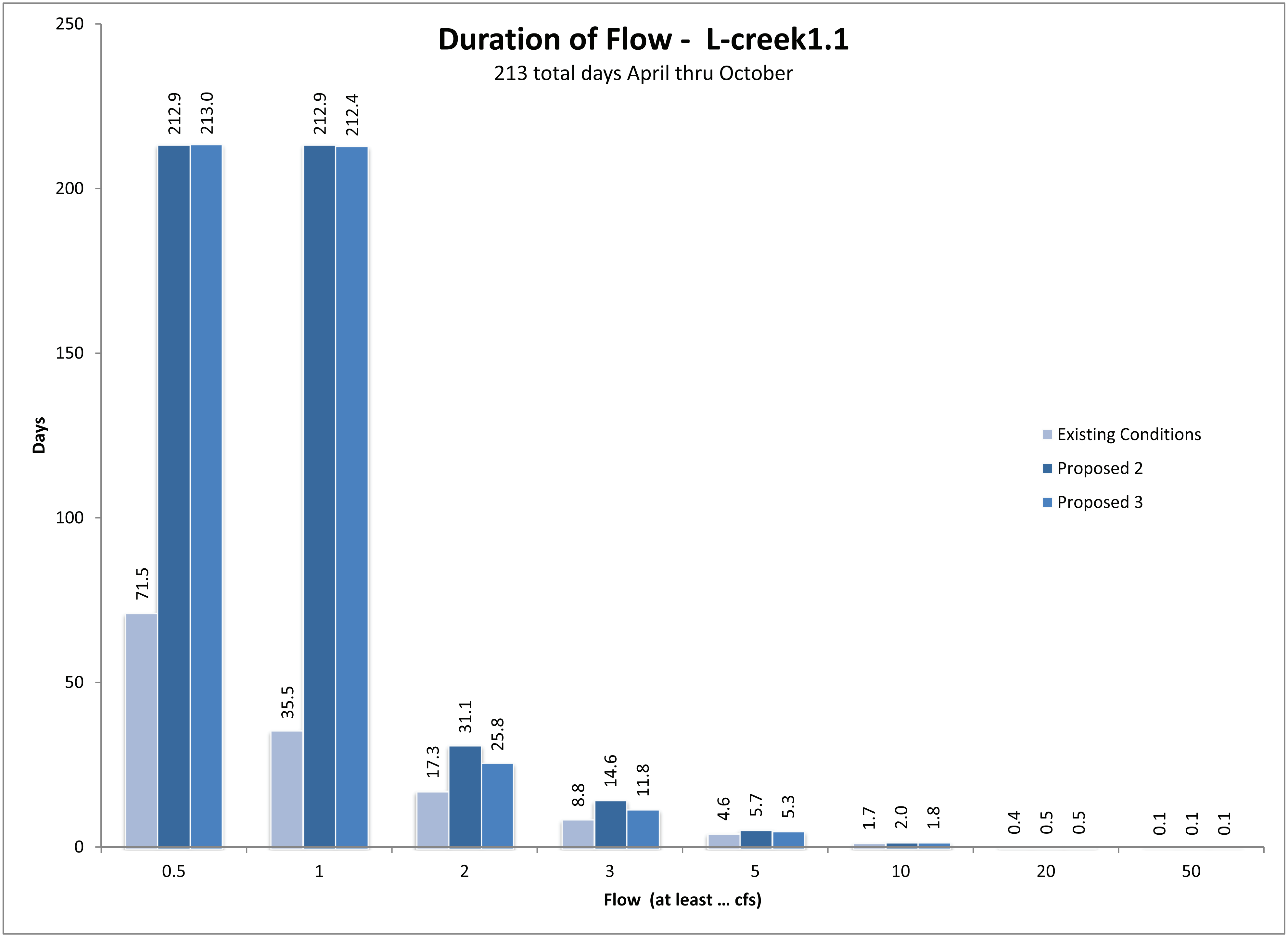


Figure 13. Duration of Flow for L-Div-2

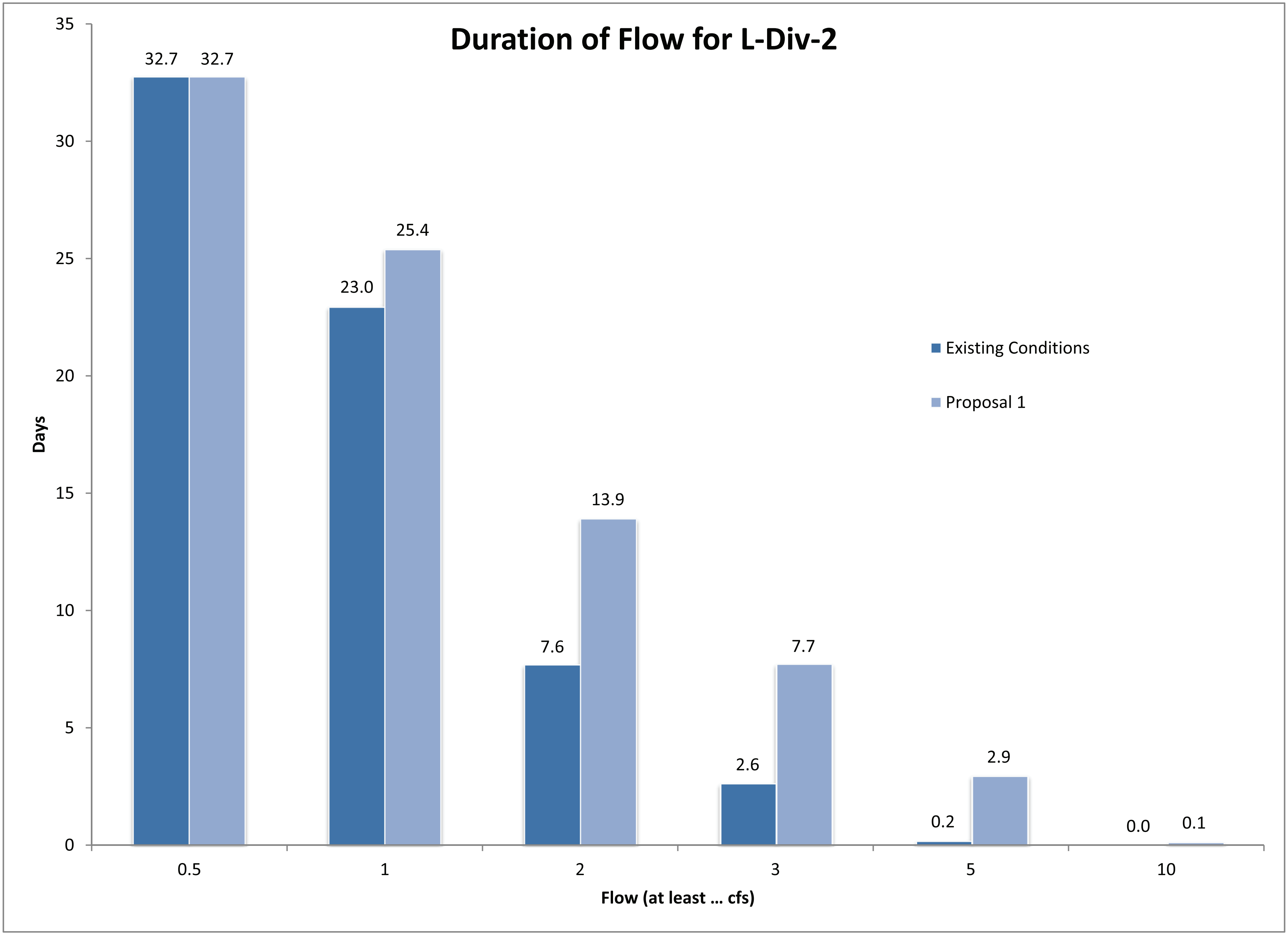


Figure 14. Existing Conditions Hydrograph for L-creek1.1

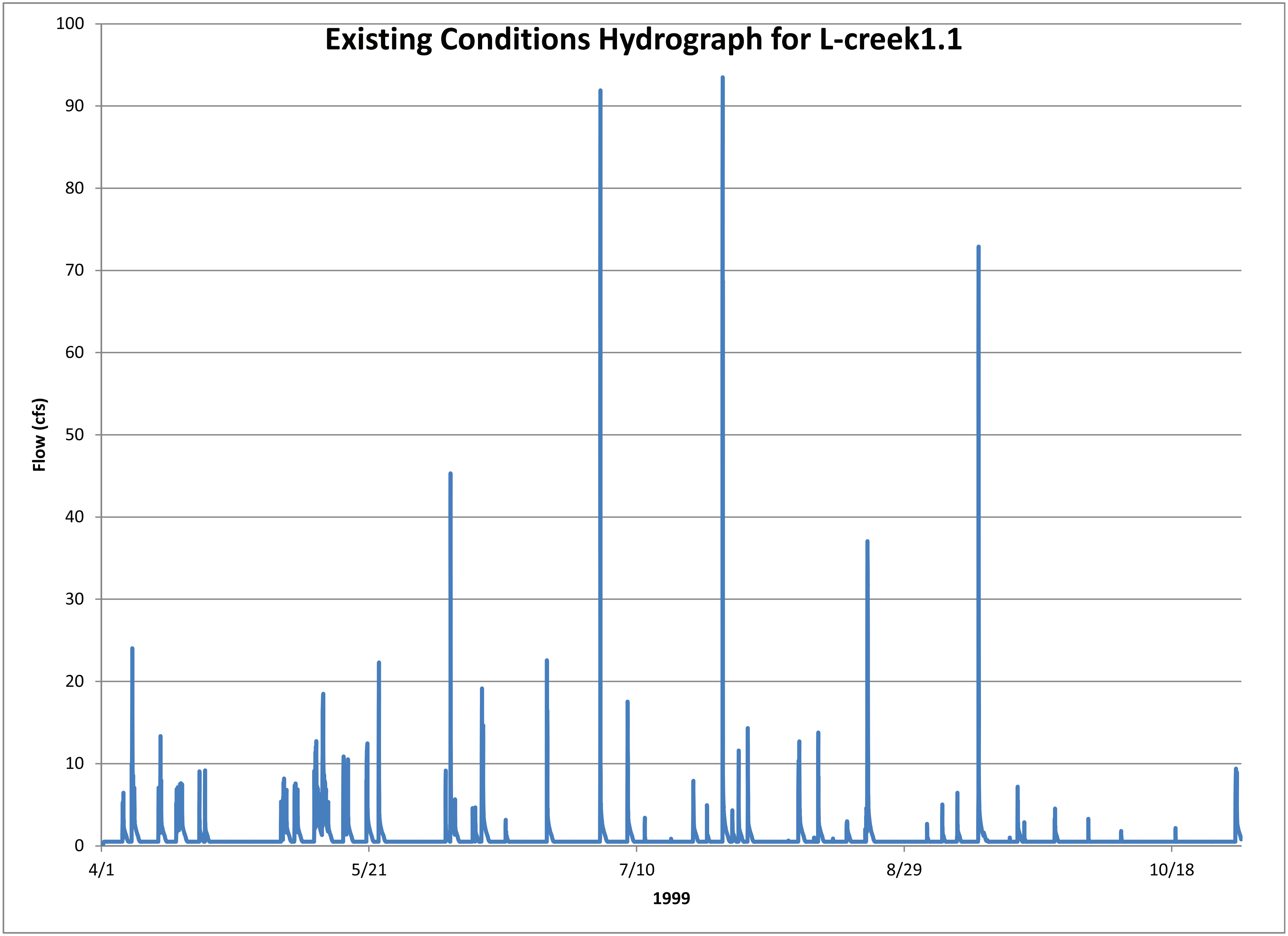


Figure 15. Proposal 3 Hydrograph for L-creek1.1

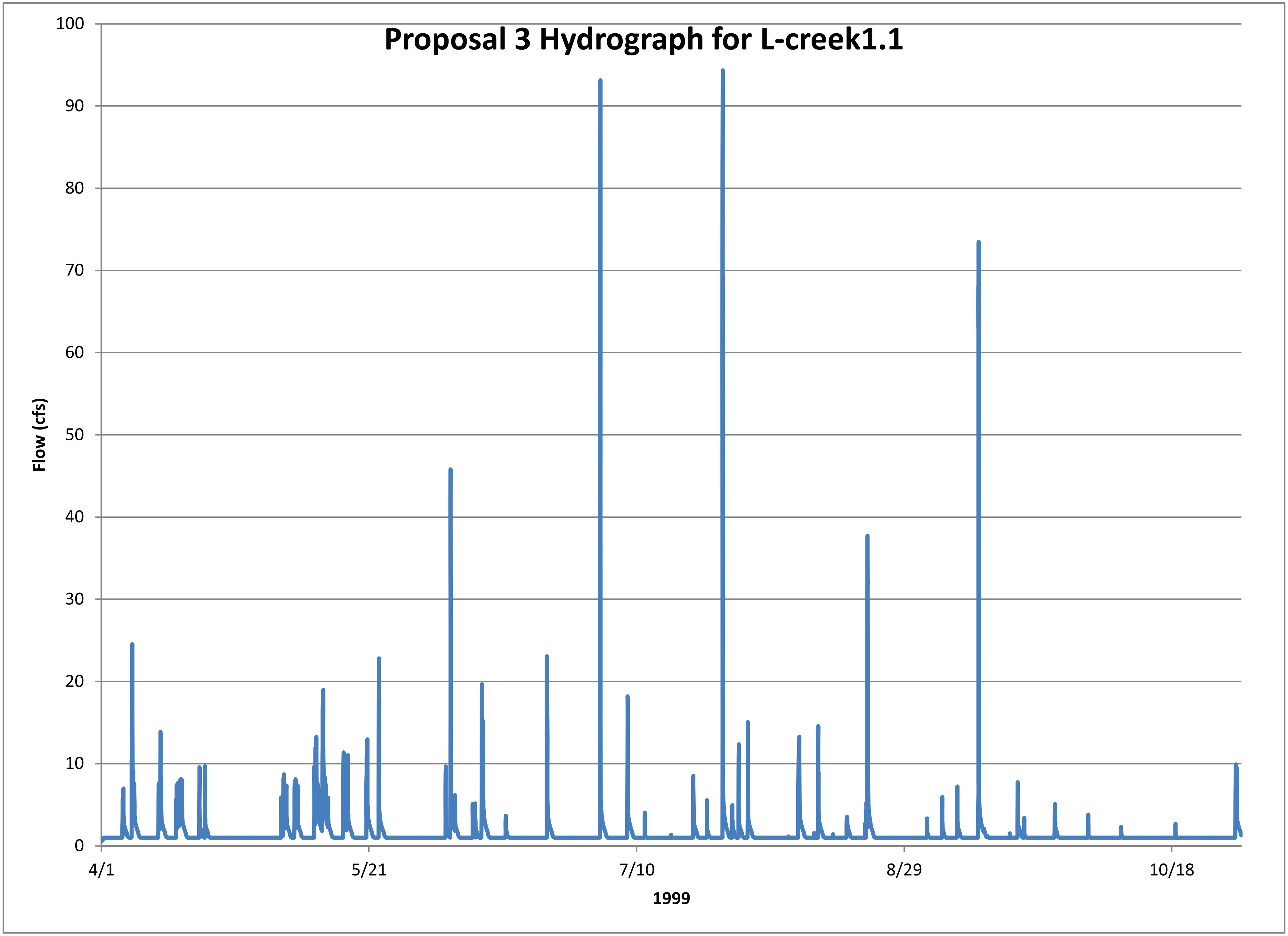
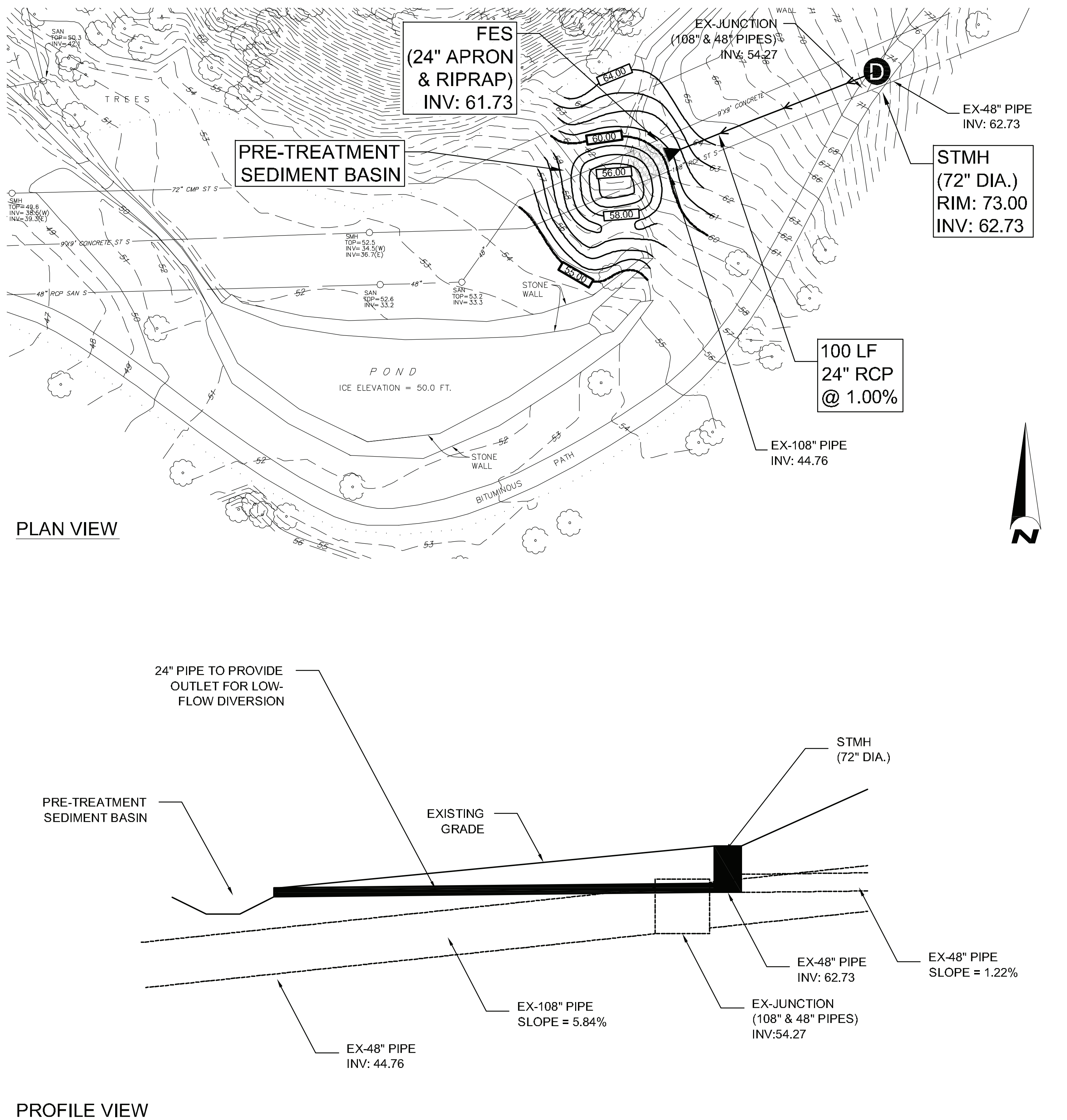
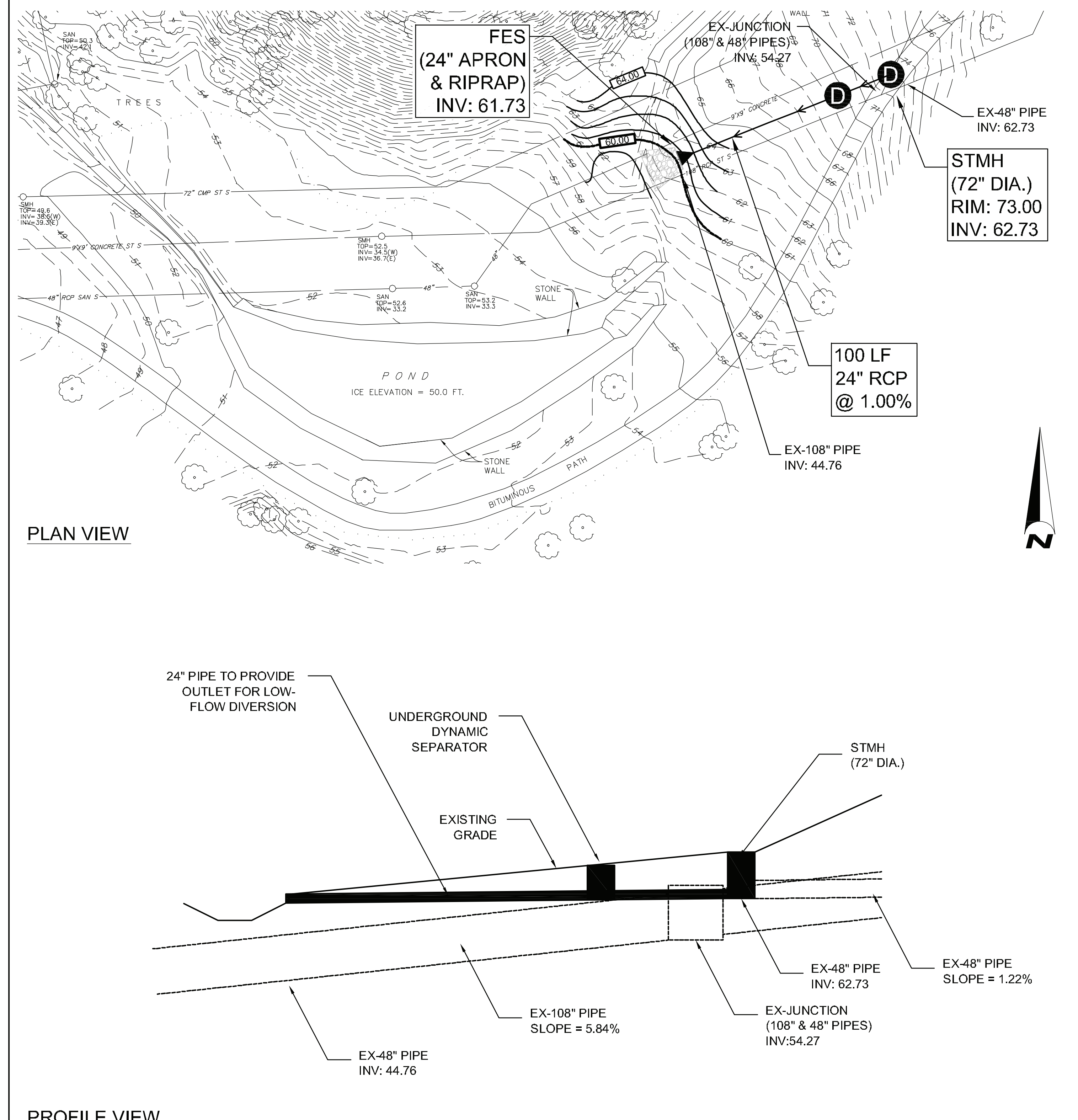


Figure 16. Options 4a and 4b



1 F-16 OPTION 4A - 48" PIPE LOW-FLOW DIVERSION & EXISTING MIDDLE, IN-CREEK POND IMPROVEMENTS

NO SCALE



2 F-16 OPTION 4B - 48" PIPE LOW-FLOW DIVERSION & UNDERGROUND DYNAMIC SEPARATOR

NO SCALE

NO	DATE	BY	REVISION
6			
5			
4			
3			
2			
1			

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

INDIVIDUAL CERTIFYING
DATE: 04/10/2013 LICENSE # XXXXX

SUBMISSION DATE: 04/10/2013
DESIGN BY DRL DRAWN BY DRL
EOR PROJECT NO. 00161-0017

EOR water ecology community
Emmons & Olivier Resources, Inc.
651 Hale Avenue North
Oakdale, MN 55128
Tele: 651.770.8448
www.eorinc.com

CITY OF SAINT PAUL
DEPT. OF PARKS & REC.
25 W. 4TH STREET, SUITE 400
SAINT PAUL, MN 55102

SWEDE HOLLOW PARK
DAYLIGHTED STREAM ANALYSIS
AND FEASIBILITY STUDY

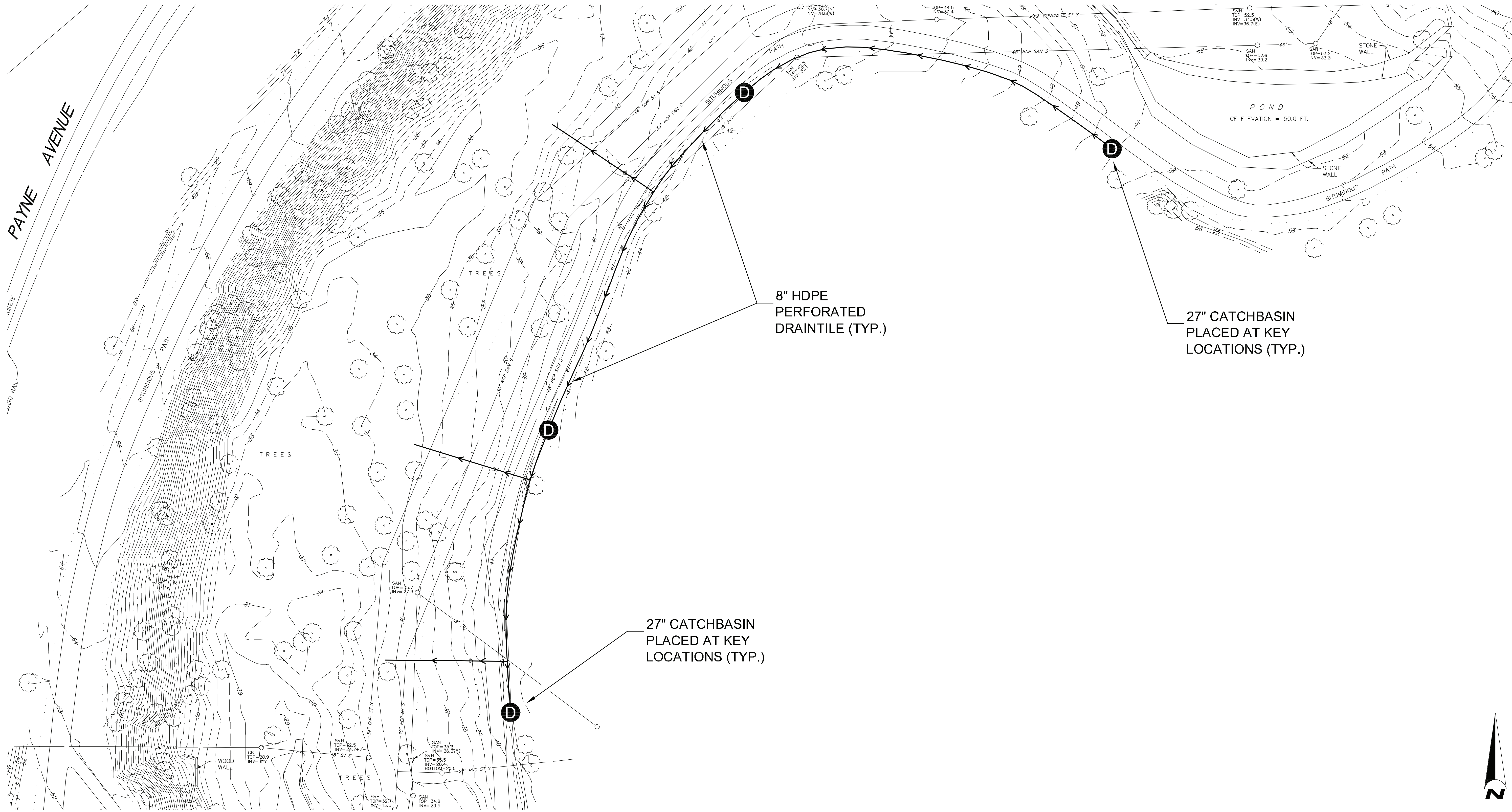
STATE PROJECT NO. CITY PROJECT NO. ####

OPTIONS 4A AND 4B

FIGURE 16

Plot Date: 04/10/2013
Drawing name: X:\Clients_Municipal\161_St_Paul\0017_Swede_Hollow_Daylighted_Stream_Analysis_Feasibility_Study\09_GIMS_ProjectName\dwg\00161-0017_Report-Options_20130410.dwg
Xrefs:, 00161-0017_Working Drawing_20120822, 20111201001-01092012

Figure 17. Option 5



1 F-17 OPTION 5 - GROUNDWATER HARVESTING & DISCHARGE INTO THE SECOND HALF OF THE LOWER CHANNEL

NO SCALE

NO	DATE	BY	REVISION
6			
5			
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3			
2			
1			

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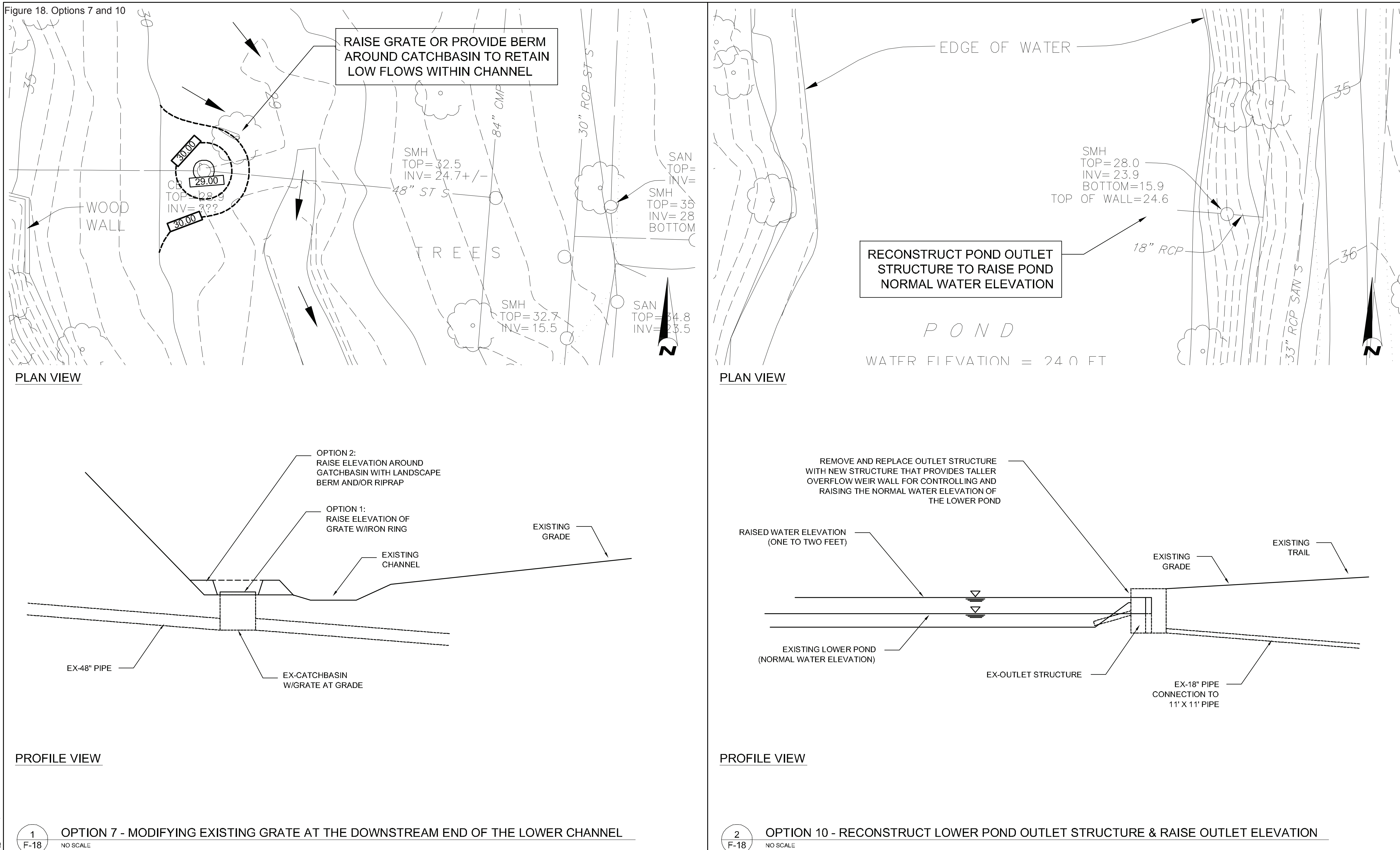
STATE PROJECT NO. CITY PROJECT NO. ####

OPTION 5

FIGURE 17

Plot Date: 04/10/2013
Drawing name: X:\Clients_Municipal\161_St_Paul\0017_Swede_Hollow_Daylighted_Stream_Analysis_Feasibility_Study\09_GIMS_ProjectName\dwg\00161-0017_Report-Options_20130410.dwg
Xrefs:, 00161-0017_Working Drawing_20120822, 20112010001-0102012

Figure 18. Options 7 and 10



NO	DATE	BY	REVISION
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4			
3			
2			
1			

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA .

INDIVIDUAL CERTIFYING
DATE: 04/10/2013 LICENSE # XXXXX

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AND FEASIBILITY STUDY

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OPTIONS 7 AND 10

FIGURE 18

Plot Date: 04/10/2013
Drawing name: X:\Clients_Municipal\161_St_Paul\0017_Swede_Hollow_Daylighted_Stream_Analysis_Feasibility_Study\09_GIMS_ProjectName\dwg\00161-0017_Report-Options_20130410.dwg
Xrefs:, 00161-0017_Working Drawing_20120822, 20112010001-01092012

1. Location, Topographic and Utility Survey for St. Paul Parks and Recreation; Sheets 1 through 3; Prepared by Sunde Land Surveying; January 9, 2012; PDF File by City of Saint Paul.

2. Location, Topographic and Utility Survey for St. Paul Parks and Recreation; Sheets 1 through 3; Prepared by Sunde Land Surveying; January 9, 2012; AutoCAD DWG File by City of Saint Paul.

4. Detail Sheet for Construction of Clearwater Diversion Structure – Commission 8996; Sheet 2 of 2; Prepared by TKDA; October 28, 1987; PDF File by City of Saint Paul

5. Scheme "A" Plan & Profile Sheet for Construction of Clearwater Diversion – Commission 8996; Sheet X of X; Prepared by TKDA; Receipt Date of September 29, 1987; PDF File by City of Saint Paul.

6. Numerous Historic Sewer Plan & Profile Sheets for Pipes In and Around Swede Hollow; Dated: Late 1800's to Early 2000's; Public Works On-line Data Portal by City of Saint Paul.

7. Storm Sewer Data; Undated; GIS File by City of Saint Paul via Capitol Region Watershed District.

8. Watershed Drainage Areas Data; May 21, 2012; GIS File by Capitol Region Watershed District.

9. Soil Survey Data; August 2, 2006; United States Department of Agriculture, Natural Resources Conservation Service.

10. Elevation and Contour Data; September 6, 2003; United State Geological Survey.

11. Water Quality Report 2012; Undated; Saint Paul Regional Water Services; 2 sided pamphlet.

12. Chloride and Fluoride in Minnesota's Ground Water; May 1999; Minnesota Pollution Control Agency; 2 page FAQ.

13. Phosphorus Removal by Minnesota Municipal Wastewater Treatment Facilities, Appendix A of report: wq-qqtp9-06a; April 13, 2011; Minnesota Pollution Control Agency; 15 page report.

14. 2010 Monitoring Report; April 13, 2011; Capitol Region Watershed District; Pages 53 - 56; Overview of Phalen Creek Subwatershed.

Table 2. Swede Hollow Water Resource Improvement Options - Qualitative and Quantitative Assessment

SWEDE HOLLOW WATER RESOURCE IMPROVEMENT OPTIONS

QUALITATIVE AND QUANTITATIVE ASSESSMENT

- ⊗ Degrade
- ○ No or Minor Benefit
- ◉ Moderate Benefit
- ● Significant Benefit

†From a non-local, more regional perspective

WATER SOURCE OPTIONS		RECREATION & ECOLOGY				STORMWATER MANAGEMENT†			OTHER KEY PROs OR CONs	COST	
ID	Description	Riparian health	Duration of flow	Lower pond aesthetics	Corridor aesthetics	Volume	Rate	Water quality		Construction	20-yr. O&M & inspection
1A	Existing low-flow diversion with size increase of the existing outlet pond	○	○	○	⊗	○	○	◉	Provides enough periodic flow to keep upper channel open from vegetation growth	$29,000	$36,500
1B	Existing low-flow diversion with underground dynamic separator	◉	○	◉	○	○	○	●		$133,000	$45,500
2	Underground storage tank (from 108" or 90" pipe) & slow-flow release	◉	◉	◉	◉	◉	●	●		$519,000	$36,500
3A	90" pipe low-flow diversion & size increase of the existing outlet pond	⊗	○	○	⊗	○	○	◉	Very short and flushy flows will be added to the system	$92,000	$20,000
3B	90" pipe low-flow diversion & underground dynamic separator	⊗	○	○	○	○	○	●	Very short and flushy flows will be added to the system	$190,000	$29,000
4A	48" pipe low-flow diversion & existing middle, in-creek pond improvements	●	●*	◉	⊗	◉	◉	○	Water not accessible until "Middle Pond". * Significant uncertainty regarding the availability of continuous flows exceeding 0.5 cfs	$153,000	$20,000
4B	48" pipe low-flow diversion & underground dynamic separator	●	●*	◉	◉	◉	◉	◉		$214,000	$35,500
5	Groundwater harvesting & discharge into the second half of the lower channel	○	◉	○	◉	○	○	○	Water only accessible below "Middle Pond", midway into the lower channel	$51,000	$20,000
6A	Water recirculation – from the middle pond to the upper outlet pond	○	◉	◉	○	○	○	◉	Circulation not provided below "Middle Pond". Water aeration is considered a moderate benefit	$104,000	$45,000
6B	Water recirculation – from the lower pond to the upper outlet pond	◉	●	●	◉	◉	○	◉	Water aeration is considered a moderate benefit	$208,000	$55,000

OTHER CORRIDOR IMPROVEMENTS		RECREATION & ECOLOGY				STORMWATER MANAGEMENT†			OTHER KEY PROs OR CONs	COST	
ID	Description	Riparian health	Duration of flow	Lower pond aesthetics	Corridor aesthetics	Volume	Rate	Water quality		Construction	20-yr. O&M & inspection
7	Modifying existing grate at the downstream end of the lower channel	○	○	●	◉	◉	◉	●	Not an additional water source option, but does prevent flows from bypassing the lower pond	$15,500	$5,000
8	Channel improvements – upper reach	◉	○	○	●	○	○	○		$58,000	$15,000
9	Channel improvements – lower reach	◉	○	○	●	○	○	○		$122,500	$18,500
10	Reconstruct lower pond outlet structure & raise outlet elevation	○	○	●	○	◉	◉	●		$30,000	$9,000

Note:
All costs have been estimated using 2014 values and assume a 30% contingency for construction. Operations and Maintenance (O&M) and inspection costs are amortized over a 20-year period, assuming an average annual rate of inflation equal to 2.00%.

Table 3. XP-SWMM Modeling Scenarios

Option ID	Description
Existing Conditions	108” pipe partially obstructing 21” clearwater diversion pipes; shear gate completely open; minor debris and sediment in 21” pipe. 0.25 cfs added to each of the following: Middle Pond, Downstream of Middle Pond, and Lower Pond to simulate groundwater flow.
Existing Conditions w/Minor Adjustments	Obstruction within clearwater diversion removed; fully cleaned and maintained 21” pipe. 0.25 cfs added to each of the following: Middle Pond, Downstream of Middle Pond, and Lower Pond to simulate groundwater flow.
New Water Source (4A/4B)	Clearwater diversion left as is; add 0.75 cfs in Pond 1 to simulate 48” connection (total of 1 cfs when combined with existing groundwater flow). 0.25 cfs added to each of the following: Downstream of Middle Pond and Lower Pond to simulate groundwater flow.
Redirected Water Source (5)	Clearwater diversion left as is; add 0.5 cfs downstream of Middle Pond (for total of 0.75 cfs); 0.25 cfs added to each of the following: Middle Pond and Lower Pond to simulate groundwater flow.

Table 4. Estimated Costs for Preferred Water Resource Improvements

Option ID	Description	Costs		
		Design	Construction	20-Year O&M and Inspection
4A	48” pipe low-flow diversion & existing middle, in creek pond improvements	$45,900	$153,000	$20,000
4B	48” pipe low-flow diversion & underground dynamic separator	$64,200	$214,000	$35,500
5	Ground water harvesting & discharge into the second half of the lower channel	$15,300	$51,000	$20,000
7A	Modifying existing grate at the downstream end of the lower channel	$4,650	$15,500	$5,000
7B	Modifying existing flared end section near the northeast corner of the lower pond	$4,650	$15,500	$5,000
9	Channel improvements (lower reach)	$36,750	$122,500	$18,500
10	Reconstruct lower pond outlet structure & raise outlet elevation	$9,000	$30,000	$9,000

Note:
All costs have been estimated using 2014 values and assume a 30% contingency for construction, with design fees assumed as 30% of construction costs. Operations and Maintenance (O&M) and inspection costs are amortized over a 20-year period, assuming an average annual rate of inflation equal to 2.00%.