2024 STORMWATER QUALITY AND QUANTITY MONITORING PROGRAM

CITY OF ST. PAUL

April 23, 2025

Prepared for:
City of St. Paul
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WSB PROJECT NO. 022099

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BMP	Best Management Practices
CCB	Capital City Bikeway
CRWD	Capital Region Watershed District
Cu-ft	Cubic feet
DP	Dissolved phosphorus
EMC	Event mean concentration
FT	Feet
FWA	Flow-weighted average
HDPE	High-density polyethylene
In/hr	Inches per hour
IR	In-rock
lbs	Pounds
mg/L	Milligrams per liter
MS4	Municipal Separate Storm Sewer System
MSWM	Minnesota Stormwater Manual
MPCA	Minnesota Pollution Control Agency
MPN	Most probable number
MnDOT	Minnesota Department of Transportation
NPDES	National Pollutant Discharge Elimination System
OCS	Outlet control structure
SP	Poorly graded sand
SPCD	Saint Paul City Datum
SRP	Soluble reactive phosphorus
TP	Total phosphorus
TSS	Total suspended solids

1. Introduction

The purpose of this report is to present the findings of the City of Saint Paul's (City) 2024 Stormwater Monitoring Program. The monitoring was conducted to fulfill requirements of the City's National Pollutant Discharge Elimination System (NPDES) MS4 Phase I Permit. The data was collected, analyzed and used to quantify stormwater volumes and loads from the Municipal Separate Storm Sewer System (MS4). This data will support in the evaluation of efficacy of the City's Stormwater Management Program.

Since 2006, the Minnesota Pollution Control Agency (MPCA) has required the city to construct stormwater volume reduction Best Management Practices (BMPs) concurrent with City projects that generate or reconstruct impervious surfaces. The MPCA requirements stipulate that these BMPs must provide volume reduction for the runoff from a one-inch rainfall event over the impervious surfaces of the project. In 2015, the watershed updated their standard to require that the BMP provide volume reduction for the runoff from a 1.1-inch rainfall event over the impervious surface of the project. The city has typically achieved this by constructing infiltration BMPs.

The focus of the City's stormwater monitoring program has been to monitor the effectiveness and maintenance needs of stormwater BMPs. Outfall monitoring data, collected by Capitol Region Watershed District (CRWD), is used to evaluate pollutant loading from major sub-watersheds and to estimate City-wide pollutant loading from the MS4.

Four BMPs and two drainage areas monitored via storm pipe were monitored in 2024 to quantify progress toward meeting the City's stormwater management goals and to refine current design and maintenance practices. Rainfall was also measured at four locations in the city. The 2024 monitoring sites are shown in **Figure 1-1** and listed in **Table 1-1**. This effort focused on evaluating four major parameters during the monitoring period:

- Water level/infiltration rate
- Volume reduction
- Pollutant capture
- BMP maintenance

To evaluate these parameters, electronic monitoring equipment was used to continuously measure system water levels, inflow/outflow volumes, and rainfall amounts. In addition, visual inspections and measurements of sediment accumulation were conducted periodically for each system to assess maintenance needs.

Three of the monitored BMPs are pervious pavement sites, evaluated for infiltration performance. Long-term monitoring at these sites is completed to research the benefits, feasibility, and sustainability of pervious surface parking lanes, alleyways, and bike trails in the city.

This report describes the procedures and methods used to collect water quality and quantity data, provides background information for each site monitored, and presents the results of the monitoring that was completed.

Table 1-1: 2024 City of Saint Paul Monitoring Site Summary

BMP/Site Name	BMP/Site Type	Monitored Parameters[1]
Beacon Bluff	Underground Infiltration Gallery & Rain Garden	WL, Q, WQ, GW
St. Albans Street	Underground Infiltration Gallery	WL, Q, WQ
Hampden Park	Underground Infiltration Gallery	WL, Q, WQ, GW
Victoria Street	Pervious Pavers & Underground Infiltration Gallery	WL, Q, WQ, Infiltration
West Shepard Pond	Storm Pipe/Stormwater Pond	WL, Q, WQ
Allianz Field	Filtration Chamber	WL, Q, WQ
Jackson Street Pervious Bike Path	Pervious Asphalt	Infiltration
Capital Region Watershed District Office	Rainfall Monitoring Location	R
Trout Brook Nature Sanctuary	Rainfall Monitoring Location	R
Hampden Park Co-op	Rainfall Monitoring Location	R
Victoria Park	Rainfall Monitoring Location	R

1 WL- Water Level, Q – Flow Rate, WQ – Water Quality, GW – Groundwater, R – Rainfall

2. Procedures and Methodology

This section outlines the procedures and methods followed to perform monitoring and data analysis. For more detailed information related to the equipment use monitoring protocols followed for this monitoring program, see the 2024 Stormwater Monitoring Protocols document located in **Appendix F**.

2.1. Infiltration Rate

The infiltration rate was measured at applicable locations by collecting water level data on a continual basis. The data was analyzed to estimate the average infiltration rates observed during the monitoring period. The following provides a detailed description of this process. The water level data collected at those sites was reviewed to determine level fluctuation over the monitoring period and to compare against normal and high-water elevations.

2.1.1 Data Collection

Water levels were monitored using electronic level loggers. The loggers were configured at each site to log data at a minimum of one reading per hour for groundwater and once every 15 minutes for BMPs.

Enclosures for the infiltration gallery level loggers were installed at Beacon Bluff, St. Albans Street, and Hampden Park. These consisted of three-inch-diameter PVC pipes with four rows of half inch-diameter holes drilled along the pipe, achieving approximately twenty holes per foot. The enclosures were wrapped with a highly permeable geotextile fabric and secured with zip ties to protect the instrument from fine sediment accumulation. Enclosures were secured to the system floor and to the access riser wall (**Photo 2-1**). Groundwater and rain garden locations were monitored from permanent monitoring wells (**Photo 2-2**).

Photo 2-1:
Infiltration Gallery Level Monitoring Enclosure

Photo 2-2:
Beacon Bluff Rain Garden and In-Rock Wells

2.1.2 Data Analysis

The data collected at each site reflected hydrograph-type curves resulting from the rise and fall of water within the systems during and after significant rainfall events. The data was analyzed in Microsoft Excel to develop stage/infiltration rate relationships for each system. Since the infiltration rates increase exponentially at higher depths in the systems, this relationship was developed by calculating the infiltration rate at each half foot height increment. These calculations also accounted for the volume of runoff entering the system while drawdown was occurring. Infiltration of water in the horizontal direction through the vertical surfaces of the trenches was not included in this analysis, as the policies of the watershed districts only recognize infiltration through the bottom horizontal surface. The infiltration rates calculated at each increment were averaged and plotted on a graph.

The following equation was used to perform these calculations at each half foot increment:

$$\boldsymbol{Infiltration\ Rate}\left(\frac{\boldsymbol{in}}{\boldsymbol{hr}}\right) = \frac{\mathbf{0.5}\ \boldsymbol{ft} + \frac{\mathbf{V_{in}}}{\mathbf{WHSA}}}{\boldsymbol{\Delta t}}$$

where:

V_{in} = Inflow Volume (cu-ft)
WHSA = Wetted Horizontal Surface Area (sq-ft)
Δt = Time it takes for water level to drop by 0.5 ft

Monitored Infiltration rates were evaluated against design infiltration rates and infiltration rates observed during pre-construction field testing.

2.2. Flow & Volume Reduction

Stormwater runoff volume was measured at Beacon Bluff, Victoria Street, St. Albans Street, Hampden Park, Allianz Field, and West Shepard Pond using continuous flow monitoring equipment. At BMP Sites, the data was utilized to determine the total volume of water draining to and captured by each system. Collected data was analyzed using Flowlink software and Microsoft Excel to quantify the volumes measured during each discrete rainfall event recorded during the monitoring periods. The following section provides brief descriptions of the methods and procedures used to quantify flow at each system.

2.2.1 Data Collection

Teledyne ISCO 2150 area velocity flow modules and sensors were used to monitor runoff volumes. These devices measure water level and flow velocity. Combining this information with a known conduit shape, the flow rate, and flow volume through the conduit were calculated. Each of the monitored systems received stormwater runoff from a diversion structure located along the storm sewer system. The 2150 flow sensors were positioned at the upstream and downstream pipes in these structures to measure the total volume draining to each BMP and the total volume that bypassed each BMP. **Photos 2-3** and **2-4** show the flow meters installation in West Shepard Pond and Victoria Street, respectively.

The flow modules were configured at each site to log data at one-minute intervals once the water level in the upstream pipe was greater than one-inch above the pipe invert to increase the resolution of the flow data.

Photo 2-3: Flow Monitoring Module Install Process

Photo 2-4: Flow Monitoring Equipment Install

2.2.2 Data Analysis

Flow data was regularly imported into Flowlink 5.1 for storage and analysis. Data was analyzed and validated using built-in velocity error checking parameters. The flow level and velocity data were converted to total flow volumes and exported to a Microsoft Excel spreadsheet for further analysis. Each rainfall event and associated inflow and outflow volumes were tabulated.

For the Beacon Bluff, Saint Albans Street, and Hampden Park BMPs, runoff volume was estimated for un-monitored system inlets by taking monitored flow data and multiplying by the ratio of the respective drainage areas.

2.3. Water Quality

Water quality was monitored at the Beacon Bluff BMP, Victoria Street BMP, West Shepard, Hampden Park, Allianz Field, and St. Albans Street. The following section provides a summary of the methods and procedures used to collect and test water quality samples and analyze the data.

2.3.1 Data Collection

Photo 2-5:
Job Box Housing ISCO 6712 Sampler

Photo 2-6:
ISCO Bottle Configuration

ISCO 6712 automatic samplers were installed at all water quality locations. (**Photos 2-5** and **2-6**).

The automatic samplers were configured to collect 250 mL samples at constant volume intervals. The flow pacing intervals were initially estimated for each site to provide a minimum of six samples during a quarter-inch storm, but less than 120 samples for the three-inch storm. Flow pacing was refined during the monitoring period to achieve this objective.

Samples from sufficiently sized rainfall events were submitted to the Metropolitan Council Environmental Services (MCES) Laboratory for analysis. The samples were composed using a batch mixing technique to create one sample for the event. All water quality monitoring site composite samples were analyzed for the parameters listed in **Table 2-1** as volumes allowed, in accordance with the City's NPDES Permit. Grab samples were also collected during select storm events and analyzed for *E. Coli* and grease. The most probable number (MPN) procedure was used to determine the concentration of *E. Coli* in the stormwater runoff.

Table 2-1: Water Quality Parameters

Monitoring Parameters			
Parameters	**Method**	**Sample Type**	**Frequency**
Oil and Grease	SM 5210B	Grab	Quarterly
Chloride, Total	SM4500	Composite	10/year
Copper, Total (as Cu)	EPA 200.7	Composite	10/year
E. coli	MPN	Grab	Quarterly
Flow	NA	Measurement	NA
Hardness, Carbonate (as CaCo3)	SM 2340B	Composite	10/year
Lead, Total (as Pb)	EPA 200.7	Composite	10/year
Nitrite Plus Nitrate, Total (as N)	SM4500/NO3F	Composite	10/year
Nitrogen, Ammonia, Un-ionized (as N)	EPA 350.1	Composite	10/year
Nitrogen, Kjeldahl, Total	EPA 351.2	Composite	10/year
pH	EPA 9045D	Grab	Quarterly
Phosphate, total Dissolved or Ortho	EPA 365.1	Composite	10/year
Phosphorus, Total as P	EPA 365.1	Composite	10/year
Precipitation	NA	Measurement	1 x Day
Solids, Total Dissolved (TDS)	SM2540 C-97	Composite	10/year
Solids, Total Suspended (TSS)	ASTM D3977-97	Composite	10/year
Chemical Oxygen Demand (COD)	EPA 9056A	Composite	10/year
Organic Dissolved Carbon	EPA 9060A	Composite	10/year
Volatile Suspended Solids (VSS)	EPA 160.4	Composite	10/year
Zinc, Total (as Zn)	EPA 200.7	Composite	10/year

2.3.2 Data Analysis

The event means concentrations (EMCs) derived from sampling events were multiplied by the corresponding volume measurements taken at each site for every rainfall event sampled. For storm events with no sampling data, a flow weighted EMC concentration from that site's entire monitoring period was used. This information was tabulated and summed to determine the total amount of pollutants generated in the contributing drainage areas and the number of pollutants captured by the BMP, at applicable sites.

2.4. Maintenance Inspections

BMP inspections were conducted at Beacon Bluff, St. Albans Street, Hampden Park, and Victoria Street sites periodically during the monitoring period. Pre-treatment structures were inspected for accumulated sediment depth and floatable debris. Underground chambers were inspected from the level monitoring location for accumulation of sediment, debris, and standing water. Inspection photos are included in the photo log (**Appendix E**).

2.5. Pervious Surface Infiltration Rate

The infiltration rate of the permeable surfaces was measured at Jackson Street pervious pavement sites following the protocols outlined in ASTM method C1701 (**Appendix G**). The following section provides a summary of those methods.

2.5.1 Data Collection

Infiltration tests were conducted according to the modified ASTM C1701 methods for measuring infiltration rates (**Photo 2-7**). Eighteen locations at Jackson Street were evaluated to develop an average infiltration rate measurement for each site. Tests were taken at locations that remained consistent year to year and included a combination of high and low traffic areas. At each test location, a pre-wet test was conducted, followed by two infiltration tests. The two infiltration tests were averaged to generate the infiltration rate for each location. If after 15 minutes of monitoring during a pre-wet test no infiltration was observed, the test was concluded, and no subsequent tests were completed.

Photo 2-7: Permeable Pavement Infiltration Test

3. Precipitation Summary

As part of the City's stormwater monitoring program, seasonal precipitation monitoring is conducted at the following locations: Capital Region Watershed District, Trout Brook Nature Sanctuary, Hampden Park Co-op and Victoria Park (**Figure 1-1**). The precipitation data collected at these locations provides localized rainfall totals which are utilized for calculating rainfall intensity and runoff yield at monitored BMP sites. Each station is equipped with an automated tipping bucket that records continuously throughout the season.

Precipitation data collected by MCES, Minnesota Climatology Working Group (MCWG), and the National Weather Service (NWS) is used to supplement the City's data as needed. This includes any data gaps in seasonally monitored stations as well as parameters, such as snowfall and snowpack depth, which exceed the limitations of the City's monitoring equipment. These stations also provide a longer period of record which is valuable for analyzing rainfall trends.

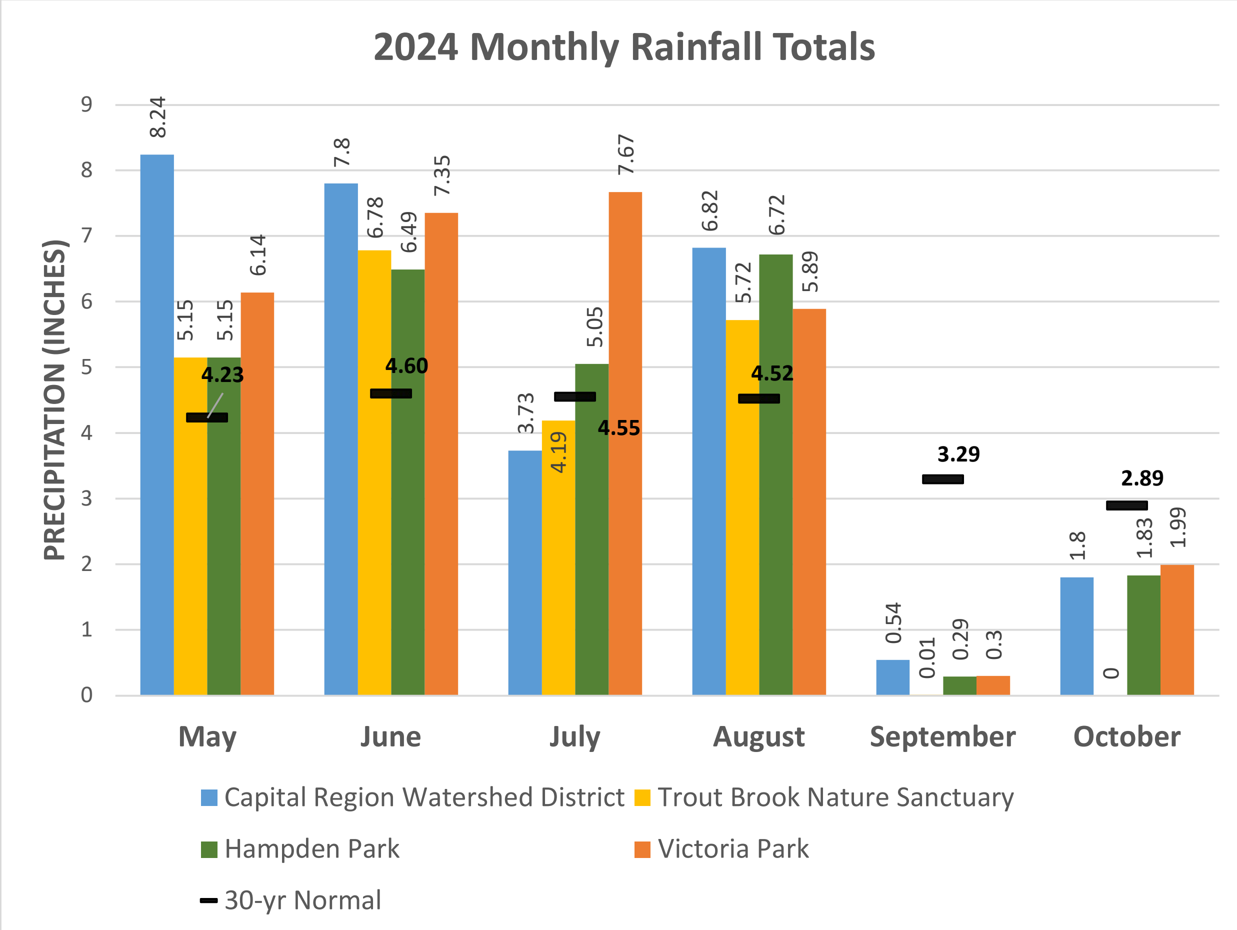
Table 3-1 and **Chart 3-1** show 2024 monthly precipitation totals for seasonally monitored sites compared to the 30-year normal. The 30-year normal reflect data collected from 1991-2020 by the U of MN St. Paul station.

May through October rainfall ranged from 21.85 inches at the Trout Brook Nature Sanctuary to 28.93 inches at Capital Region Watershed District. The City-wide seasonal total average was 26.41 inches which is 2.33 inches more than the 30-year normal. The greatest variability between stations was observed during the month of July with 3.94 inches more rainfall recorded at Victoria Park than at Capital Region Watershed District. The month of September saw the greatest departure from the 30-year normal (-3.01 inches).

Table 3-1: 2024 Seasonal Precipitation Summary

Month	Capital Region Watershed District	Trout Brook Nature Sanctuary	Hampden Park Co-op	Victoria Park	City-Wide Average	30-yr Normal	Departure from 30-yr Normal
May	8.24	5.15	5.15	6.14	6.17	4.23	+1.94
June	7.8	6.78	6.49	7.35	7.11	4.60	+2.51
July	3.73	4.19	5.05	7.67	5.16	4.55	+0.61
August	6.82	5.72	6.72	5.89	6.29	4.52	+1.77
September	0.54	0.01	0.29	0.3	0.29	3.29	-3.01
October	1.8	0	1.83	1.99	1.41	2.89	-1.49
Seasonal Total	**28.93**	**21.85**	**25.53**	**29.34**	**26.41**	**24.08**	**+2.333**

Chart 3-1



Major rainfall events from 2024 are provided in **Table 3-2** below:

Table 3-2: 2024 Significant Rainfall Events

Date	Duration (hr)	Rainfall Total (in)[1]	Intensity (in/hr)	Event Category (precipitation frequency estimate)
5/21/24	7.40	1.83	0.25	1-year
7/31/24-8/1/24	12.82	1.27	0.10	1-year
8/5/24	5.53	1.15	0.21	1-year
8/29/24	2.77	0.60	0.22	1-year

1 - Rainfall event totals may not reflect total daily rainfall.

Table 3-3 below provides an eight-year monthly precipitation summary as recorded at the University of Minnesota Saint Paul Campus. In 2024 the annual precipitation exceeded the 30-year normal. Total precipitation in 2024 was 37.95 inches, 2.33 inches above normal. June had the greatest amount of precipitation at 7.99 inches, which was above the 30-year normal by 3.39 inches. September varied the greatest and had 0.66 inches of precipitation which was 2.63 inches below the 30-year normal.

Table 3-3: 5-year Precipitation Summary (UMN – Saint Paul Campus)

Month	2016	2017	2018	2019	2020	2021	2022	2023	2024	30-yr Normal
January	0.28	0.93	1.07	0.36	0.81	0.62	0.54	1.78	0.10	0.68
February	0.79	0.70	1.24	2.31	0.53	0.41	0.48	2.19	0.65	0.75
March	2.15	0.58	1.38	2.09	2.76	2.94	3.19	1.84	2.55	1.61
April	3.66	3.68	2.37	3.37	1.67	2.46	3.57	3.84	3.85	3.02
May	2.05	6.54	3.52	6.44	4.43	3.36	4.89	1.50	5.54	4.23
June	3.65	3.16	4.64	2.85	4.15	1.57	0.80	2.02	7.99	4.60
July	5.97	2.45	4.07	4.75	2.20	1.57	1.37	3.90	4.81	4.55
August	9.90	8.89	2.91	6.88	3.70	6.56	4.58	5.72	7.06	4.52
September	5.19	1.25	7.19	4.88	1.05	1.82	0.29	5.66	0.66	3.29
October	3.32	4.84	3.4	4.93	2.25	2.29	0.24	3.96	1.20	2.89
November	2.70	0.42	1.41	1.67	1.37	0.97	2.04	0.09	2.32	1.53
December	2.01	0.62	1.32	2.42	0.88	1.94	1.80	2.40	1.22	1.06
Total	**41.67**	**34.06**	**34.52**	**42.95**	**25.80**	**26.51**	**23.79**	**34.90**	**37.95**	**32.73**
Departure from 30-yr Normal	**+8.94**	**+1.33**	**+1.79**	**+10.22**	**-6.93**	**-6.22**	**-8.94**	**+2.17**	**-5.22**	**N/A**

4. Beacon Bluff

This system, shown in **Figure 4-1**, is owned and operated by the City. The Saint Paul Port Authority contributed financially to the project and oversaw its construction. Volume reduction credits were split between the City and the Saint Paul Port Authority based on the respective financial contributions. Performance monitoring of the system has been conducted since 2012 and rainfall monitoring for the site is conducted at Wilder Recreation Center, located 0.4 miles to the west. The BMP system details are provided in **Table 4-1**.

The system is comprised of three connected stormwater treatment structures, which include a stormwater pond west of the Duchess Street cul-de-sac (west pond), an infiltration basin east of the cul-de-sac (rain garden) (**Photo 4-1**), and an underground infiltration chamber (**Photo 4-2**) constructed directly beneath the rain garden. The underground chamber consists of three parallel, 215-foot-long, ten-foot-diameter perforated metal pipes for infiltration.

The Beacon Bluff system has a total drainage area of 143.6 acres, which consists of three sub watersheds. Stormwater from a 136.8-acre drainage area is routed to a diversion structure in the storm sewer along Duchess Street (MH7). The diverted stormwater passes through a manhole equipped with a SAFL Baffle pre-treatment system for particle settling and then discharges to the rain garden. Two inlets on the eastern side of the rain garden discharge stormwater from a 4.7-acre drainage area immediately surrounding the BMP. Stormwater from a 2.1-acre drainage area discharges to the west pond, which outlets directly to the underground chamber.

Overflow grates within the rain garden allow stormwater to spill from the rain garden, directly into the underground chamber. When the underground chamber reaches capacity, stormwater discharges from the underground system, through an outlet control structure, back to the main storm sewer line.

Table 4-1: Beacon Bluff BMP Details

Total Drainage Area to BMP	143.6 acres
Sub-watershed to Diversion Structure (discharge to rain garden)	*136.8 acres*
Sub-watershed to Eastern Inlet Pipes (discharge to rain garden)	*4.7 acres*
Sub-watershed to West Pond (discharge from west pond to underground chamber)	*2.1 acres*
Year Constructed	2011
Total Construction Cost	$980,000
Storage Volume	159,350 cu-ft
Volume Reduction Credit Received by the City of Saint Paul	116,435 cu-ft
Volume Reduction Credit Received by Saint Paul Port Authority	42,925 cu-ft

Photo 4-1: Underground Infiltration Chamber (Facing West)

Photo 4-2: Rain Garden Located above Infiltration Chambers (Facing East)

4.1. Water Level and Infiltration Rate Monitoring

Water level was monitored by a logger placed directly in the BMP Pipe. The water level in the rain garden was not measured in 2024 due to piezometer damage following a dredge in the Spring of 2019. An additional logger was installed within the outlet control structure of the system to confirm when flow was being conveyed back to the storm sewer from the underground chamber. Groundwater elevation was also measured in two locations at the site. Water level elevations within the system and groundwater, and daily rainfall totals are presented on **Chart A.1** and **A.2** of **Appendix A**.

Photo 4-3: Water being conveyed back to the storm sewer from the underground chamber in the outlet control structure.

Overflow in the outlet control structure to the storm sewer, (**Photo 4-3**), occurred during eight treatment events. The 2024 underground chamber infiltration rate and infiltration rate trends are provided on **Charts A.3** and **A.4** of **Appendix A**, respectively. The 2024 average infiltration rate for the BMP Pipe was 0.06 inches per hour (in/hr). This is a decrease from the rates observed in 2023 (0.11 in/hr) and equal to the rates from 2022 (0.06 in/hr) (**Table 4-2**). Sediment accumulation has been observed ranging from 0.7 ft, across the basin. The 141.5-acre drainage area discharging directly to the pond conveys a significant amount of sediment and debris, which has accumulated primarily around the diversion inlet pipe. Dredge maintenance was completed on the rain garden over the Spring of 2019.

Table 4-2: Beacon Bluff Infiltration Rates

Location	Average Infiltration Rate (in/hr)												
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Beacon Bluff Rain Garden (IR-31)	2.9	0.85	0.70	0.29	0.43	0.50	0.40	NA	NA	NA	NA	NA	NA
Beacon Bluff Underground System (IR-32)	2.55	0.57	0.64	0.30	0.15	0.11	0.12	0.12	0.12	0.09	0.06	0.11	0.06

The water level in the underground system ranged from 6.7 ft to 18.3 ft deep. Depths greater than 10 feet indicate the water is rising into the substrate above the 10-ft diameter corrugated metal infiltration pipes. The data indicates that the system did not drain to empty during the 2024 monitoring period, including over the winter months. The underground system discharged back to the storm sewer (system outflow) during 4 storm events in 2024. Discharge events occurred in 2015 (five), 2016 (nine), 2017 (10) 2018 (14), 2019 (15), 2020 (seven), 2021 (nine), 2022 (six), 2023 (eight). Groundwater elevations at the site were a minimum of 11 ft below the bottom of the underground chamber, which suggests that groundwater mounding is not the cause of standing water in the system.

The 2024 underground chamber infiltration rate trends are provided on **Chart A.4** of **Appendix A**. From 2012 to 2024, the infiltration rate has decreased from 2.55 in/hr to 0.06 in/hr, with the largest decline following the first year of monitoring in 2012. As mentioned above, standing water in the underground system has resulted in a decrease in infiltration rates.

4.2. Volume Reduction Monitoring

Stormwater flowing into the BMP was measured in the Duchess Street diversion structure and at the outlet of the west pond, which discharges directly to the underground chamber. Volume that bypassed the system was measured with a flow meter downstream of the Duchess Street diversion structure. Inflow volume from the inlets discharging into the eastern side of the rain garden was modeled using the Duchess upstream flow data and the ratio of drainage areas. Level logger data from within outlet control structure was used to identify when the underground system was at capacity, and to estimate the volume conveyed back to the storm sewer system from the BMP. Flow rates and daily rainfall are depicted on **Chart B.1** of **Appendix B**. An event-based volume reduction summary is provided with the pollutant loading data in **Table C.2** of **Appendix C**. A summary of the 2024 Beacon Bluff Volume Reduction is included in **Table 4-3** below.

In 2024, total runoff to the Beacon Bluff system was 1,234,151 cubic feet (cu-ft). Of that volume, 846,497 cu-ft was captured by the system, resulting in a 69% volume reduction. The total flow conveyed back to the storm sewer via the rain garden's outlet control structure was 322,562 cu-ft. For the 136.8-acre drainage area to the diversion structure, the total water yield was 9,022 cu-ft/acre which is equivalent to 2.49 inches of runoff because of 21.91 inches of rain (11%). The greatest volume captured by the BMP was 75,035 cu-ft on October 31, 2024. This volume represents 47% of the total storage capacity of the system.

Table 4-3: Beacon Bluff Volume Reduction

Monitoring Period	5/16/24 – 11/1/24		
Total Rainfall		21.91	in.
Diversion Structure Water Balance			
Runoff Volume:		1,170,360	cu-ft
Runoff Yield:		2.36	in/acre
Bypassed Volume:		65,092	cu-ft
Volume Diverted into BMP:		1,105,269	cu-ft
Beacon Bluff Rain Garden and Infiltration Gallery Inputs			
Inflow Volume from Diversion Structure:	SubWSHD A	1,105,269	cu-ft
Inflow Volume from West Pond:	SubWSHD B	7,886	cu-ft
Inflow Volume from Eastern Inlets:	SubWSHD C	55,904	cu-ft
System Discharge (conveyed back to storm sewer from OCS):		32,562	cu-ft
Beacon Bluff System Performance			
Total Runoff Volume:		1,234,151	cu-ft
Total Runoff Volume Captured:		846,497	cu-ft
Percent of Total Runoff Volume Captured:		69	%
Maximum Percentage of Storage: Volume Utilized [1]		47	%

[1] This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume. The system exceeded 100% capacity on several occasions, but only a portion of the total capacity was available for infiltration due to standing water in the BMP.

4.3. Pollutant Removal Monitoring

A water quality sampler was placed in the Duchess Street diversion structure to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC during each event for each parameter analyzed. Grab samples were collected in the diversions structure near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.1** and **C.2** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 4-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period, 4,924 pounds of TSS and 55.13 pounds of TP were captured by the system. Over the past 10 years of monitoring, 118,443 pounds of TSS and 545 pounds of TP have been captured at the Beacon Bluff Site.

Table 4-4: Beacon Bluff Load/Capture Summary

Monitoring Period		5/16/24 – 11/1/24		
Total Rain		21.91		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	89.9	6,925	4,924	71.1
Volatile Suspended Solids	108.4	8,351	5,729	68.6
Total Dissolved Solids	56.3	4340	3,012	69.4
Total Phosphorus	0.72	55.13	37.82	68.6
Orthophosphate	0.140	10,771	7,346	68.2
Chloride	5.1	404	278.0	68.8
Total Kjeldahl Nitrogen	4.37	337	231.0	68.6
Nitrate + Nitrite as N	0.467	14.0	10.9	77.6

4.4. Maintenance Inspection

Visual inspections of the pretreatment structure, rain garden, and underground system were completed during site visits to determine performance and maintenance needs. As shown in **Table 4-5**, sediment depths in the pretreatment device were approximately 0.4 ft to 2.2 ft throughout the 2024 season. Floatable and trash were observed in the pretreatment structure during all visits and within the rain garden.

Standing water was observed in the underground system on all visits, as discussed in **Section 4.1**. The last chamber inspection was completed in November 2014 when the system was mostly empty. At that time, roughly 0.25 ft of sediment was observed along the bottom within the grooves of the corrugated pipe. See **Appendix E** for photos of the BMP inspections.

Table 4-5: Beacon Bluff Maintenance Inspections

Date	Sediment Depth in Pre-treatment (ft)	Sediment Depth in Infiltration Gallery (ft)[1]	Standing Water in Infiltration Gallery?	Observations
5/24/24	1.0	NM	Yes	Heavy sedimentation
6/14/24	1.6	NM	Yes	Heavy vegetation in rain garden
7/10/24	1.9	NM	Yes	SAFL bent
8/16/24	2.1	NM	Yes	Trash
Pretreatment Chamber cleaned on 10/3/2024				
10/14/24	0.1	NM	Yes	Trash
12/6/24	0.9	NM	Yes	Trash

[1] Not Measured – Sediment levels could not be evaluated in the infiltration galley due to the depth of standing water and the total depth of the system.

5. St. Albans Street

This system, shown in **Figure 5-1**, was constructed in 2010 to provide volume reduction along the Central Corridor light rail transit way. Volume and flow have been monitored at the site since 2012, with water quality monitored from 2014 through 2023.

A manhole structure positioned along the main storm sewer under Aurora Avenue diverts stormwater into the underground infiltration system (**Photo 5-1**) via a 30-inch elliptical pipe. The system is also connected to the University Avenue storm sewer system. Any runoff that does not get treated by infiltration trenches and tree planters along University Avenue is directed to this system (**Photo 5-1**). When the system reaches its storage capacity, water flows west through the existing storm sewer system. The system includes a pretreatment structure comprised of a grit chamber and baffled weir to provide settling for sediment and skimming. Rainfall monitoring for the site is conducted on the roof of Fire Station 18, located across the street from the BMP. The BMP system details are provided in **Table 5-1**.

Table 5-1: St. Albans Street BMP Details

Total Drainage Area to BMP	25.2 acres
Year Constructed	2010
Total Construction Cost	$381,903
Storage Volume	31,189 cu-ft
Volume Reduction Credit Received by the City of Saint Paul	31,189 cu-ft

Photo 5-1: St. Albans 48” Perforated HDPE Installation

5.1. Water Level and Infiltration Rate Monitoring

BMP water level was monitored in the access manhole at the northwest corner of the system. The 2024 water elevations and daily rainfall are provided on **Chart A.5** of **Appendix A**. Water level monitoring indicated that the infiltration gallery reached 100% capacity four times in 2024. The infiltration gallery drew down to empty in less than a 24-hour period after the conclusion of each rain event.

Infiltration rates are presented in **Chart A.6** of **Appendix A**. In 2024, the average infiltration rate of the BMP pipe was 10.0 in/hr (**Table 5-2**), which is below the design infiltration rate of 26.0 in/hr. Infiltration rate trends for the St. Albans Street BMP pipe are depicted on **Chart A.7**.

Table 5-2: St. Albans Infiltration Rate

Location	Average Infiltration Rate (in/hr)												
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
St. Albans Street BMP Pipe	38.3	35.7	64.8	55.3	36.2	20.6	21.2	11.0	9.9	11.8	14.0	11.7	10.0

5.2. Volume Reduction Monitoring

Two flow meters were installed in the storm sewer diversion manhole located in the intersection of St. Albans Street and Aurora Avenue. One meter was installed in the elliptical pipe to capture flows into the system from the south, and the other was installed in the downstream pipe to measure flows bypassing the system to the west. The difference in volume recorded by the two meters is assumed to be diverted into, and infiltrated by, the BMP. Flow entering the system from the 30-inch pipe at the corner of St. Albans Street and University Avenue was modeled using previous years. Flow rates and daily rainfall are depicted on **Chart B.2** of **Appendix B**.

In 2024, total runoff for the St. Albans Street system was 493,103 cu-ft. Of that volume, 435,935 cu-ft was captured and infiltrated by the system, resulting in a volume reduction of 93.8% (**Table 5-3**). 16 storm events caused water to bypass the BMP system, and only 4 of those bypass events were above 500 cf of water. The total water yield for the 25.2-acre drainage area is 19,568 cu-ft/acre which is equivalent to 5.4 inches of runoff resulting from 23.83 inches of rain (21%). The greatest volume infiltrated by the BMP was 45,980 cu-ft because of a 1.83-inch rain event, which represents 147% of the total storage capacity of the system. Storm-specific rainfall and volume reduction data is provided on **Chart C.4** of **Appendix C**.

Table 5-3: St. Albans Street Volume Reduction

Monitoring Period	5/15/24 – 11/13/24	
Total Rainfall	23.83	in
System Water Balance		
Aurora Runoff Volume:	278,175	cu-ft
Aurora Bypassed Volume:	28,584	cu-ft
St. Albans and University Volume	186,344	cu-ft
St. Albans System Performance		
Total Runoff Volume	493,103	cu-ft
Runoff Yield	5.4	in/acre
Total Runoff Volume Captured	435,935	cu-ft
Percent of Runoff Volume Captured:	93.8	%
Maximum Volume Discharge to BMP	45,980	cu-ft
Maximum Percentage of Storage Volume Utilized[1]	147	%

[1] This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume.

5.3. Pollutant Removal Monitoring

A water quality sampler was placed in the diversion structure at the intersection of St. Albans and Aurora Ave. to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC during each event for each parameter analyzed. Grab samples were collected in the diversions structure near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.3** and **C.4** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 5-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period, 3,142 pounds of TSS and 9.69 pounds of TP were captured by the system.

Table 5-4: St. Albans Load/Capture Summary

Monitoring Period		5/15/24 – 11/13/24		
Total Rain		23.83		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	122.9	3,412	3078	90.2
Volatile Suspended Solids	43.7	1,222	1110	90.8
Total Dissolved Solids	44.0	1,270	1191	93.8
Total Phosphorus	0.34	9.69	9.03	93.2
Ortho-phosphate	0.072	2.078	1.95	94
Chloride	15.5	432.5	391	90.5
Total Kjeldahl Nitrogen	1.83	52.4	49	93
Nitrate + Nitrite as N	0.61	16.6	15	88.4

5.4. Maintenance Inspection

The pretreatment device and the underground infiltration system were inspected during site visits to evaluate maintenance needs of the BMP. As shown in **Table 5-5**, minimal sediment was observed in both the pretreatment device and the infiltration gallery. Garbage was observed in the pretreatment and infiltration gallery. Water level monitoring in the infiltration gallery confirms that the system is regularly drawn down to empty, which is consistent with no standing water observed during most BMP inspection visits. See **Appendix E** for the **Photolog**.

Table 5-5: St. Albans Maintenance Inspections

Date	Sediment Depth in Pre-treatment (ft)	Sediment Depth in Infiltration Gallery (ft)	Standing Water in Infiltration Gallery?	Observations
5/31/24	0.1	0.1	No	Less trash than previous spring
6/14/24	0.1	0.1	No	Trash
7/3/24	0.1	0.1	No	Trash
8/7/24	0.2	0.1	No	Trash
System cleaned on 8/20/2024				
10/14/24	0.1	0.1	No	Trash
12/6/24	0.1	0.1	No	Good structural condition

6. Hampden Park

The Hampden Park infiltration gallery, shown in **Figure 6-1,** was constructed in 2014. The system consists of eight parallel perforated pipes that are 5 ft in diameter, and range in length from 40 to 100 ft. Runoff is routed to the system via a 24-inch RCP from the storm sewer line near Hampden and Raymond Avenues. Prior to entering the infiltration gallery, stormwater passes through a Vortechs pre-treatment chamber for particle settling. The infiltration gallery receives flow from a second inlet location along Hampden Avenue, farther to the north. When the system reaches full capacity, stormwater is routed back to the storm sewer via a 24-inch pipe from the southeast side of the system. Rainfall monitoring is conducted on top of the Hampden Park Co-Op across the street from the park. Monitoring has been conducted at the site since 2014. The BMP system details are provided in **Table 6-1** below.

Photo 6-1: Hampden Park BMP Construction

Table 6-1 Hampden Park BMP Details

Total Drainage Area to BMP	7.8 acres
Year Constructed	2014
Total Construction Cost	$687,132
Total Storage Volume	31,808 cu-ft
Volume Reduction Credit Received by the City of Saint Paul – Public Works	24,908 cu-ft
Volume Reduction Credit Received by the City of Saint Paul – Parks and Recreation	6,900 cu-ft

6.1. Water Level and Infiltration Rate Monitoring

Water levels were monitored within the underground infiltration system and groundwater (P2), using electronic water level loggers. Water levels and daily rainfall for 2024 are provided on **Chart A.8** and **A.9** of **Appendix A**. Water levels within the BMP, ranged from 0 to 2.1 ft. The BMP water level must exceed 6.5 ft for the system to reach capacity and for water to be conveyed back to the sewer system. Based on the 2024 level data, no flow discharged back to the sewer system. In 2024, infiltration rates decreased since 2023.

The 2024 infiltration rates are presented on **Chart A.10** of **Appendix A** and are adjusted for incremental volume flow. The adjusted average infiltration rate for the BMP was 9.99 in/hr, which is above the design infiltration rate of 1.8 in/hr. Infiltration rates at the base of site during construction were calculated to be, on average, 60 in/hr using a Double Ring Infiltrometer (DRI). Infiltration rate trends are depicted on **Chart A.11**. Water level data shows that all 2024 events were infiltrated within 8 hours of a treatment event.

Table 6-2: Hampden Park Infiltration Rate

Location	Average Infiltration Rate (in/hr)								
	2016	2017	2018	2019	2020	2021	2022	2023	2024
Hampden Park BMP	14.38	8.30	11.19	11.57	41.09	21.27	10.93	13.60	9.99

6.2. Volume Reduction Monitoring

One flow meter was installed within the 24-inch RCP diverting flow from the storm sewer to the BMP from the intersection of Hampden and Raymond Avenues. The metered drainage area consists of 6.7 acres of the total 7.8-acre drainage area to the BMP. The 2024 flow rates and daily rainfall are depicted in **Chart B.3** of **Appendix B**. No discharge was observed at the system outlet therefore that data is not plotted.

In 2024, the total monitored runoff was 119,046 cu-ft. Since the monitored level within the BMP did not reach the discharge outlet, 100% of the runoff was infiltrated by the system (**Table 6-3**). The total water yield for the 7.8-acre drainage area is 15,262 cu-ft/acre which is equivalent to 4.2 inches of runoff because of 9.66 inches of total rain (43%). The greatest volume received by the BMP was 21,967 cu-ft because of a 1.83-inch rain event on May 21st, 2024. This volume represents 69% of the total storage capacity of the system. Storm-specific rainfall and volume reduction data is provided on **Chart C.6** of **Appendix C**.

Table 6-3: Hampden Park Volume Reduction

Monitoring Period	5/15/24 – 9/21/24	
Total Rainfall	9.66	in
Hampden Park Water Balance		
Raymond/Hampden Runoff Volume[1]	119,046	cu-ft
System Bypass Volume	0	cu-ft
Hampden Park System Performance		
Total Runoff Volume	119,046	cu-ft
Runoff Yield	4.2	in/acre
Total Runoff Volume Captured	119,046	cu-ft
Percent of Runoff Volume Captured	100	%
Maximum Event Volume Captured by BMP	21,967	cu-ft
Maximum Percentage of Storage Volume Utilized[2]	69	%

[1] – The second system inlet along Hampden Avenue is not monitored, and the volume discharged to the system from that location is estimated based on monitored data at Hampden/Raymond and the ratio of the drainage areas.

[2] - This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume.

6.3. Pollutant Removal Monitoring

A water quality sampler was placed at the intersection of Hampden and Raymond Avenues to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC during each event for each parameter analyzed. Grab samples were collected in the 24 in RCP near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.5** and **C.6** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 6-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period, 997 pounds of TSS and 1.38 pounds of TP were captured by the system. The percentage captured for all parameters was 100% in 2024.

Table 6-4: Hampden Park/Capture Summary

Monitoring Period		5/15/24 – 9/21/24		
Total Rain (in)		9.66		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	134.1	997	997	100
Volatile Suspended Solids	31.8	236	236	100
Total Dissolved Solids	59.2	440	440	100
Total Phosphorus	0.2	1.38	1.38	100
Orthophosphate	0.027	0.20	0.20	100
Chloride	6.341	47.1	47.1	100
Total Kjeldahl Nitrogen	1.17	8.7	8.7	100
Nitrate + Nitrite as N	0.45	3.4	3.4	100

6.4. Maintenance Inspection

Sediment depths in the pretreatment structure and in the underground infiltration system were measured during site visits to determine performance and maintenance needs. As shown in **Table 6-5**, minimal sediment was observed in both the pretreatment device and infiltration gallery after maintenance was completed on July 18, 2024.

Table 6-5: Hampden Park BMP Maintenance Inspection

Date	**Sediment Depth in Pre-treatment (ft)**	**Sediment Depth in Infiltration Gallery (ft)**	**Standing water in Infiltration Gallery?**	**Observations**
5/31/24	0.3	0.5	No	A few spots in pre-treatment chamber as deep as 2’
6/16/24	0.3	0.5	No	Mat of vegetation on surface of water in pretreatment chamber
7/3/24	0.4	0.5	No	Trash and leaves in pretreatment chamber
Pretreatment chamber cleaned on 7/18/24				
8/21/24	0.2	0.5	No	No deep spots of sediment present in pretreatment chamber
10/15/24	0.2	0.5	No	Leaves
12/6/24	0.5	0.5	No	A few spots in pre-treatment chamber as deep as 2’

7. Victoria Street

Victoria Street monitoring site is located just East of Orchard Recreation Center and includes a permeable paver parking lane. The northern cap of the BMP was damaged and replaced in 2024. Stormwater runoff within the 19.1 acre sub watershed is diverted from the main storm sewer to the underground system. When the system has reached its storage capacity, runoff continues to flow downstream through the storm sewer. The system includes a pretreatment structure consisting of a grit chamber for sediment capture and a baffled weir for skimming. In addition, the runoff from Victoria Street flows to the permeable paver parking lane, passes through a layer of stone aggregate below the pavers and is collected by a drain tile pipe. The drain tile discharges the runoff into the underground infiltration system. Rainfall monitoring is conducted on top of Fire Station 18. The BMP system details are provided in **Table 7-1** below.

Table 7-1 Victoria Street BMP Details

Total Drainage Area to BMP	19.1 acres
Year Constructed	2010
Total Construction Cost	$174,000
Total Storage Volume	16,714 cu-ft
Volume Reduction Credit Received by the City of Saint Paul – Public Works	16,714 cu-ft

This system consists of one 384-foot-long, 60-inch-diameter perforated HDPE pipe located below a permeable paver parking lane. It was constructed to meet the volume reduction requirements for the Front/Victoria Residential Street Vitality Program (RSVP) project.

7.1. Water Level and Infiltration Rate Monitoring

In 2024, water levels were monitored continuously in the access manhole at the north end of the underground system along Victoria Street. Water levels were monitored within the underground infiltration using an electronic water level logger. Water levels and daily rainfall for 2024 are provided on **Chart A.12** of **Appendix A**. Water level within the BMP ranged from 0 to 7.3 ft. The BMP water level must exceed 5 ft for the system to reach capacity and for water to flow to the sewer system. Based on the 2024 level data, the system reached capacity four times.

The 2024 infiltration rates are presented in **Chart A.13** of **Appendix A** and are adjusted for incremental volume flow. The adjusted average infiltration rate for the BMP was 16.08 in/hr, which is greater than the design infiltration rate of 12.8 in/hr. Infiltration rates at the base of the system during construction were calculated to be, on average, 95.9 in/hr using a Double Ring Infiltrometer (DRI). Infiltration rate trends are depicted in **Chart A.14**. Water level data shows that all 2024 events were infiltrated within 4 hours of a treatment event.

Table 7-2: Victoria Street Infiltration Rate

Location	Average Infiltration Rate (in/hr)							
	2012	2013	2019	2020	2021	2022	2023	2024
Victoria Street BMP	46.56	48.04	21.08	48.80	25.52	45.07	42.34	16.08

7.2. Volume Reduction Monitoring

One flow meter was installed upstream of the system and one flow meter downstream of the diversion structure located near the intersection of Victoria Street and Orchard Avenue. The metered drainage area consists of 19.1 acres and drains to the BMP. The 2024 flow rates and daily rainfall are depicted in **Chart B.4** of **Appendix B**.

In 2024, the total runoff to the Victoria Street system was 490,587 cu-ft. The system captured 91.5% of that volume (**Table 7-3**). The total water yield for the 19.1-acre drainage area is 25,685 cu-ft/acre which is equivalent to 7.08 inches of runoff because of 24.19 inches of rain (29%). The greatest volume infiltrated by the BMP was 39,321 cu-ft from a 1.83-inch rain event on May 21, 2024. This volume represents 235% of the total storage capacity of the system. Storm-specific rainfall and volume reduction data is provided on **Chart C.8** of **Appendix C**.

Table 7-3: Victoria Street Volume Reduction

Monitoring Period	4/26/24 – 10/31/24	
Total Rainfall	24.19	in
Victoria Street Water Balance		
Runoff Volume	490,587	
System Bypass Volume	41,502	
Victoria Street System Performance		
Total Runoff Volume	490,587	cu-ft
Runoff Yield	7.08	in/acre
Total Runoff Volume Captured	449,109	cu-ft
Percent of Runoff Volume Captured	91.5	%
Maximum Event Volume Captured by BMP	39,321	cu-ft
Maximum Percentage of Storage Volume Utilized[1]	235	%

[1] This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume.

7.3. Pollutant Removal Monitoring

A water quality sampler was placed in the diversion structure to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC's for each event for each parameter analyzed. Grab samples were also collected in the diversion manhole near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.7** and **C.8** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 7-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to orthophosphate. During the monitoring period, 1,877 pounds of TSS and 10.13 pounds of TP were captured by the system. The percentage captured for all parameters was 91.5 in 2024.

Table 7-4: Victoria Street Load/Capture Summary

Monitoring Period		4/26/24 – 10/31/24		
Total Rainfall		24.19		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	77.6	2,062	1,887	91.5
Volatile Suspended Solids	27.8	738	675	91.5
Total Dissolved Solids	269.1	7,148	6,540	91.5
Total Phosphorus	0.42	11.07	10.13	91.5
Orthophosphate	0.10	2.66	2.43	91.5
Chloride	5.8	152.8	139.8	91.5
Total Kjeldahl Nitrogen	2.23	59.1	54.07	91.5
Nitrate + Nitrite as N	0.30	7.96	7.28	91.5

7.4. Maintenance Inspection

Sediment depths in the pretreatment structure and in the underground infiltration system were measured during site visits to determine performance and maintenance needs. As shown in **Table 7-5**, minimal sediment was observed in both the pretreatment device and infiltration gallery.

Table 7-5: Victoria Street BMP Maintenance Inspection

Date	Sediment Depth in Pre-treatment (ft)	Sediment Depth in Infiltration Gallery (ft)	Standing water in Infiltration Gallery?	Observations
6/14/24	0.9	0.1	Y	Trash in pretreatment
7/24/24	1.2	0.1	Y	Trash in pretreatment
System cleaned 8/20/24				
9/13/24	0.1	0.1	Y	Repairs to end cap has not hindered infiltration
10/16/24	0.2	0.1	Y	Leaves and grass
12/6/24	0.3	0.1	Y	Leaves and grass

8. West Shepard Pond

The Shepard Road Pond monitoring location is the median of Shepard Road, just under the Smith Avenue Bridge. Monitoring here provides water quality and quantity data of water flowing from the east and west along Shepard Road. Monitoring at this site was initiated in 2023.

Photo 8-1: West Shepard Pond

8.1. Volume Monitoring

A job box housing a flow meter was placed in the median of Shepard Road near the east bound lane. A flow sensor was placed in the southwest inlet and routed underground to the job box. The 2024 flow rates and daily rainfall are depicted in **Chart B.5** of **Appendix B**.

The downstream sensor was stolen by vandals during the 2024 monitoring period. As a result total pollutant loads have been calculated instead of the volume reductions calculated in 2023. The total volume flowing to the West Shepard Pond system was 355,095 cu-ft. A summary of the system can be found below (**Table 8-1.2**). The total water yield for the 8.70-acre drainage area is 40,816 cu-ft/acre. This is a water yield 11.2 inches. The greatest monitored event-based volume moving through the system was 26,337 cu-ft as a result of a 1.60-inch rain event on July 21, 2024.

Table 8-2: West Shepard Volume Summary

Monitoring Period	5/15/2024 – 11/10/2024	
Total Rainfall	28.32	in
West Shepard Pond Water Balance		
Runoff Volume	355,095	cu-ft
West Shepard Pond System Performance		
Total Runoff Volume	355,095	cu-ft
Runoff Yield	11.2	in/acre
Maximum Event Volume	26,337	cu-ft

8.2. Pollutant Monitoring

A water quality sampler was placed in the job box to collect samples during high flow/rain events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC's for each event for each parameter analyzed. Grab samples were also collected in the stream, near the automated sampler and tested for *E. Coli*. See **Charts C.9** and **C.10** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 8.1-3 below provides a load summary for flow weighted averages of pollutants entering the city defined in NPDES Permit issued to the City in addition to ortho-phosphate.

Table 8-3: West Shepard Pond Pollutant Load Summary

Monitoring Period		5/15/24 – 11/10/24
Total Rainfall		28.3
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**
Total Suspended Solids	24.8	549.5
Volatile Suspended Solids	8.6	190.6
Total Dissolved Solids	40.3	893.4
Total Phosphorus	0.10	2.19
Orthophosphate	0.014	0.312
Chloride	6.2	137.3
Total Kjeldahl Nitrogen	0.58	12.9
Nitrate + Nitrite as N	0.31	6.9

9. Allianz Field Soccer Stadium

The Allianz Field Soccer Stadium is a filtration chamber located on the north side of interstate 94, between Snelling Avenue and Pascal Street in the Midway neighborhood of Saint Paul, Minnesota. Allianz Field was designed with multiple "Shared Stacked Green Infrastructure" (SSGI) to collect, treat, and reuse stormwater from this area and protect the Mississippi River from storm water pollution. Beneath the Allianz Field parking lot lies four underground storage tanks, three tanks are dedicated to rate control and treatment and one dedicated to storm water reuse. The stormwater tank is a 90,000 cubic-foot Steel Reinforced Polyethylene (SRPE) pipe. The drainage area of this site is 11.18 acres and can be seen in **Figure 9-1**.

9.1. Water Level Monitoring

Water level loggers were placed in tank C, tank D, and the filter cartridge chamber. The logger in tank D did not register any water level increases through the monitoring season. This was either due to a logger malfunction or the placement of the logger in the tank. Water levels and rainfall in tank C and the filter cartridge chamber can be found **Appendix A**.

9.2. Volume and Pollutant Monitoring

A flow meter and water quality sampler were installed in the manhole and pipe entering tank C to monitor flow and water quality entering the thank. Another flow meter placed downstream of the filter cartridge chamber. The monitoring conditions were challenging, so not enough data was collected to determine pollutant reductions. With a full monitoring season, we expect to have better data collection in 2025. The 2024 flow rates can be found in **Appendix B** and collected water quality data can be found in **Appendix C**.

During the 2024 monitoring period, the total event volume moving through the system downstream of the filter chamber was 331,129 cu-ft (**Table 9-2**). The total water yield for the 19.1-acre drainage area is 18,894 cu-ft/acre. The greatest event-based volume moving through the system was 31,161 cu-ft as a result of a 2.16-inch rain event on August 5, 2024.

Table 9-2: Allianz Field Volume Summary

Monitoring Period	7/25/2024 - 11/20/2024	
Total Rainfall	10.26	
Allianz Field Water Balance		
Total Volume	331,129	cu-ft
Maximum Event Volume	31,161	cu-ft

10. River Level Monitoring

To determine elevations of the Mississippi River in relation to the United States Geological Survey (USGS) monitoring station at the Robert Street Bridge, a water level logger was installed within the Mississippi River located near an outfall at Kaposia Landing. A correlation between the two sites is difficult and seems to change based on the river height. The elevation at Kaposia Landing was 0.03 feet below the USGS monitoring station. Loggers at Lilydale and Kaposia were lost during a high-water event in June. A replacement logger was put in at Kaposia in September. During this lower water period, the Kaposia and the USGS station were almost identical and could show a very flat portion of the river between the two monitoring sites.

Table 10-1 depicts the difference between river monitoring locations as well as their approximate river mile location. **Chart 10-1** shows an estimation of river level based off the monitored water level measurements and compared to the continuous USGS monitoring station near Robert Street Bridge.

Table 10-1

	USGS	Kaposia Landing
Approximate River Mile	839.25	835.4
Mile Difference from USGS		Downstream 3.85 miles
Difference from USGS		-0.03 ft

Chart 10-1

11. Pervious Surface Infiltration Assessment

The City has been monitoring the performance of pervious pavement BMPs constructed in the City since 2012. Pervious pavement was constructed with substantial void space to allow for infiltration or filtration of stormwater through the pavement surface as a means of stormwater management. Pervious pavement BMPs monitored in the City include porous asphalt and permeable interlocking concrete pavers. The purpose of the infiltration testing is to monitor the change in site conditions and infiltration capability of the BMPs overtime. Pavement maintenance is also monitored to study the effect of routine and rehabilitative maintenance on these BMPs.

Infiltration testing was completed at the Jackson Street Pervious Bike Path BMP in October of 2024. The Infiltration testing methodologies are described in **Section 2.5.** A photolog of infiltration testing is provided in the **Appendix.**

11.1.Jackson Street

The Jackson Street BMP (**Photo 11-5** and **11-6**) is a designated bike path constructed of pervious asphalt. It is a section of the Capital City Bikeway (CCB), a system of off-street bicycle trails in downtown Saint Paul. The BMP is eight blocks long, stretching from Kellogg Street to 11th Street, and consists of 2,750 square yards of pervious asphalt. Stormwater runoff filters through the asphalt and underlying media and is then conveyed to the storm sewer system via drain tile.

Monitoring locations JS-1 through JS-11 were established in November 2016 upon completion of the four-block stretch from Kellogg Boulevard to 7th Place East. Monitoring locations JS-12 through JS-18 were established in November 2017 upon completion of the four-block stretch from 7th Place East to 11th street. The monitoring locations were carefully selected to evaluate sediment loading and asphalt compaction from varying levels of pedestrian and vehicular traffic. Each site was characterized into one of three groups, identified in **Table 11-2**, based on their location and surroundings. The site and infiltration test locations are depicted in **Figure 11-2**. Site photos are provided in **Appendix E**.

Table 11-2: Monitoring Site Traffic Characterization

Site Traffic Characterization
Low: No driving and minimal foot traffic area. Adjacent to planter or minimal impervious surface.
Medium: Pedestrian cross walks or adjacent to large areas of impervious surface.
High: Driveways for parking or businesses, heavy vehicular traffic.

Photo 11-5: Capital City Bikeway (CCB) – Jackson Street/Kellogg Avenue

Photo 11-6: Jackson Street Infiltration Test

Infiltration Test Results and Observations

The site was tested for infiltration in August 2023. The infiltration test results from the 18 locations are summarized in **Chart 11-1** and **Chart D.2** in **Appendix D**, which includes all infiltration test results completed to-date. **Table 11-3** is color coded to identify the site traffic characterizations described above. The infiltration tests results are also summarized in **Table 11-3**, which presents an average infiltration rate based on the monitoring location traffic characterization. The infiltration test locations are depicted in **Figure 11-2**.

Table 11-3: Jackson Street Infiltration Rate Summary (in/hr)

Location	Test Location Description	Nov 2016 Infiltr. Rate	Jun 2017 Infiltr. Rate	Nov 2017 Infiltr. Rate	Jul 2018 Infiltr. Rate	Oct 2018 Infiltr. Rate	Jul 2019 Infiltr. Rate	Oct 2019 Infiltr. Rate	Jul 2020 Infiltr. Rate	Nov 2020 Infiltr. Rate	Aug 2021 Infiltr. Rate	Nov 2021 Infiltr. Rate	Aug 2022 Infiltr. Rate	Aug 2023 Infiltr. Rate	Nov 2023 Infiltr. Rate	Oct 2024 Infiltr. Rate
JS-1	Northern half of Securian ramp entrance. Non-painted surface east of path center line.	572.6	9.3	3.9	0	0	0	0	0	0	0	0	0	0	0	0
JS-2	Midline of Securian ramp entrance. Non-painted surface east of path center line.	750.4	6.3	0	0	0	0	0	0	0	0	0	0	0	0	0
JS-3	Jackson Street pedestrian crosses south of 6th Street. Near midline of bike path.	1282.1	1069.0	793.8	642.2	247.1	67.1	30.4	7.0	0.0	0	0	0	0	0	0
JS-4	Midblock between 6th & 5th Street. North of skyway. Near midline of bike path.	2122.2	1520.1	1372.0	1026.7	733.7	1050.1	764.4	516.3	299.9	254.1	253.7	46.1	149.9	38.1	0
JS-5	345 parking ramp entrance. Non-painted surface just north of the midline of the entrance. Midline of bike path.	385.9	4.5	0	0	0	0	0	0	0	0	0	0	0	0	0
JS-6	345 parking ramp entrance. Green painted stripe farthest south. West side of bike path.	118.7	12.1	0	0	0	0	0	0	0	0	0	0	0	0	0
JS-7	Jackson Street pedestrian crosses north of 4th Street. Near midline of bike path.	533.7	353.9	181.7	73.7	29.4	0	0	0	0	0	0	0	0	0	0

JS-8	Midblock between 4th & Kellogg. Western edge of bike path (adjacent to concrete).	177.5	275.3	90.8	0	0	0	0	0	0	0	0	0	0	0	0
JS-9	Midblock between 4th & Kellogg. Eastern side of bike path.	277.9	56.1	2.4	0	0	0	0	0	0	0	0	0	0	0	0
JS-10	In line with the southern wall of the US Courthouse (facing Kellogg). Western edge of bike path adjacent to concrete.	557.9	125.5	2.1	0	0	0	0	0	0	0	0	0	0	0	0
Location	**Test Location Description**	**Nov 2016 Infiltr. Rate**	**Jun 2017 Infiltr. Rate**	**Nov 2017 Infiltr. Rate**	**Jul 2018 Infiltr. Rate**	**Oct 2018 Infiltr. Rate**	**Jul 2019 Infiltr. Rate**	**Oct 2019 Infiltr. Rate**	**Jul 2020 Infiltr. Rate**	**Nov 2020 Infiltr. Rate**	**Aug 2021 Infiltr. Rate**	**Nov 2021 Infiltr. Rate**	**Aug 2022 Infiltr. Rate**	**Aug 2023 Infiltr. Rate**	**Nov 2023 Infiltr. Rate**	**Oct 2024 Infiltr. Rate**
JS-11	In line with the southern wall of the US Courthouse (facing Kellogg). Eastern side of the bike path.	471.5	125.4	35.5	0	0	0	0	0	0	0	0	0	0	0	0
JS-12	N of Credit Union Driveway between 11th St. and 10th St Midline of bike path, next to a planter.	NE	NE	843.3	827.2	877.1	710.5	633.3	620.4	572.0	442.7	432.0	274.3	0	0	0
JS-13	In front of Child Care Center between 11th St. and 10th St. Western edge of bike path, next to a planter.	NE	NE	1246.7	1696.9	1179.2	889.5	809.6	608.6	839.8	537.8	753.0	69.8	0	13.0	38.5

JS-14	S of 10th St. Adjacent to planter (2nd weir). Between Western edge and bike path midline.	NE	NE	464.4	575.1	447.5	323.3	211.4	207.8	195.4	148.9	128.7	7.9	10.4	0	0
JS-15	Firestone driveway, N of 2nd stripe from the S.	NE	NE	100.0	0	0	0	0	0	0	0	0	0	0	0	0
JS-16	Pedestrian cross, SW intersection of Jackson and 9th.	NE	NE	1104.4	190.1	9.0	0	0	0	0	0	0	0	0	0	0
JS-17	Mid-block of 9th St. and 7th St. Adjacent to planter (southern-most tree). Just W of bike path midline.	NE	NE	1670.0	1605.0	1369.7	1329.5	1082.1	1343.2	640.1	1263.5	1194.5	1174.0	744.4	888.6	661.1
JS-18	Pedestrian cross, NW intersection of Jackson and 7th Pl. Adjacent to large concrete area.	NE	NE	665.4	589.6	521.5	215.7	327.7	160.4	115.5	33.0	0	0	0	0	0
Site Average:		659.1	323.4	476.5	401.5	300.8	254.8	214.4	192.4	147.9	148.9	153.4	87.3	50.3	52.2	38.9
Average of Sites JS-1 through JS-11 (established Nov 2016):				225.6	158.4	91.8	558.6	72.3	47.6	27.3	23.1	23.1	4.2	13.6	3.5	0.0
Average of Sites JS-12 through JS-18 (established Nov 2017):				870.6	783.4	629.1	693.7	437.7	420.1	337.5	346.6	358.3	218.0	107.8	128.8	99.9

NE – Not Established

Table 11-3: Jackson Street Infiltration Summary by Site Traffic Characterization

Site Traffic Characterization	Nov 2016	Jun 2017	Nov 2017	Jul 2018	Oct 2018	Jul 2019	Oct 2019	Jul 2020	Nov 2020	Aug 2021	Nov 2021	Aug 2022	Aug 2023	Nov 2023	Oct 2024
Low: No driving and minimal foot traffic area. Adjacent to planter or minimal impervious surface.	2122	1520	1119	1146	921	861	700	659	509	529	552	314	181	188	140
Medium: Pedestrian cross walks or adjacent to large areas of impervious surface.	550	334	360	187	101	35	45	21	14	4	0	0	0	0	0
High: Driveways for parking or businesses, heavy vehicular traffic.	457	8	21	0	0	0	0	0	0	0	0	0	0	0	0

A summary of the 2024 infiltration testing completed at the Jackson Street Pervious Pavement Site is provided below:

- The overall site infiltration rate was 38.9 inches per hour (in/hr) in October 2024
  - 16 of 18 locations showed no infiltration rate in 2024.
  - Of the remaining three locations where infiltration occurred, infiltrations rates ranged from 38.5 in/hr to 661.1 in/hr.
- Low traffic areas had an average infiltration rate of 140 in/hr in 2024.
- Medium traffic areas had an average infiltration rate of 0.0 in/hr in 2024.
  - Locations JS-7 through JS-11 are within the first constructed section of the pervious pavement near the Jackson Street and Kellogg Boulevard intersection. These locations have not shown any infiltration since October 2018.
- High traffic areas had an infiltration rate of 0.0 in/hr in 2024.
  - High traffic locations have not shown any infiltration since November 2017.

Photo 11-7: Test Locations JS-1 and JS-2 (high traffic)

12. City-wide Loading Assessment

12.1. 2024 Pollutant Loading Calculations

Monitoring major outfalls within the City of Saint Paul was completed by the Capitol Region Watershed District (CRWD) in 2024. Annual and seasonal pollutant loads were estimated for each subwatershed within the city for the loading parameters identified in the City's MS4 permit which include chloride (Cl), Total Kjeldahl Nitrogen (TKN), Total Phosphorus (TP), Nitrate Plus Nitrite (NO3 +NO2), Total Suspended Solids (TSS), and Volatile Suspended Solids (VSS). The subwatersheds within the City are included in **Table 12-1** below.

Monitoring data collected by CRWD from the following subwatersheds was utilized for this assessment: East Kittsondale, St. Anthony Park, and Trout Brook. Monitoring of each subwatershed was completed at or near the outfall. The stations were configured to collect continuous flow measurements, and water quality, in accordance with the City's MS4 Permit.

Table 12-1 Watershed Inventory

Watershed	Area [acre]	Runoff Coefficient [.]	Rainfall Station
Battle Creek	1106	0.54	Trout Brook
Beaver Lake	192	0.33	Trout Brook
Belt Line	3014	0.55	Trout Brook
Crosby	1679	0.45	Hampden Park Co-op
Davern	1302	0.55	Hampden Park Co-op
Downtown	550	0.75	CWRD Office
East Kittsondale	1872	0.62	CWRD Office
Fish Creek	46	0.52	Trout Brook
Goodrich/Western	424	0.63	CWRD Office
Griffith/Pt. Douglas	460	0.61	Trout Brook
Hidden Falls	313	0.55	Hampden Park Co-op
Highwood	1123	0.50	Trout Brook
Lake Como	1294	0.47	Hampden Park Co-op
Lake Phalen	1013	0.42	Trout Brook
Mississippi River Blvd.	2391	0.58	Hampden Park Co-op
MRWMO	135	0.70	Hampden Park Co-op
Phalen Creek	1405	0.62	Trout Brook
Pigs Eye	3001	0.40	Trout Brook
Riverview	1017	0.57	Trout Brook
St. Anthony Hill	2651	0.64	CWRD Office
St. Anthony Park	2481	0.68	Hampden Park Co-op
Trout Brook	3963	0.62	Trout Brook
Urban	327	0.57	Trout Brook
West Kittsondale	1042	0.67	Hampden Park Co-op
West Seventh	451	0.60	CWRD Office

Monitored Subwatershed

Annual and seasonal city-wide flow-weighted averages were calculated for each of the loading pollutants from the monitored outfall data. TKN, TP, TSS and VSS loads were generated by CRWD in the WISKI data management program. This allowed for the extraction of baseflow and the associated load from the event load for those parameters. Cl and NO_2+NO_3 loads were calculated for the event-based volume (baseflow volume extracted), although the base flow loading for those parameters was not extracted. The following formula was used to calculate the annual/seasonal flow weighted mean concentrations (**Table 12-2**):

$$C = \frac{\sum(F_i \times C_i)}{\sum(F_i)}$$

C = annual/seasonal flow weighted mean concentration [mg/L]*
F_i = the event-based flow for an individual event [cf]
C_i = the pollutant concentration for an individual event [mg/L]

*As described above, the flow-weighted mean concentration for TKN, TP, TSS, and VSS, was calculated from loads generated in the WISKI program, which extracted baseflow loading (not reflected in the formula above)

Table 12-2: City-wide Annual and Seasonal Flow-weighted Mean Concentrations

Parameter	Cl	TKN	TP	NO_2+NO_3	TSS	VSS
Units	**[mg/L]**	**[mg/L]**	**[mg/L]**	**[mg/L]**	**[mg/L]**	**[mg/L]**
Annual	279.2	2.0	0.40	0.62	201.0	47.7
Q1 (Jan-Mar)	824.1	2.4	0.35	0.76	228.6	44.7
Q2 (Apr-Jun)	242.7	2.0	0.35	0.60	218.0	52.5
Q3 (Jul-Sep)	224.8	1.8	0.37	0.59	189.5	40.5
Q4 (Oct-Dec)	331.9	2.0	0.61	0.70	167.4	50.3

Based on these calculated flow-weighted mean concentrations, the Simple Method was used to calculate each subwatershed's pollutant loading. Loads for the four monitored subwatersheds were generated using actual monitored loads. The Simple Method is shown below:

$$L = 2.72\left(\frac{PP_jR_v}{12}\right)(CA)$$

L = pollutant loading for the year/season [lb]
P = rainfall depth for the year/season [in]
P_j = correction factor for storms that produce no runoff [.]
R_v = runoff coefficient [.]
C = flow-weighted mean concentration [mg/L]
A = area of the watershed [acre]

Values used in loading calculations:
R_v and A = Table 1
C = Table 2
P = Table 3
P_j = 0.85

The annual/seasonal precipitation totals for four different rainfall monitoring locations in St. Paul are provided in **Section 3** the **Table 3-1**. Each subwatershed was assigned precipitation data from the nearest precipitation monitoring site (see **Table 12-1** for assignments). The rainfall data was used as an input to the Simple Method for load calculations, as described above. Rain data outside the seasonal monitoring period was supplemented with data from the University of Minnesota – St. Paul.

The annual and seasonal pollutant loads for each of the City's subwatersheds are presented in **Tables 12-3 – 12-7**. Loads for the five monitored sites are actual totals calculated for each station. Those sites are highlighted blue.

Table 12-3. Annual Pollutant Loadings (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	1055249	7392	1509	2339	759797	180218
Beaver Lake	111949	784	160	248	80605	19119
Belt Line	2928950	20516	4189	6491	2108894	500214
Crosby	1359752	9525	1945	3013	979045	232222
Davern	1288754	9027	1843	2856	927925	220097
Downtown	819358	5739	1172	1816	589952	139932
East Kittsondale	190398	4532	863	747	308190	118153
Fish Creek	42264	296	60	94	30431	7218
Goodrich/Western	530587	3717	759	1176	382031	90615
Griffith/Pt. Douglas	495785	3473	709	1099	356974	84672
Hidden Falls	309816	2170	443	687	223073	52911
Highwood	992101	6949	1419	2199	714329	169434
Lake Como	1094532	7667	1565	2426	788082	186927
Lake Phalen	751735	5266	1075	1666	541262	128383
Mississippi River Blvd.	2495767	17482	3569	5531	1796995	426234
MRWMO	170070	1191	243	377	122453	29045
Phalen Creek	226734	4292	781	844	361245	119124
Pigs Eye	2120957	14857	3033	4700	1527126	362223
Riverview	1024240	7175	1465	2270	737470	174923
St. Anthony Hill	3370075	23606	4820	7469	2426512	575551
St. Anthony Park	311400	7306	1203	1859	558390	219637
Trout Brook	89389	4067	993	670	285181	91275
Urban	329328	2307	471	730	237122	56244
West Kittsondale	1256432	8801	1797	2784	904653	214577
West Seventh	537499	3765	769	1191	387009	91796

Table 12-4: Q1 (Jan-Mar) Pollutant Loading (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	312924	922	132	287	86797	16969
Beaver Lake	33197	98	14	30	9208	1800
Belt Line	868551	2558	367	797	240915	47099
Crosby	395870	1166	167	363	109805	21467
Davern	375200	1105	158	344	104072	20346
Downtown	109374	322	46	100	30338	5931
East Kittsondale	171790	1622	215	239	73959	30143
Fish Creek	12533	37	5	11	3476	680
Goodrich/Western	70827	209	30	65	19646	3841
Griffith/Pt. Douglas	147020	433	62	135	40780	7972
Hidden Falls	90198	266	38	83	25019	4891
Highwood	294198	866	124	270	81603	15954
Lake Como	318656	939	135	292	88387	17280
Lake Phalen	222920	657	94	205	61833	12088
Mississippi River Blvd.	726603	2140	307	667	201542	39402
MRWMO	49513	146	21	45	13734	2685
Phalen Creek	184841	1157	230	292	112173	32210
Pigs Eye	628949	1852	266	577	174455	34106
Riverview	303728	895	128	279	84247	16470
St. Anthony Hill	449864	1325	190	413	124782	24395
St. Anthony Park	194500	1164	139	422	64688	17522
Trout Brook	21816	668	124	63	45075	12920
Urban	97659	288	41	90	27088	5296
West Kittsondale	365790	1077	155	336	101461	19836
West Seventh	71750	211	30	66	19902	3891

Table 12-5: Q2 (Apr-Jun) Pollutant Loading (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	449989	3738	656	1112	404083	97233
Beaver Lake	47738	397	70	118	42868	10315
Belt Line	1248991	10374	1820	3086	1121573	269880
Crosby	546653	4540	797	1351	490885	118120
Davern	518110	4303	755	1280	465254	111952
Downtown	398577	3311	581	985	357915	86124
East Kittsondale	10927	1772	325	277	134710	55330
Fish Creek	18022	150	26	45	16184	3894
Goodrich/Western	258104	2144	376	638	231773	55771
Griffith/Pt. Douglas	211418	1756	308	522	189849	45683
Hidden Falls	124553	1035	182	308	111847	26913
Highwood	423061	3514	616	1045	379902	91414
Lake Como	440028	3655	641	1087	395138	95080
Lake Phalen	320562	2663	467	792	287859	69266
Mississippi River Blvd.	1003358	8334	1462	2479	900998	216804
MRWMO	68372	568	100	169	61397	14774
Phalen Creek	7719	861	150	191	62654	25113
Pigs Eye	904439	7512	1318	2234	812171	195430
Riverview	436766	3628	636	1079	392209	94376
St. Anthony Hill	1639373	13616	2389	4050	1472129	354233
St. Anthony Park	42770	1996	320	462	204440	71069
Trout Brook	20711	1084	269	169	77410	25208
Urban	140435	1166	205	347	126108	30345
West Kittsondale	505115	4195	736	1248	453585	109144
West Seventh	261466	2172	381	646	234792	56497

Table 12-6: Q3 (Jul-Sep) Pollutant Loading

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	256608	2030	422	671	216359	46178
Beaver Lake	27223	215	45	71	22953	4899
Belt Line	712242	5635	1171	1862	600525	128173
Crosby	394658	3122	649	1032	332755	71021
Davern	374051	2959	615	978	315380	67313
Downtown	198137	1568	326	518	167059	35656
East Kittsondale	5317	980	182	188	81703	28833
Fish Creek	10277	81	17	27	8665	1849
Goodrich/Western	128306	1015	211	336	108181	23090
Griffith/Pt. Douglas	120562	954	198	315	101651	21696
Hidden Falls	89922	711	148	235	75817	16182
Highwood	241252	1909	397	631	203411	43415
Lake Como	317680	2513	522	831	267851	57169
Lake Phalen	182802	1446	301	478	154129	32896
Mississippi River Blvd.	724377	5731	1191	1894	610757	130357
MRWMO	49362	391	81	129	41619	8883
Phalen Creek	6253	2050	346	268	176292	56646
Pigs Eye	515760	4081	848	1349	434862	92815
Riverview	249068	1971	409	651	210001	44822
St. Anthony Hill	814950	6448	1340	2131	687123	146656
St. Anthony Park	51793	3969	704	892	278316	51793
Trout Brook	35340	2008	482	377	125182	39235
Urban	80084	634	132	209	67522	14412
West Kittsondale	364670	2885	599	954	307470	65625
West Seventh	129978	1028	214	340	109590	23390

Table 12-7: Q4 (Oct-Dec) Pollutant Loading (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	181007	1098	335	381	91331	27450
Beaver Lake	19203	116	35	40	9689	2912
Belt Line	502403	3047	928	1057	253497	76190
Crosby	185991	1128	344	391	93845	28206
Davern	176280	1069	326	371	88945	26733
Downtown	124754	757	231	262	62947	18919
East Kittsondale	2364	158	141	43	17818	3846
Fish Creek	7249	44	13	15	3658	1099
Goodrich/Western	80786	490	149	170	40762	12251
Griffith/Pt. Douglas	85042	516	157	179	42910	12897
Hidden Falls	42378	257	78	89	21382	6427
Highwood	170175	1032	314	358	85865	25807
Lake Como	149713	908	277	315	75541	22704
Lake Phalen	269860	1637	499	568	136163	40924
Mississippi River Blvd.	341378	2071	631	718	172249	51770
MRWMO	23263	141	43	49	11738	3528
Phalen Creek	27921	225	55	93	10126	5155
Pigs Eye	363808	2207	672	765	183566	55172
Riverview	175688	1066	325	369	88647	26643
St. Anthony Hill	513120	3112	948	1079	258904	77815
St. Anthony Park	22338	177	40	84	10946	22338
Trout Brook	11522	307	118	61	37514	13912
Urban	56490	343	104	119	28503	8567
West Kittsondale	171859	1042	318	361	86715	26062
West Seventh	81838	496	151	172	41293	12411

13. 2024 Summary

In 2024, six stormwater BMPs were monitored along with two locations that provide upstream stormwater data. All locations were evaluated for performance in 2024 to help the City meet its NPDES MS4 Permit monitoring requirements. The BMP systems that were monitored include underground infiltration systems, a rain garden, and pervious pavement. The systems were monitored to evaluate infiltration rates, volume reduction, and pollutant removal efficiencies. Long-term monitoring data has shown how the effectiveness of these systems change over time.

13.1. Underground Infiltration Systems/Outfall

Four underground infiltration BMPs (Beacon Bluff, St. Albans, Hampden Park, and Victoria Street) were monitored for flow to evaluate runoff and volume reduction at BMP Sites. The runoff data for each site was normalized over the individual drainage areas to evaluate drainage characteristics that contribute to each Site. A summary of the 2024 runoff and volume reduction data is presented in **Table 13-1** below.

Table 13-1: Runoff Summary

BMP Site	Drainage Area (acres)	Total Monitored Runoff (cf)	% Runoff Captured	Water Yield (in/acre)	Water Yield (cu-ft/acre)
Beacon Bluff	143.6	1,105,269	69	2.4	9,022
St. Albans	25.2	465,519	94	5.4	19,568
Hampden Park	7.8	119,406	100	4.2	15,262
Victoria Street	19.1	490,587	92	7.1	25,685

TSS and TP loads captured by the monitored BMPs are summarized in **Table 13-2**. TSS and TP loads were calculated using 2024 flow data and flow-weighted averages. Beacon Bluff had the largest runoff volume and captured the largest amount of TSS and TP. The total TSS load and TP load captured by the four systems was 22,981 pounds and 59.96 pounds, respectively.

Table 13-2: Underground Infiltration System Pollutant Capture Summary

BMP Site	TSS Captured (pounds)	TP Captured (pounds)
Beacon Bluff	4,925	37.82
St. Albans	3,412	9.69
Hampden Park	997	1.38
Victoria Street	2,062	11.07
Total	**22,981**	**59.96**

A summary of the 2024 infiltration rates for the underground infiltration systems is provided below.

- The infiltration rate for the Beacon Bluff underground system was 0.06 in/hr, which is 2.4% of the post-construction infiltration rate. The underground system no longer drains to empty, and groundwater mounding does not appear to be the cause of standing water, based on groundwater elevation data. Even with standing water observed in the BMP and an increase in system discharge events, the BMP captured 69% of the total volume monitored.

- The 2024 St. Albans infiltration rate of 10.0 in/hr is greater than the MSWM infiltration rate, but less than design rate of 26.0 in/hr. The St. Albans BMP system regularly drained to empty within 24 hours of a runoff event.
- The infiltration rate for the Hampden Park BMP was 9.99 in/hr, which exceeded the design rate of 1.8 in/hr. No overflow bypass was observed and 100% of the volume received by the BMP was infiltrated. The Hampden Park BMP system regularly drained to dry within 8 hours of a runoff event.
- The infiltration rate for the Victoria Street BMP was 16.08 in/hr, which is above the designed infiltration rate of 12.8 in/hr. The Victoria Street BMP regularly drained to empty within 10 hours of a runoff event.

13.2. Pervious Pavement

Infiltration testing was conducted at Jackson Street pervious asphalt in 2024. The average infiltration rate at Jackson Street was 38.9 in/hr. in 2024.

The 2024 infiltration rate at Jackson Street Site ranged from 38.5 to 661.1 in/hr., depending on the volume of traffic at that site. Of the 18 total sites,16 sites showed no infiltration in 2024. Low traffic areas were observed to have significantly greater infiltration rates on average (140 in/hr) than medium traffic (0 in/hr) and high traffic (0 in/hr) areas. Areas of high traffic have not shown any infiltration since October 2018.

13.3. 2024 Recommendations

The recommendations for the 2024 Monitoring Program include:

- Continue to perform inspections and regular maintenance on BMP pre-treatment systems and infiltration galleries.
- Continue to notify of potential illicit discharges observed at flow monitoring locations.
- Continue to complete infiltration testing at Jackson Street Pervious Bike Path to further evaluate changes in pervious surface performance with respect to pavement traffic.
- Continue river level monitoring within the Mississippi River in protected areas to capture more data during different river stages.
- According to the MPCA Minnesota Stormwater Manual, E. coli, oil and grease levels can vary greatly depending on the time of year, location, and land use. Based on sample results within the monitored watersheds, no further practices to reduce the amount of E. coli, oil and grease are recommended to be taken.
- Remove accumulated sediment at in the inlets of West Shepard Pond.

14. References

City of Saint Paul, 2018. 2017 Water Quality and Quantity Monitoring Report. Saint Paul, MN.

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Erickson, Andrew J., John S. Gulliver, and Peter T. Weiss. "Monitoring an Iron-Enhanced Sand Filter Trench for the Capture of Phosphate from Stormwater Runoff." Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/175078, 2015.

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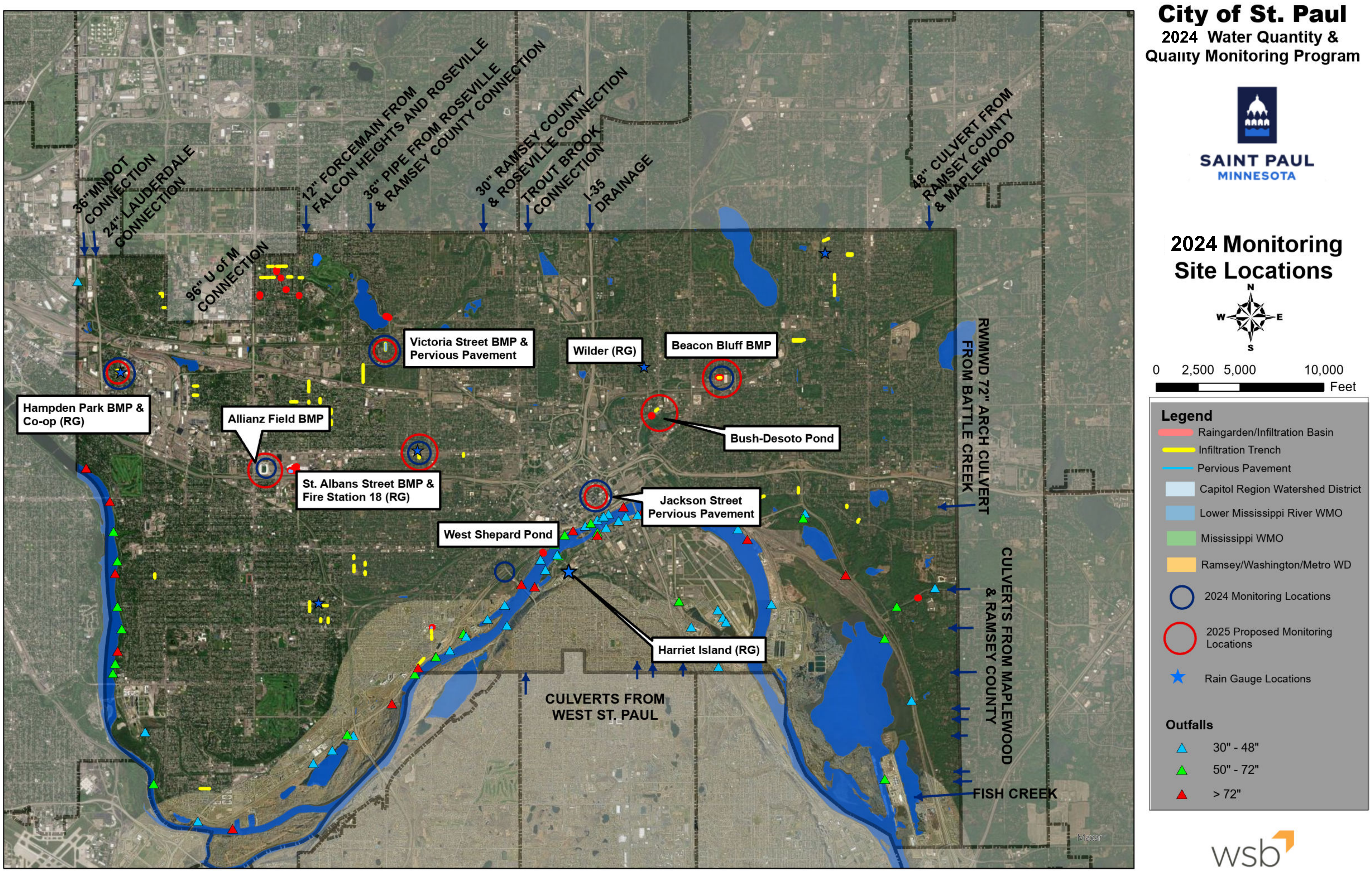
Minnesota Pollution Control Agency 2008. Minnesota Stormwater Manual. Version 2. Accessed 2017. https://stormwater.pca.state.mn.us/index.php?title=Main_Page.

Minnesota Department of Transportation, 2015. Study: "Permeable Pavements in Cold Climates: State of the Art and Cold Climate Case Studies". Accessed 2017. https://lrrb.org/pdf/201530.pdf.

LIST OF FIGURES



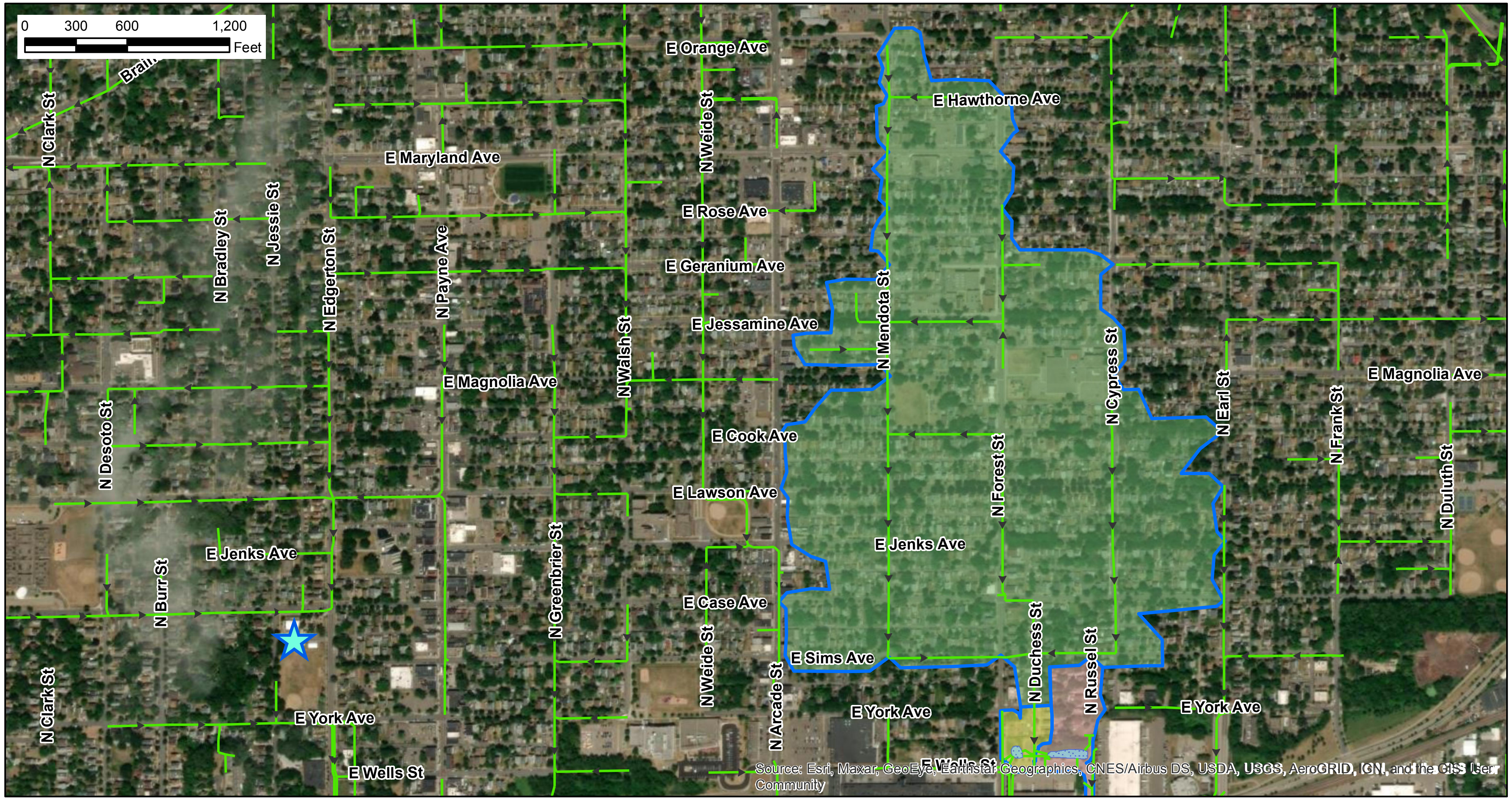
City of St. Paul
2024 Water Quantity & Quality Monitoring Program
SAINT PAUL MINNESOTA
2024 Monitoring Site Locations
N S W E
0 2,500 5,000 10,000 Feet
Legend
Raingarden/Infiltration Basin
Infiltration Trench
Pervious Pavement
Capitol Region Watershed District
Lower Mississippi River WMO
Mississippi WMO
Ramsey/Washington/Metro WD
2024 Monitoring Locations
2025 Proposed Monitoring Locations
Rain Gauge Locations
Outfalls
30" - 48"
50" - 72"
> 72"
36" MNDOT CONNECTION
24" LAUDERDALE CONNECTION
96" U of M CONNECTION
12" FORCEMAIN FROM FALCON HEIGHTS AND ROSEVILLE
36" PIPE FROM ROSEVILLE & RAMSEY COUNTY CONNECTION
30" RAMSEY COUNTY & ROSEVILLE CONNECTION
TROUT BROOK CONNECTION
I-35 DRAINAGE
48" CULVERT FROM RAMSEY COUNTY & MAPLEWOOD
RWMWD 72" ARCH CULVERT FROM BATTLE CREEK
CULVERTS FROM MAPLEWOOD & RAMSEY COUNTY
FISH CREEK
CULVERTS FROM WEST ST. PAUL
Victoria Street BMP & Pervious Pavement
Wilder (RG)
Beacon Bluff BMP
Hampden Park BMP & Co-op (RG)
Allianz Field BMP
Bush-Desoto Pond
St. Albans Street BMP & Fire Station 18 (RG)
Jackson Street Pervious Pavement
West Shepard Pond
Harriet Island (RG)
Maxar
wsb

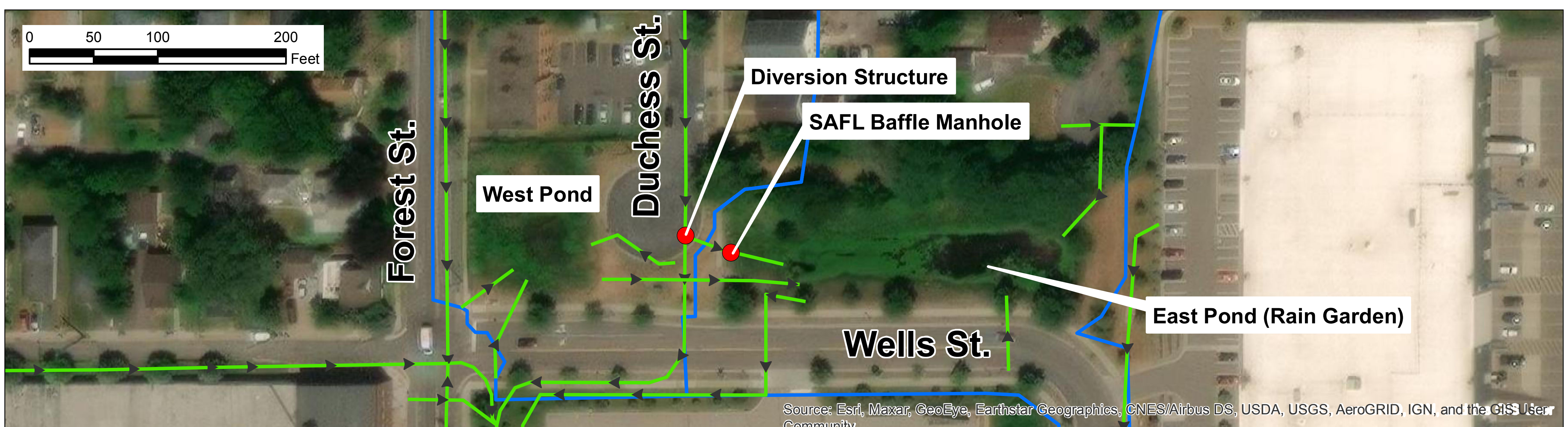
City of St. Paul

2024 Water Quantity and Quality Monitoring Program

SAINT PAUL
MINNESOTA

FIGURE 4-1
Beacon Bluff Infiltration BMP Drainage Areas





N W E S

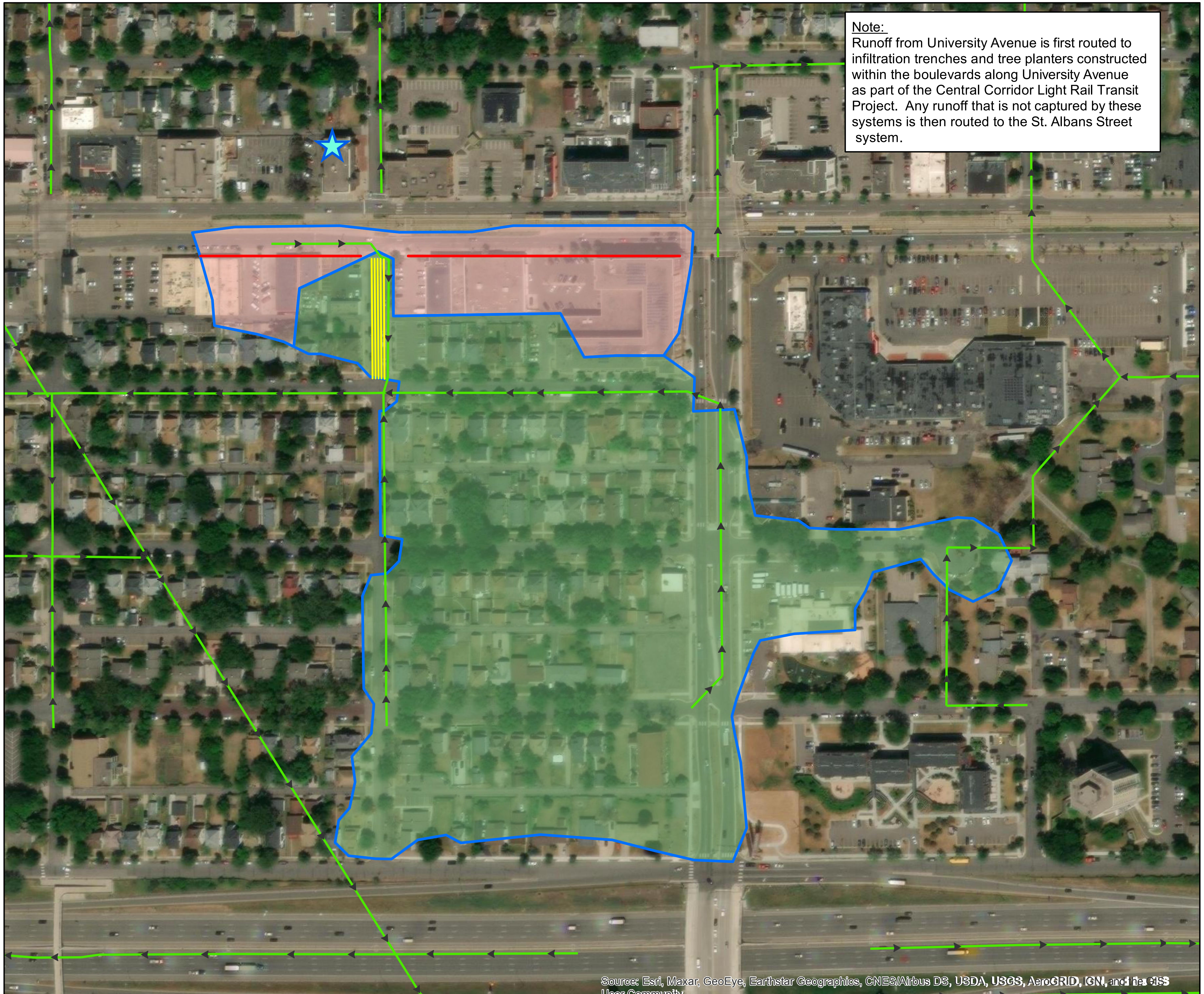
Legend

- Underground Chamber
- Storm Pipe
- Rain Gauge Location

Drainage Areas

- Subwatershed A - Diversion Structure (136.8 ac)
- Suwatershed B - East Pond (4.7 ac)
- Subwatershed C - West Pond (2.1 ac)

wsb



City of St. Paul

2024 Water Quantity and Quality Monitoring Program

SAINT PAUL
The Most Livable City in America

FIGURE 5-1

St. Albans Street Infiltration BMP Drainage Areas

N W E S

0 100 200 400 Feet

Legend

Infiltration Trench
CCLRT Infiltration Trench (Not monitored)
Storm Pipe
Rain Gauge Location

Drainage Areas

St. Albans Infiltration System (20.3 ac)
CCLRT Infiltration Trenches (4.9 acres)

wsb

City of St. Paul

2024 Water Quantity and Quality Monitoring Program

SAINT PAUL MINNESOTA

FIGURE 6-1 Hampden Park Infiltration BMP Drainage Area

Legend

- Storm Pipe
- Rain Gauge Location
- Hampden Park BMP
- Hampden Park BMP Drainage Area

wsb

City of St. Paul

2024 Water Quantity and Quality Monitoring Program

SAINT PAUL
MINNESOTA

FIGURE 7-1
Victoria Street Infiltration BMP Drainage Areas

Legend

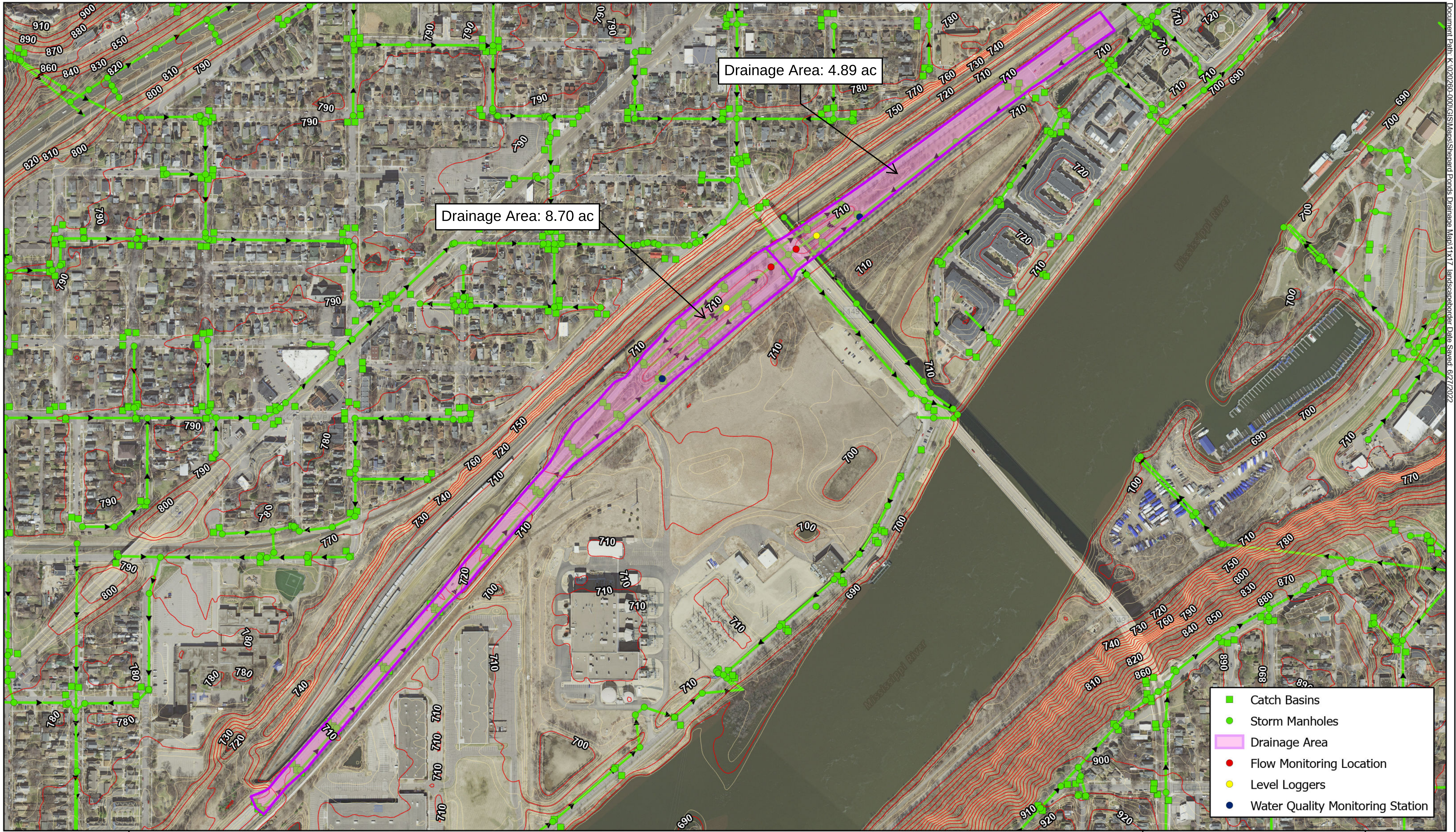
Infiltration BMPs

- Infiltration Trench
- Pervious Pavement
- Storm Pipe
- Rain Gauge Location

Drainage Areas

- Infiltration Trench (19.1 ac)
- Pervious Pavement (1.0 ac)

wsb



SAINT PAUL
MINNESOTA

Shepard Ponds

2024 Water Quantity and Quality Monitoring Program

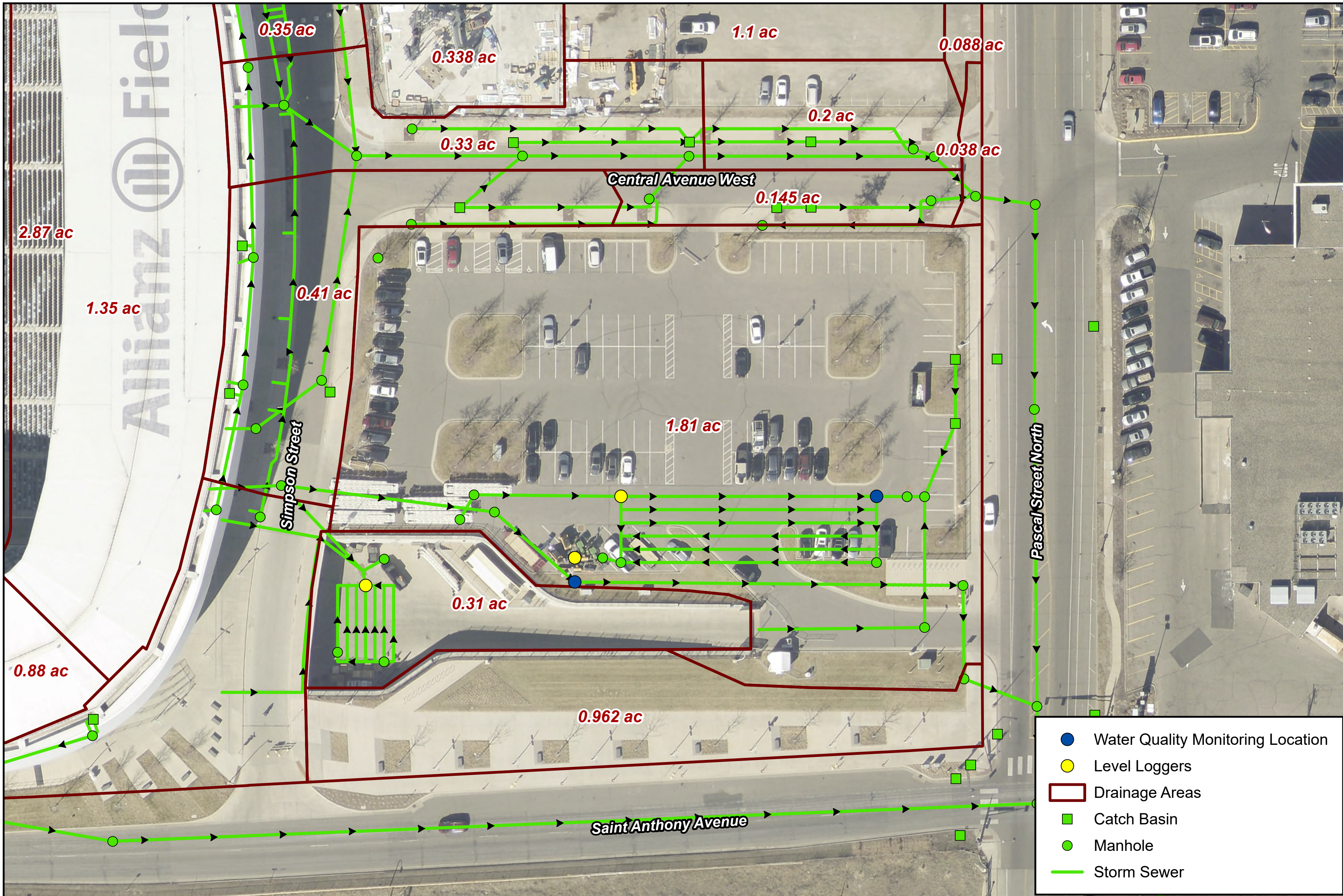
Figure 8-1

N

0 400 Feet

1 inch = 400 feet

wsb



Document Path: M:\027878-000\GIS\Working\027878-000 Snelling Midway\Monitoring Map Date Saved: 4/17/2025

SAINT PAUL
MINNESOTA

Figure 9-1 Snelling-Midway Drainage

2025 Stormwater Quality Monitoring
City of Saint Paul

N

0 75 Feet

1 inch = 75 feet

wsb

Figure 10-2 Jackson Street (pg 1of2)
JS-1 - JS-11 Pervious Test Locations
2024 Water Quantity and Quality Monitoring Program
City of Saint Paul, MN

● Pervious Pavement Testing Locations
Pervious Asphalt Bike Path

N

0 50 Feet
1 inch = 42 feet

wsb

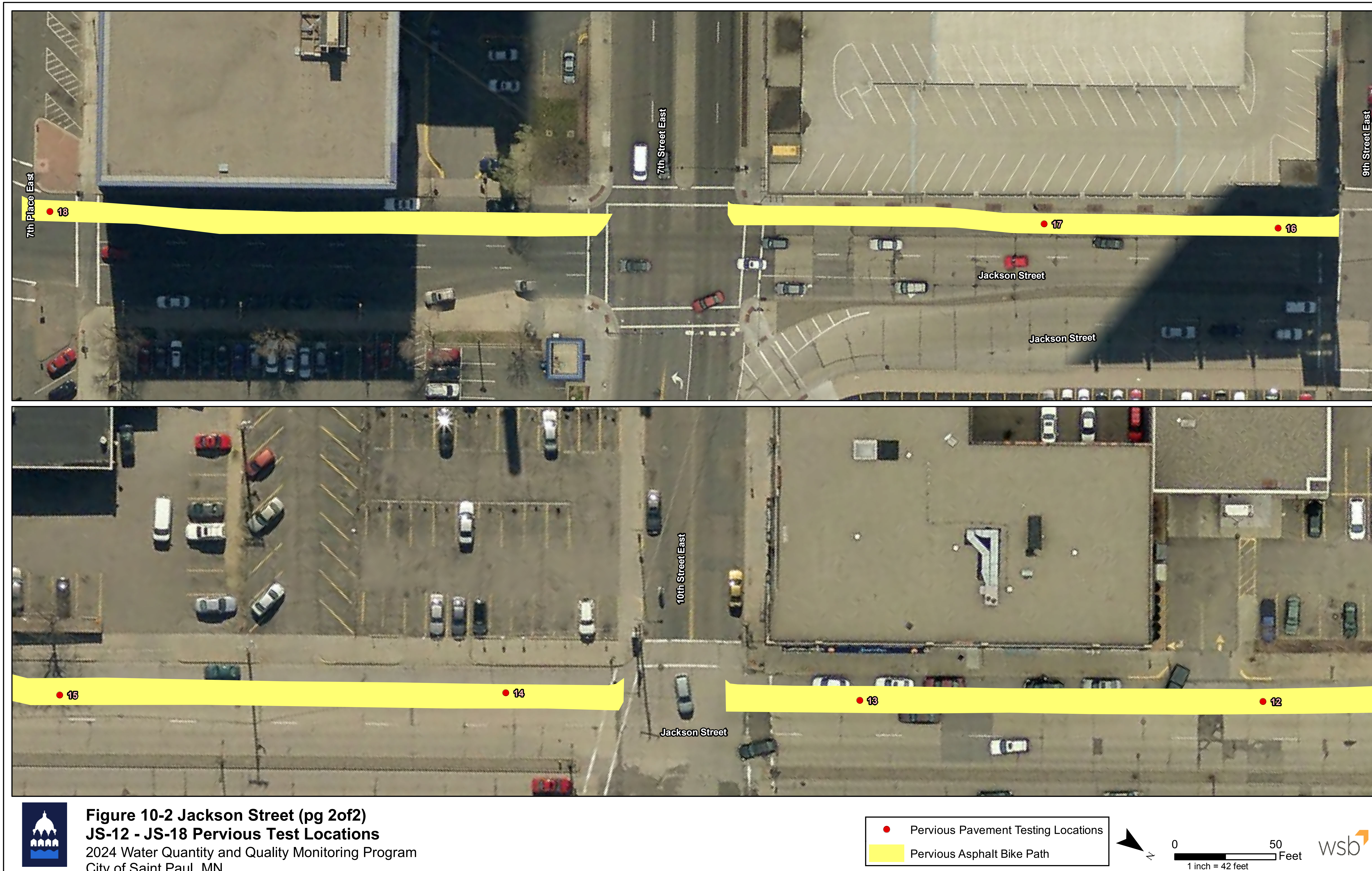


Figure 10-2 Jackson Street (pg 2of2)
JS-12 - JS-18 Pervious Test Locations
2024 Water Quantity and Quality Monitoring Program
City of Saint Paul, MN

APPENDICES

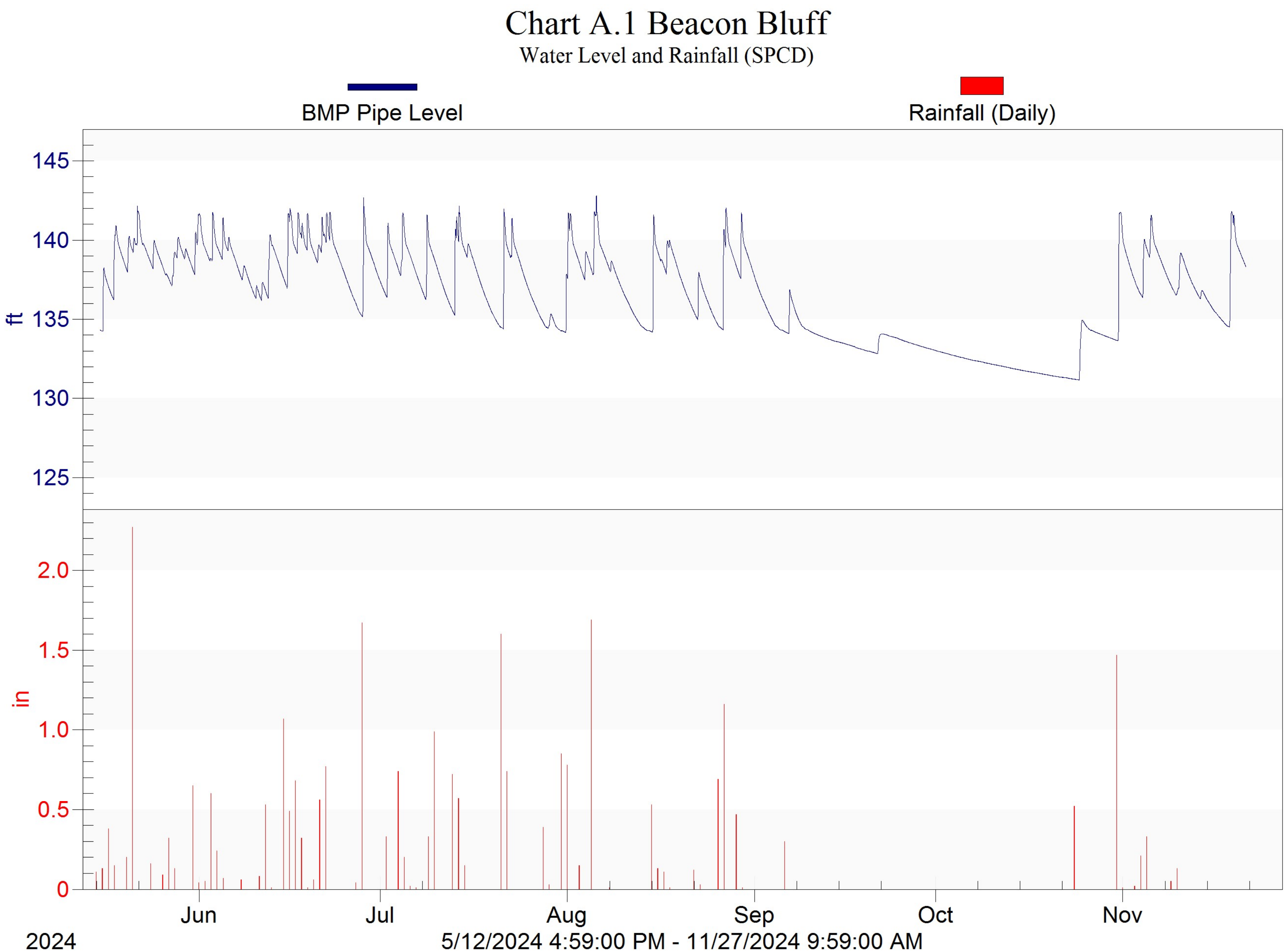
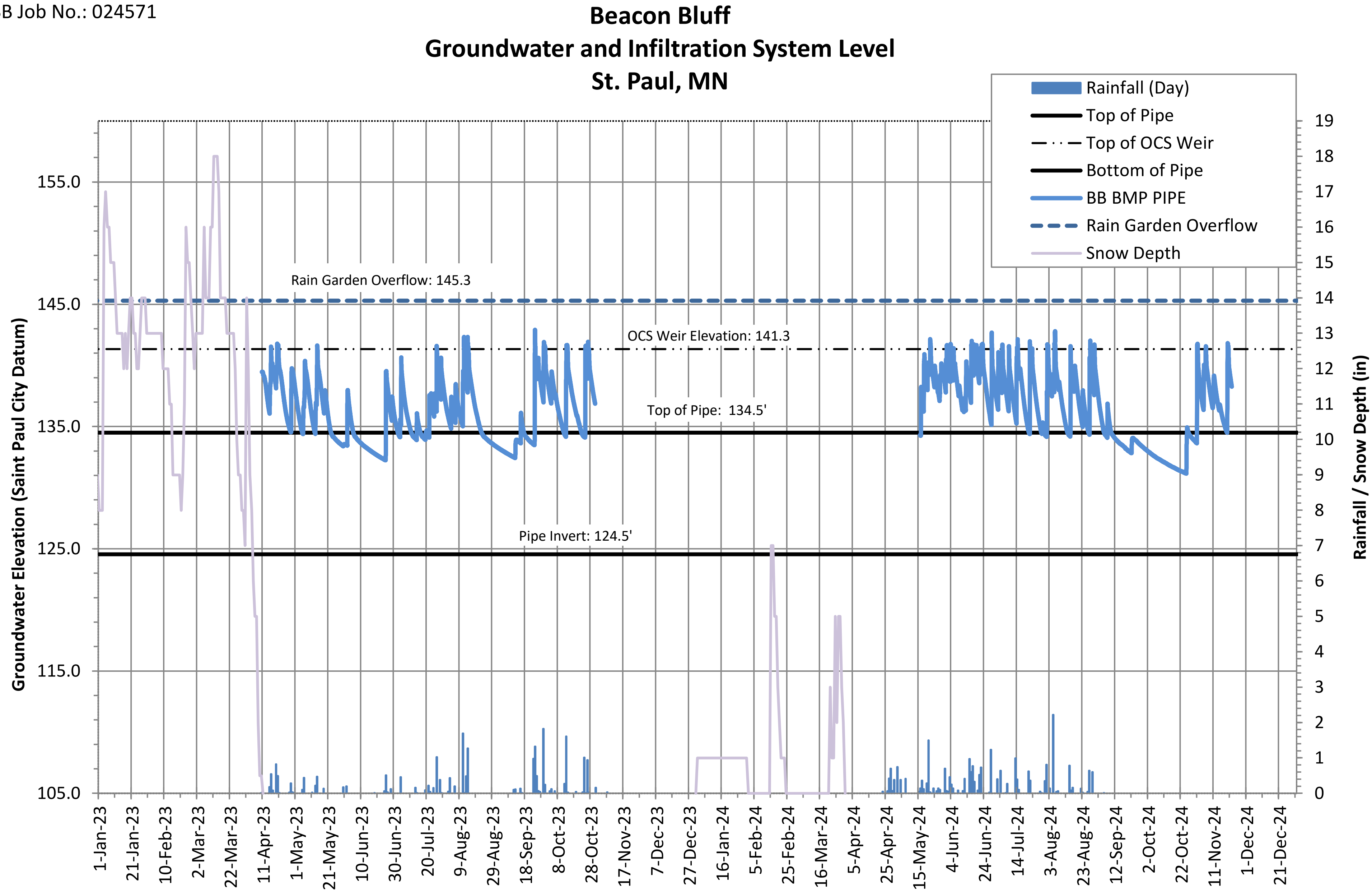
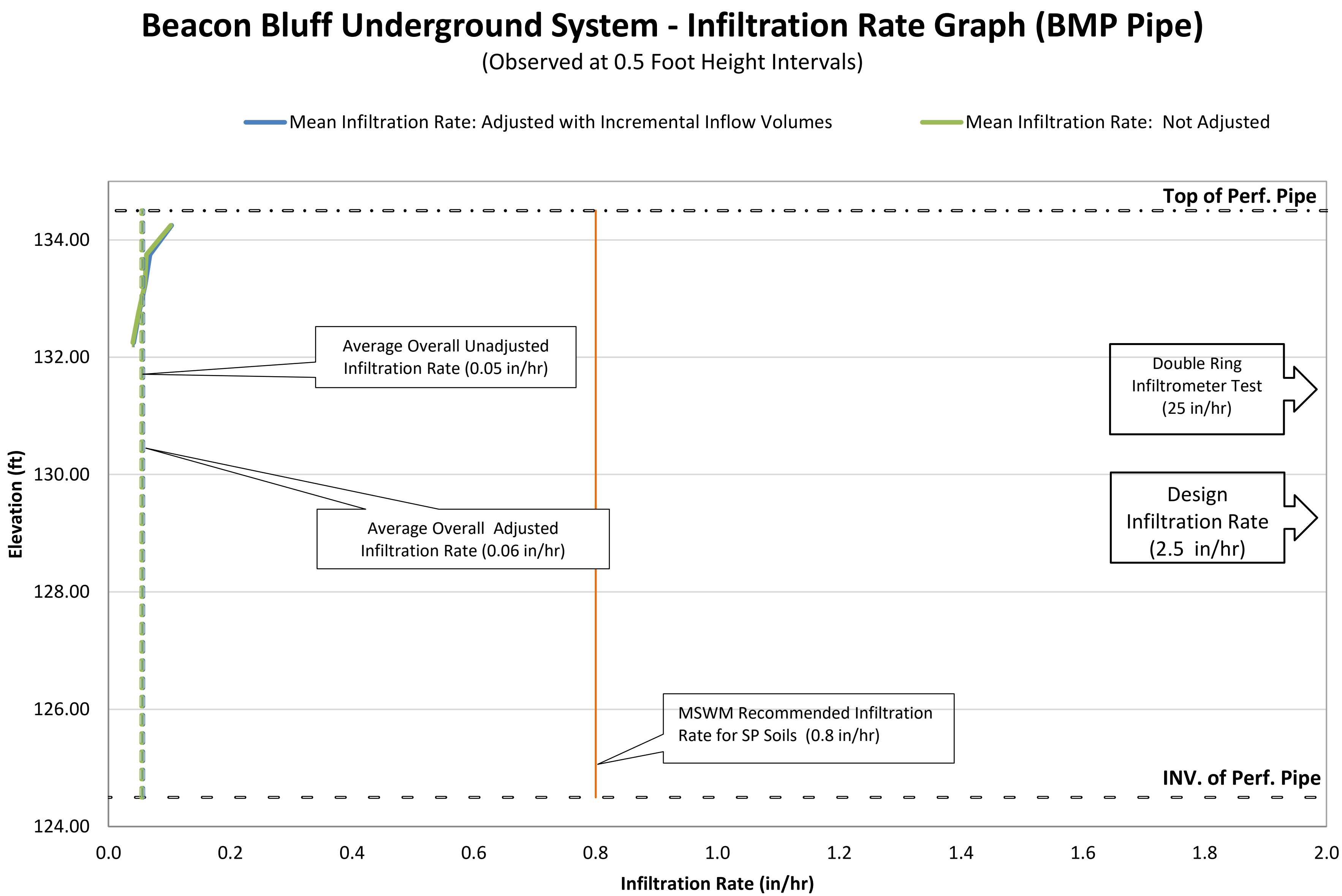


Chart A.1 Beacon Bluff
Water Level and Rainfall (SPCD)
BMP Pipe Level
Rainfall (Daily)
ft
145
140
135
130
125
in
2.0
1.5
1.0
0.5
0
Jun
Jul
Aug
Sep
Oct
Nov
2024
5/12/2024 4:59:00 PM - 11/27/2024 9:59:00 AM

City of Saint Paul
2024 Beacon Bluff Groundwater and System Level
Chart A.2
WSB Job No.: 024571



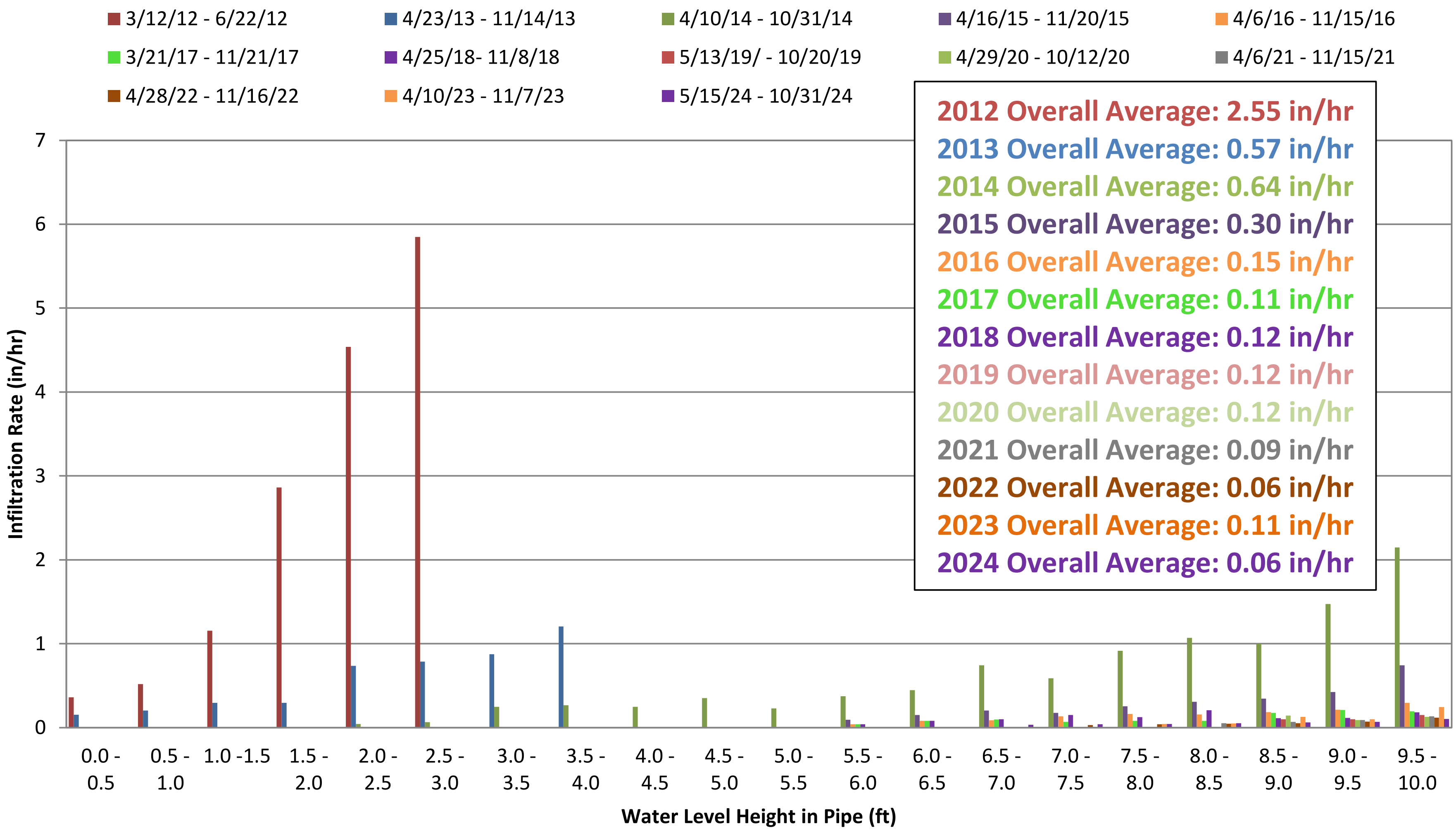
City of Saint Paul
2024 Water Quality and Quantity Report
Chart A.3
WSB Project No.: 024571



Note: Pipe Invert is 124.5'
Pipe perforated around circumference of pipe

City of Saint Paul
2024 Water Quality and Quantity Report
Chart A.5
WSB Job No.: 024571

Infiltration Rate Trends
Beacon Bluff Underground System
Adjusted with Incremental Inflow Volumes



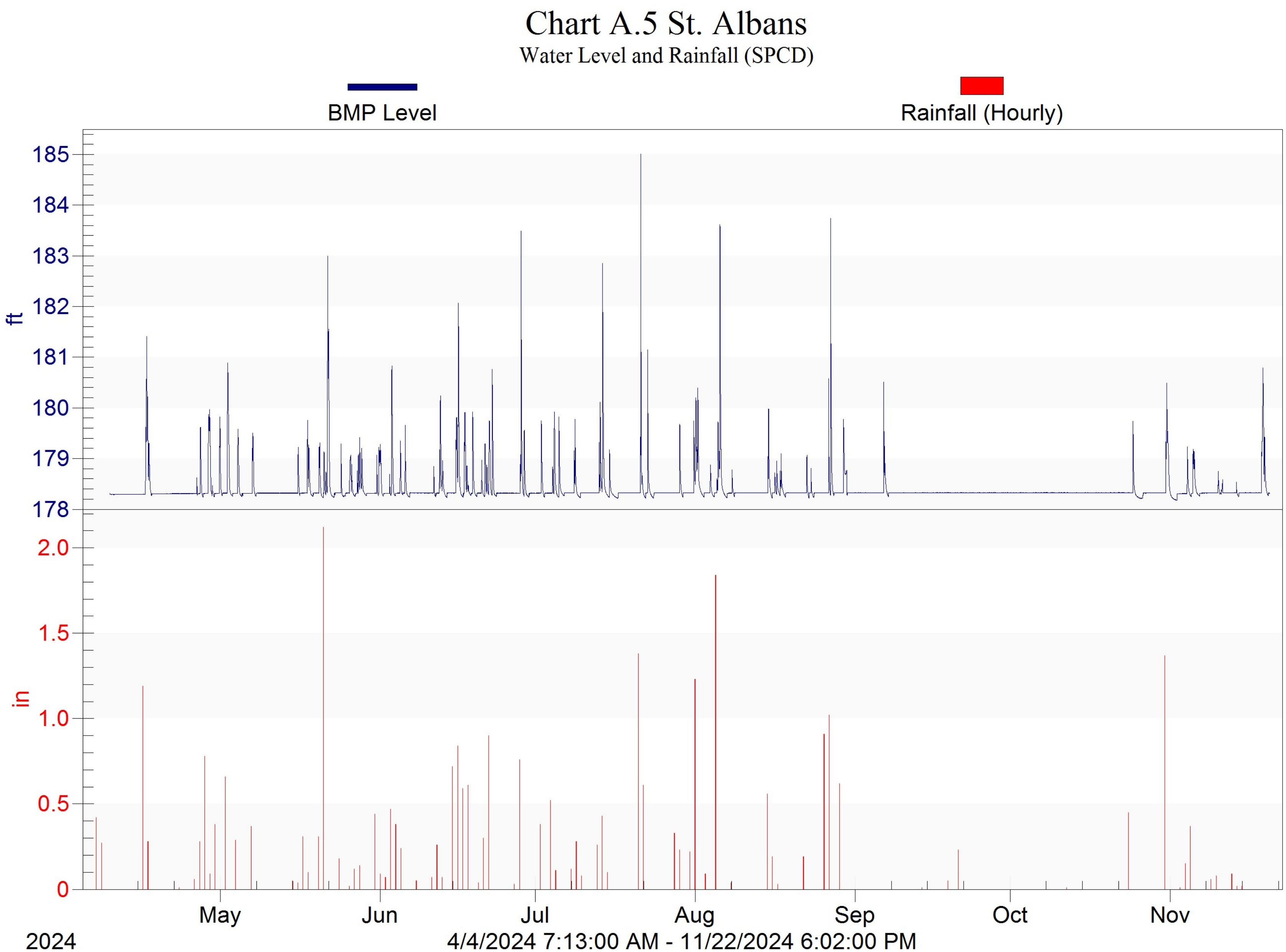
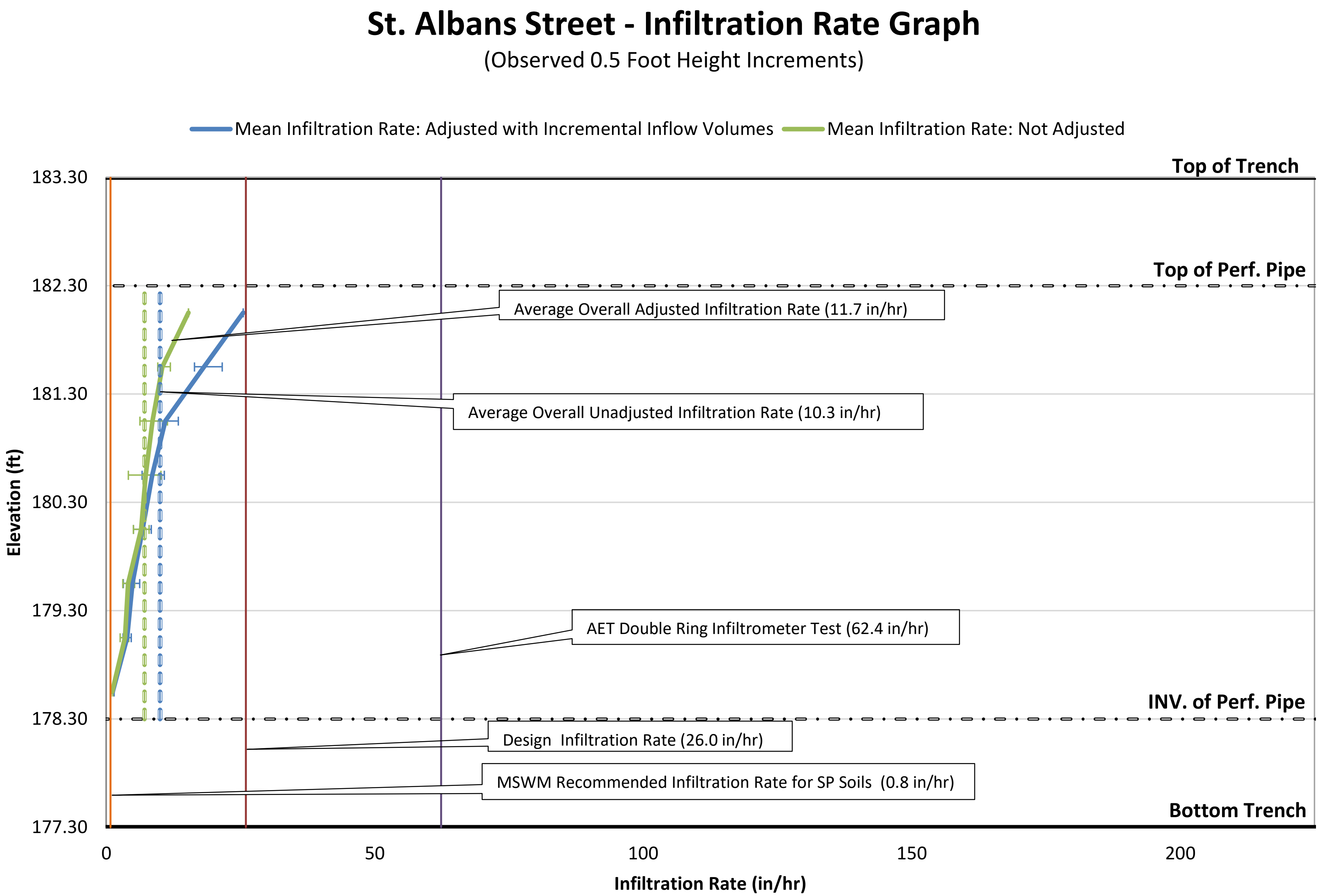


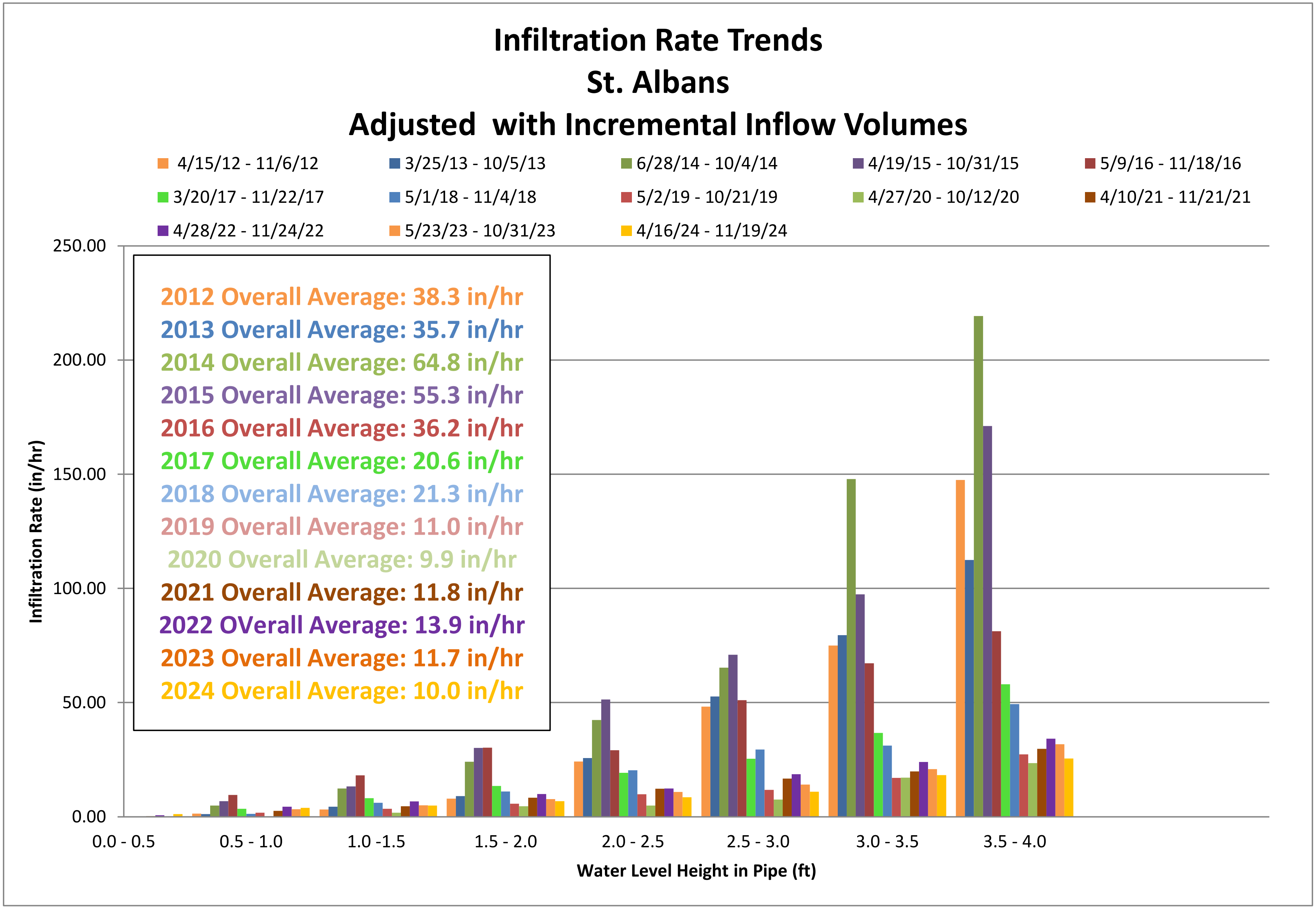
Chart A.5 St. Albans
Water Level and Rainfall (SPCD)
BMP Level
Rainfall (Hourly)
ft
185
184
183
182
181
180
179
178
in
2.0
1.5
1.0
0.5
0
May
Jun
Jul
Aug
Sep
Oct
Nov
2024
4/4/2024 7:13:00 AM - 11/22/2024 6:02:00 PM

City of Saint Paul
2024 Water Quality and Quantity Report
Chart A.6
WSB Job No.: 024571



Note: Pipe Invert is 178.3'
Error Bars Represent 25th and 75th Percentiles
Pipe perforated w/ 2 rows of holes at Elev: 178.9' and 179.2'

City of Saint Paul
2024 Water Quality and Quantity Report
Chart A.7
WSB Project No.: 024571



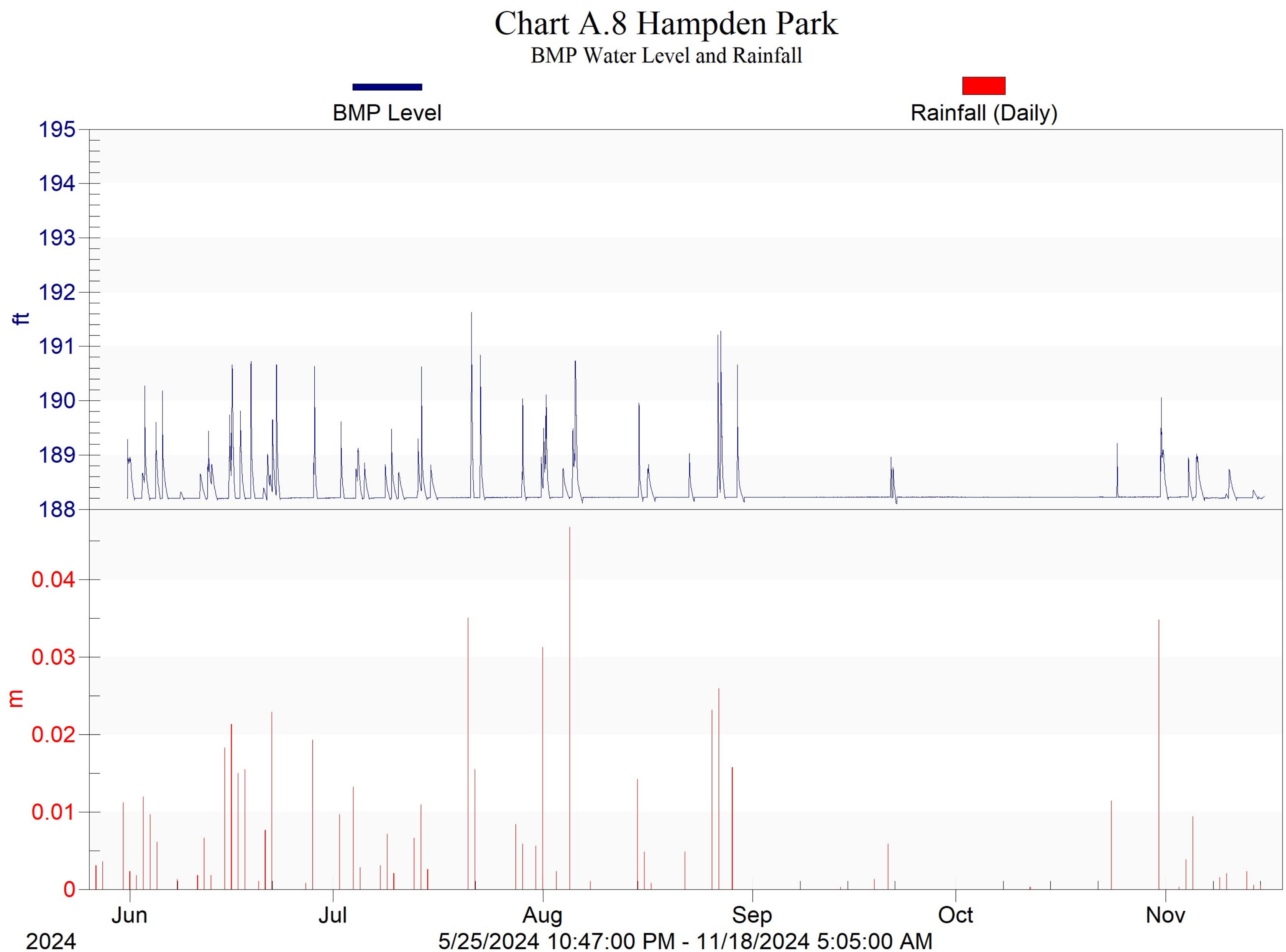
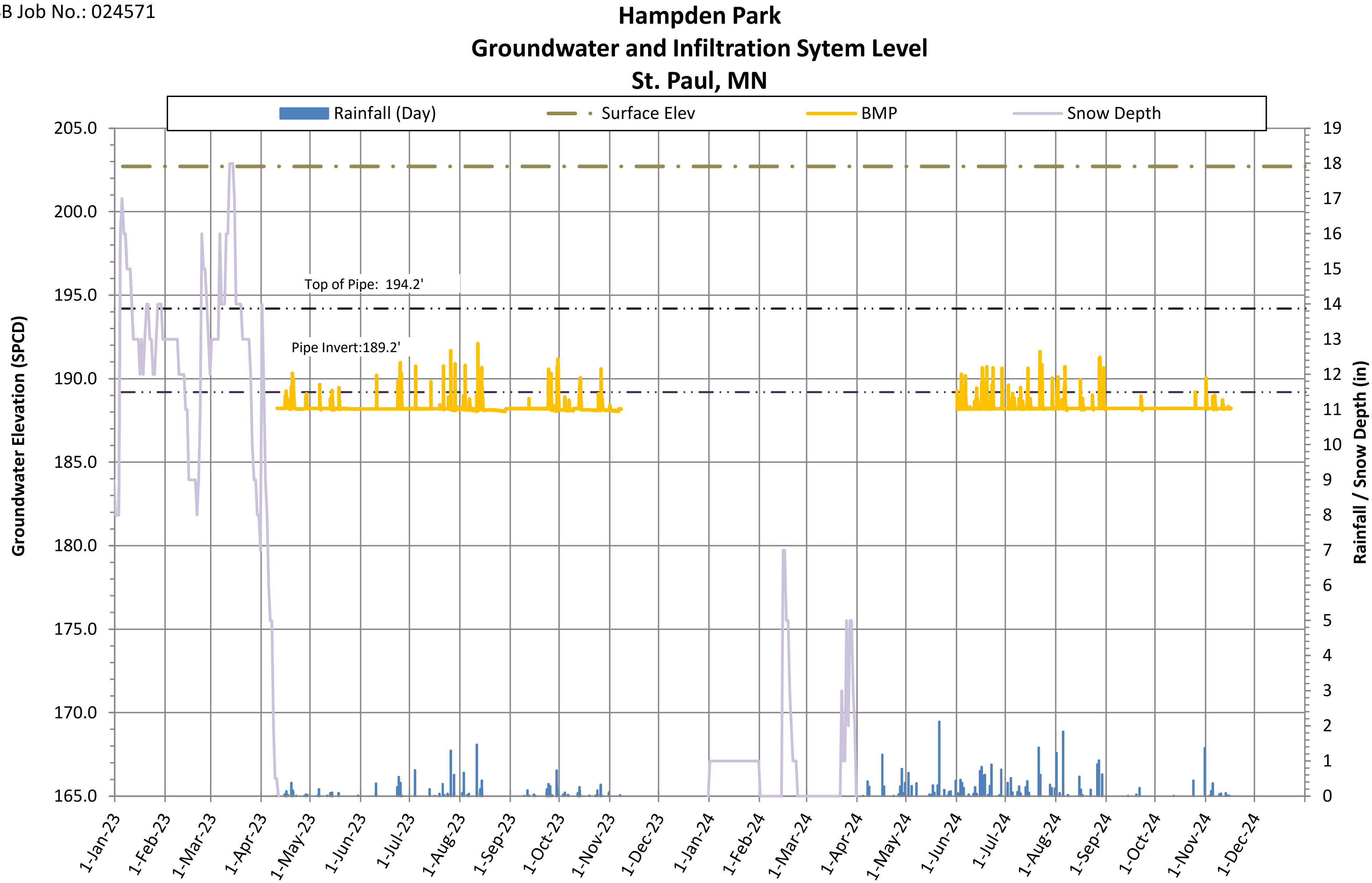
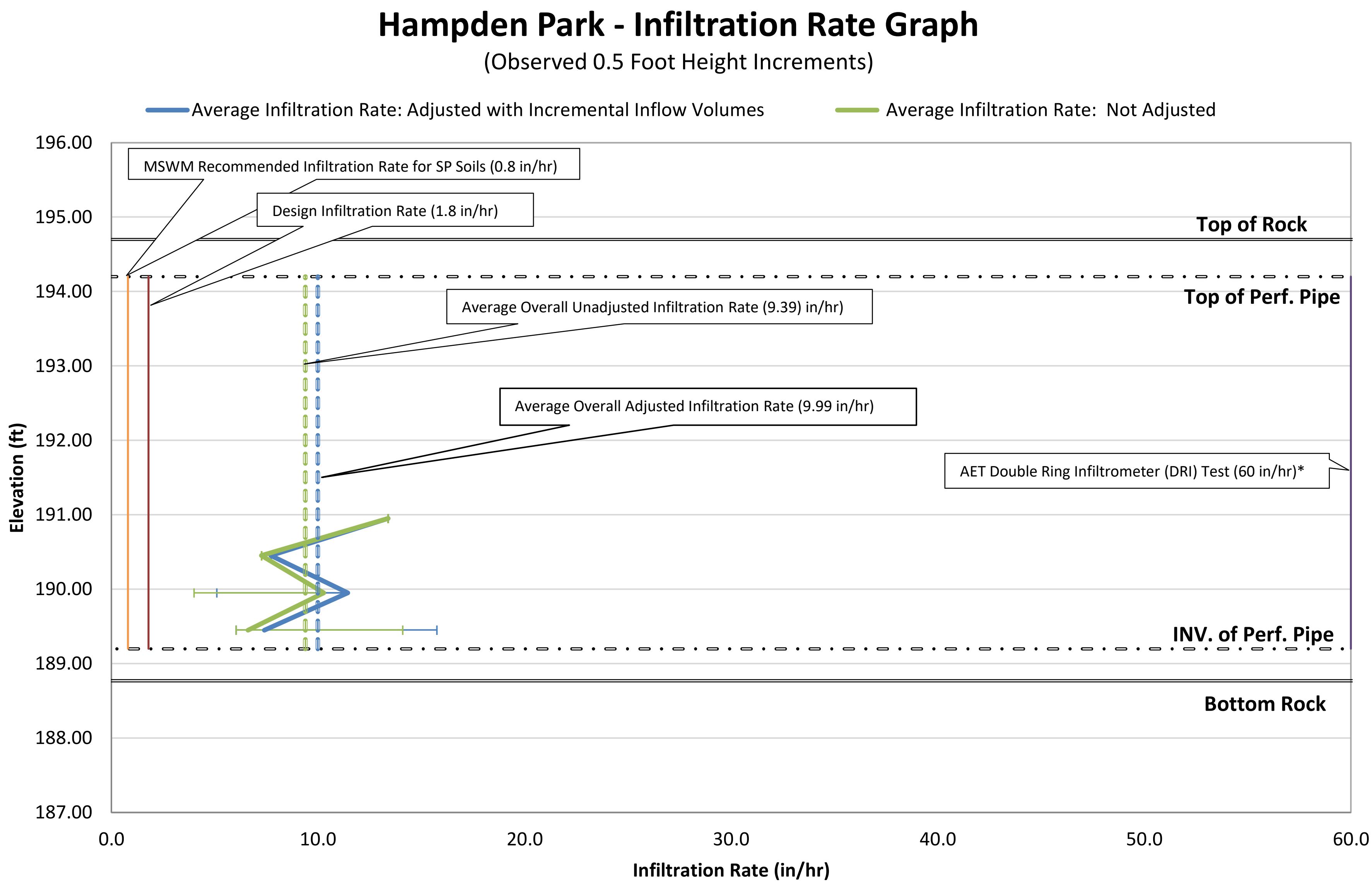


Chart A.8 Hampden Park
BMP Water Level and Rainfall
BMP Level
Rainfall (Daily)
195
194
193
192
191
190
189
188
ft
0.04
0.03
0.02
0.01
0
m
Jun
Jul
Aug
Sep
Oct
Nov
2024
5/25/2024 10:47:00 PM - 11/18/2024 5:05:00 AM

City of Saint Paul
2024 Water Quality and Quantity Report
Chart A.9
WSB Job No.: 024571



City of Saint Paul
2024 Water Quality and Quantity Monitoring
Chart A.10
WSB Job No.: 024571



Note: Pipe Invert is 189.2'
Error Bars Represent 25th and 75th Percentiles
* The DRI testing was completed on top of a 5 ft layer of fine filter aggregate that was constructed above the native soils, per the design.

City of Saint Paul
2024 Water Quality and Quantity Report
Chart A.11
WSB Job No.: 024571

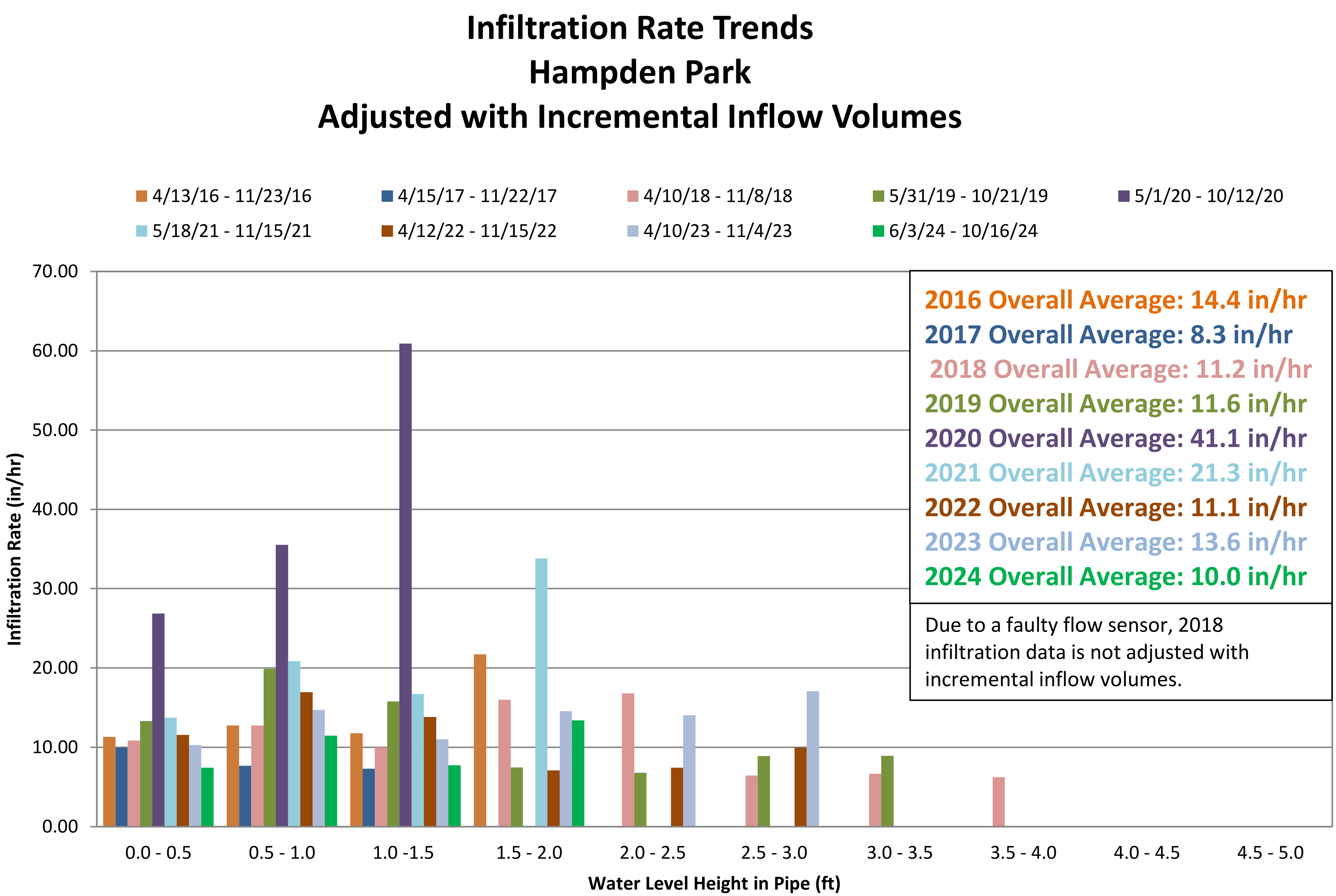
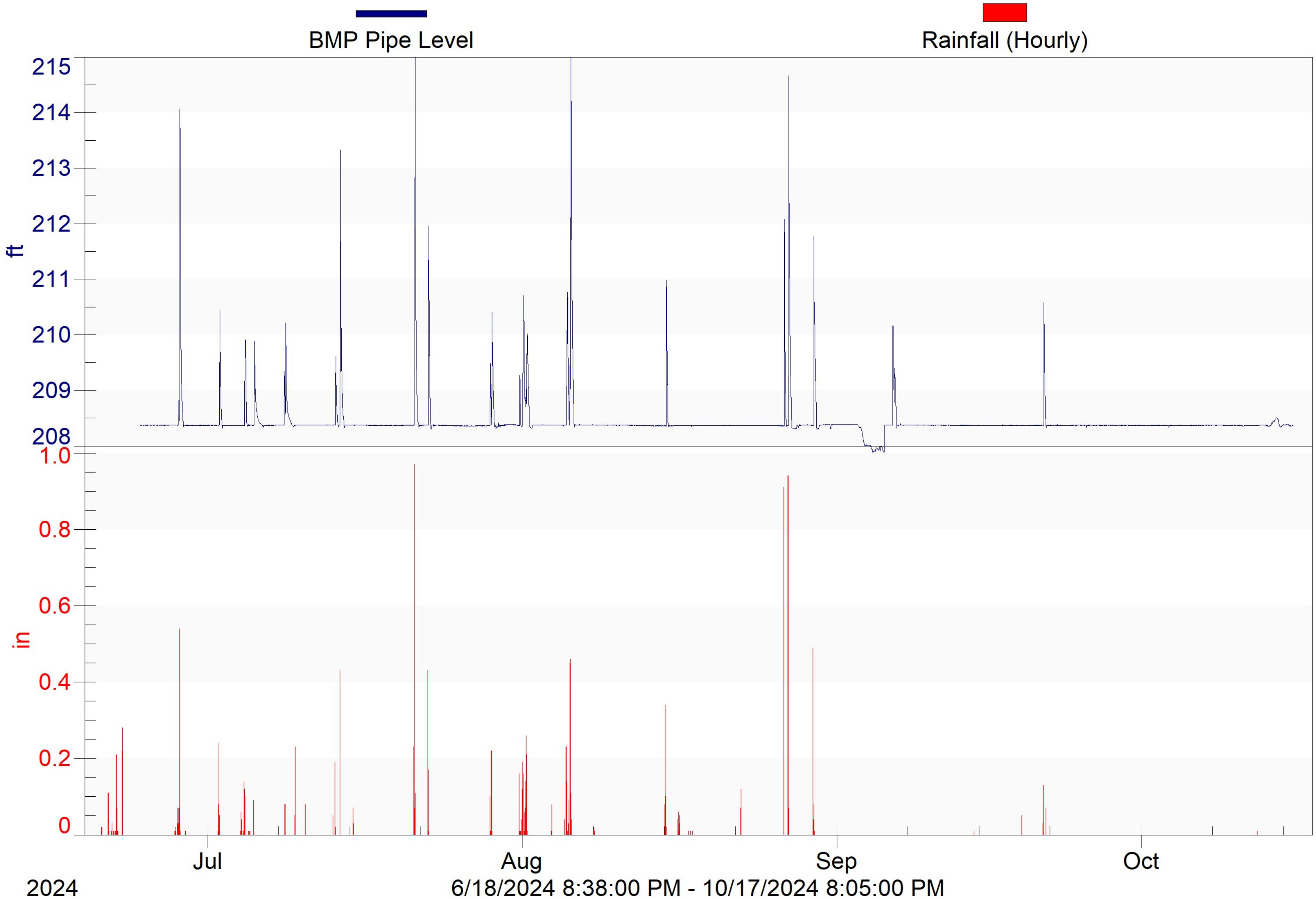
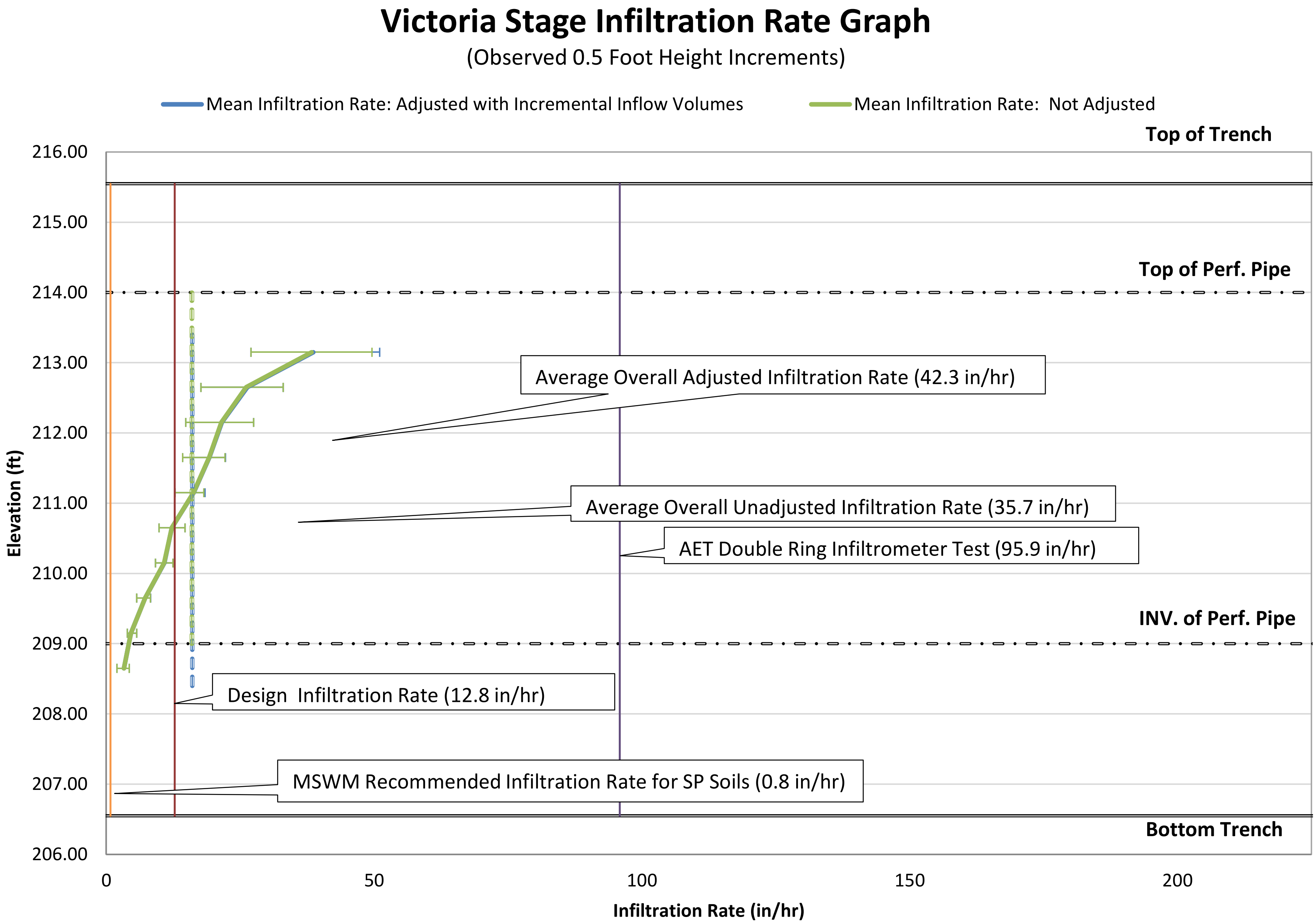


Chart A.12 Victoria

Water Level and Rainfall (SPCD)



City of Saint Paul
2024 Water Quality and Quantity Report
Chart A.13
WSB Job No.: 024571



Pipe Invert is 209
Error Bars Represent 25th and 75th Percentiles

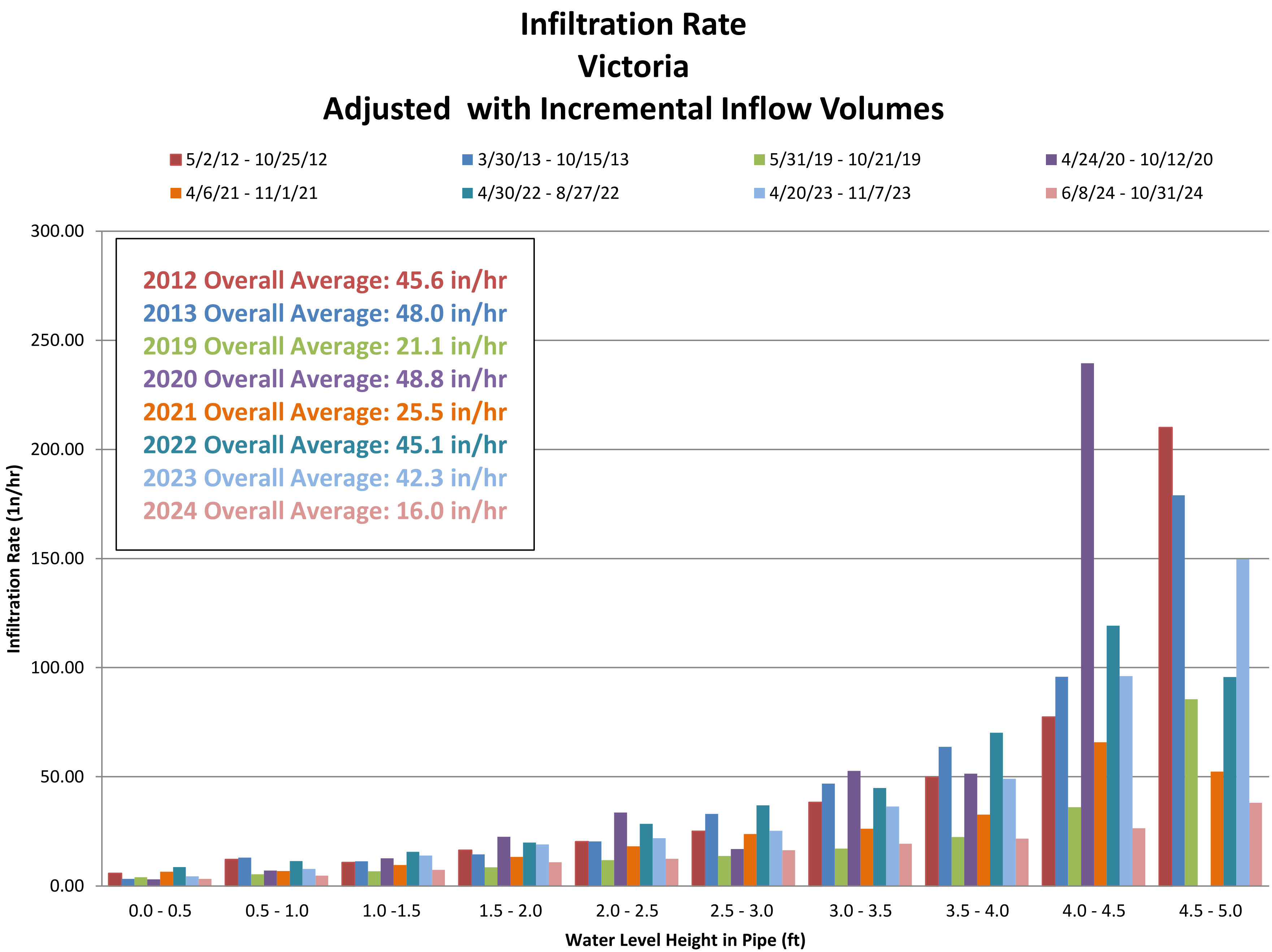

Infiltration Rate
Victoria
Adjusted with Incremental Inflow Volumes
5/2/12 - 10/25/12
3/30/13 - 10/15/13
5/31/19 - 10/21/19
4/24/20 - 10/12/20
4/6/21 - 11/1/21
4/30/22 - 8/27/22
4/20/23 - 11/7/23
6/8/24 - 10/31/24
2012 Overall Average: 45.6 in/hr
2013 Overall Average: 48.0 in/hr
2019 Overall Average: 21.1 in/hr
2020 Overall Average: 48.8 in/hr
2021 Overall Average: 25.5 in/hr
2022 Overall Average: 45.1 in/hr
2023 Overall Average: 42.3 in/hr
2024 Overall Average: 16.0 in/hr
Infiltration Rate (1n/hr)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.0 - 0.5
0.5 - 1.0
1.0 -1.5
1.5 - 2.0
2.0 - 2.5
2.5 - 3.0
3.0 - 3.5
3.5 - 4.0
4.0 - 4.5
4.5 - 5.0
Water Level Height in Pipe (ft)

Chart A.15 Allianz Field Soccer Stadium

Watever Levels and Rainfall (SPCD)

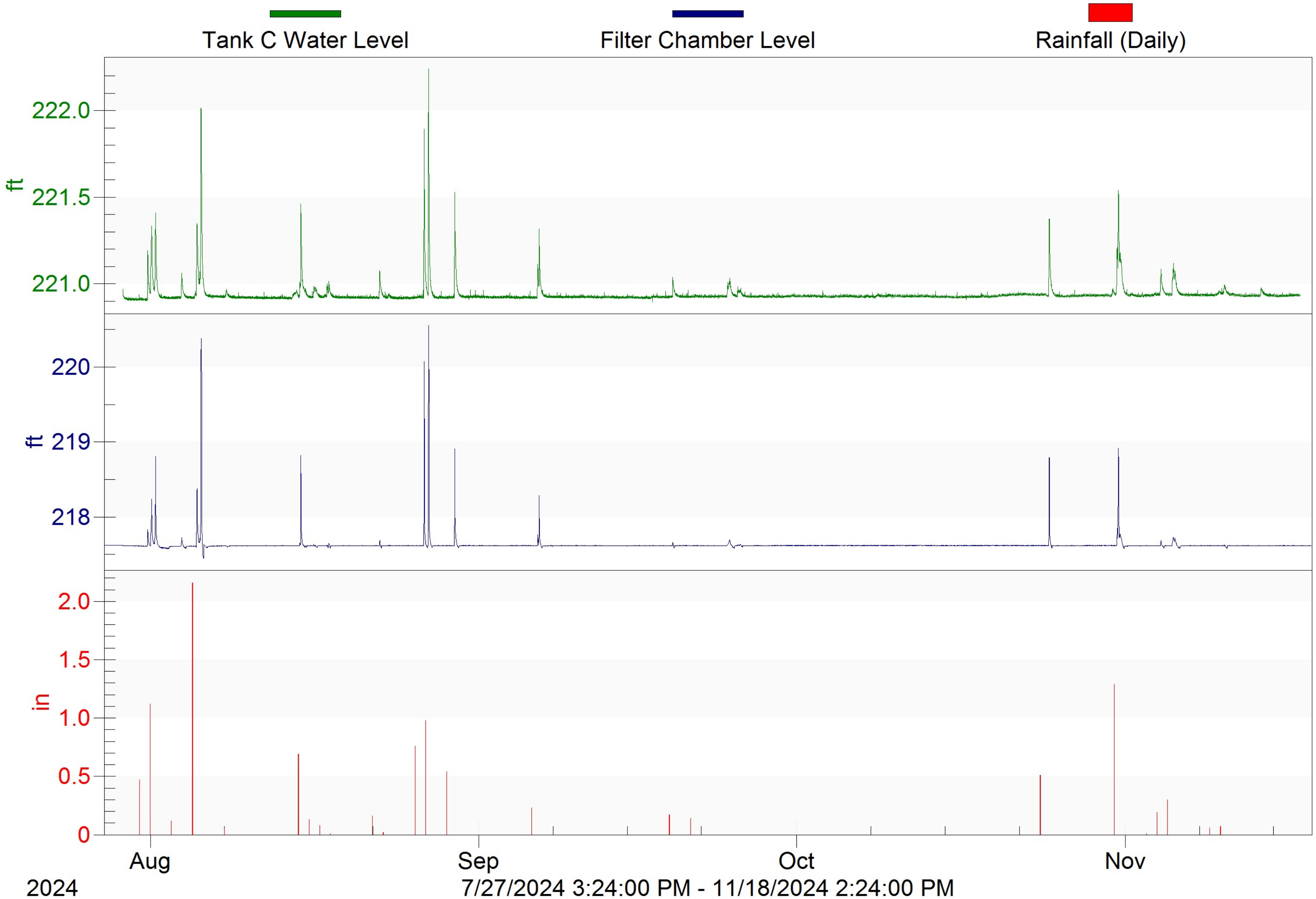


Chart B.1 Beacon Bluff

Flow Rates and Rainfall

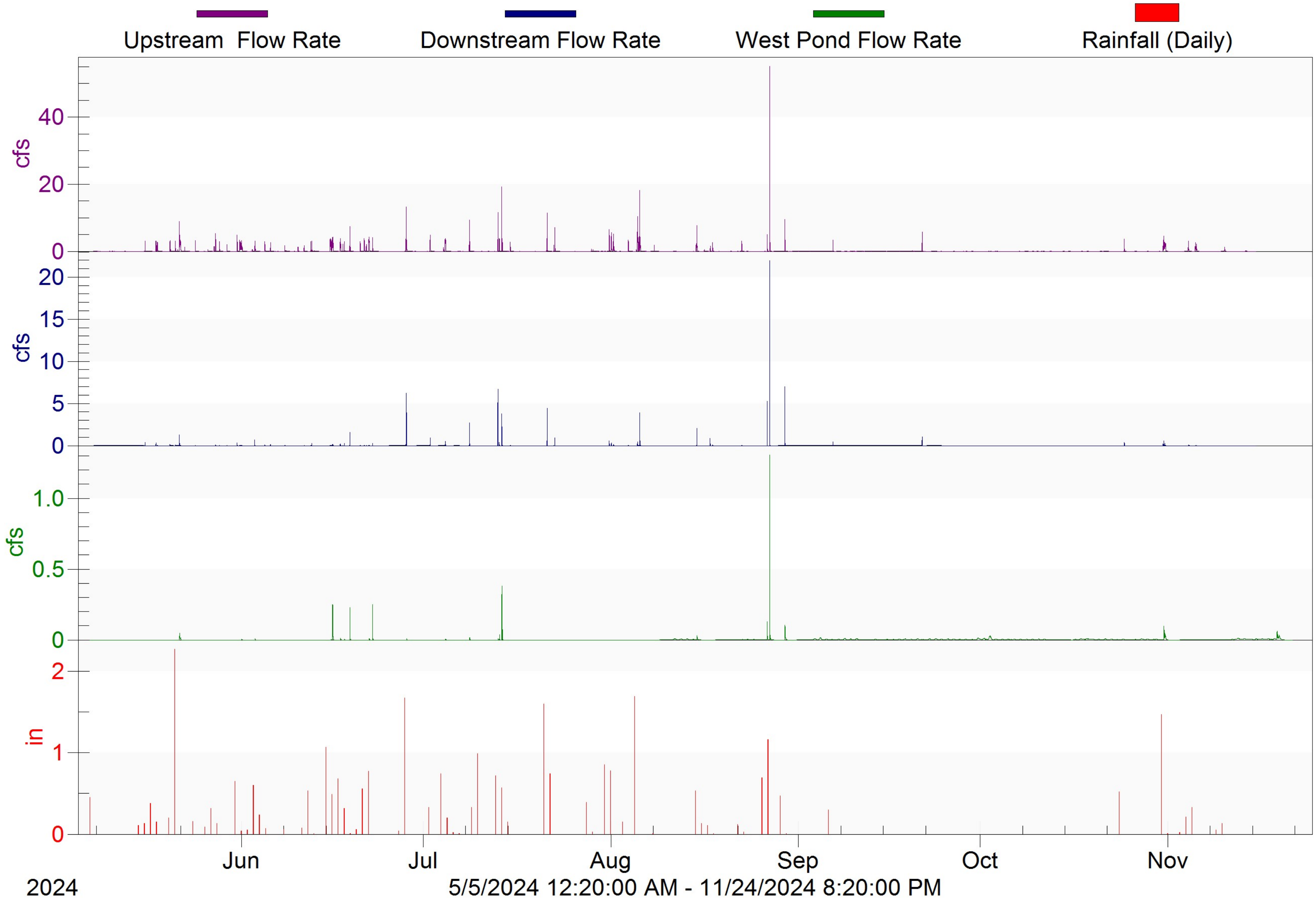


Chart B.2 St. Albans

Flow Rates and Rainfall

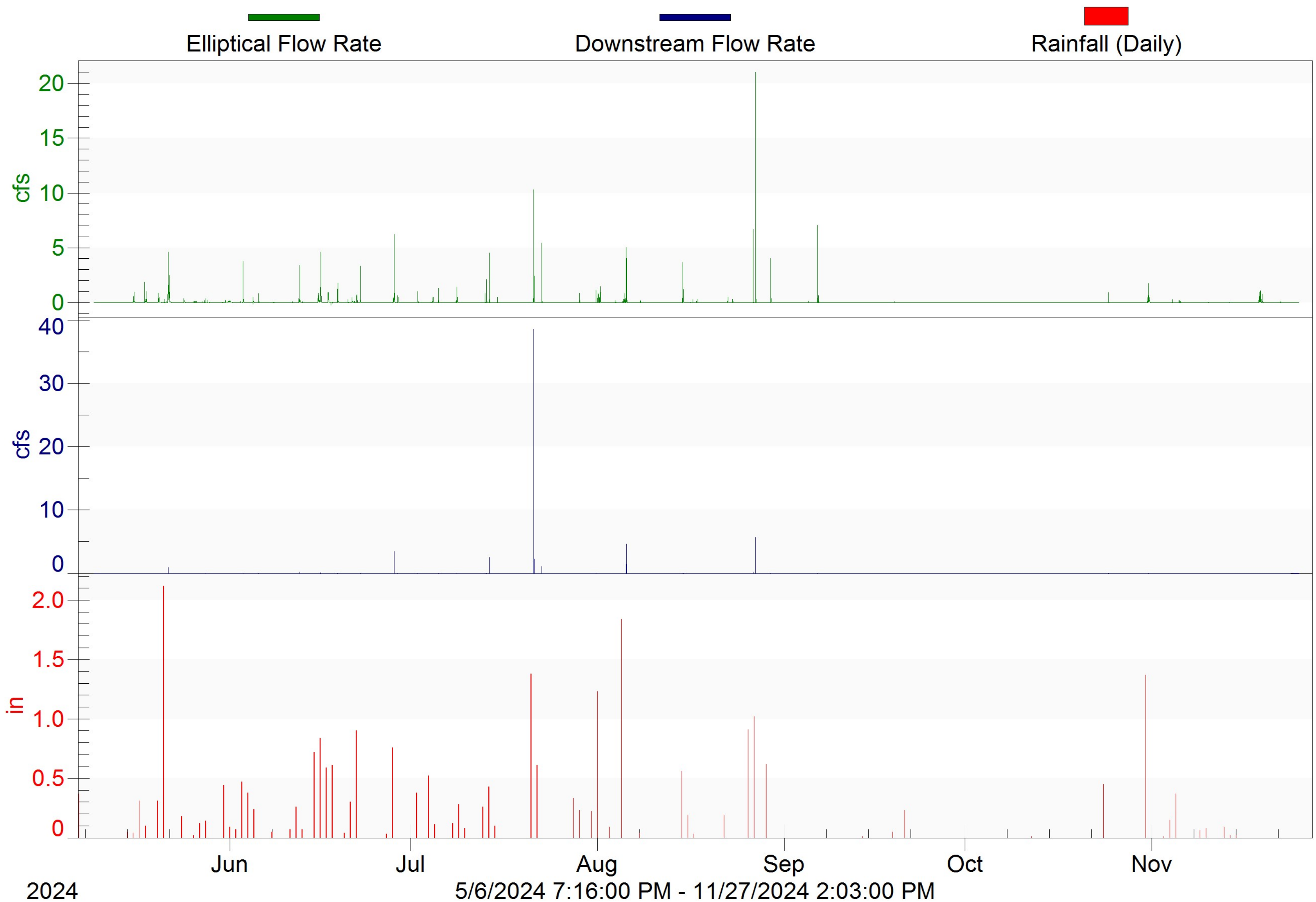


Chart B.3 Hampden Park

Flow Rates and Rainfall

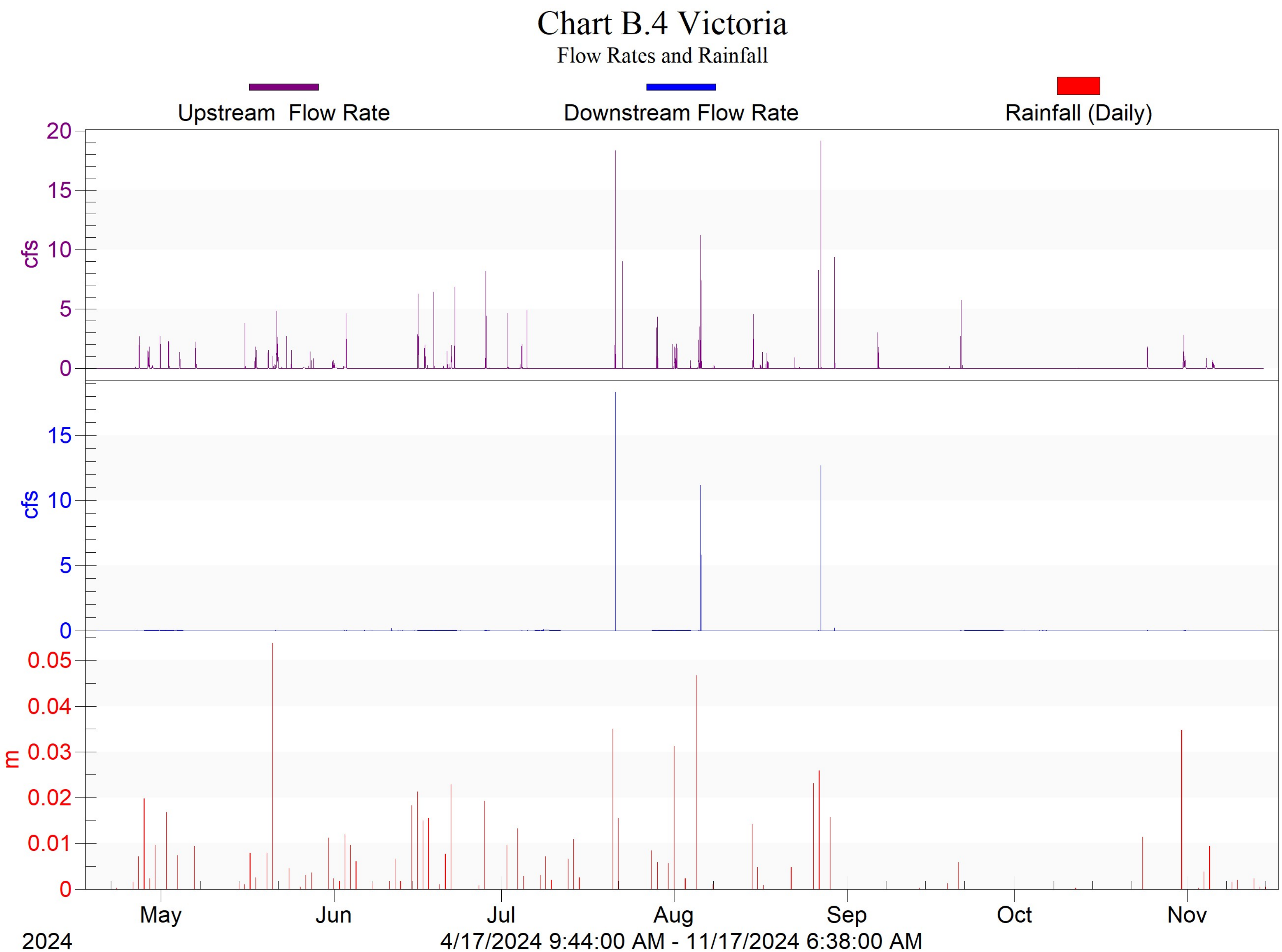


Chart B.4 Victoria
Flow Rates and Rainfall
Upstream Flow Rate
Downstream Flow Rate
Rainfall (Daily)
cfs
20
15
10
5
0
cfs
15
10
5
0
m
0.05
0.04
0.03
0.02
0.01
0
May
Jun
Jul
Aug
Sep
Oct
Nov
2024
4/17/2024 9:44:00 AM - 11/17/2024 6:38:00 AM

Chart B.5 West Shepard Pond

Flow Rates and Rainfall

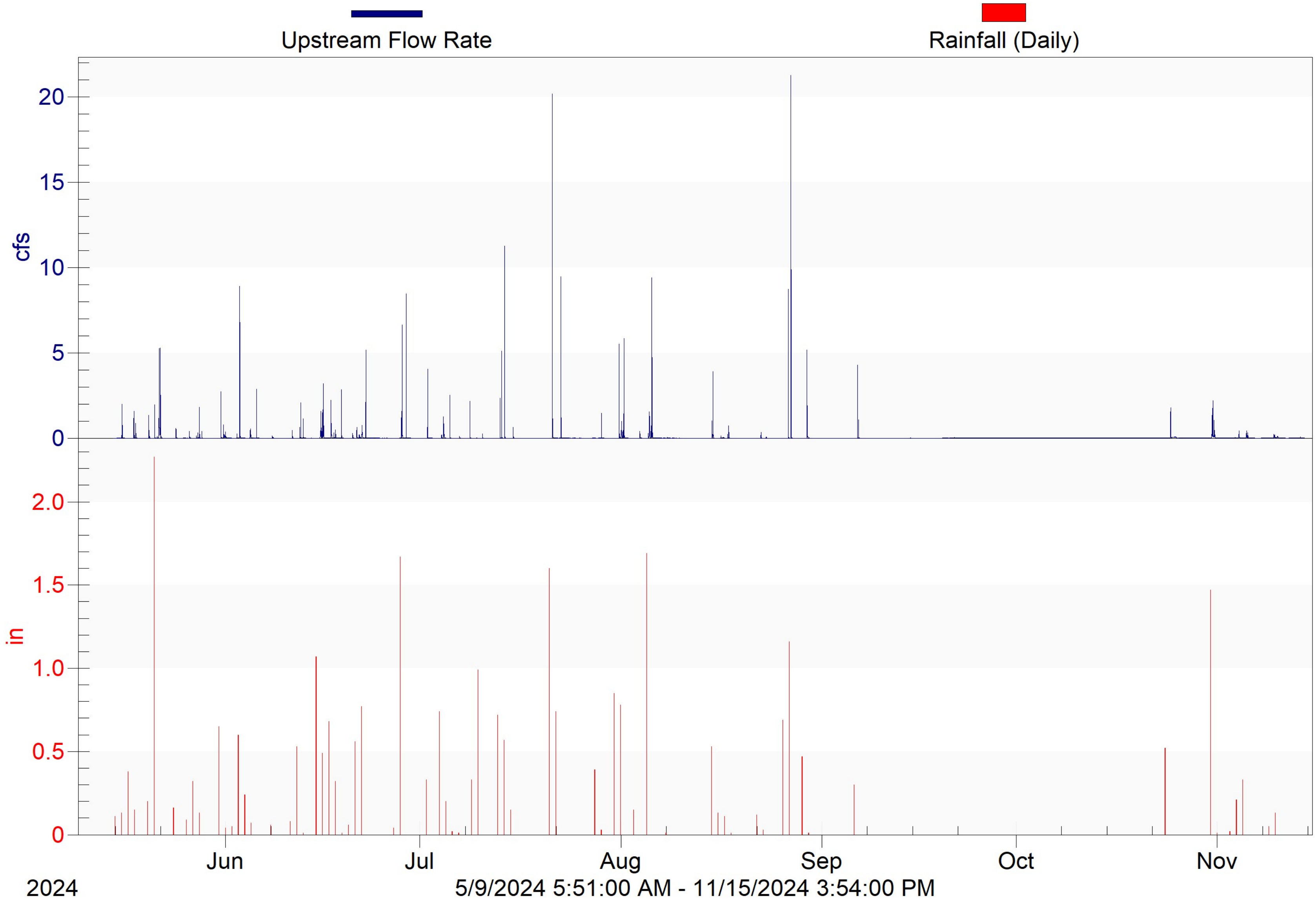
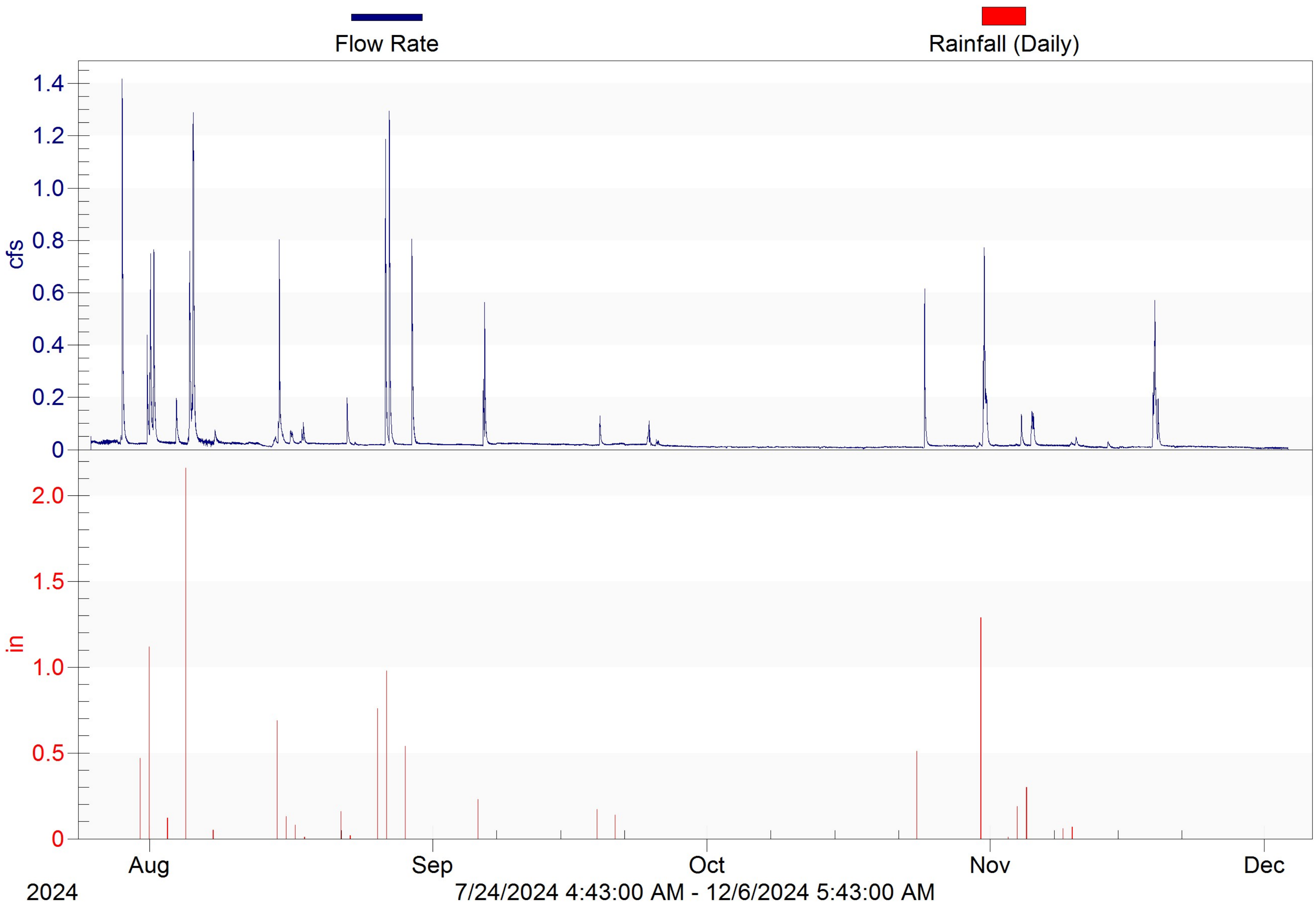


Chart B.6 Allianz Field Soccer Stadium

Flow Rates and Rainfall



City of Saint Paul
2024 Water Quality and Quantity Report
Table C.1
WSB Project Number: 024571

BEACON BLUFF WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3251225	4/2/2024 11:41	4/2/2024 11:41	46.0	856.0		0.41	0.161	456.0		2.66	0.530 <	52	21.4	13.9	107.0	40.0	7.4	229.0	2420
3260025	5/2/2024 10:24	5/2/2024 10:24	31.0	62.0			0.290	5.0 <			0.260 <		5.7	8.3	28.4	5.7	6.9	34.0	2420
3263964	5/15/2024 22:38	5/16/2024 2:18	764.0	124.0	251.0	1.58	0.527	10.0		8.95	1.160	67	33.3	39.9	190.0	55.1		392.0	
3265017	5/20/2024 3:13	5/20/2024 7:06	193.0	48.0 <	94.0	0.76	0.154	5.9		3.54	0.600	38	17.4	19.8	92.1	19.2		200.0	
3265594	5/21/2024 16:52	5/21/2024 22:58	81.0	48.0	32.0	0.28	0.057	5.0 <		1.57	0.320 <	25	11.1	16.3	53.8	7.5		101.0	
3269818	6/4/2024 19:29	6/4/2024 22:51	74.0	66.0			0.163	5.4			0.510	27	9.8	8.5	42.4	15.5		76.0	
3273577	6/15/2024 14:16	6/15/2024 16:49	101.0	56.0			0.145	5.0 <			0.390 <	27	10.1	8.6	43.7	11.5		81.0	
3283144	7/21/2024 9:01	7/21/2024 13:15	160.0	71.0			0.210	5.0 <			0.430 <	35	16.3	24.0	75.8	15.4		110.0	
3286410	8/1/2024 9:21	8/1/2024 9:21															6.7		2420
3286817	8/1/2024 0:01	8/1/2024 2:41	38.0	43.0			0.073	5.0 <			0.620 <	20	6.8	6.5	26.7	7.4		18.0	
3288482	8/5/2024 4:47	8/5/2024 11:37	44.0	46.0				5.0 <				19	5.7	6.7	30.7			40.0	
3290755	8/15/2024 2:04	8/15/2024 7:00	73.0	84.0			0.061	5.0 <			0.260 <	27	13.6	10.5	57.3	18.7		99.0	
3293970	8/26/2024 19:44	8/26/2024 21:16	137.0	76.0		0.52	0.120	5.0 <		5.10	0.540 <	30	14.4	14.0	66.9	8.3		103.0	
3312454	10/31/2024 11:52	10/31/2024 11:52	25.0	120.0		1.15	0.834	5.3	0.17	1.83			9.2	6.9	49.0	46.8	6.2	300.0	2420
MINIMUM			**25.0**	**43.0**	**32.0**	**0.28**	**0.057**	**5.0**	**0.17**	**1.57**	**0.26**	**19.4**	**5.7**	**6.5**	**26.7**	**5.7**	**6.2**	**18.0**	**2420.0**
AVERAGE			**135.9**	**130.8**	**125.7**	**0.78**	**0.233**	**40.2**	**0.17**	**3.94**	**0.51**	**33.4**	**13.4**	**14.1**	**66.4**	**20.9**	**6.8**	**137.2**	**2420.0**
MEDIAN			**74.0**	**66.0**	**94.0**	**0.64**	**0.158**	**5.0**	**0.17**	**3.10**	**0.51**	**27.3**	**11.1**	**10.5**	**53.8**	**15.5**	**6.8**	**101.0**	**2420.0**
MAXIMUM			**764.0**	**856.0**	**251.0**	**1.58**	**0.834**	**456.0**	**0.17**	**8.95**	**1.16**	**67.0**	**33.3**	**39.9**	**190.0**	**55.1**	**7.4**	**392.0**	**2420.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported

J - Result reported as estimated between the MDL and Reporting Limit (RL)

> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2024 Beacon Bluff Pollutant Loading
Table C.2
WSB Job No.: 024571

BEACON BLUFF VOLUME AND POLLUTANT REDUCTION SUMMARY

Event Time Interval		Sampling Data								Event Loading and Volume Data[1]															
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	Volume Directed from Diversion Structure into Surface Basin (1)	Inflow Volume from West Pond (Subwatershed B - Discharges to Underground System) (2)	Inflow Volume from Eastern Inlet (Subwatershed C - Discharges to Surface Basin)[3] (3)	Underground System Discharged Volume (4)	Volume Captured by BMP (1+2+3)-4	% of Total Inflow to BMP from Diversion Structure	Overall Volume reduction	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cf	cf	cf	cf	cf			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/15/2024 22:30	5/16/2024 2:41	**764.0**	**124.0**	**251.0**	**1.58**	**0.527**	**10.0**	**8.95**	**1.160**	0.19	5174	0	254	0	5429	95.3%	97.3%	258.9	42.0	85.1	0.54	0.18	3.4	3.03	0.39
5/17/2024 19:47	5/18/2024 0:14	90	56	108	0.7	0.14	5	4.4	0.54	0.35	15766	0	765	0	16531	95.4%	98.5%	92.8	58.1	111.9	0.74	0.14	5.3	4.51	0.55
5/18/2024 2:15	5/18/2024 4:57	90	56	108	0.7	0.14	5	4.4	0.47	0.12	10443	0	501	0	10943	95.4%	99.6%	61.4	38.5	74.1	0.49	0.10	3.5	2.99	0.32
5/20/2024 2:45	5/20/2024 7:03	**193.0**	**48.0** <	**94.0**	**0.76**	**0.154**	**5.9**	**3.54**	**0.600**	0.28	14280	0	690	0	14970	95.4%	98.9%	180.4	44.9	87.8	0.71	0.14	5.5	3.31	0.56
5/21/2024 1:15	5/21/2024 3:10	**81.0**	**48.0**	**32.0**	**0.28**	**0.057**	**5.0** <	**1.57**	**0.320** <	0.10	7124	0	344	0	7468	95.4%	98.9%	37.8	22.4	14.9	0.13	0.03	2.3	0.73	0.15
5/21/2024 16:49	5/22/2024 0:15	90	56	108	0.7	0.14	5	4.4	0.26	1.35	60668	377	2970	45708	18307	94.7%	27.9%	102.7	64.3	123.9	0.82	0.16	5.9	5.00	0.30
5/22/2024 14:15	5/22/2024 15:47	90	56	108	0.7	0.14	5	4.4	1.16	0.03	2088	0	100	0	2188	95.4%	100.0%	12.3	7.7	14.8	0.10	0.02	0.7	0.60	0.16
5/24/2024 8:07	5/24/2024 10:29	90	56	108	0.7	0.14	5	4.4	0.00	0.14	10880	0	521	0	11401	95.4%	99.8%	64.0	40.1	77.2	0.51	0.10	3.7	3.11	0.00
5/26/2024 10:00	5/26/2024 11:23	90	56	108	0.7	0.14	5	4.4	0.00	0.06	735	0	35	0	770	95.4%	100.0%	4.3	2.7	5.2	0.03	0.01	0.2	0.21	0.00
5/27/2024 10:45	5/27/2024 13:05	90	56	108	0.7	0.14	5	4.4	0.00	0.06	3076	0	147	0	3222	95.4%	100.0%	18.1	11.3	21.8	0.14	0.03	1.0	0.88	0.00
5/27/2024 16:45	5/27/2024 18:58	90	56	108	0.7	0.14	5	4.4	0.00	0.07	7103	0	341	0	7443	95.4%	99.6%	41.8	26.2	50.4	0.33	0.06	2.4	2.03	0.00
5/28/2024 8:18	5/28/2024 10:14	90	56	108	0.7	0.14	5	4.4	0.43	0.07	7073	0	340	0	7413	95.4%	99.5%	41.6	26.1	50.2	0.33	0.06	2.4	2.02	0.20
5/31/2024 6:27	5/31/2024 8:36	90	56	108	0.7	0.14	5	4.4	0.00	0.27	9574	0	467	0	10042	95.3%	97.9%	56.3	35.3	68.0	0.45	0.09	3.2	2.74	0.00
5/31/2024 16:28	6/1/2024 5:00	90	56	108	0.7	0.14	5	4.4	0.00	0.49	59226	17	2831	8963	53111	95.4%	85.5%	298.0	186.7	359.5	2.37	0.46	17.1	14.50	0.00
6/3/2024 3:03	6/3/2024 8:44	90	56	108	0.7	0.14	5	4.4	0.00	0.46	16162	17	781	10052	6908	95.3%	40.3%	38.8	24.3	46.8	0.31	0.06	2.2	1.89	0.00
6/4/2024 19:24	6/4/2024 23:39	**74.0**	**66.0**	108	0.7	**0.163**	**5.4**	4.4	**0.510**	0.25	15029	0	721	0	15749	95.4%	99.6%	72.8	64.9	106.6	0.70	0.16	5.3	4.30	0.50
6/5/2024 18:26	6/5/2024 20:01	90	56	108	0.7	0.14	5	4.4	0.62	0.14	4360	0	210	0	4570	95.4%	99.0%	25.6	16.1	30.9	0.20	0.04	1.5	1.25	0.18
6/8/2024 2:30	6/8/2024 8:24	90	56	108	0.7	0.14	5	4.4	0.00	0.08	3948	0	189	0	4137	95.4%	99.9%	23.2	14.5	28.0	0.18	0.04	1.3	1.13	0.00
6/11/2024 7:30	6/11/2024 9:30	90	56	108	0.7	0.14	5	4.4	0.00	0.07	3755	0	179	0	3934	95.4%	100.0%	22.1	13.8	26.6	0.18	0.03	1.3	1.07	0.00
6/12/2024 10:00	6/12/2024 12:37	90	56	108	0.7	0.14	5	4.4	0.00	0.12	8620	0	414	0	9033	95.4%	99.6%	50.7	31.7	61.1	0.40	0.08	2.9	2.47	0.00
6/12/2024 14:15	6/12/2024 16:25	90	56	108	0.7	0.14	5	4.4	0.26	0.25	5276	0	256	0	5531	95.4%	98.6%	31.0	19.4	37.4	0.25	0.05	1.8	1.51	0.09
6/15/2024 14:11	6/15/2024 21:13	**101.0**	**56.0**	108	0.7	**0.145**	**5.0** <	4.4	**0.390** <	0.61	46679	6	2239	7008	41916	95.4%	85.3%	264.3	146.5	283.7	1.87	0.38	13.1	11.44	1.02
6/15/2024 22:59	6/16/2024 5:27	90	56	108	0.7	0.14	5	4.4	0.00	0.96	40060	1120	1933	29874	13239	92.7%	30.4%	74.3	46.5	89.6	0.59	0.12	4.3	3.61	0.00
6/17/2024 5:23	6/17/2024 11:17	90	56	108	0.7	0.14	5	4.4	0.00	0.62	32724	89	1574	11796	22592	95.2%	65.2%	126.8	79.4	152.9	1.01	0.20	7.3	6.17	0.00
6/17/2024 17:00	6/17/2024 18:45	90	56	108	0.7	0.14	5	4.4	0.54	0.05	4132	0	197	0	4330	95.4%	100.0%	24.3	15.2	29.3	0.19	0.04	1.4	1.18	0.15
6/17/2024 23:29	6/18/2024 1:42	90	56	108	0.7	0.14	5	4.4	0.00	0.10	6577	15	318	0	6911	95.2%	98.8%	38.8	24.3	46.8	0.31	0.06	2.2	1.89	0.00
6/18/2024 20:57	6/18/2024 23:33	90	56	108	0.7	0.14	5	4.4	0.00	0.33	15154	462	751	5426	10941	92.4%	64.6%	61.4	38.5	74.1	0.49	0.10	3.5	2.99	0.00
6/20/2024 14:15	6/20/2024 16:06	90	56	108	0.7	0.14	5	4.4	0.00	0.08	8250	0	394	0	8645	95.4%	100.0%	48.5	30.4	58.5	0.39	0.08	2.8	2.36	0.00
6/21/2024 5:35	6/21/2024 8:47	90	56	108	0.7	0.14	5	4.4	0.00	0.24	22883	0	1096	0	23979	95.4%	99.8%	134.5	84.3	162.3	1.07	0.21	7.7	6.55	0.00
6/21/2024 13:20	6/21/2024 16:03	90	56	108	0.7	0.14	5	4.4	0.00	0.06	6112	0	292	0	6404	95.4%	100.0%	35.9	22.5	43.3	0.29	0.06	2.1	1.75	0.00
6/22/2024 0:00	6/22/2024 5:01	90	56	108	0.7	0.14	5	4.4	0.54	0.42	36978	71	1770	8255	30565	95.2%	78.6%	171.5	107.4	206.9	1.36	0.27	9.8	8.34	1.02
6/22/2024 14:41	6/22/2024 17:10	90	56	108	0.7	0.14	5	4.4	0.47	0.52	13017	473	634	9033	5092	91.9%	35.4%	28.6	17.9	34.5	0.23	0.04	1.6	1.39	0.15
6/28/2024 2:17	6/28/2024 8:14	90	56	108	0.7	0.14	5	4.4	0.26	1.23	29594	12	1644	28523	2727	94.7%	7.6%	15.3	9.6	18.5	0.12	0.02	0.9	0.74	0.04
7/2/2024 1:15	7/2/2024 5:54	90	56	108	0.7	0.14	5	4.4	0.51	0.40	22767	0	1133	0	23900	95.3%	96.2%	134.1	84.0	161.8	1.07	0.21	7.7	6.52	0.76
7/4/2024 8:00	7/4/2024 19:31	90	56	108	0.7	0.14	5	4.4	0.26	0.64	44156	29	2164	8230	38119	95.3%	80.3%	213.9	134.0	258.0	1.70	0.33	12.2	10.41	0.62
7/8/2024 13:00	7/8/2024 18:06	90	56	108	0.7	0.14	5	4.4	1.16	0.27	23525	38	1220	790	23993	94.9%	89.5%	134.6	84.3	162.4	1.07	0.21	7.7	6.55	1.74
7/13/2024 8:02	7/13/2024 9:33	90	56	108	0.7	0.14	5	4.4	0.00	0.46	8272	13	553	0	8838	93.6%	72.7%	49.6	31.1	59.8	0.39	0.08	2.8	2.41	0.00
7/13/2024 13:30	7/13/2024 15:45	90	56	108	0.7	0.14	5	4.4	0.00	0.22	15477	52	754	0	16283	95.0%	98.1%	91.4	57.2	110.2	0.73	0.14	5.2	4.45	0.00
7/13/2024 23:37	7/14/2024 2:33	90	56	108	0.7	0.14	5	4.4	0.00	0.70	19187	993	1088	21200	68	89.7%	0.3%	0.4	0.2	0.5	0.00	0.00	0.0	0.02	0.00
7/15/2024 8:40	7/15/2024 11:02	90	56	108	0.7	0.14	5	4.4	0.00	0.10	6076	0	291	0	6367	95.4%	99.8%	35.7	22.4	43.1	0.28	0.06	2.0	1.74	0.00
7/21/2024 8:58	7/21/2024 13:22	**160.0**	**71.0**	108	0.7	**0.210**	**5.0** <	4.4	**0.430** <	0.62	23283	0	1313	11197	13399	94.7%	46.5%	133.8	59.4	90.7	0.60	0.18	4.2	3.66	0.36
7/22/2024 18:00	7/22/2024 19:37	90	56	108	0.7	0.14	5	4.4	0.00	0.35	10092	0	518	0	10610	95.1%	93.3%	59.5	37.3	71.8	0.47	0.09	3.4	2.90	0.00
7/28/2024 23:45	7/29/2024 2:09	90	56	108	0.7	0.14	5	4.4	0.00	0.06	1120	0	54	0	1174	95.4%	100.0%	6.6	4.1	7.9	0.05	0.01	0.4	0.32	0.00
7/31/2024 16:38	7/31/2024 20:11	90	56	108	0.7	0.14	5	4.4	0.00	0.21	8343	0	416	0	8759	95.2%	95.9%	49.1	30.8	59.3	0.39	0.08	2.8	2.39	0.00
7/31/2024 23:40	8/1/2024 4:31	90	56	108	0.7	0.14	5	4.4	0.00	0.56	44307	0	2172	6862	39617	95.3%	83.2%	222.3	139.2	268.2	1.77	0.35	12.7	10.82	0.00
8/1/2024 7:42	8/1/2024 14:01	**38.0**	**43.0**	108	0.7	**0.073**	**5.0** <	4.4	**0.620** <	0.32	27535	0	1326	4077	24784	95.4%	85.2%	58.8	66.5	167.8	1.11	0.11	7.7	6.77	0.96
8/3/2024 21:11	8/3/2024 23:05	90	56	108	0.7	0.14	5	4.4	0.00	0.14	9581	0	458	0	10039	95.4%	99.8%	56.3	35.3	68.0	0.45	0.09	3.2	2.74	0.00
8/5/2024 5:04	8/5/2024 22:18	**44**	**46**	108	0.7	0.14	**5.0** <	4.4	0.00	2.22	120004	0	6078	77788	48294	95.2%	36.2%	132.7	138.7	326.9	2.16	0.42	15.1	13.18	0.00
8/8/2024 0:20	8/8/2024 4:18	90	56	108	0.7	0.14	5	4.4	0.00	0.08	3667	0	175	0	3842	95.4%	100.0%	21.6	13.5	26.0	0.17	0.03	1.2	1.05	0.00
8/15/2024 1:58	8/15/2024 7:09	**73.0**	**84.0**	108	0.7	**0.061**	**5.0** <	4.4	**0.260** <	0.78	24784	163	1293	603	25637	94.4%	89.9%	116.8	134.4	173.5	1.14	0.10	8.0	7.00	0.42
8/16/2024 9:00	8/16/2024 11:27	90	56	108	0.7	0.14	5	4.4	0.00	0.06	1202	0	57	0	1260	95.4%	100.0%	7.1	4.4	8.5	0.06	0.01	0.4	0.34	0.00
8/17/2024 9:41	8/17/2024 11:03	90	56	108	0.7	0.14	5	4.4	0.00	0.15	2207	0	129	0	2336	94.5%	82.7%	13.1	8.2	15.8	0.10	0.02	0.8	0.64	0.00
8/22/2024 13:45	8/22/2024 16:18	90	56	108	0.7	0.14	5	4.4	0.00	0.13	8908	21	426	0	9356	95.2%	99.8%	52.5	32.9	63.3	0.42	0.08	3.0	2.55	0.00
8/26/2024 19:30	8/26/2024 21:20	**137.0**	**76.0**	108	**0.52**	**0.120**	**5.0** <	**5.10**	**0.540** <	0.04	8497	282	517	0	9296	91.1%	80.0%	79.5	44.1	62.9	0.30	0.07	2.9	2.96	0.31
8/27/2024 5:40	8/27/2024 9:25	90	56	108	0.7	0.14	5	4.4	0.00	0.64	38877	1854	2608	21261	22079	89.2%	37.4%	123.9	77.6	149.4	0.99	0.19	7.1	6.03	0.00
8/29/2024 16:30	8/29/2024 22:29	90	56	108	0.7	0.14	5	4.4	0.00	0.60	21753	686	1288	5916	17811	91.4%	61.6%	99.9	62.6	120.6	0.80	0.16	5.7	4.86	0.00
10/24/2024 17:40	10/24/2024 20:57	90	56	108	0.7	0.14	5	4.4	0.00	0.52	8665	35	461	0	9160	94.6%	90.3%	51.4	32.2	62.0	0.41	0.08	2.9	2.50	0.00
10/31/2024 3:30	10/31/2024 17:07	90	56	108	0.7	0.14	5	4.4	0.00	1.47	70463	1063	3508	0	75035	93.8%	96.2%	421.0	263.7	507.9	3.35	0.65	24.1	20.49	0.00
Sum										21.91	1,105,269	7,886	55,904	322,562	846,497			**4,924**	**3,012**	**5,729**	**37.82**	**7.346**	**273.0**	**231.0**	**10.9**
Average		166.5	66.2	125.7	0.79	0.168	5.6	4.79	0.537																
Weighted Ave		89.9	56.3	108.4	0.72	0.140	5.1	4.37	0.467																
STDEV		215.8	24.7	112.9	0.57	0.144	1.6	3.13	0.264																
Median		91.0	61.0	94.0	0.64	0.145	5.0	4.32	0.510																
Min		38.0	43.0	32.0	0.28	0.057	5.0	1.57	0.260																
Max		764.0	124.0	251.0	1.58	0.527	10.0	8.95	1.160																
Percent Capture of Total Runoff															**69%**			**71.1%**	**69.4%**	**68.6%**	**68.6%**	**68.2%**	**68.8%**	**68.6%**	**77.6%**

Calculated Volume 3

< Sample Was not detected above the method detection limit (MDL) - MDL is reported
J Result reported as estimated between the MDL and the Reporting Limit (RL)
BOLD Sampled Event
GREY Events with no sampling data (weighted average used)
1 See Figure 2 for Locations of Subwatersheds
2 Erroneous flow data was recorded at the diversion upstream, on occasion, as a result of turbulent and high velocity flow. Runoff to the diversion was modeled for those events using a rainfall to runoff ratio developed using historical monitoring data. The events are shaded brown.
3 Volume calculated based on ratio of Subwatershed C area to Subwatershed A area - (4.66 ac)/(136.77 ac)*(Upstream Volume)

City of Saint Paul
2024 Water Quality and Quantity Report
Table C.3
WSB Project Number: 024571

SAINT ALBANS WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3251219	4/2/2024 11:08	4/2/2024 11:08	93.0	1310.0		0.69		760.0		3.60	0.500 <	76	41.4	17.4	245.0		7.20	248.0	1120
3259999	5/2/2024 10:00	5/2/2024 10:00	13.0	29.0			0.101	5.0 <			0.260 <		10.0	4.1	29.1	14.4	7.6	46.0	2420
3265588	5/21/2024 16:39	5/21/2024 19:59	115.0	45.0	45.0	0.32	0.042	19.6		1.84	0.650 <	36	16.4	25.4	95.3	5.9		91.0	
3266466	5/24/2024 8:07	5/24/2024 9:56	43.0	49.0	25.0	0.23	0.130	5.3		1.38	0.580 <	23	10.8	6.3	58.8	15.0		78.0	
3269262	6/3/2024 4:04	6/3/2024 5:30	206.0	31.0		0.39	0.064	5.0 <	0.24	2.45	0.430 <	44	26.2	36.5	130.0	3.6		116.0	
3286404	8/1/2024 10:42	8/1/2024 10:42															7.60		1414
3312448	10/31/2024 12:45	10/31/2024 12:45	85.0	57.0		0.47	0.326	5.0 <	0.12	0.81			45.4	21.7	124.0	18.7	5.90	108.0	2420
MINIMUM			**13.0**	**29.0**	**25.0**	**0.2**	**0.0**	**5.0**	**0.1**	**0.8**	**0.3**	**23.0**	**10.0**	**4.1**	**29.1**	**3.6**	**5.9**	**46.0**	**1120**
AVERAGE			**92.5**	**253.5**	**35.0**	**0.4**	**0.1**	**133.3**	**0.2**	**2.0**	**0.5**	**44.5**	**25.0**	**18.6**	**113.7**	**11.5**	**7.1**	**114.5**	**1844**
MEDIAN			**89.0**	**47.0**	**35.0**	**0.4**	**0.1**	**5.2**	**0.2**	**1.8**	**0.5**	**39.7**	**21.3**	**19.6**	**109.7**	**14.4**	**7.4**	**99.5**	**1917**
MAXIMUM			**206.0**	**1310.0**	**45.0**	**0.7**	**0.3**	**760.0**	**0.2**	**3.6**	**0.7**	**75.7**	**45.4**	**36.5**	**245.0**	**18.7**	**7.6**	**248.0**	**2420**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported

J - Result reported as estimated between the MDL and Reporting Limit (RL)

> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2024 St. Albans Volume Reduction Pollutant Loading
Table C.4
WSB Project No.: 024571

SAINT ALBANS INFILTRATION SYSTEM VOLUME REDUCTION AND POLLUTANT LOADING

Event Time Interval		Sampling Data									Event Loading and Volume Data													
Start	End	TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	Eliptical Volume (1)	University 1 Volume (2)	Bypass Volume (3)	Volume Captured by BMP (1+2-3)	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Total Nitrogen	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cu-ft	cu-ft	cu-ft	cu-ft	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/15/24 22:00	5/16/24 15:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.09	2100	1407	0	3506	93.4	82.3	42.4	0.57	0.137	13.6	0.0	3.0	0.1
5/17/24 19:15	5/17/24 23:35	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.31	4522	3030	0	7551	58.0	20.7	20.6	0.16	0.034	7.3	0.0	0.9	0.3
5/18/24 2:23	5/18/24 4:40	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.09	1560	1045	0	2605	20.0	7.2	7.1	0.05	0.012	2.5	0.0	0.3	0.1
5/20/24 2:15	5/20/24 6:38	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.3	3070	2057	0	5126	39.3	14.1	14.0	0.11	0.023	5.0	0.0	0.6	0.2
5/21/24 1:00	5/21/24 4:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.2	927	621	0	1548	11.9	4.3	4.2	0.03	0.007	1.5	0.0	0.2	0.1
5/21/24 10:15	5/21/24 13:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.07	434	291	0	724	5.6	2.0	2.0	0.02	0.003	0.7	0.0	0.1	0.0
5/21/24 16:45	5/22/24 2:00	**115.0**	**45.0**	**45.0**	**0.32**	**0.042**	**19.6**	0.2	**1.84**	**0.650** <	1.83	27786	18617	423	45980	330.1	129.2	129.2	0.92	0.121	56.3	0.0	5.3	1.9
5/24/24 8:00	5/24/24 16:15	**43.0**	**49.0**	**25.0**	**0.23**	**0.130**	**5.3**	0.2	**1.38**	**0.580** <	0.18	1930	1293	0	3223	8.7	9.9	5.0	0.05	0.026	1.1	0.0	0.3	0.1
5/28/24 7:00	5/28/24 17:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.13	941	631	0	1572	12.1	4.3	4.3	0.03	0.007	1.5	0.0	0.2	0.1
5/31/24 6:15	5/31/24 15:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.15	1096	734	0	1830	14.0	5.0	5.0	0.04	0.008	1.8	0.0	0.2	0.1
5/31/24 15:30	6/1/24 13:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.38	3747	2511	0	6258	48.0	17.2	17.1	0.13	0.028	6.1	0.0	0.7	0.2
6/2/24 17:30	6/2/24 22:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.07	528	354	0	882	6.8	2.4	2.4	0.02	0.004	0.9	0.0	0.1	0.0
6/3/24 2:15	6/3/24 7:00	**206.0**	**31.0**	44	**0.39**	**0.064**	**5.0**	< **0.24**	**2.45**	**0.430** <	0.46	5888	3945	16	9818	126.3	19.0	26.8	0.24	0.039	3.1	0.0	1.5	0.3
6/4/24 19:15	6/5/24 0:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.38	1794	1202	0	2996	23.0	8.2	8.2	0.06	0.013	2.9	0.0	0.3	0.1
6/5/24 18:15	6/5/24 19:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.23	1205	807	2	2010	15.4	5.5	5.5	0.04	0.009	1.9	0.0	0.2	0.1
6/8/24 4:15	6/8/24 9:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.05	127	85	0	212	1.6	0.6	0.6	0.00	0.001	0.2	0.0	0.0	0.0
6/11/24 7:15	6/11/24 13:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.07	367	246	0	614	4.7	1.7	1.7	0.01	0.003	0.6	0.0	0.1	0.0
6/12/24 10:00	6/12/24 12:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.12	1019	682	0	1701	13.1	4.7	4.6	0.04	0.008	1.6	0.0	0.2	0.1
6/12/24 14:15	6/12/24 16:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.12	3816	2557	30	6343	48.7	17.4	17.3	0.13	0.028	6.1	0.0	0.7	0.2
6/12/24 23:15	6/13/24 2:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.09	327	219	0	545	4.2	1.5	1.5	0.01	0.002	0.5	0.0	0.1	0.0
6/15/24 14:00	6/15/24 21:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.5	6425	4305	0	10730	82.4	29.5	29.3	0.23	0.048	10.4	0.0	1.2	0.4
6/15/24 22:46	6/16/24 6:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	1.05	16854	11292	19	28127	215.9	77.3	76.7	0.59	0.126	27.3	0.0	3.2	1.1
6/17/24 5:30	6/17/24 12:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.56	6867	4601	0	11467	88.0	31.5	31.3	0.24	0.051	11.1	0.0	1.3	0.4
6/17/24 17:16	6/17/24 20:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.02	500	335	0	835	6.4	2.3	2.3	0.02	0.004	0.8	0.0	0.1	0.0
6/18/24 20:45	6/19/24 1:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.61	3585	2402	6	5980	45.9	16.4	16.3	0.13	0.027	5.8	0.0	0.7	0.2
6/20/24 14:15	6/20/24 18:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.04	634	425	0	1058	8.1	2.9	2.9	0.02	0.005	1.0	0.0	0.1	0.0
6/21/24 5:15	6/21/24 10:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.21	1865	1250	0	3115	23.9	8.6	8.5	0.07	0.014	3.0	0.0	0.4	0.1
6/21/24 14:15	6/21/24 20:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.05	551	369	0	921	7.1	2.5	2.5	0.02	0.004	0.9	0.0	0.1	0.0
6/21/24 23:30	6/22/24 4:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.44	4056	2717	0	6773	52.0	18.6	18.5	0.14	0.030	6.6	0.0	0.8	0.3
6/22/24 14:30	6/22/24 17:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.5	6419	4301	6	10714	82.2	29.4	29.2	0.23	0.048	10.4	0.0	1.2	0.4
6/28/24 2:00	6/28/24 4:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.13	1197	802	0	2000	15.3	5.5	5.5	0.04	0.009	1.9	0.0	0.2	0.1
6/28/24 4:45	6/28/24 9:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.65	19564	13108	3544	29128	223.6	80.0	79.5	0.61	0.131	28.2	0.0	3.3	1.1
6/28/24 20:30	6/28/24 22:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.01	1114	746	0	1860	14.3	5.1	5.1	0.04	0.008	1.8	0.0	0.2	0.1
7/2/24 2:30	7/2/24 6:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.37	2689	1801	0	4490	34.5	12.3	12.2	0.09	0.020	4.4	0.0	0.5	0.2
7/4/24 7:30	7/4/24 11:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.12	86	58	0	144	1.1	0.4	0.4	0.00	0.001	0.1	0.0	0.0	0.0
7/4/24 14:00	7/4/24 19:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.4	3174	2127	0	5301	40.7	14.6	14.5	0.11	0.024	5.1	0.0	0.6	0.2
7/5/24 14:00	7/5/24 16:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.09	2072	1388	7	3453	26.5	9.5	9.4	0.07	0.015	3.3	0.0	0.4	0.1
7/8/24 16:00	7/8/24 19:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.12	2716	1820	5	4531	34.8	12.4	12.4	0.10	0.020	4.4	0.0	0.5	0.2
7/13/24 8:00	7/13/24 9:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.05	1205	807	0	2012	15.4	5.5	5.5	0.04	0.009	1.9	0.0	0.2	0.1
7/13/24 13:30	7/13/24 16:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.21	3950	2647	10	6587	50.6	18.1	18.0	0.14	0.030	6.4	0.0	0.8	0.3
7/14/24 1:15	7/14/24 3:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.43	8892	5958	0	14850	114.0	40.8	40.5	0.31	0.067	14.4	0.0	1.7	0.6
7/15/24 8:30	7/15/24 10:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.1	1164	780	0	1944	14.9	5.3	5.3	0.04	0.009	1.9	0.0	0.2	0.1
7/21/24 8:45	7/21/24 13:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	1.35	24253	16250	16407	24096	184.9	66.2	65.7	0.51	0.108	23.3	0.0	2.8	0.9
7/22/24 17:45	7/22/24 20:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.61	5772	3868	0	9640	74.0	26.5	26.3	0.20	0.043	9.3	0.0	1.1	0.4
7/28/24 23:30	7/29/24 1:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.56	2522	1690	0	4212	32.3	11.6	11.5	0.09	0.019	4.1	0.0	0.5	0.2
7/31/24 17:30	7/31/24 20:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.18	2029	1359	0	3388	26.0	9.3	9.2	0.07	0.015	3.3	0.0	0.4	0.1
8/1/24 0:00	8/1/24 4:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.51	6350	4254	0	10604	81.4	29.1	28.9	0.22	0.048	10.3	0.0	1.2	0.4
8/1/24 6:00	8/1/24 13:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.74	7392	4953	0	12345	94.7	33.9	33.7	0.26	0.055	12.0	0.0	1.4	0.5
8/3/24 21:18	8/3/24 23:18	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.09	225	151	0	376	2.9	1.0	1.0	0.01	0.002	0.4	0.0	0.0	0.0
8/5/24 7:47	8/5/24 12:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.6	4829	3235	0	8064	61.9	22.2	22.0	0.17	0.036	7.8	0.0	0.9	0.3
8/5/24 13:29	8/5/24 17:07	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.13	1103	739	0	1842	14.1	5.1	5.0	0.04	0.008	1.8	0.0	0.2	0.1
8/5/24 17:19	8/5/24 21:49	123	44	44	0.3	0.07	16	0.2	1.8	0.61	1.05	21876	14657	3534	32998	253.3	90.6	90.0	0.70	0.148	32.0	0.0	3.8	1.3
8/8/24 1:18	8/8/24 2:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.01	131	88	0	218	1.7	0.6	0.6	0.00	0.001	0.2	0.0	0.0	0.0
8/8/24 3:01	8/8/24 5:04	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.03	322	216	0	539	4.1	1.5	1.5	0.01	0.002	0.5	0.0	0.1	0.0
8/15/24 1:52	8/15/24 2:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.09	354	237	0	591	4.5	1.6	1.6	0.01	0.003	0.6	0.0	0.1	0.0
8/15/24 4:15	8/15/24 6:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.47	4569	3061	9	7622	58.5	20.9	20.8	0.16	0.034	7.4	0.0	0.9	0.3
8/16/24 8:45	8/16/24 11:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.11	76	51	0	127	1.0	0.3	0.3	0.00	0.001	0.1	0.0	0.0	0.0
8/16/24 14:15	8/16/24 19:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.08	171	115	0	286	2.2	0.8	0.8	0.01	0.001	0.3	0.0	0.0	0.0
8/17/24 10:00	8/17/24 11:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.01	75	50	0	126	1.0	0.3	0.3	0.00	0.001	0.1	0.0	0.0	0.0
8/17/24 15:00	8/17/24 16:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.01	317	212	0	529	4.1	1.5	1.4	0.01	0.002	0.5	0.0	0.1	0.0
8/22/24 12:45	8/22/24 18:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.19	1096	734	0	1830	14.0	5.0	5.0	0.04	0.008	1.8	0.0	0.2	0.1
8/26/24 19:30	8/26/24 21:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.91	6263	4196	0	10459	80.3	28.7	28.5	0.22	0.047	10.1	0.0	1.2	0.4
8/27/24 5:35	8/27/24 7:14	123	44	44	0.3	0.07	16	0.2	1.8	0.61	1.01	14446	9646	4561	19531	149.9	53.6	53.3	0.41	0.088	18.9	0.0	2.2	0.7
8/29/24 16:45	8/29/24 20:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.6	4375	2932	5	7302	56.0	20.1	19.9	0.15	0.033	7.1	0.0	0.8	0.3
9/19/24 4:30	9/19/24 5:45	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.05	28	19	0	47	0.4	0.1	0.1	0.00	0.000	0.0	0.0	0.0	0.0
10/24/24 18:15	10/24/24 21:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.44	1407	943	0	2350	18.0	6.5	6.4	0.05	0.011	2.3	0.0	0.3	0.1
10/31/24 4:00	10/31/24 6:09	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.24	231	155	0	386	3.0	1.1	1.1	0.01	0.002	0.4	0.0	0.0	0.0
10/31/24 6:45	10/31/24 10:56	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.69	3738	2504	0	6242	47.9	17.1	17.0	0.13	0.028	6.0	0.0	0.7	0.2
10/31/24 11:15	10/31/24 16:45	**85.0**	**57.0**	44	**0.47**	**0.326**	**5.0**	< **0.12**	**0.81**	0.61	0.39	3007	2015	0	5022	26.6	17.9	13.7	0.15	0.102	1.6	0.0	0.3	0.2
11/4/24 7:15	11/4/24 12:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.15	931	624	0	1555	11.9	4.3	4.2	0.03	0.007	1.5	0.0	0.2	0.1
11/5/24 10:45	11/5/24 20:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.34	1235	827	0	2062	15.8	5.7	5.6	0.04	0.009	2.0	0.0	0.2	0.1
11/9/24 17:15	11/10/24 5:15	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.06	8	5	0	13	0.1	0.0	0.0	0.00	0.000	0.0	0.0	0.0	0.0
11/10/24 6:30	11/10/24 13:00	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.08	192	128	0	320	2.5	0.9	0.9	0.01	0.001	0.3	0.0	0.0	0.0
11/13/24 19:15	11/14/24 0:30	123	44	44	0.3	0.07	16	0.2	1.8	0.61	0.07	90	60	0	150	1.2	0.4	0.4	0.00	0.001	0.1	0.0	0.0	0.0
Sum											23.83	278175	186344	28584	**435935**	3412	1270	1222	9.69	2.078	432.5	0.0	52.4	16.6
Average		112.3	45.5	35.0	0.35	0.141	8.7	0.18	1.62	0.42														
Weighted Avg		122.9	44.0	43.7	0.34	0.072	15.5	0.20	1.83	0.61														
STDEV		69.1	10.9	14.1	0.10	0.129	7.3	0.08	0.70	0.11														
Min		43.0	31.0	25.0	0.23	0.042	5.0	0.12	0.81	0.43														
Max		206.0	57.0	45.0	0.47	0.326	19.6	0.24	2.45	0.65														
Percent Capture															**93.8%**	**90.2%**	**93.8%**	**90.8%**	**93.2%**	**94.0%**	**90.5%**	**#DIV/0!**	**93.0%**	**88.4%**

< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
BOLD Sampling ev Sampled Event
1 University Volumes after are estimated flow based on the relationship between the elipital and unvisity volumes for previous flow events

City of Saint Paul
2024 Water Quality and Quantity Report
Table C.5
WSB Project Number: 024571

HAMPDEN WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3251227	4/2/2024 10:27	4/2/2024 10:27	87.0	2270.0		0.59	0.062	1360.0		2.24	0.260 <	102	35.1	16.2	306.0	9.8	7.20	236.0	96
3260027	5/2/2024 9:30	5/2/2024 9:30	23.0	28.0			0.016	5.0 <			0.260 <		4.4	2.0	35.9	2.5	8.20	19.0	108
3265596	5/21/2024 0:52	5/21/2024 2:06	328.0	340.0	49.0	0.33	0.086	5.0 <		2.42	0.960 <	63	12.8	11.1	112.0	7.5		95.0	
3265598	5/21/2024 16:48	5/21/2024 22:11	133.0	27.0	30.0	0.17	0.015	6.4		0.99	0.400 <	44	10.3	11.2	81.3	3.0		62.0	
3266470	5/24/2024 7:59	5/24/2024 8:55	61.0	78.0	30.0	0.22	0.084	10.8		1.59	0.590 <	40	11.3	5.8	106.0	13.3		282.0	
3269820	6/4/2024 18:01	6/4/2024 21:36	91.0	50.0			0.010 <	5.6			0.390 <	37	8.2	4.5	67.7	8.8		57.0	
3286412	8/1/2024 11:14	8/1/2024 11:14															7.2		2420
3290757	8/15/2024 1:53	8/15/2024 5:43	99.0	52.0			0.026	5.0 <			0.380 <	39	9.6	5.6	80.5	9.7		66.0	
3291429	8/16/2024 8:28	8/16/2024 9:48	10.0																
3312456	10/31/2024 12:16	10/31/2024 12:16	38.0	34.0		0.19	0.104	5.0 <	0.17	0.58			7.8	3.3	56.8	6.7	6.70	48.0	2420
MINIMUM			**10.0**	**27.0**	**30.0**	**0.2**	**0.0**	**5.0**	**0.2**	**0.6**	**0.3**	**37.3**	**4.4**	**2.0**	**35.9**	**2.5**	**6.7**	**19.0**	**96.0**
AVERAGE			**96.7**	**359.9**	**36.3**	**0.3**	**0.1**	**175.4**	**0.2**	**1.6**	**0.5**	**54.4**	**12.4**	**7.5**	**105.8**	**7.7**	**7.3**	**108.1**	**1261.0**
MEDIAN			**87.0**	**51.0**	**30.0**	**0.2**	**0.0**	**5.3**	**0.2**	**1.6**	**0.4**	**42.2**	**10.0**	**5.7**	**80.9**	**8.2**	**7.2**	**64.0**	**1264.0**
MAXIMUM			**328.0**	**2270.0**	**49.0**	**0.6**	**0.1**	**1360.0**	**0.2**	**2.4**	**1.0**	**102.0**	**35.1**	**16.2**	**306.0**	**13.3**	**8.2**	**282.0**	**2420.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported

J - Result reported as estimated between the MDL and Reporting Limit (RL)

> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

HAMPDEN PARK VOLUME AND POLLUTANT REDUCTION SUMMARY

Event Time Interval		Sampling Data										Event Loading and Volume Data													
		TSS	TDS	VSS	TP	Ortho-P	Chloride		Total Kjeldahl Nitrogen	Nitrate + Nitrite as N		Interval Rain	Hampden/Raymond Inflow Volume (1)	Eastern Hampden Modeled Inflow Volume[1] (2)	Bypass Volume2 (3)	Volume Captured by BMP (1+2-3)	Percent Captured	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start	**End**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L		In.	cu-ft	cu-ft	cu-ft	cu-ft		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/15/24 22:10	5/16/24 1:26	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.08	2274	375	0	2649	100%	22.2	9.8	5.3	0.03	0.004	1.05	0.19	0.07
5/17/24 19:15	5/18/24 0:00	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.27	2449	404	0	2853	100%	23.9	10.6	5.7	0.03	0.005	1.13	0.21	0.08
5/18/24 2:15	5/18/24 4:45	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.09	640	106	0	745	100%	6.2	2.8	1.5	0.01	0.001	0.30	0.05	0.02
5/20/24 3:09	5/20/24 6:36	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.30	3228	533	0	3761	100%	31.5	13.9	7.5	0.04	0.006	1.49	0.28	0.11
5/21/24 0:55	5/21/24 2:08	***328.0***	***340.0***	***49.0***	***0.33***	***0.086***	***5.0***	<	***2.42***	***0.96***	<	0.19	2164	357	0	2521	100%	51.6	53.5	7.7	0.05	0.014	0.79	0.38	0.15
5/21/24 8:22	5/21/24 12:15	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.07	1269	209	0	1478	100%	12.4	5.5	2.9	0.02	0.002	0.59	0.11	0.04
5/21/24 16:45	5/22/24 1:06	***133.0***	***27.0***	***30.0***	***0.17***	***0.015***	***6.4***		***0.99***	***0.40***	<	1.83	18856	3111	0	21967	100%	182.4	37.0	41.1	0.23	0.021	8.78	1.36	0.55
5/24/24 7:51	5/24/24 9:58	***61.0***	***78.0***	***30.0***	***0.22***	***0.084***	***10.8***		***1.59***	***0.59***	<	0.18	1783	294	0	2077	100%	7.9	10.1	3.9	0.03	0.011	1.40	0.21	0.08
5/31/24 16:26	6/1/24 4:01	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.41	9274	1530	0	10805	100%	90.4	40.0	21.5	0.13	0.018	4.28	0.79	0.31
6/2/24 17:34	6/2/24 19:55	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.07	1713	283	0	1996	100%	16.7	7.4	4.0	0.02	0.003	0.79	0.15	0.06
6/3/24 2:17	6/3/24 5:52	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.45	5612	926	0	6538	100%	54.7	24.2	13.0	0.08	0.011	2.59	0.48	0.19
7/28/24 20:15	7/29/24 0:00	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.56	1012	167	0	1179	100%	9.9	4.4	2.3	0.01	0.002	0.47	0.09	0.03
7/31/24 17:15	7/31/24 18:30	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.16	840	139	0	979	100%	8.2	3.6	1.9	0.01	0.002	0.39	0.07	0.03
8/1/24 0:00	8/1/24 14:00	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		1.27	9044	1492	0	10536	100%	88.2	39.0	20.9	0.12	0.018	4.17	0.77	0.30
8/3/24 22:00	8/4/24 0:15	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.09	830	137	0	967	100%	8.1	3.6	1.9	0.01	0.002	0.38	0.07	0.03
8/5/24 4:15	8/5/24 12:30	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.62	4135	682	0	4817	100%	40.3	17.8	9.6	0.06	0.008	1.91	0.35	0.14
8/5/24 15:30	8/5/24 22:00	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		1.15	15993	2639	0	18631	100%	156.0	68.9	37.0	0.22	0.031	7.38	1.36	0.53
8/8/24 2:15	8/8/24 5:15	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.04	247	41	0	288	100%	2.4	1.1	0.6	0.00	0.000	0.11	0.02	0.01
8/15/24 1:45	8/15/24 6:06	**99.0**	**52.0**	*32*	*0.2*	**0.026**	**5.0**	<	*1.2*	**0.38**	<	0.56	4596	758	0	5354	100%	33.1	17.4	10.6	0.06	0.009	1.67	0.39	0.13
8/16/24 8:30	8/16/24 12:45	**10.0**	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.10	866	143	0	1009	100%	0.6	3.7	2.0	0.01	0.002	0.40	0.07	0.03
8/16/24 13:00	8/16/24 14:30	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.07	439	72	0	511	100%	4.3	1.9	1.0	0.01	0.001	0.20	0.04	0.01
8/17/24 10:00	8/17/24 22:15	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.03	196	32	0	229	100%	1.9	0.8	0.5	0.00	0.000	0.09	0.02	0.01
8/22/24 13:36	8/22/24 15:49	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.19	1519	251	0	1769	100%	14.8	6.5	3.5	0.02	0.003	0.70	0.13	0.05
8/29/24 16:41	8/29/24 19:30	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.60	10348	1707	0	12055	100%	100.9	44.6	23.9	0.14	0.020	4.77	0.88	0.34
9/19/24 6:21	9/19/24 8:30	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.05	685	113	0	798	100%	6.7	3.0	1.6	0.01	0.001	0.32	0.06	0.02
9/21/24 9:06	9/21/24 10:30	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.16	1737	287	0	2024	100%	16.9	7.5	4.0	0.02	0.003	0.80	0.15	0.06
9/21/24 16:00	9/21/24 16:45	*134*	*59*	*32*	*0.2*	*0.03*	*6*		*1.2*	*0.5*		0.07	437	72	0	510	100%	4.3	1.9	1.0	0.01	0.001	0.20	0.04	0.01
Sum												9.66	102185	16861	0	**119046**	100%	997	440	236	1.38	0.20	47.1	8.7	3.4
Average		126.2	124.3	36.3	0.24	0.053	6.8		1.67	0.58															
Weighted Avg		134.1	59.2	31.8	0.19	0.027	6.3		1.17	0.45															
STDEV		121.7	145.3	11.0	0.08	0.038	2.7		0.72	0.27															
Min		10.0	27.0	30.0	0.17	0.015	5.0		0.99	0.38															
Max		328.0	340.0	49.0	0.33	0.086	10.8		2.42	0.96															
Percent Capture																**100%**		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
BOLD Sampling event
1 - Additional stormwater is conveyed to the system from the east via a pipe along Hampden Avenue.
This flow is modeled using the monitored flow from the Hampden/Raymond location and the ratio of
2 - Water Levels in the BMP did not exceed the system outlet elevation
*Samples identified as outliers have been omitted from annual flow weighted averages

City of Saint Paul
2024 Water Quality and Quantity Report
Table C.7
WSB Project Number: 024571

VICTORIA WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3251221	4/2/2024 10:54	4/2/2024 10:54	13.0	396.0		0.36	0.208	164.0		1.85	0.430	68	6.7	3.7	29.5	34.8	7.3	128.0	206
3255280	4/16/2024 11:28	4/17/2024 0:43	191.0	56.0		0.69	0.189	9.2		3.81	0.680 <	37	13.1	20.3	86.0	19.2		154.0	
3260021	5/2/2024 9:49	5/2/2024 9:49	25.0	30.0			0.071	5.0 <			0.260 <		2.6	3.3	16.3	12.9	7.7	52.0	291
3265013	5/17/2024 21:14	5/18/2024 4:09	72.0	48.0 <	42.0	0.56	0.135	5.0 <		3.19	0.260 <	26	7.0	7.4	34.8	9.9		89.0	
3265019	5/20/2024 3:39	5/20/2024 6:34	68.0	48.0 <	46.0	0.60	0.185	5.0 <		2.63	0.520	29	7.2	5.9	39.2	17.7		107.0	
3265590	5/21/2024 17:14	5/21/2024 21:44	48.0	474.0	21.0	0.32	0.064	5.0 <		2.03	0.260 <	18	5.7	11.6	36.2	4.3		72.0	
3266468	5/24/2024 8:34	5/24/2024 9:54	136.0	124.0	54.0	0.69	0.396	27.7		2.68	0.580 <	65	7.4	19.7	44.6	16.8		71.0	
3269264	6/3/2024 4:24	6/3/2024 6:14	210.0	48.0 <		0.57	0.100	5.0 <	0.23	4.37	0.330 <	30	11.5	23.1	67.2	5.5		151.0	
3286406	8/1/2024 10:58	8/1/2024 10:58															6.8		2420
3290748	8/15/2024 4:13	8/15/2024 6:34	73.0	35.0				5.0 <			0.260 <	20	6.2	9.8	35.5			60.0	
3291427	8/18/2024 18:44	8/18/2024 19:44	7.0	59.0		0.18	0.082	5.0 <		1.03	0.260 <	27	4.0	1.4	15.2	10.7		45.0	
3312450	10/31/2024 12:32	10/31/2024 12:32	560.0	183.0		3.48	2.150	10.5	0.15	7.71			23.4	63.4	177.0	97.7	6.2	671.0	980
MINIMUM			**7.0**	**30.0**	**21.0**	**0.2**	**0.1**	**5.0**	**0.2**	**1.0**	**0.3**	**17.7**	**2.6**	**1.4**	**15.2**	**4.3**	**6.2**	**45.0**	**206.0**
AVERAGE			**127.5**	**136.5**	**40.8**	**0.8**	**0.4**	**22.4**	**0.2**	**3.3**	**0.4**	**35.4**	**8.6**	**15.4**	**52.9**	**23.0**	**7.0**	**145.5**	**974.3**
MEDIAN			**72.0**	**56.0**	**44.0**	**0.6**	**0.2**	**5.0**	**0.2**	**2.7**	**0.3**	**28.6**	**7.0**	**9.8**	**36.2**	**14.9**	**7.1**	**89.0**	**635.5**
MAXIMUM			**560.0**	**474.0**	**54.0**	**3.5**	**2.2**	**164.0**	**0.2**	**7.7**	**0.7**	**68.4**	**23.4**	**63.4**	**177.0**	**97.7**	**7.7**	**671.0**	**2420.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported

J - Result reported as estimated between the MDL and Reporting Limit (RL)

> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

VICTORIA VOLUME AND POLLUTANT REDUCTION SUMMARY

Event Time Interval		Sampling Data								Rain	Event Loading and Volume Data													
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Amount	Interval Rain	Runoff Volume (1)	Bypassed Volume (2)	Volume Captured by BMP (1-2)	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start	End	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	(in)	In.	cu-ft	cu-ft	cu-ft	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
4/26/2024 9:18	4/26/2024 10:16	78	269	28	0.4	0.10	6	2.2	0.30	0.05	0.05	260	0	260	1.3	4.4	0.5	0.0	0.002	0.1	0.0	0.0
4/27/2024 1:37	4/27/2024 4:16	78	269	28	0.4	0.10	6	2.2	0.30	0.24	0.24	7371	0	7371	35.7	123.8	12.8	0.2	0.046	2.6	1.0	0.1
4/28/2024 14:03	4/28/2024 23:12	78	269	28	0.4	0.10	6	2.2	0.30	0.72	0.72	19909	2	19907	96.5	334.4	34.5	0.5	0.125	7.1	2.8	0.4
4/29/2024 7:11	4/29/2024 14:54	78	269	28	0.4	0.10	6	2.2	0.30	0.07	0.07	1844	1	1843	8.9	31.0	3.2	0.0	0.012	0.7	0.3	0.0
4/30/2024 19:23	4/30/2024 21:53	78	269	28	0.4	0.10	6	2.2	0.30	0.38	0.38	9162	0	9162	44.4	153.9	15.9	0.2	0.057	3.3	1.3	0.2
5/2/2024 6:29	5/2/2024 11:44	78	269	28	0.4	0.10	6	2.2	0.30	0.61	0.61	15148	1	15147	73.4	254.5	26.3	0.4	0.095	5.4	2.1	0.3
5/4/2024 6:49	5/4/2024 10:22	78	269	28	0.4	0.10	6	2.2	0.30	0.29	0.29	7964	1	7963	38.6	133.8	13.8	0.2	0.050	2.9	1.1	0.1
5/7/2024 3:39	5/7/2024 8:50	78	269	28	0.4	0.10	6	2.2	0.30	0.36	0.36	8132	0	8132	39.4	136.6	14.1	0.2	0.051	2.9	1.1	0.2
5/15/2024 22:24	5/16/2024 2:19	78	269	28	0.4	0.10	6	2.2	0.30	0.09	0.09	4085	0	4085	19.8	68.6	7.1	0.1	0.026	1.5	0.6	0.1
5/17/2024 19:47	5/18/2024 0:12	**72.0**	**48.0** <	**42.0**	**0.56**	**0.135**	**5.0** <	**3.19**	**0.260** <	0.31	0.31	6555	0	6555	29.5	19.6	17.2	0.2	0.055	2.0	1.3	0.1
5/18/2024 2:23	5/18/2024 4:39	78	269	28	0.4	0.10	6	2.2	0.30	0.09	0.09	2996	0	2996	14.5	50.3	5.2	0.1	0.019	1.1	0.4	0.1
5/20/2024 3:06	5/20/2024 6:41	**68.0**	**48.0** <	**46.0**	**0.60**	**0.185**	**5.0** <	**2.63**	**0.520**	0.30	0.30	5840	0	5840	24.8	17.5	16.8	0.2	0.067	1.8	1.0	0.2
5/21/2024 1:09	5/21/2024 2:33	78	269	28	0.4	0.10	6	2.2	0.30	0.20	0.20	1717	0	1717	8.3	28.9	3.0	0.0	0.011	0.6	0.2	0.0
5/21/2024 10:07	5/21/2024 12:16	78	269	28	0.4	0.10	6	2.2	0.30	0.04	0.04	790	0	789	3.8	13.3	1.4	0.0	0.005	0.3	0.1	0.0
5/21/2024 16:42	5/22/2024 0:29	**48.0**	**474.0**	**21.0**	**0.32**	**0.064**	**5.0** <	**2.03**	**0.260** <	1.83	1.83	39321	0	39321	117.8	1163.5	51.5	0.8	0.157	12.3	5.0	0.6
5/24/2024 7:59	5/24/2024 9:04	**136.0**	**124.0**	**54.0**	**0.69**	**0.396**	**27.7**	**2.68**	**0.580** <	0.18	0.18	2528	0	2528	21.5	19.6	8.5	0.1	0.062	4.4	0.4	0.1
5/26/2024 9:40	5/26/2024 10:43	78	269	28	0.4	0.10	6	2.2	0.30	0.02	0.02	179	0	179	0.9	3.0	0.3	0.0	0.001	0.1	0.0	0.0
5/27/2024 11:00	5/27/2024 11:55	78	269	28	0.4	0.10	6	2.2	0.30	0.04	0.04	384	0	384	1.9	6.4	0.7	0.0	0.002	0.1	0.1	0.0
5/27/2024 17:15	5/27/2024 18:28	78	269	28	0.4	0.10	6	2.2	0.30	0.07	0.07	1434	0	1434	6.9	24.1	2.5	0.0	0.009	0.5	0.2	0.0
5/27/2024 23:12	5/27/2024 23:45	78	269	28	0.4	0.10	6	2.2	0.30	0.01	0.01	583	0	583	2.8	9.8	1.0	0.0	0.004	0.2	0.1	0.0
5/28/2024 7:35	6/1/2024 4:26	78	269	28	0.4	0.10	6	2.2	0.30	0.65	0.65	7867	0	7867	38.1	132.2	13.6	0.2	0.049	2.8	1.1	0.1
6/2/2024 17:25	6/2/2024 19:44	78	269	28	0.4	0.10	6	2.2	0.30	0.07	0.07	579	0	579	2.8	9.7	1.0	0.0	0.004	0.2	0.1	0.0
6/3/2024 2:11	6/3/2024 6:39	**210.0**	**48.0** <	28	**0.57**	**0.100**	**5.0** <	2.3	**0.330** <	0.46	0.46	9996	0	9996	131.0	30.0	17.3	0.4	0.062	3.1	1.4	0.2
6/15/2024 22:57	6/16/2024 3:56	78	269	28	0.4	0.10	6	2.2	0.30	1.05	1.05	29201	2	29200	141.5	490.6	50.6	0.8	0.183	10.5	4.1	0.5
6/17/2024 5:17	6/17/2024 10:45	78	269	28	0.4	0.10	6	2.2	0.30	0.55	0.55	15155	3	15152	73.4	254.6	26.3	0.4	0.095	5.4	2.1	0.3
6/17/2024 17:24	6/17/2024 18:43	78	269	28	0.4	0.10	6	2.2	0.30	0.02	0.02	429	1	428	2.1	7.2	0.7	0.0	0.003	0.2	0.1	0.0
6/18/2024 20:38	6/19/2024 0:02	78	269	28	0.4	0.10	6	2.2	0.30	0.58	0.58	8507	2	8506	41.2	142.9	14.7	0.2	0.053	3.1	1.2	0.2
6/20/2024 14:13	6/20/2024 15:38	78	269	28	0.4	0.10	6	2.2	0.30	0.04	0.04	367	1	366	1.8	6.1	0.6	0.0	0.002	0.1	0.1	0.0
6/21/2024 5:32	6/21/2024 8:21	78	269	28	0.4	0.10	6	2.2	0.30	0.21	0.21	5341	1	5340	25.9	89.7	9.3	0.1	0.033	1.9	0.7	0.1
6/21/2024 14:18	6/21/2024 15:58	78	269	28	0.4	0.10	6	2.2	0.30	0.04	0.04	841	1	840	4.1	14.1	1.5	0.0	0.005	0.3	0.1	0.0
6/21/2024 23:59	6/22/2024 4:21	78	269	28	0.4	0.10	6	2.2	0.30	0.44	0.44	11785	2	11783	57.1	198.0	20.4	0.3	0.074	4.2	1.6	0.2
6/22/2024 14:36	6/22/2024 16:43	78	269	28	0.4	0.10	6	2.2	0.30	0.50	0.50	11799	1	11798	57.2	198.2	20.5	0.3	0.074	4.2	1.6	0.2
6/27/2024 21:56	6/27/2024 22:48	78	269	28	0.4	0.10	6	2.2	0.30	0.03	0.03	38	0	38	0.2	0.6	0.1	0.0	0.000	0.0	0.0	0.0
6/28/2024 1:59	6/28/2024 3:47	78	269	28	0.4	0.10	6	2.2	0.30	0.10	0.10	2248	0	2248	10.9	37.8	3.9	0.1	0.014	0.8	0.3	0.0
6/28/2024 5:02	6/28/2024 8:05	78	269	28	0.4	0.10	6	2.2	0.30	0.65	0.65	19043	0	19043	92.3	319.9	33.0	0.5	0.119	6.8	2.6	0.4
7/2/2024 2:35	7/2/2024 5:42	78	269	28	0.4	0.10	6	2.2	0.30	0.37	0.37	7961	0	7961	38.6	133.7	13.8	0.2	0.050	2.9	1.1	0.1
7/4/2024 7:36	7/4/2024 11:01	78	269	28	0.4	0.10	6	2.2	0.30	0.12	0.12	1144	0	1144	5.5	19.2	2.0	0.0	0.007	0.4	0.2	0.0
7/4/2024 14:00	7/4/2024 18:41	78	269	28	0.4	0.10	6	2.2	0.30	0.40	0.40	11875	0	11875	57.6	199.5	20.6	0.3	0.074	4.3	1.7	0.2
7/5/2024 13:52	7/5/2024 15:19	78	269	28	0.4	0.10	6	2.2	0.30	0.09	0.09	3423	0	3423	16.6	57.5	5.9	0.1	0.021	1.2	0.5	0.1
7/10/2024 15:21	7/12/2024 15:03	78	269	28	0.4	0.10	6	2.2	0.30	0.48	0.48	1940	0	1940	9.4	32.6	3.4	0.1	0.012	0.7	0.3	0.0
7/21/2024 8:46	7/21/2024 16:45	78	269	28	0.4	0.10	6	2.2	0.30	1.35	1.35	35140	24271	10868	52.7	182.6	18.8	0.3	0.068	3.9	1.5	0.2
7/22/2024 17:56	7/22/2024 19:03	78	269	28	0.4	0.10	6	2.2	0.30	0.60	0.60	6276	0	6276	30.4	105.4	10.9	0.2	0.039	2.3	0.9	0.1
7/28/2024 20:12	7/29/2024 2:20	78	269	28	0.4	0.10	6	2.2	0.30	0.55	0.55	8882	2	8880	43.0	149.2	15.4	0.2	0.056	3.2	1.2	0.2
7/31/2024 17:29	7/31/2024 18:51	78	269	28	0.4	0.10	6	2.2	0.30	0.17	0.17	2321	1	2321	11.2	39.0	4.0	0.1	0.015	0.8	0.3	0.0
7/31/2024 22:15	8/1/2024 4:01	78	269	28	0.4	0.10	6	2.2	0.30	0.52	0.52	12285	3	12283	59.5	206.3	21.3	0.3	0.077	4.4	1.7	0.2
8/1/2024 6:08	8/1/2024 16:30	78	269	28	0.4	0.10	6	2.2	0.30	0.74	0.74	8605	4	8600	41.7	144.5	14.9	0.2	0.054	3.1	1.2	0.2
8/3/2024 21:18	8/3/2024 23:21	78	269	28	0.4	0.10	6	2.2	0.30	0.09	0.09	1220	1	1219	5.9	20.5	2.1	0.0	0.008	0.4	0.2	0.0
8/5/2024 4:36	8/5/2024 21:54	78	269	28	0.4	0.10	6	2.2	0.30	1.82	1.82	44726	9182	35544	172.3	597.1	61.6	0.9	0.222	12.8	4.9	0.7
8/7/2024 21:00	8/8/2024 3:50	78	269	28	0.4	0.10	6	2.2	0.30	0.04	0.04	451	0	451	2.2	7.6	0.8	0.0	0.003	0.2	0.1	0.0
8/15/2024 1:53	8/15/2024 6:56	**73.0**	**35.0**	28	0.4	0.10	**5.0** <	2.2	**0.260** <	0.56	0.56	9569	0	9569	43.6	20.9	16.6	0.2	0.060	3.0	1.3	0.2
8/16/2024 9:15	8/16/2024 10:31	78	269	28	0.4	0.10	6	2.2	0.30	0.10	0.10	490	0	490	2.4	8.2	0.8	0.0	0.003	0.2	0.1	0.0
8/16/2024 12:29	8/16/2024 19:22	78	269	28	0.4	0.10	6	2.2	0.30	0.08	0.08	1559	0	1559	7.6	26.2	2.7	0.0	0.010	0.6	0.2	0.0
8/17/2024 9:54	8/17/2024 20:02	**7.0**	**59.0**	28	**0.18**	**0.082**	**5.0** <	**1.03**	**0.260** <	0.03	0.03	2372	0	2372	1.0	8.7	4.1	0.0	0.012	0.7	0.2	0.0
8/22/2024 13:47	8/22/2024 16:00	78	269	28	0.4	0.10	6	2.2	0.30	0.19	0.19	2123	0	2123	10.3	35.7	3.7	0.1	0.013	0.8	0.3	0.0
8/26/2024 19:33	8/26/2024 20:29	78	269	28	0.4	0.10	6	2.2	0.30	0.91	0.91	7721	0	7721	37.4	129.7	13.4	0.2	0.048	2.8	1.1	0.1
8/27/2024 5:36	8/27/2024 8:03	78	269	28	0.4	0.10	6	2.2	0.30	1.01	1.01	17134	8007	9127	44.2	153.3	15.8	0.2	0.057	3.3	1.3	0.2
8/29/2024 16:56	8/29/2024 21:45	78	269	28	0.4	0.10	6	2.2	0.30	0.60	0.60	7609	13	7595	36.8	127.6	13.2	0.2	0.048	2.7	1.1	0.1
9/19/2024 6:35	9/19/2024 7:15	78	269	28	0.4	0.10	6	2.2	0.30	0.05	0.05	133	0	133	0.6	2.2	0.2	0.0	0.001	0.0	0.0	0.0
9/21/2024 9:22	9/21/2024 10:27	78	269	28	0.4	0.10	6	2.2	0.30	0.16	0.16	3400	0	3400	16.5	57.1	5.9	0.1	0.021	1.2	0.5	0.1
9/21/2024 16:08	9/21/2024 16:40	78	269	28	0.4	0.10	6	2.2	0.30	0.07	0.07	253	0	253	1.2	4.3	0.4	0.0	0.002	0.1	0.0	0.0
10/24/2024 18:25	10/24/2024 22:43	78	269	28	0.4	0.10	6	2.2	0.30	0.45	0.45	7748	0	7748	37.6	130.2	13.4	0.2	0.048	2.8	1.1	0.1
10/31/2024 3:24	10/31/2024 17:42	78	269	28	0.4	0.10	6	2.2	0.30	1.35	1.35	24827	0	0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0
Sum										24.19	24.19	490,587	41,502	424,258	**2062**	**7148**	**738**	**11.07**	**2.662**	**152.8**	**59.13**	**7.96**
Average		87.7	119.4	40.8	0.49	0.160	8.2	2.31	0.353													
Weighted Ave*		77.6	269.1	27.8	0.42	0.100	5.8	2.23	0.300													
STDEV		66.1	159.1	14.1	0.19	0.123	8.6	0.74	0.138													
Median		72.0	48.0	44.0	0.57	0.118	5.0	2.47	0.260													
Min		7.0	35.0	21.0	0.18	0.064	5.0	1.03	0.260													
Max		210.0	474.0	54.0	0.69	0.396	27.7	3.19	0.580													
Percent Capture														**91.5%**	**91.5%**	**91.5%**	**91.5%**	**91.5%**	**91.5%**	**91.5%**	**91.5%**	**91.5%**

< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
BOLD Sampled Event

*11/6/22 sampling event excluded from weighted average due to abornmally high results

City of Saint Paul
2023 Water Quality and Quantity Report
Table C.9
WSB Project Number: 022099

WEST SHEPARD POND WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3137483	2/6/2023 13:05	2/6/2023 13:05	29.0	9920.0	15.0 <	0.31	0.112	7240.0	1.46	2.80	0.770	154	28.3	3.8	130.0	2.7	7.10	134.0	1
3151258	4/3/2023 13:21	4/3/2023 13:21	10.0	1300.0	3.0	0.53	0.397	1240.0	0.18	1.80	1.640	196	13.9	5.3	31.6	4.7		45.0	
3178275	7/4/2023 10:53	7/4/2023 11:33	720.0	78.0	56.0	0.26	0.022	24.0	0.15	1.57	0.430 <	45 <	11.5	5.1	86.1	5.2		62.0	
3180778	7/13/2023 22:24	7/13/2023 22:51	186.0	142.0	77.0	0.47	0.037	36.1	0.20	2.49	0.510 <	45 <	28.1	13.8	196.0			160.0	
3184187	7/26/2023 1:43	7/26/2023 5:38	76.0	32.0	29.0	0.19	0.017	5.4	0.20	1.45	0.280 <	45 <	8.8	4.9	59.4	3.6		43.0	
3189525	8/11/2023 0:58	8/11/2023 2:24	19.0	81.0		0.12	0.011	13.1	0.06 <	0.55	0.350 <	45 <	4.2	1.4	24.7	9.8		50.0	
3190138	8/13/2023 22:54	8/14/2023 7:43	7.0	37.0		0.05 <	0.017	5.0 <	0.07	0.18	0.260 <	45 <	1.9	0.7	11.7	2.1		15.0 <	
3202690	9/23/2023 18:09	9/23/2023 23:58	23.0	74.0		0.16	0.023	11.3	0.06 <	0.66	0.260 <	45 <	6.9	2.2	34.2	11.1		44.0	
3202927	9/25/2023 14:13	9/25/2023 14:13																	>2420 >
3203608	9/25/2023 13:34	9/25/2023 17:29	17.0	35.0		0.10	0.010 <	5.0 <	0.10	0.51	0.260 <	45 <	3.0	1.1	18.6	2.8	8.40	15.0 <	
3202927	9/25/2023 14:13	9/25/2023 14:13																	>2420 >
3204966	9/29/2023 4:29	9/29/2023 11:34	21.0	44.0		0.09 0.00	0.028	5.4	0.30	0.68	0.620	45	4.0	1.6	23.5	2.3		22.0	
3204968	9/29/2023 21:14	9/29/2023 22:39	33.0	24.0		0.13	0.030	5.0	0.28	0.95	0.400	45	5.9	2.5	29.0	1.7		24.0	
3205832	10/3/2023 21:39	10/4/2023 1:34	48.0	79.0	27.0	0.27	0.025	15.7	0.06	1.54	0.620	45	9.7	3.7	111.0	21.2		98.0	
MINIMUM			**7.0**	**24.0**	**3.0**	**0.1**	**0.0**	**5.0**	**0.1**	**0.2**	**0.3**	**45.0**	**1.9**	**0.7**	**11.7**	**1.7**	**7.1**	**15.0**	**1.0**
AVERAGE			**99.1**	**987.2**	**34.5**	**0.2**	**0.1**	**717.2**	**0.3**	**1.3**	**0.5**	**66.7**	**10.5**	**3.8**	**63.0**	**6.1**	**7.8**	**59.3**	**1.0**
MEDIAN			**26.0**	**76.0**	**28.0**	**0.2**	**0.0**	**12.2**	**0.2**	**1.2**	**0.4**	**45.0**	**7.9**	**3.1**	**32.9**	**3.6**	**7.8**	**44.5**	**1.0**
MAXIMUM			**720.0**	**9920.0**	**77.0**	**0.5**	**0.4**	**7240.0**	**1.5**	**2.8**	**1.6**	**196.0**	**28.3**	**13.8**	**196.0**	**21.2**	**8.4**	**160.0**	**1.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported

J - Result reported as estimated between the MDL and Reporting Limit (RL)

> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2024 St. Albans Volume Reduction Pollutant Loading
Table C.10
WSB Project No.: 024571

WEST SHEPARD POND POLLUTANT LOADING

Event Time Interval		Sampling Data									Event Loading and Volume Data												
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	South Inlet Volume (1)	Noth Inlet Volume 1 Volume (2)	Total Volume (1+2)	TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Kjeldahl Nitrogen	Nitrate + Nitrite as N
Start	End	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cu-ft	cu-ft	cu-ft	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/15/24 22:29	5/15/24 23:09	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.07	233	23	256	0.4	0.6	0.1	0.00	0.000	0.1	0.0	0.0	0.0
5/15/24 23:42	5/16/24 0:09	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.16	85	8	93	0.1	0.2	0.0	0.00	0.000	0.0	0.0	0.0	0.0
5/16/24 0:36	5/16/24 2:13	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.01	2130	213	2343	3.6	5.9	1.3	0.01	0.002	0.9	0.0	0.1	0.0
5/17/24 19:45	5/17/24 22:01	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.37	4079	408	4487	6.9	11.3	2.4	0.03	0.004	1.7	0.0	0.2	0.1
5/17/24 23:00	5/17/24 23:40	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.01	166	17	183	0.3	0.5	0.1	0.00	0.000	0.1	0.0	0.0	0.0
5/18/24 2:15	5/18/24 4:18	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.14	1551	155	1706	2.6	4.3	0.9	0.01	0.002	0.7	0.0	0.1	0.0
5/20/24 2:30	5/20/24 6:45	**29**	**52**	**14**	**0.15**	**0.020**	***14.1***	0.1	**1.17**	**0.49** <	0.19	1916	192	2108	3.8	6.8	1.8	0.02	0.003	1.9	0.0	0.2	0.1
5/21/24 1:15	5/21/24 4:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.15	1553	155	1709	2.6	4.3	0.9	0.01	0.002	0.7	0.0	0.1	0.0
5/21/24 10:30	5/21/24 13:00	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.06	132	13	146	0.2	0.4	0.1	0.00	0.000	0.1	0.0	0.0	0.0
5/21/24 16:30	5/21/24 20:27	**24**	**24** <	**8**	**0.08**	**0.016**	***5.0*** <	0.1	**0.46**	**0.26** <	1.42	17367	1737	19103	28.6	28.6	9.5	0.10	0.019	6.0	0.1	0.5	0.3
5/21/24 20:28	5/22/24 2:00	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.65	11376	1138	12513	19.4	31.5	6.7	0.08	0.011	4.8	0.0	0.5	0.2
5/24/24 8:00	5/24/24 10:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.16	1314	131	1446	2.2	3.6	0.8	0.01	0.001	0.6	0.0	0.1	0.0
5/26/24 9:00	5/26/24 12:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.09	863	86	950	1.5	2.4	0.5	0.01	0.001	0.4	0.0	0.0	0.0
5/27/24 11:15	5/27/24 12:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.03	209	21	230	0.4	0.6	0.1	0.00	0.000	0.1	0.0	0.0	0.0
5/27/24 17:15	5/27/24 19:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.27	469	47	516	0.8	1.3	0.3	0.00	0.000	0.2	0.0	0.0	0.0
5/27/24 23:30	5/28/24 0:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.02	1113	111	1224	1.9	3.1	0.7	0.01	0.001	0.5	0.0	0.0	0.0
5/28/24 7:45	5/28/24 9:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.12	465	47	512	0.8	1.3	0.3	0.00	0.000	0.2	0.0	0.0	0.0
5/31/24 6:15	5/31/24 8:02	**78**	**56**	9	**0.17**	**0.028**	***12.0***	0.1	**0.95**	**0.29** <	0.19	3199	320	3519	17.1	12.3	1.9	0.04	0.006	2.6	0.0	0.2	0.1
5/31/24 16:15	6/1/24 5:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.50	4040	404	4444	6.9	11.2	2.4	0.03	0.004	1.7	0.0	0.2	0.1
6/2/24 17:45	6/2/24 20:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.05	343	34	377	0.6	0.9	0.2	0.00	0.000	0.1	0.0	0.0	0.0
6/3/24 4:11	6/3/24 5:51	**17**	40	9	**0.07**	0.01	***5.0*** <	**0.06** <	**0.44**	**0.26** <	0.59	8733	873	9606	10.2	24.2	5.2	0.04	0.008	3.0	0.0	0.3	0.2
6/4/24 19:15	6/4/24 23:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.24	2031	203	2234	3.5	5.6	1.2	0.01	0.002	0.9	0.0	0.1	0.0
6/5/24 18:15	6/5/24 19:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.07	1777	178	1954	3.0	4.9	1.0	0.01	0.002	0.8	0.0	0.1	0.0
6/8/24 3:45	6/8/24 6:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.05	211	21	232	0.4	0.6	0.1	0.00	0.000	0.1	0.0	0.0	0.0
6/8/24 7:00	6/8/24 9:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.01	136	14	150	0.2	0.4	0.1	0.00	0.000	0.1	0.0	0.0	0.0
6/11/24 7:15	6/11/24 10:00	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.08	552	55	607	0.9	1.5	0.3	0.00	0.001	0.2	0.0	0.0	0.0
6/12/24 9:45	6/12/24 11:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.20	1137	114	1250	1.9	3.1	0.7	0.01	0.001	0.5	0.0	0.0	0.0
6/12/24 14:30	6/12/24 15:16	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.06	1194	119	1314	2.0	3.3	0.7	0.01	0.001	0.5	0.0	0.0	0.0
6/12/24 23:00	6/13/24 0:06	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.27	1067	107	1174	1.8	3.0	0.6	0.01	0.001	0.5	0.0	0.0	0.0
6/15/24 14:00	6/15/24 20:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.67	5165	516	5681	8.8	14.3	3.0	0.04	0.005	2.2	0.0	0.2	0.1
6/15/24 22:45	6/16/24 4:00	**27**	**36**	9	0.1	**0.010**	***6.0***	0.1	0.6	0.3	0.88	10992	1099	12091	20.4	27.2	6.5	0.07	0.008	4.5	0.0	0.4	0.2
6/17/24 5:30	6/17/24 10:00	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.59	6055	605	6660	10.3	16.7	3.6	0.04	0.006	2.6	0.0	0.2	0.1
6/17/24 17:30	6/17/24 18:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.05	315	31	346	0.5	0.9	0.2	0.00	0.000	0.1	0.0	0.0	0.0
6/17/24 23:15	6/18/24 0:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.04	482	48	531	0.8	1.3	0.3	0.00	0.000	0.2	0.0	0.0	0.0
6/18/24 20:45	6/19/24 0:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.32	4736	474	5209	8.1	13.1	2.8	0.03	0.005	2.0	0.0	0.2	0.1
6/20/24 14:30	6/20/24 15:19	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.06	364	36	400	0.6	1.0	0.2	0.00	0.000	0.2	0.0	0.0	0.0
6/21/24 5:15	6/21/24 7:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.26	1995	200	2195	3.4	5.5	1.2	0.01	0.002	0.8	0.0	0.1	0.0
6/21/24 14:15	6/21/24 18:53	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.10	717	72	788	1.2	2.0	0.4	0.00	0.001	0.3	0.0	0.0	0.0
6/22/24 0:07	6/22/24 4:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.38	3849	385	4234	6.5	10.6	2.3	0.03	0.004	1.6	0.0	0.2	0.1
6/22/24 14:45	6/22/24 16:28	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.59	7943	794	8737	13.5	22.0	4.7	0.05	0.008	3.4	0.0	0.3	0.2
6/28/24 1:45	6/28/24 7:52	25	40	9	0.1	0.01	6	0.1	0.6	0.3	1.38	20967	2097	23064	35.7	58.0	12.4	0.14	0.020	8.9	0.1	0.8	0.4
6/28/24 20:30	6/28/24 21:46	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.31	6796	680	7475	11.6	18.8	4.0	0.05	0.007	2.9	0.0	0.3	0.1
7/2/24 2:31	7/2/24 5:05	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.33	4751	475	5226	8.1	13.1	2.8	0.03	0.005	2.0	0.0	0.2	0.1
7/4/24 7:15	7/4/24 9:16	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.14	597	60	657	1.0	1.7	0.4	0.00	0.001	0.3	0.0	0.0	0.0
7/4/24 14:00	7/4/24 18:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.59	4656	466	5122	7.9	12.9	2.7	0.03	0.005	2.0	0.0	0.2	0.1
7/5/24 14:00	7/5/24 15:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.19	2002	200	2202	3.4	5.5	1.2	0.01	0.002	0.9	0.0	0.1	0.0
7/7/24 1:00	7/7/24 3:00	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.03	167	17	184	0.3	0.5	0.1	0.00	0.000	0.1	0.0	0.0	0.0
7/9/24 16:00	7/9/24 18:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.33	48	5	53	0.1	0.1	0.0	0.00	0.000	0.0	0.0	0.0	0.0
7/10/24 15:15	7/10/24 17:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.99	231	23	254	0.4	0.6	0.1	0.00	0.000	0.1	0.0	0.0	0.0
7/13/24 7:45	7/13/24 8:49	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.12	2001	200	2201	3.4	5.5	1.2	0.01	0.002	0.9	0.0	0.1	0.0
7/13/24 13:30	7/13/24 14:20	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.59	5895	590	6485	10.0	16.3	3.5	0.04	0.006	2.5	0.0	0.2	0.1
7/14/24 1:15	7/14/24 2:20	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.58	8994	899	9893	15.3	24.9	5.3	0.06	0.009	3.8	0.0	0.4	0.2
7/15/24 8:15	7/15/24 9:53	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.15	1029	103	1132	1.8	2.8	0.6	0.01	0.001	0.4	0.0	0.0	0.0
7/21/24 8:45	7/21/24 12:22	**17**	**50**	9	0.1	**0.010** <	***6.1***	0.1	0.6	0.3	1.60	23942	2394	26337	28.0	82.2	14.1	0.16	0.016	10.0	0.1	1.0	0.5
7/22/24 17:45	7/22/24 18:50	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.73	8671	867	9538	14.7	24.0	5.1	0.06	0.008	3.7	0.0	0.3	0.2
7/28/24 23:45	7/29/24 1:00	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.42	2188	219	2407	3.7	6.1	1.3	0.01	0.002	0.9	0.0	0.1	0.0
7/31/24 17:30	7/31/24 20:18	**66**	40	9	0.1	0.01	6	0.1	0.6	0.3	0.70	5477	548	6025	24.8	15.2	3.2	0.04	0.005	2.3	0.0	0.2	0.1
8/1/24 0:00	8/1/24 3:46	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.52	5409	541	5950	9.2	15.0	3.2	0.04	0.005	2.3	0.0	0.2	0.1
8/1/24 6:00	8/1/24 13:25	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.41	12011	1201	13213	20.4	33.2	7.1	0.08	0.012	5.1	0.0	0.5	0.3
8/3/24 21:15	8/3/24 23:19	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.15	1232	123	1356	2.1	3.4	0.7	0.01	0.001	0.5	0.0	0.0	0.0
8/5/24 4:30	8/5/24 5:22	25	40	9	0.1	0.01	***7.1***	0.1	0.6	0.3	0.05	357	36	393	0.6	1.0	0.2	0.00	0.000	0.2	0.0	0.0	0.0
8/5/24 7:45	8/5/24 11:21	**7**	**58**	9	0.1	0.01	6	0.1	0.6	0.3	0.49	5446	540	5985	2.6	21.7	3.2	0.04	0.005	2.3	0.0	0.2	0.1
8/5/24 14:30	8/5/24 15:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.15	547	0	547	0.8	1.4	0.3	0.00	0.000	0.2	0.0	0.0	0.0
8/5/24 15:45	8/5/24 21:24	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.99	16477	0	16477	25.5	41.4	8.8	0.10	0.015	6.4	0.1	0.6	0.3
8/15/24 1:45	8/15/24 2:28	**25**	**47**	9	0.1	0.01	6	0.1	0.6	0.3	0.09	810	0	810	1.3	2.4	0.4	0.01	0.001	0.3	0.0	0.0	0.0
8/15/24 3:45	8/15/24 6:22	25	40	9	0.1	**0.010**	***7.9***	0.1	0.6	**0.26** <	0.43	6796	0	6796	10.5	17.1	3.6	0.04	0.004	3.4	0.0	0.2	0.1
8/16/24 8:45	8/16/24 11:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.07	288	0	288	0.4	0.7	0.2	0.00	0.000	0.1	0.0	0.0	0.0
8/16/24 14:15	8/16/24 21:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.06	149	0	149	0.2	0.4	0.1	0.00	0.000	0.1	0.0	0.0	0.0
8/17/24 10:00	8/17/24 11:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.07	312	0	312	0.5	0.8	0.2	0.00	0.000	0.1	0.0	0.0	0.0
8/17/24 15:00	8/17/24 16:45	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.04	564	0	564	0.9	1.4	0.3	0.00	0.000	0.2	0.0	0.0	0.0
8/22/24 14:00	8/22/24 16:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.12	778	0	778	1.2	2.0	0.4	0.00	0.001	0.3	0.0	0.0	0.0
8/23/24 10:30	8/23/24 12:00	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.02	100	0	100	0.2	0.3	0.1	0.00	0.000	0.0	0.0	0.0	0.0
8/26/24 19:30	8/26/24 20:24	**17**	**31**	9	**0.13**	**0.024**	***5.0***	0.1	**0.72**	**0.47** <	0.69	8347	0	8347	8.9	16.2	4.5	0.07	0.013	2.6	0.0	0.4	0.2
8/27/24 5:30	8/27/24 6:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	1.16	20347	0	20347	31.5	51.2	10.9	0.13	0.018	7.9	0.1	0.7	0.4
8/29/24 17:00	8/29/24 19:43	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.46	5663	0	5663	8.8	14.2	3.0	0.04	0.005	2.2	0.0	0.2	0.1
9/6/24 12:00	9/6/24 13:15	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.14	3115	0	3115	4.8	7.8	1.7	0.02	0.003	1.2	0.0	0.1	0.1
9/6/24 16:00	9/6/24 16:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.16	785	0	785	1.2	2.0	0.4	0.00	0.001	0.3	0.0	0.0	0.0
10/24/24 18:15	10/24/24 21:30	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.51	6942	0	6942	10.7	17.5	3.7	0.04	0.006	2.7	0.0	0.3	0.1
10/31/24 3:00	10/31/24 6:41	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.62	3333	0	3333	5.2	8.4	1.8	0.02	0.003	1.3	0.0	0.1	0.1
10/31/24 7:04	10/31/24 11:22	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.62	8618	0	8618	13.3	21.7	4.6	0.05	0.008	3.3	0.0	0.3	0.2
10/31/24 11:31	10/31/24 16:39	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.23	4297	0	4297	6.6	10.8	2.3	0.03	0.004	1.7	0.0	0.2	0.1
11/4/24 7:15	11/4/24 11:20	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.21	2225	0	2225	3.4	5.6	1.2	0.01	0.002	0.9	0.0	0.1	0.0
11/5/24 10:30	11/5/24 20:10	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.33	3935	0	3935	6.1	9.9	2.1	0.02	0.003	1.5	0.0	0.1	0.1
11/9/24 16:45	11/10/24 10:06	25	40	9	0.1	0.01	6	0.1	0.6	0.3	0.18	2258	0	2258	3.5	5.7	1.2	0.01	0.002	0.9	0.0	0.1	0.0
Sum											28.32	331607	23487	355095	549.5	893.4	190.6	2.19	0.312	137.3	1.3	12.9	6.9
Average		30.7	44.3	11.0	0.12	0.017	7.6	0.06	0.75	0.34													
Weighted Avg		24.8	40.3	8.6	0.10	0.014	6.2	0.06	0.58	0.31													
STDEV		22.9	12.4	4.2	0.04	0.007	3.3		0.32	0.11													
Min		7.0	24.0	8.0	0.07	0.010	5.0	0.06	0.44	0.26													
Max		78.0	58.0	14.0	0.17	0.028	14.1	0.06	1.17	0.49													
Percent Capture																							

< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
BOLD Sampling eve Sampled Event
1 North Inlet Volumes are estimated flows based on modeling using monitored flow from the South Inlet
Winter season rainfall & snowmelt events - No representative water quality data was collected

City of Saint Paul
2024 Water Quality and Quantity Report
Table C.11
WSB Project Number: 024571

ALLIANZ FIELD FILTER CHAMBER EFFLUENT WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3286819	7/31/2024 17:58	8/1/2024 5:18	4.0	363.0			0.026	158.0			1.180 <	102	2.8	0.5 <	17.7	3.9		398.0	
3290759	8/15/2024 4:30	8/15/2024 9:10	10.0	471.0			0.047	207.0			1.620 <	134	5.5	0.6	23.5	3.6		19.0	
3294404	8/27/2024 5:51	8/29/2024 10:46	6.0	119.0		0.10	0.056	52.0		0.47	0.600 <	34	2.8	0.5 <	19.6	2.4		15.0 <	
MINIMUM			**4.0**	**119.0**	**0.0**	**0.1**	**0.0**	**52.0**	**0.0**	**0.5**	**0.6**	**34.4**	**2.8**	**0.5**	**17.7**	**2.4**	**0.0**	**15.0**	**0.0**
AVERAGE			**6.7**	**317.7**	**#DIV/0!**	**0.1**	**0.0**	**139.0**	**#DIV/0!**	**0.5**	**1.1**	**90.1**	**3.7**	**0.5**	**20.3**	**3.3**	**#DIV/0!**	**144.0**	**#DIV/0!**
MEDIAN			**6.0**	**363.0**	**#NUM!**	**0.1**	**0.0**	**158.0**	**#NUM!**	**0.5**	**1.2**	**102.0**	**2.8**	**0.5**	**19.6**	**3.6**	**#NUM!**	**19.0**	**#NUM!**
MAXIMUM			**10.0**	**471.0**	**0.0**	**0.1**	**0.1**	**207.0**	**0.0**	**0.5**	**1.6**	**134.0**	**5.5**	**0.6**	**23.5**	**3.9**	**0.0**	**398.0**	**0.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

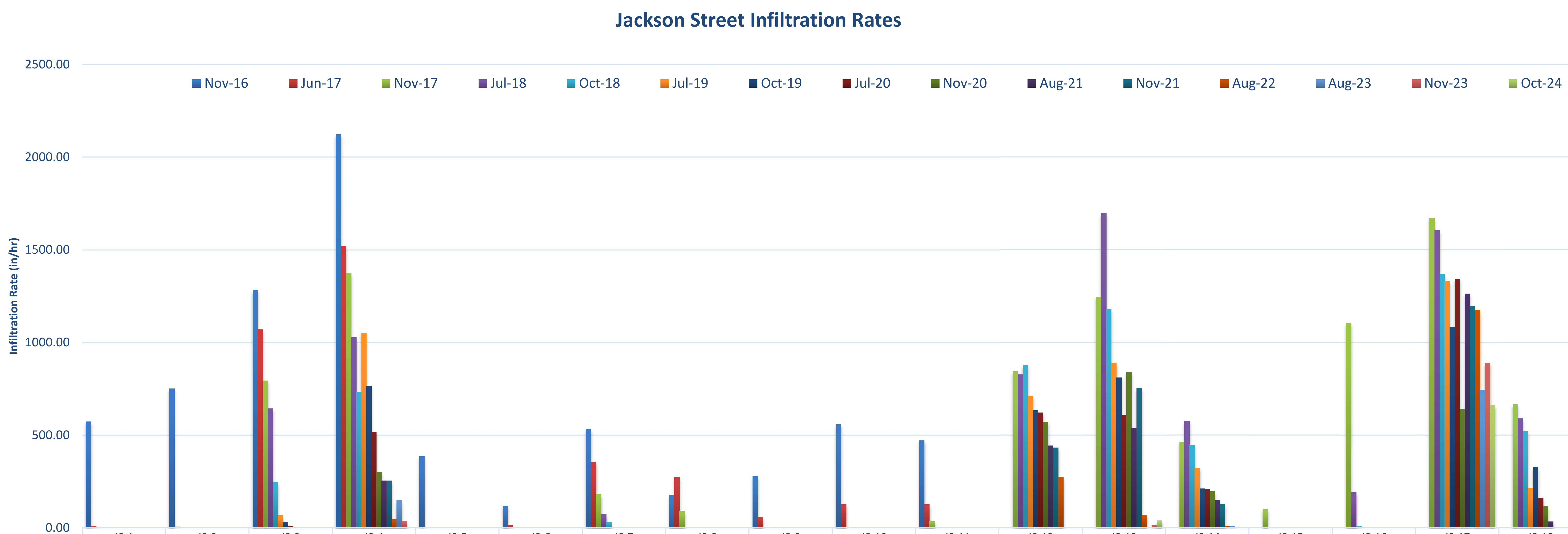
Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported

J - Result reported as estimated between the MDL and Reporting Limit (RL)

> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2024 Water Quality and Quantity Report
Chart D.1
WSB Project No.: 024571



	JS-1	JS-2	JS-3	JS-4	JS-5	JS-6	JS-7	JS-8	JS-9	JS-10	JS-11	JS-12	JS-13	JS-14	JS-15	JS-16	JS-17	JS-18
Nov-16	572.60	750.40	1282.07	2122.21	385.88	118.70	533.72	177.47	277.93	557.90	471.54							
Jun-17	9.29	6.30	1069.04	1520.13	4.49	12.12	353.94	275.34	56.12	125.46	125.40							
Nov-17	3.86	0.00	793.76	1371.96	0.00	0.00	181.73	90.77	2.38	2.07	35.49	843.29	1246.74	464.43	99.97	1104.44	1669.95	665.40
Jul-18	0.00	0.00	642.24	1026.71	0.00	0.00	73.71	0.00	0.00	0.00	0.00	827.22	1696.93	575.13	0.00	190.07	1604.98	589.63
Oct-18	0.00	0.00	247.09	733.69	0.00	0.00	29.44	0.00	0.00	0.00	0.00	877.09	1179.25	447.48	0.00	9.02	1369.65	521.52
Jul-19	0.00	0.00	67.07	1050.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	710.52	889.49	323.26	0.00	0.00	1329.45	215.70
Oct-19	0.00	0.00	30.35	764.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	633.28	809.62	211.40	0.00	0.00	1082.13	327.70
Jul-20	0.00	0.00	7.05	516.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	620.41	608.65	207.81	0.00	0.00	1343.21	160.40
Nov-20	0.00	0.00	0.00	299.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	572.01	839.81	195.40	0.00	0.00	640.06	115.47
Aug-21	0.00	0.00	0.00	254.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	442.70	537.80	148.90	0.00	0.00	1263.50	33.00
Nov-21	0.00	0.00	0.00	253.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	432.00	753.00	128.70	0.00	0.00	1194.50	0.00
Aug-22	0	0	0	46.13	0	0	0	0	0	0	0	274.28	69.76	7.885	0	0	1173.965	0
Aug-23	0	0	0	149.9	0	0	0	0	0	0	0	0	0	10.4	0	0	744.4	0
Nov-23	0	0	0	38.1	0	0	0	0	0	0	0	0	13	0	0	0	888.6	0
Oct-24	0	0	0	0	0	0	0	0	0	0	0	0	38.5	0	0	0	661.1	0

Saint Paul Permeable Pavement Testing

Saint Paul Permeable Pavement Testing

Saint Paul Permeable Pavement Testing

Saint Paul Permeable Pavement Testing

Saint Paul Permeable Pavement Testing

Saint Paul Permeable Pavement Testing

STORMWATER MONITORING PROTOCOL

2024 Stormwater Monitoring Program
Field Standard Operating Procedures

FOR THE CITY OF
ST. PAUL, MINNESOTA

wsb

TITLE PAGE

TABLE OF CONTENTS

I. Contents

Attachments:

WSB Confined Space Entry Permit

Metropolitan Council Environmental Services Laboratory Chain-of-Custody (BMP Infiltration Sites)

I. Objectives

This section provides a summary of objectives for this monitoring effort. These objectives are presented in question form anticipating that the answers will be obtained through analysis of the data collected as part of this monitoring program.

a) How do team members maintain a safe work environment?

b) How much stormwater runoff volume reduction is achieved by each BMP on an event and annual basis?

c) What is the average measured infiltration rate of each BMP?

d) How often does each BMP require maintenance?

e) How many volume reduction credits are available at each BMP? Do they perform in accordance with or exceed watershed district rules?

f) What is the cost per cubic-foot of volume reduction actually being achieved by each BMP?

g) What is the mass of pollutants (TP, TSS, chlorides, etc.) removed from the stormwater system by each BMP on an average annual basis?

II. Safety Overview

The following safety guidelines have been developed to ensure that all WSB team members are providing and maintaining a safe work environment. Proper planning and situational awareness can help team members identify and eliminate potentially dangerous situations. Every team member has stop work authority if they feel endangered by unsafe working conditions. All team members are encouraged to report unsafe acts or unsafe working conditions to their supervisor as soon as possible. The following sections describe potentially hazardous working conditions and hazard mitigation procedures.

II.1 Adverse Weather Conditions:

Field team members will likely encounter a wide range of weather conditions during field duties. Field staff should be aware of the weather conditions and take proper measures to protect themselves from the elements.

- During excessive heat and sun conditions, field staff should stay hydrated, don skin protective clothing, and apply sunscreen .During excessive cold conditions, field staff should dress in layers and avoid perspiration
- During lightning producing conditions, field staff must seek shelter in a work vehicle or other safe location if a lightning strike or thunder is observed. The field staff should wait at least 30 minutes from the last lightning strike before resuming outdoor activities. Lightning safety is especially important due to the likelihood of thunderstorms during stormwater sampling events
- Field staff should be aware of the signs of heat exhaustion, heat stroke, hypothermia, and frostbite, and have an understanding of basic first aid procedures

II.2 Working in the street:

At times, it will be necessary for team members to access manholes in roadways.

- While working in roadways, field staff should be visible to traffic, don reflective vests and hardhats, and utilize vehicle hazard lights
- Field staff should park close to the manhole and encompass work area with safety cones
- Field staff should be aware of any unauthorized entry into the work area by untrained personnel or the public
- Ensure that all MH lids and access points are secured prior to leaving site.

II.3 Confined Space Entry[1]

Only staff with OSHA Confined Space Entry training can complete a confined space entry. When entry to confined spaces is required for monitoring activities, the following checklist must be reviewed and adhered to:

Permits/Notifications:

- Execute a confined space entry permit form and follow appropriate protocols (**Confined Space Entry Permit Attached**). See WSB's safety office, Trent Noeker, for a copy of the form
- Obtain a no fee lane use right-of-way permit if work is to be done in the street:

[1] Review Entering and Working in Confined Spaces, Confined Space Entry Program for WSB & Associates, Inc. for WSB's confined space entry protocols prior to entering a confined space.

- St. Paul ROW: 651-266-6151

- Notify City staff
  - St. Paul Sewer Maintenance: 651-266-9836
- Notify local fire department of planned confined space entry

Required Safety Gear:

- Hard hat
- Sturdy boots
- Reflective safety vest
- 4-Gas Monitor
- Tripod
- 3-way lifeline winch
- Body harness
- Air ventilation blower and generator
- 28” reflective traffic cones and vehicle hazard lighting

Gear Maintenance:

- **Calibrate 4-gas monitor every 180 days:** The 4-gas monitor will indicate when calibration is needed. Viking Safety Products will calibrate the device free of charge. Call Viking for more information: 651-646-6374.
- **Inspect the tripod for wear and damage annually:** Viking Safety Products will inspect the equipment and provide a formal certificate of inspection. Call Viking for more information: 651-646-6374

General Confined Space Entry Procedures:

- Never complete a confined space entry during a rain event. Check the weather forecast and ensure clear conditions for the duration of the entry.
- Prior to leaving the office, confirm all equipment is functioning and that monitoring equipment is in compliance with the calibration schedule.
- Secure the area from untrained personnel and pedestrians.
- Ensure team members are knowledgeable of the roles and responsibilities of the confined space entrant, attendant, and supervisor.
- Complete air monitoring prior to, and for the duration of the confined space entry. Ensure team members are knowledgeable of the 4-gas monitor alarms and unsafe gas levels that prompt an evacuation of the confined space.
- Utilize a rope and bucket to deliver equipment to the entrant.
- Ensure there is a reliable method of communication between all team members completing the confined space entry.

III. Monitoring Sites

Below is a summary of sites which are included in this monitoring effort. Equipment and methods used and monitoring parameters analyzed for each site are provided for quick reference. (See Figures for site locations and monitoring configuration.)

III.1 Beacon Bluff:

This site consists of an infiltration basin situated over the top of an underground infiltration pipe gallery system. Stormwater flows into the infiltration basin from three storm sewer outfalls and into the underground chambers from a single storm sewer pipe. An outlet pipe connected directly to the underground chambers conveys overflow back to the storm sewer when the system reaches capacity.

Equipment:

- 3 – ISCO 2150 Area velocity sensors (Upstream, Downstream, WPO)
- 5 – System Level Loggers
  - BMP Pipe
  - OCS
  - BaroTroll (atmospheric logger)
- 2 – Rugged Troll 100
  - GW-50
  - GW-53
- 1 – ISCO 6712 Portable Water Quality Sampler

Monitoring Parameters:

- Rainfall
- Flow Rate/Volume
- Water Level/Infiltration rate
- Water Quality **(NPDES Permit Required Parameters)**

III.2 West Shepard Road Pond:

The West Shepard Road Pond is a clay-lined pond that receive water from the east and west along Shepard, just under the Smith Avenue Bridge. The water from this pond then flows to the main sewer line.

Equipment:

- 1 – ISCO 2150 Area Velocity Sensors
- 1 – Level Troll 500
  - East and West Pond
- 1 – ISCO 712 Portable Water Quality Sampler

Monitoring Parameters:

- Rainfall
- Flow Rate/Volume
- Water Level

- Water Quality **(NPDES Permit Required Parameters)**

III.3 St. Albans:

The St. Albans Street infiltration system was constructed in 2010 to provide volume reduction along the Central Corridor. The system was constructed in an offline configuration. When the system reaches its storage capacity, water stops flowing into the system and continues through the storm sewer. The system includes a pretreatment structure which consists of box culvert sections and baffled weirs to provide skimming and settling of runoff prior to entering the infiltration chamber.

Equipment:

3 – ISCO 2150 Area Velocity Sensors (Upstream, Downstream)
1 – ISCO 6712 Portable Water Quality Sampler
1 - Level Troll 500
BMP Pipe

Monitoring Parameters:

- Rainfall
- Flow Rate/Volume
- Water Level/Infiltration Rate
- Water Quality **(NPDES Permit Required Parameters)**

III.4 Allianz Field Soccer Stadium:

The Allianz Field Soccer Stadium is a filtration chamber located on the north side of interstate 94, between Snelling Avenue and Pascal Street in the Midway neighborhood of Saint Paul, Minnesota. Allianz field was designed with multiple "Shared Stacked Green Infrastructure" (SSGI) to collect, treat, and reuse stormwater from this area and protect the Mississippi River from storm water pollution. Beneath the Allianz field parking lot lies four underground storage tanks, three tanks are dedicated to rate control and treatment and one dedicated to storm water reuse. The stormwater tank is a 90,000 cubic-foot Steel Reinforced Polyethylene (SRPE) pipe. The drainage area of this site is 11.18 acres

Equipment:

2 – ISCO 2150 Area Velocity Sensor (influent and effluent)
2 – ISCO 6712 Portable Water Quality Sampler (influent and effluent)
3- Level Troll 500 Water Level Loggers

Monitoring Parameters:

- Rainfall
- Flow Rate/Volume
- Water Quality **(NPDES Permit Required Parameters)**

III.5 Hampden Park

The Hampden Park infiltration gallery was constructed in 2014. The system consists of eight parallel perforated pipes that are five feet in diameter and range in length from 40 to 100 feet. Runoff is routed to the pretreatment system via a 24" RCP from main storm sewer near Hampden and Raymond Avenues. From that location, stormwater enters a pretreatment structure which consists of a box culvert section and baffled weir to provide skimming and settling of runoff prior to entering the infiltration chamber. The infiltration gallery receives flow from a second inlet location along Raymond Avenue, farther to the north. When the system reaches full capacity, stormwater is routed back to the storm sewer via a 24" pipe from the southeast side of the system.

Equipment:

1 – ISCO 2150 Area Velocity Sensor (Upstream)
1 – ISCO 6712 Portable Water Quality Sampler
1 – Rugged Troll 100
BMP

Monitoring Parameters:

- Rainfall
- Water level/Infiltration rate
- Flow Rate
- Water Quality **(NPDES Permit Required Parameters)**

III.6 Victoria Street

This site was constructed in an offline configuration. Flow is diverted from the main storm sewer to the system. When the system has reached its storage capacity, water stops flowing into the system and continues through the storm sewer. The system includes a pretreatment structure which consists of a box culvert section and a baffled weir to provide skimming and settling of runoff prior to entering the infiltration chamber. A permeable paver parking area is located above this system and discharges filter stormwater into it via an 8-inch drain tile.

Equipment (Complete set at each of the three ponds) :

2 – ISCO 2150 Area velocity sensors (Upstream and Downstream)
1 – ISCO 6712 Portable Water Quality Sampler
1 – Rugged Troll 100
BMP

Monitoring Parameters:

- Rainfall
- Water Level
- Flow Rate

- ☐ Water Quality **(NPDES Permit Required Parameters)**

IV. Preparation and Logistics

Preparedness is crucial to successful implementation of this monitoring program. Anticipation of target storm events, readiness with field equipment, and understanding of confined space entry procedures play a role in this process. This section provides essential information related to these items.

IV.1 Storm Selection Criteria for Water Quality Sampling

The activities below should be completed at least weekly to determine the potential need to prepare sampling equipment and mobilize crews to undertake water quality samplings:

- ☐ Track storms using local ALERT systems and by accessing National Weather Service forecasts: www.nws.noaa.gov
- ☐ Determine Quantity of Precipitation Forecast (QPF) for an impending storm
- ☐ If QPF is greater than 0.1-inches initiate sample collection preparation procedures (see **Section VI**)

IV.2 Portable Sampler (ISCO 6712) Preparation

This is to be done after all sampling events and or when receive a low battery alarm.

- ☐ Change out samples bottles in automated sampler with clean bottles
- ☐ Reset automated sampler for a new event. Update the sample flow volume interval if more or less samples need to be collected based on lab requirements, storm event size, or modification to protocols
- ☐ Ensure that batteries are adequately charged and positioned
- ☐ Make sure clean grab sample bottles are on hand

V. Visual Inspection and Manual Data Collection

Routine BMP inspections conducted on a visual basis will provide information related to specific maintenance needs and provide information that may be pertinent to any anomalies in the water quality sampling results. Additionally, the pervious pavement infiltration studies will consist of manual data collection in accordance with ASTM method C1701. The following section provides field guidance for those tasks.

Infiltration Systems<u>Frequency:</u>

- Once per month

<u>Visual Inspection:</u>

- Identify significant obstructions present in the source pipes
- Indicate whether there is standing water in the infiltration system
- Indicate whether there is evidence of illicit discharges
- Identify any structural issues in the system
- Describe other observations
- Sketch inspection observations as appropriate

<u>Manual Data Collection:</u>

- Take digital photos of all visual inspection parameters
- Quantify the amount of sediment present in the system's:
  - Sump manhole
  - Pretreatment device
  - Stormwater storage area
- Quantify the amount of floatables present in the system's:
  - Sump manhole
  - Pretreatment device
  - Stormwater storage area

<u>Required Equipment:</u>

- Measuring rod
- Digital camera

<u>Required Forms:</u>

- Infiltration BMP Inspection and Maintenance Form

V.1 Pervious Pavement Infiltration Tests

<u>Frequency:</u>

- Once per year

<u>Visual Inspection:</u>

- Identify number and location of missing pavers (if present)
- Identify significant cracking, chips, or other damage
- Identify location and approximate depth of deflection

Manual Data Collection:

- Take digital photos of all visual inspection parameters
- Record depth of aggregate at six (6) locations (if pavers)
- Measure infiltration rate in six (6) locations
    - Follow the modified ASTM method C1701
    - Locations should be marked by a drill hole or a nail so that the same locations can be tested each time
    - 3 locations should be within 1 foot of the concrete strip separating the permeable surface from the roadway

Equipment:

- Infiltration measurement apparatus
- Water tank and feeder hose
- Digital camera
- Scale
- 12” PVC Pipe
- Plumbers putty

Required Forms:

- Permeable paver inspection form

Monitoring Parameters:

- Infiltration rate
- BMP visual inspection

VI. Sample Collection, Preservation, and Laboratory Analysis

The following procedures must be followed to maintain a consistent approach for obtaining composite water quality samples and to reduce the risk of cross contamination when retrieving and transporting samples to the laboratories:

VI.1 Composite Sampling Using Automated Sampler:

Estimating pollutant loads as part of this monitoring program will include determination of the event mean concentration (EMC) for the target storm events using composite samples. To obtain composite samples that are representative of the storm events analyzed, the following minimum number of aliquots and percent capture values should be met:

Total Event Precipitation (in.)	Minimum Acceptable Number of Aliquots	Percent Capture Requirement[2]
0 – 0.25	6	85
0.25 – 0.50	8	80
0.50 – 1.0	10	80
> 1.0	12	75

To meet these requirements the automatic samplers should be programmed to collect samples at flow-paced intervals. Determination of the flow volume between sampling events should be based on the following information:

Total Event Precipitation (in.)	Robie Street Outfall	Beacon Bluff
	Runoff Volume (cu-ft)	Runoff Volume (cu-ft)
0.10-0.15”	30,840	4,500
0.25”	51,400	20,986
0.5”	102,800	63,000
1.0”	205,600	156,756
2.0”	411,200	373,550
3.0”	616,800	657,879

<u>Program Automated Sampling Parameters:</u>

Based on the information above and other considerations, the following provides the parameters that should be used for programming the automated samplers:

- **Start Time:** Begin sampling at specific water level depths
  - Hampden Park: 0.75-inches
  - Beacon Bluff: 1.25-inches
  - Saint Albans: 1.1-inches

[2] $Percent\ storm\ capture = \frac{flow\ volume\ that\ passed\ during\ sample\ collection}{total\ flow\ that\ passed\ during\ the\ entire\ monitoring\ event}$

- Victoria: 1.15-inches
- Sackett: 3.5-inches
- Battle Creek: 4-inches

- **Pacing:** Set sampler to collect samples at constant flow volume intervals
  - Beacon Bluff: minimum 1,500 cu-ft
  - Saint Albans: 200 cu-ft
  - Victoria: 175 cu-ft
  - Hampden Park: 300 cu-ft
  - Sackett: 250 cu-ft
  - Battle Creek: 1,500 cu-ft
- **Distribution:** Multiple samples per bottle - sample aliquot volume should be no less than 200 mL

Multiple bottles will be collected for each event. The testing laboratory should be directed to develop a composite sample with the collection of bottles by either batch mixing or by combining equal fractions of each bottle into a single bottle or container.

VI.2 Grab Sample Collection

Grab samples will be collected for E coli analysis at all monitoring locations Samples will be collected from the influent stormwater stream prior to entering the systems. The purpose of E. coli analysis is to ensure that human effluent is not contaminating the water. The following provides the process for obtaining the grab samples:

<u>Sampling Locations:</u>

- Man holes up stream of the automatic samplers

<u>Procedures:</u>

- Collect 3 samples (one every 10 minutes for composite testing) while it is raining.
- Use sterile sample bottles with an unbroken seal when testing for e-coli
- Place sample bottle directly below or in outfall water stream to collect the sample

<u>Required Equipment:</u>

- Personal rain gear
- Powder-free nitrile gloves
- 1-Liter plastic sample bottles and lids
- Sterile bacteria sample bottles and lids from laboratory
- Bottle labels and water proof pen
- Chain of custody forms for laboratory
- Manhole pick
- Cooler with ice
- Grab sample collection rod

VI.3 Analytical Parameters:

The following table provides a list of parameters and the sampling frequency as established by Permit No. MN0061263. Samples collected from the automated samplers will be analyzed for the water quality parameters in Table 1 of the City of St. Paul's MS4 permit (when volumes allow).

Monitoring Parameters		
Parameters	**Sample Type**	**Frequency**
BOD, Carbonaceous 5-Day (20 Deg C)	Composite or Grab	Quarterly
Chloride, Total	Composite or Grab	As noted for loading calculations (Par V.C7.f)
Copper, Total (asCu)	Composite or Grab	Monthly
E. coli	Grab	Quarterly
Flow	Measurement	
Hardness, Carbonate (as CaCo3)	Composite or Grab	Monthly
Lead, Total (as Pb)	Composite or Grab	Monthly
Nitrite Plus Nitrate, Total (asN)	Composite	As noted for loading calculations (Par V.C7.f)
Nitrogen, Ammonia, Un-ionized (as N)	Composite	Quarterly
Nitrogen, Kjeldahl, Total	Composite	As noted for loading calculations (Par V.C7.f)
pH	Composite or Grab	Quarterly
Phosphorus, total Dissolved or Ortho	Composite	Quarterly
Phosphorus, Total as P	Composite	As noted for loading calculations (Par V.C7.f)
Precipitation	Measurement	1 x Day
Solids, Total Dissolved (TDS)	Composite	Quarterly
Solids, Total Suspended (TSS)	Composite	As noted for loading calculations (Par V.C7.f)
Sulfate	Composite or Grab	2 x Year
Volatile Suspended Solids (VSS)	Composite	As noted for loading calculations (Par V.C7.f)
Zinc, Total (as Zn)	Composite or Grab	Monthly

VI.4 Sample Preservation

- Collect samples from automated sampler within 24 hours
- Composite individual sample containers from the autosampler into one, clean, 4-liter jug, provided by MCES Lab
  - If the storm event produced volume in exceess of 4 liters, the sample volume shall be composited in the churn sampler splitter.
  - Fill the churn will all samples collected from the event. One staff shall provide constant mixing using the paddle, while the other staff shall open the spickot, gradually filling the lab container with the mixed sample
  - The churn sampler splitter shall be cleaned between uses
- The sample containers shall be labeled with the relevant Site and sample information which shall include:

- Site Name [**See attached Chain of Custody (CoC)** examples for Site IDs].
    - The composite start and end time, as indicated on the autosampler
    - Name of staff collecting the sample
- The sampler shall complete a CoC form to submit with the sampler or communicate sample information to the Project Manager to complete the form electronically, and submit to the lab
- Place all samples to be analyzed in a cooler with ice
    - Target holding temperature for samples is 4˚C
- Deliver samples to lab

VI.5 Cleaning of Sample Equipment and Bottles

- **Clean sample bottles and churn splitter after every use:** wash them with a brush and soapy water or use a dishwasher
- **Clean the suction line, strainer, and pump tubes twice per year:** Place the end of the suction line in a cleaning solution and pump it through the system. Rinse with clean water

VI.6 Quality Assurance/Quality Control:

- Before samples are collected, make sure that all sampling equipment and bottles are cleaned using the appropriate cleaning procedures
- Wear powder-free nitrile gloves when handling bottles, lids, tubing, or strainers.
- Never touch the inside surface or exposed end of a sample bottle or lid, even with a gloved hand
- Never let any material other than sample water touch the inside surface or exposed end of sample bottle
- Avoid allowing rain water to drip from rain gear or other surfaces into sample bottles

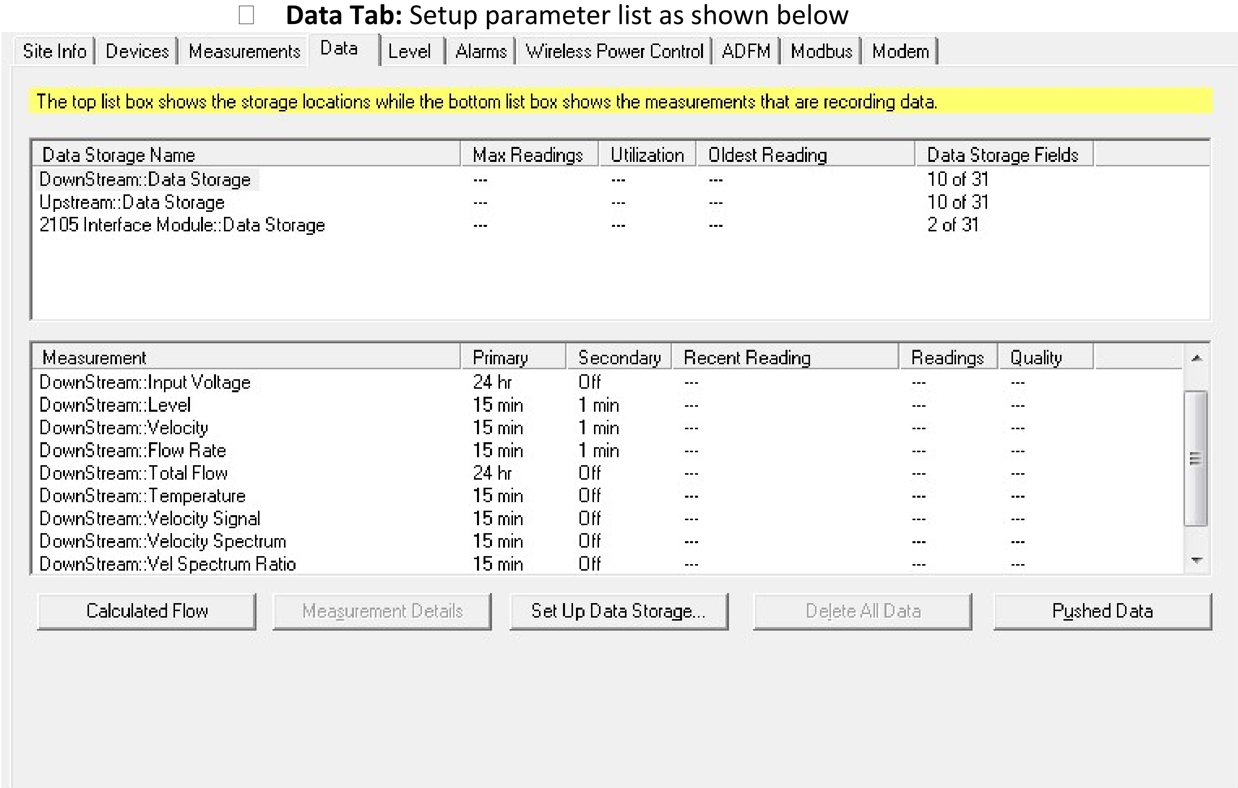
VII. Operation and Maintenance of Monitoring Equipment

The following provides a summary of procedures to follow for operating and maintaining monitoring equipment for collection of flow, rainfall, water level, and sampling data. These procedures should be followed when the devices are initially setup and during routine data dumps and maintenance activities.

VII.1 Flow Meters (ISCO 2150)[3] and Interface Modules (ISCO 2105/2103)[4]:

Setup/Initialization:

- **Software Required:** Flowlink
- **Quick Connect:** Connect the device to a laptop using the communication cable. Start Flowlink and select Quick Connect Icon in the tool bar. Use “Direct” Type Connection and check “Create New Site” for new instillation. Click on the large *2100 Instruments* button to connect
- **Site Info Tab:** Add applicable information and “Synchronize Site’s Time to Computer’s”
- **Devices Tab:** Change Module Names for Area Velocity Meters to reflect location
- **Data Tab:** Setup parameter list as shown below



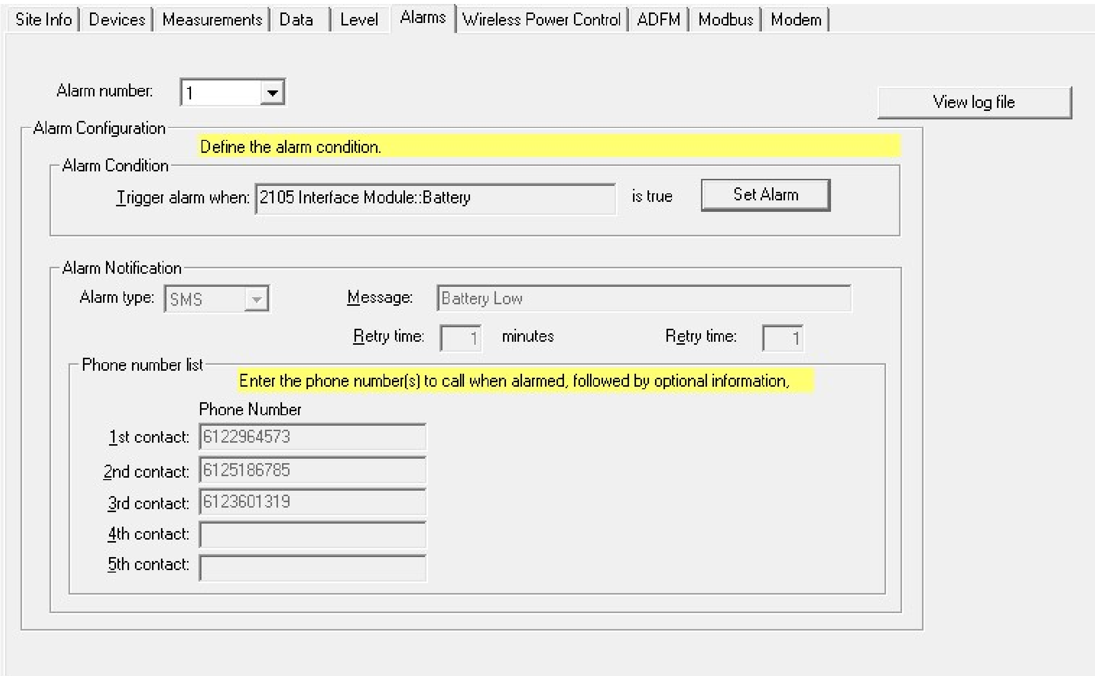
- **Measurement Details:** Set units for all measurements (in, cfs, or cf)
  - **Level:** If flow is present, measure the water depth from the water surface to the channel bottom. Enter the value on the *Level*

[3] See 2150 Area Velocity Flow Module and Sensor – Installation and Operation Guide, Teledyne ISCO, Rev. March 9, 2011.
[4] See 2105 Interface Module – Installation and Operation Guide, Teledyne ISCO, Rev. July 8, 2010.

measurement tab in FLowlink. If no flow is present, enter a value of zero. (Level measurements may drift over time, so it is important to do this routinely.)

- **Velocity Measure Tab:**
  - **No Velocity Data:** Uncheck the *"Set flow rate to zero if no velocity data"* checkbox on the *Velocity* measurement tab in Flowlink. Data can be post processed to remove low level velocity noise
  - **Synchronize Velocity Measurements:** Check the Prevent *interference box* on the *Velocity* measurement tab in Flowlink to prevent velocity signal interference at sites with multiple modules
- **Flow Rate Tab:** Input pipe shape and diameter.

- **Data Storage Rates:** Click on *Set Up Data Storage…* button on a measurement tab in Flowlink to set storage rate.
  - Level, Velocity, Flow Rate, Total flow,: Primary = *15 min*, Secondary = *1 min* (Flow Depth > 1in)
  - Temperature, Velocity Signal, Velocity Spectrum, Velocity Spectrum Ratio: Primary = 15 min
  - Input Voltage, Wireless Signal: Primary = *24 hours*
    Note: In "Condition Builder" set Hysteresis to 0.5" and Duration to 5 min for all Sampler Level Triggers.
- **Pushed Data Capability:** Click the Pushed Data button to set up a schedule for the data to be pushed
  - **Set IP address:** 207.173.231.99, Port 1700
  - Use Primary Data Transmission interval of *4 hours*
- **Alarms Tab:**
  - **Alarm Condition:** Define alarm condition using Equation Builder
    - Low Battery: When Modem Input voltage drops below 10V



- **Sampler Interface:**
    - **Set Up Data Storage:** Select “Enable Logging”
    - **Sampler enable:** Enable on Trigger - using equation builder to specify level threshold to enable sampler

      Note: In “Condition Builder” set Hysteresis to 0.5” and Duration to 5 min for all Sampler Level Triggers
    - **Sampler Pacing:** input desired flow pulsing interval in cubic feet

<u>Routine Data Retrieval and Re-initialization:</u>

- **Frequency:** Once per month
- **Quick Connect:** Connect the device to a laptop using the communication cable Start Flowlink and click on the large *2100 Instruments* button to connect
- Download data and transfer to WSB server folder K:\01610-100\WR\Flow Data
- Set water level to zero. (Make sure to annotate date and time of level reset)

<u>Routine Maintenance:</u>

The following maintenance activities must be completed routinely and during every field visit:

- **Check desiccant cartridges:** When entire length of the cartridge turns pink or green, the desiccant needs to be replaced
- **Check battery voltage:** Replace both batteries when voltage is below 10
- **Check hydrophobic filter:** Rinse and dry if the filter is plugged
- **Check connector O-rings:** Replace or lubricate as needed
- **Check flow sensor:** Remove debris and clean sensor as needed
- **Check sensor cable for damage:** Replace if needed. Loose cable should be fastened to the structure

VII.2 Portable Sampler (ISCO 6712)[5]:

Setup/Initialization:

- **Software Required:** Flowlink
- **Measure length of suction hose:** Length will be a required input during Program setup. Cut hose to whole ft. Increments if required. Hose should generally slope downward toward the sampling probe
- **Use Standard Program:** Follow Steps in Table 4-2 of the operation guide for flow pacing. Make the corresponding deviations listed below. Standard Programing Flow Charts can also be found in Appendix A in the operation guide (Figures A-2 & A-3)
  - (3)Set appropriate Site Description (i.e. Robie Street, Beacon Bluff)
  - (8) Select 1 pulse between sample events
  - (9) Samples/Bottle
  - (11) 5 Samples/Bottle (200 mL each)
  - (12) No Delay to Start
- **Automatically index to next bottle when sampler is enabled:** This will allow each storm event to be composited separately, but may decrease the overall available sampling volume during multiple events
  - From home screen, enter 6712.9 and hit enter
  - Enter Code: 1199 and hit enter (Sampler should report Code Accepted)
- **Calibration:** The Sampler delivers accurate sample volumes without calibration. If you find that sample volumes vary significantly from the programmed values, first check the suction line for proper installation. Be sure it slopes continuously downhill to the liquid source and drains completely after each sampling cycle. Refer to Section 4.12 of the operation guide for additional calibration notes
  - Note: If sampler does not disable when the program is set to run, check all cable connections and then make sure the 2105 is configured correctly. If the water level is below the trigger threshold, the 2105 should be indicating that the Sampler is disabled. If the sampler is still not disabling, the cable or the sampler may be malfunctioning. The cable can be diagnosed by removing the sampler cable and using a paper clip to short pins “B” and “F” on the back of the sampler control head

Routine Data Retrieval and Re-initialization:

- **Frequency:** Once per month
- **Interrupt Program:** Press the Stop button once to pause the program. Scroll down to “VIEW DATA” and check for errors with sampling. See page 4-19 in the operators guide for more information. When complete, select “RESUME PROGRAM”

Routine Maintenance:

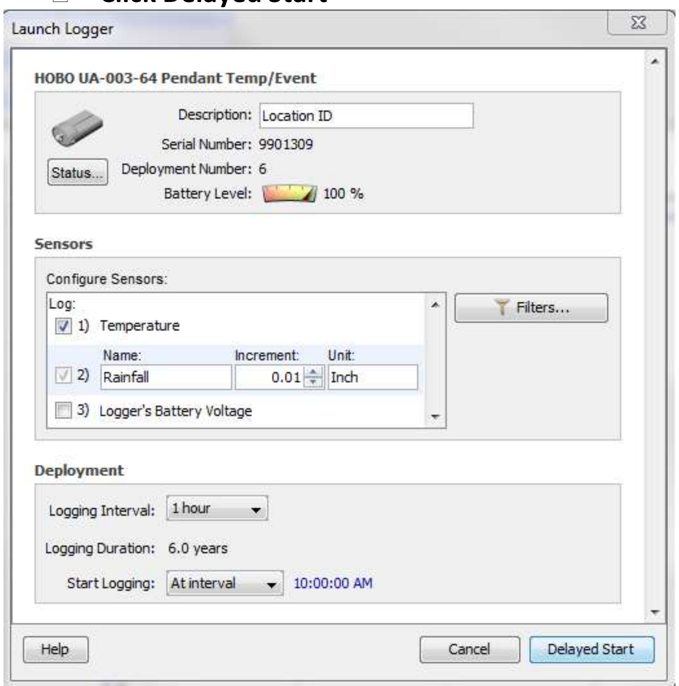
[5] See 6712 Portable Samplers – Installation and Operation Guide, Teledyne ISCO, Rev. April 11, 2011.

- **Check the pump tube for wear:** Replace if necessary
- **Check the pump tubing housing:** Clean if necessary
- **Check the suction line:** Change if necessary
- **Check the humidity indicator:** Desiccant should be replaced when all indicator areas turn light pink or white
- **Check the controller's internal battery status:** Replace the battery every five years
- **Check the keypad label:** If it has bubbles under it, the air inside the controller has expanded, and pressure can be released by unscrewing the flow meter cable or connector cap on the back of the controller

VII.3 Data Logging Rain Gauge:

Setup/Initialization:

- **Software Required:** Onset HOBOware.
- **Connect Rain Gauge:** Open HOBOware and select Launch Device.
- **Configure Sensors:**
  - Log 1) Temperature
  - Log 2) Rainfall
    - Name: Rainfall
    - Increment: 0 .01
    - Unit: Inch
- **Deployment**
  - Logging Interval: 1 hour
  - Start Logging: At Interval
- **Click Delayed Start**



Routine Data Retrieval and Re-initialization:

- **Frequency:** Once per month
- **Connect to device using HOBOware:**
- Download data using readout device and transfer to WSB server folder K:\01610-100\WR\Exported Data. (Do not stop logging before reading out the logger until the end of the season)

Routine Maintenance:

- **Check the filter screen, funnel, and tipping mechanism for debris** (dirt, bugs, bird droppings, etc.): Clean with mild soap and water
- **Check the needle bearings and apply light oil annually**

VII.4 Water Level Logger (Level Troll 500)[6]:

Setup/Initialization:

- **Software Required:** Win-Situ 5
- **Piezometer Specifications:** 3" PVC Pipe should be used as a Piezometer for underground stormwater structures. Drill ½" holes on four sides of the pipe so that there are approximately 20 holes per foot of length in the pipe. Holes do not need to be drilled above top of BMP structure. Wrap section expected to be submerged in highly permeable geotextile fabric, and secure with zip ties. Secure the pipe to the floor, the manhole, and the overhead casting wall
- Hang the Logger from the eye bolt installed inside of PVC pipe piezometer. This will allow a more accurate set up of the reference elevation
- **Stabilization Time:** Allow the Level TROLL to stabilize to the water conditions for *about an hour* before logging data. A generous stabilization time is always desirable, especially in long-term deployments. Even though the cable is shielded, temperature stabilization, stretching, and unkinking can cause apparent changes in the probe reading. If you expect to monitor water levels to the accuracy of the probe, it's worth allowing the extra time for the probe to stabilize to its environment
- **Connection:** With the Troll Com plugged into a USB port, launch Win-Situ Software
- **Win-Situ Launches:** the screen shows the "My Data Tab".
    - On first connection, be sure to select the correct COM port for a USB connection
    - Then connect to the device
- When Connected, the focus shifts to the Home tab. Readings are shown in "meter" view. Values in gray are not being updated in real time
- **Set up a site**: Click the Site Button, select the Default Site or Click the New button to set up a custom site. The site name can have up to 32 characters. Location coordinates are optional
- **Set up a data log:** follow the steps in the logging setup wizard.
    - **Log Name:** Site_2017
    - **Log Parameters:** Pressure (PSI), Temperature (F), Elevation (ft.)
    - **Choose Logging Method:** Long-Term Monitoring – Event
    - **Choose Event Parameter:**
        - Check event parameter every 1 min
        - Log all parameters when the event is greater than 0.25 ft. above BMP invert, or normal water level elevation (sites with standing water in the BMP should utilize a threshold that will prevent the "event" setting from being continuously triggered)
        - Default record data every 60 measurements
    - **Schedule Start time:** on Next Hour
    - **Output:** Depth (BMP Sites) Depth to water (Groundwater Sites)

[6] See Level TROLL – Operator's Manual, In-Situ Inc., March 2010.

        - Be sure to note the casting invert reference elevation used, and the calculated elevation of the bottom of the sensor probe in the Notes option in the Site Data Folder for future reference
    - **Specific Gravity Value**: Custom 0.999
- **Finished Programing:** Disconnect the Troll Com and reattach the desiccant

Routine Data Retrieval and Re-initialization:

- **Frequency:** Once per month
- **Connect to device using Win-Situ 5:**
- Download data and transfer to WSB server folder K:\01610-100\WR\Exported Data. (Do not stop logging until the end of the season)
- Re-reference water level elevation
    - Select "Sensor Tab" then click on calibrate sensor.
    - **Adjust Level Reference:** input the New Reference if required

Routine Maintenance:

- **Check desiccant cartridge:** When entire length of the cartridge changes color, the desiccant needs to be replaced
- **Check minimum cable bend radius:** Half the cable diameter = Approx. 0.54".
- **Check the holes in the nose cone:** If they are plugged, swish the Level TROLL in a bucket of water, rinse under a tap, or soak in a mild acidic solution such as vinegar overnight
    - DON'T dig or scrape in the pressure sensor openings!
    - DON'T touch the pressure sensor diaphragm when the nose cone is removed!
- **Check twist-lock connectors**: Keep pins on all connectors free of dirt and moisture
- **Field Recalibration:** Sensor should be factory recalibrated every 12-18 months. The following procedure may be used, **with caution,** to "zero" the offset of a vented pressure sensor to correct for electronic drift. The drifted offset is visible when the sensor is in air and reading other than zero. It is recommended you **do not** zero the offset if it is outside the specified accuracy of your pressure sensor (30 PSI Sensor: ±0.03 PSI). If the reading in air deviates from zero by more than this amount, you may want to consider a factory recalibration

Attachments

WSB Confined Space Entry Permit

Metropolitan Council Environmental Services Laboratory Chain-of-Custody (BMP Infiltration Sites)

wsb

Permit Number ____________ Date ______________

Location & Description of Confined Space:

____

____

Purpose of Entry:

____

____

Scheduled Start ______________________ a.m./p.m.
Day / Date / Time

Scheduled Finish ______________________ a.m./p.m.
Day / Date / Time

Employee(s) in charge of entry: ______________________________

Entrants:

____

____

Attendants:

____

____

Pre-Entry Authorization: ______________________________

{Check those items below which are applicable to your confined space permit.}

TYPES OF HAZARDS

- ❑ Oxygen-Deficient Atmosphere
- ❑ Oxygen-Enriched Atmosphere
- ❑ Welding/Cutting
- ❑ Engulfment
- ❑ Toxic Atmosphere
- ❑ Flammable Atmosphere
- ❑ Energized Electrical Equipment
- ❑ Entrapment
- ❑ Hazardous Chemical

Note: If welding/cutting operations are to be performed, attach form (3039) to entry form.

SAFETY PRECAUTIONS

- ❑ Self-Contained Breathing Apparatus
- ❑ Air-Line Respirator
- ❑ Fire-Retardant Clothing
- ❑ Ventilation
- ❑ Remarks
- ❑ Protective Gloves
- ❑ Lifelines
- ❑ Respirators
- ❑ Lockout/Tagout
- ❑ Fire Extinguishers
- ❑ Barricade Job Area
- ❑ Signs Posted
- ❑ Clearances Secured
- ❑ Lighting
- ❑ Ground Fault Interrupter

____

ENVIRONMENTAL CONDITIONS

TESTS TO BE TAKEN — **DATE / TIME**

Oxygen: __________% ____________________ a/p

Lower Explosive Limit: _____% ____________________ a/p

Toxic Atmosphere: ______________________________

Instruments Used: ______________________________

RE-TESTING — **DATE / TIME**

Oxygen: __________% ____________________ a/p

Lower Explosive Limit: _____% ____________________ a/p

Toxic Atmosphere: ______________________________

Instruments Used: ______________________________

Employee Conducting Safety Checks **SIGNATURE:** ______________________________

Remark on the overall condition of the confined space.

____

____

____

ENTRY AUTHORIZATION

All actions and/or conditions for safe entry have been performed.

Person in Charge of Entry ______________________________
PLEASE PRINT

ENTRY CANCELLATION

Entry has been completed and all entrants have exited permit space.

Person in Charge of Entry ______________________________
PLEASE PRINT

IN CASE OF EMERGENCY CALL 911
{CFR 1910.146 (f)(11)}

MCES Lab Services
2400 Childs Road, St. Paul, MN 55106
Email: mceslab@metc.state.mn.us
Phone: 651-602-8293

Chain of Custody Form

Client Name:	Phone #:	Email:	Sampler(s):
WSB - Client 140	612-400-5382	doneill@wsbeng.com	

MCES Project #:	*Project Task Code:	*Time Zone Used	Sampler Signature(s):
5543-16-01		☐ C S T ☑ C D T	

Lab_MN sys_loc_code*	Location	Sample Point	Sample Name	Start Date	Start Time HH:MM, military	End Date	End Time HH:MM, military	Start Depth* (lakes only)	End Depth* (lakes only)	Sampling Method*	Sample Type Code*	Sample Matrix Code*
	ST_ALBANS	MH4000	Composite							Sampling Method	Sample Type Cod	Sample Matrix
	VIC	MH655	Composite							Sampling Method	Sample Type Cod	Sample Matrix
	DESOTO	MH9655	Composite							Sampling Method	Sample Type Cod	Sample Matrix
	BEACON_BL	MH7	Composite							Sampling Method	Sample Type Cod	Sample Matrix
	HAMP_PRK	MH810793	Composite							Sampling Method	Sample Type Cod	Sample Matrix
										Sampling Method	Sample Type Cod	Sample Matrix
										Sampling Method	Sample Type Cod	Sample Matrix
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										Sampling Method	Sample Type Cod	Sample Matrix

Analyses Requested

Location	Liquid (LIQ) matrix																Filtered (FILT)				PART
	CL-AV2	TNN-AV (N	TSS-GF	TDS-180	PB-MSV2	TDS-180	CU-MSV2	ZN-MSV2	COD-A2	NO2-AV	COD-A2	HARD-MSV	OIL-SOX2	PH	ECOLI-MP	Analysis ID	ORTHO-AV	TOC-AV	Analysis ID	Analysis ID	Analysis ID
ST_ALBANS	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔					✔	✔			
VIC	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔					✔	✔			
DESOTO	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔					✔	✔			
BEACON_BL	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔					✔	✔			
HAMP_PRK	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔					✔	✔			

______ (initials)
In the event that samples are received by the lab at a temperature greater than 6°C, I authorize MCES Lab to process the samples as received.

______ (initials)
In the event that samples are received by the lab at >6°C, please contact the client at the phone # or email above before processing samples.

☐ Electronic Data Deliverable (EDD): Lab_MN Format
*required fields for Lab_MN

Relinquished by (signature):	
Date:	Time:

MCES Use Only

Received by (signature):		☐	Received on Ice
		☐	Temp Blank Used
Date:	Time:	☐	Sample Temps Used
		☐	Received at or below 6°C

Client Comments:

Time Zone

Code	Definition
CST	Central Standard Time, UTC-6
CDT	Central Daylight Time, UTC-5

Sampling Method

Lab_MN code	Definition
G	Grab Sample
CT	Comp, time paced
CF	Comp, flow paced

Sample Type Code

Lab_MN code	Definition
SAMPLE	Sample
QC-FB	Field Blank
QC-TB	Trip Blank
QC-EB	Equipment Blank

Sample Matrix Code

Lab_MN code	Definition
WTR-SURF	Surface Water
WTR-GROUND	Ground Water
WTR-SNOW	Snowmelt
WTR-STORM	Stormwater
QC-BLANK	Quality Control Blank

Lake Start Depth

Depth in **meters** of lake samples taken at a single discrete depth OR top depth of an intergrated sample. Recorded to the tenth of a meter.

Lake End Depth

Depth in **meters** of integrated lake samples. Recorded to the tenth of a meter. Leave blank for lake samples taken at a single depth.

MCES Use Only

Comments: