SAINT PAUL
MINNESOTA

# 2022 STORMWATER QUALITY AND QUANTITY MONITORING PROGRAM

CITY OF ST. PAUL

MARCH 31, 2022

Prepared for:
City of St. Paul
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WSB PROJECT NO. 020260

wsb

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| 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) 2022 Stormwater Monitoring Program. The monitoring was conducted to fulfill requirements of the City's National Pollutant Discharge Elimination System (NPDES) MS4 Phase I Permit. Data collected and analyzed is used to quantify stormwater volumes and loads from the Municipal Separate Storm Sewer System (MS4) and assist in the assessment of effectiveness of the City's Stormwater Management Program.

Since 2006, the City has been required by the Minnesota Pollution Control Agency (MPCA) 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 2022 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 2022 monitoring sites are shown on **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: 2022 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 |
| Shepard Ponds | Storm Pipe/Stormwater Pond | WL, Q, WQ |
| Bush-Desoto Street | Storm Pipe/Stormwater Pond | Q, WQ, GW |
| Jackson Street Pervious Bike Path | Pervious Asphalt | Infiltration |
| Hamline Midway Library Pervious Alleyway | Pervious Asphalt | Infiltration |
| | | |
| Wilder Recreation Center | Rainfall Monitoring Location | R |
| Fire Station 18 | Rainfall Monitoring Location | R |
| Harriet Island Park | Rainfall Monitoring Location | R |
| Hampden Park Co-op | 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 equipment use monitoring protocols that were followed for this monitoring program, see the 2022 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 then analyzed to estimate the average infiltration rates observed during the monitoring period. The following provides a detailed description of how this was completed. 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 then 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)
$\Delta t$ = 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, Desoto Ave, and Battle Creek 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 Battle Creek 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**

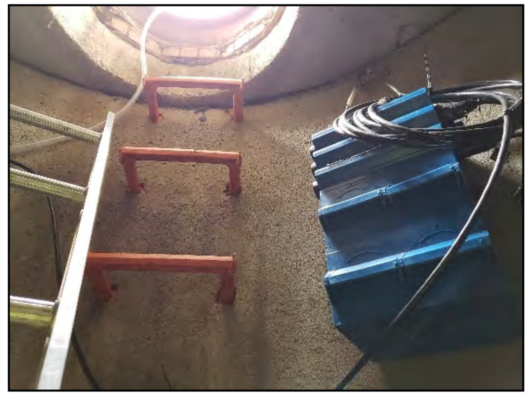


**Photo 2-4: Flow Monitoring Equipment Install**

### 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 the 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, Battle Creek, Hampden Park, Desoto Street, 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 composited 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 the **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 (asN) | 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 Soilds (VSS) | EPA 160.4 | Composite | 10/year |
| Zinc, Total (as Zn) | EPA 200.7 | Composite | 10/year |

### 2.3.2 Data Analysis

The event mean 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 the Victoria Street, Hamline Midway Library, and 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**). Five locations at Victoria Street, 18 locations at Jackson Street, and nine locations at Hamline Midway Library 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: Saint Paul Fire House 18, Wilder Recreation Center, Hampden Park Co-op and a pumphouse near the center of Harriet Island 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.

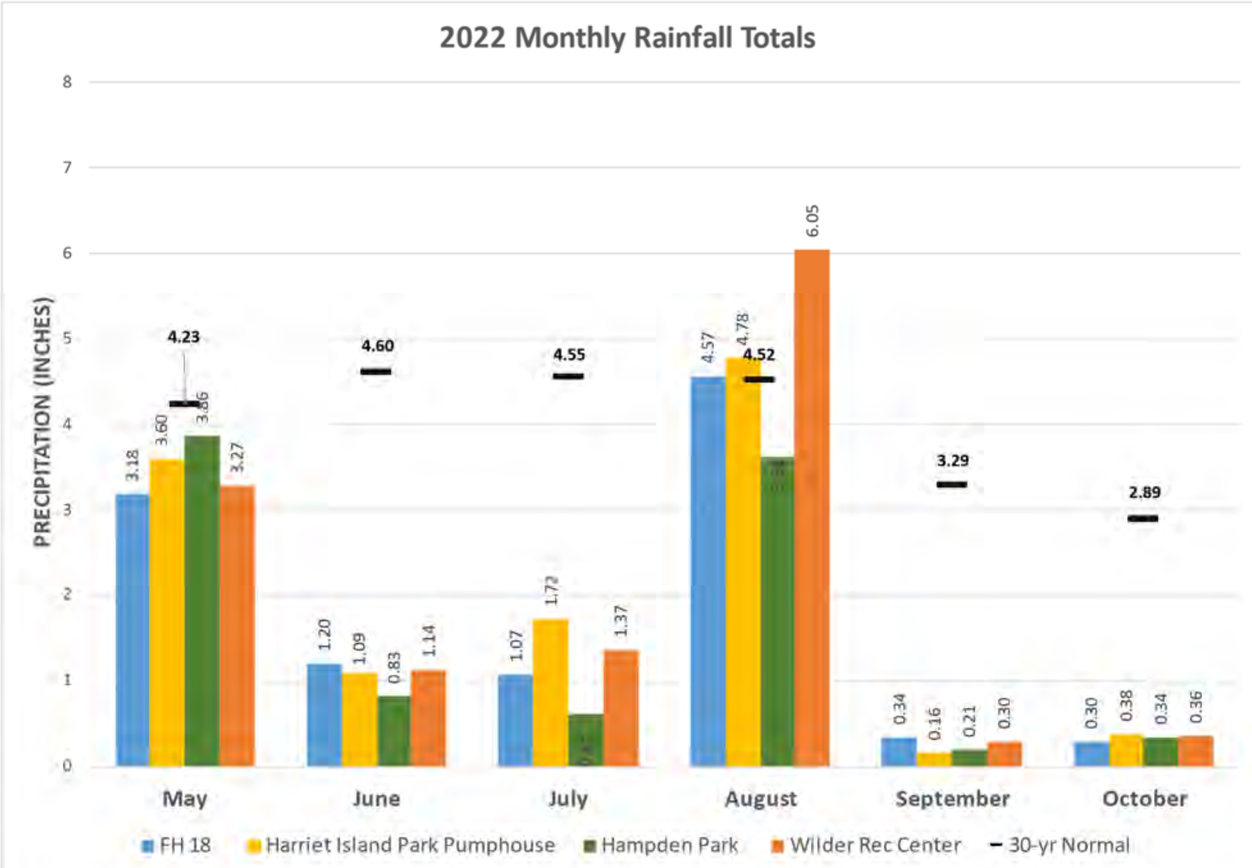
**Table 3-1** and **Chart 3-1** show 2022 monthly precipitation totals for seasonally monitored sites compared to the 30-year normal. The 30-year normal reflect data collected from 1991-2020 by the U of MN St. Paul station.

May through October rainfall ranged from 12.49 inches at the Wilder Recreation Center to 9.46 inches at Hampden Park Co-op. The City-wide seasonal total average was 11.09 inches which is 12.99 inches less than the 30-year normal. The greatest variability between stations was observed during the month of August with 2.44 inches more rainfall recorded at the Wilder Recreation Center than the Hampden Park Co-op. The month of June saw the greatest departure from the 30-year normal (-3.53 inches).

**Table 3-1: 2022 Seasonal Precipitation Summary**

| Month | FH 18 | Harriet Island Park | Hampden Park Co-op | Wilder Rec Center | City-Wide Average | 30-yr Normal | Departure from 30-yr Normal |
|---|---|---|---|---|---|---|---|
| **May** | 3.18 | 3.60 | 3.86 | 3.27 | 3.48 | 4.23 | -0.75 |
| **June** | 1.20 | 1.09 | 0.83 | 1.14 | 1.07 | 4.60 | -3.53 |
| **July** | 1.07 | 1.72 | 0.61 | 1.37 | 1.19 | 4.55 | -3.36 |
| **August** | 4.57 | 4.78 | 3.61 | 6.05 | 4.75 | 4.52 | 0.23 |
| **September** | 0.34 | 0.16 | 0.21 | 0.30 | 0.25 | 3.29 | -3.04 |
| **October** | 0.30 | 0.38 | 0.34 | 0.36 | 0.35 | 2.89 | -2.54 |
| **Seasonal Total** | **10.66** | **11.73** | **9.46** | **12.49** | **11.09** | **24.08** | **-12.99** |

**Chart 3-1**




Major rainfall events from 2022 are provided in **Table 3-2** below:

**Table 3-2: 2022 Significant Rainfall Events**

| Date | Duration (hr) | Rainfall Total (in)[1] | Intensity (in/hr) |
|---|---|---|---|
| 5/11/22 | 2.3 | 1.99 | 0.88 |
| 8/7/22 – 8/8/22 | 3.3 | 0.79 | 0.24 |
| 8/12/22 | 3.3 | 1.18 | 0.36 |
| 8/17/22 | 2.2 | 1.80 | 0.85 |
| 8/27/22 – 8/28/22 | 11.3 | 1.32 | 0.12 |

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

**Table 3-3** below provides a five-year monthly precipitation summary as recorded at the University of Minnesota Saint Paul Campus. Annual precipitation has not exceeded the 30-year normal for the last 3 years. Total precipitation in 2022 was 23.79 inches, 8.94 inches below normal. September and October saw exceptionally low amounts of rain, with only 0.53 inches combined. May had the greatest amount of precipitation at 4.89 inches, which was above the 30-year normal by 0.66 inches. June varied the greatest and had 0.80 inches of precipitation which was 3.80 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 | 30-yr Normal |
|---|---|---|---|---|---|---|---|---|
| **January** | 0.28 | 0.93 | 1.07 | 0.36 | 0.81 | 0.62 | 0.54 | 0.68 |
| **February** | 0.79 | 0.70 | 1.24 | 2.31 | 0.53 | 0.41 | 0.48 | 0.75 |
| **March** | 2.15 | 0.58 | 1.38 | 2.09 | 2.76 | 2.94 | 3.19 | 1.61 |
| **April** | 3.66 | 3.68 | 2.37 | 3.37 | 1.67 | 2.46 | 3.57 | 3.02 |
| **May** | 2.05 | 6.54 | 3.52 | 6.44 | 4.43 | 3.36 | 4.89 | 4.23 |
| **June** | 3.65 | 3.16 | 4.64 | 2.85 | 4.15 | 1.57 | 0.80 | 4.60 |
| **July** | 5.97 | 2.45 | 4.07 | 4.75 | 2.20 | 1.57 | 1.37 | 4.55 |
| **August** | 9.90 | 8.89 | 2.91 | 6.88 | 3.70 | 6.56 | 4.58 | 4.52 |
| **September** | 5.19 | 1.25 | 7.19 | 4.88 | 1.05 | 1.82 | 0.29 | 3.29 |
| **October** | 3.32 | 4.84 | 3.4 | 4.93 | 2.25 | 2.29 | 0.24 | 2.89 |
| **November** | 2.70 | 0.42 | 1.41 | 1.67 | 1.37 | 0.97 | 2.04 | 1.53 |
| **December** | 2.01 | 0.62 | 1.32 | 2.42 | 0.88 | 1.94 | 1.80 | 1.06 |
| **Total** | **41.67** | **34.06** | **34.52** | **42.95** | **25.80** | **26.51** | **23.79** | **32.73** |
| **Departure from 30-yr Normal** | **+8.94** | **+1.33** | **+1.79** | **+10.22** | **-6.93** | **-6.22** | **-8.94** | **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 contribution. 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 subwatersheds. 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[1] | 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. Water level in the rain garden was not measured in 2022 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 six treatment events. The 2022 underground chamber infiltration rate and infiltration rate trends are provided on **Charts A.3** and **A.4** of **Appendix A**, respectively. The 2022 average infiltration rate for the BMP Pipe was 0.06 inches per hour (in/hr). This is a decrease from the rates observed in 2021 (0.09 in/hr) and 2020 (0.12 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 |
| Beacon Bluff Rain Garden (IR-31) | 2.9 | 0.85 | 0.70 | 0.29 | 0.43 | 0.50 | 0.40 | 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 |

Water level in the underground system ranged from 6.8 ft to 22.0 ft deep. The water level in the pipe has not been this low since 2016. 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 2022 monitoring period, including over the winter months. The underground system discharged back to the storm sewer (system outflow) during 6 storm events in 2022. Discharge events occurred in 2015 (five), 2016 (nine), 2017 (ten) 2018 (fourteen), 2019 (fifteen), 2020 (seven) and 2021 (nine). 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 2022 underground chamber infiltration rate trends are provided on **Chart A.4** of **Appendix A**. From 2012 to 2022, 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 each year.

## 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 being 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 2022 Beacon Bluff Volume Reduction is included in **Table 4-3** below.

In 2022, total runoff to the Beacon Bluff system was 1,123,251 cubic feet (cu-ft). Of that volume, 447,127 cu-ft was captured by the system, resulting in a 37% volume reduction. The total flow conveyed back to the storm sewer via the rain garden's outlet control structure was 75,259 cu-ft. For the 136.8-acre drainage area to the diversion structure, the total water yield was 7,603 cu-ft/acre which is equivalent to 2.26 inches of runoff as a result of 12.72 inches of rain (18%). The greatest volume captured by the BMP was 100,545 cu-ft on August 17th, 2022. This volume represents 63% of the total storage capacity of the system.

**Table 4-3: Beacon Bluff Volume Reduction**

| | | | |
|---|---|---|---|
| **Monitoring Period** | 5/5/22 – 11/18/22 | | |
| **Total Rainfall** | | 12.72 | in. |
| **Diversion Structure Water Balance** | | | |
| Runoff Volume: | | 1,123,251 | cu-ft |
| Runoff Yield: | | 2.26 | in/acre |
| Bypassed Volume: | | 674,168 | cu-ft |
| Volume Diverted into BMP: | | 449,083 | cu-ft |
| **Beacon Bluff Rain Garden and Infiltration Gallery Inputs** | | | |
| Inflow Volume from Diversion Structure: | SubWSHD A | 449,083 | cu-ft |
| Inflow Volume from West Pond: | SubWSHD B | 19,649 | cu-ft |
| Inflow Volume from Eastern Inlets: | SubWSHD C | 53,654 | cu-ft |
| System Discharge (conveyed back to storm sewer from OCS): | | 75,259 | cu-ft |
| **Beacon Bluff System Performance** | | | |
| Total Runoff Volume: | | 1,196,553 | cu-ft |
| Total Runoff Volume Captured: | | 447,127 | cu-ft |
| Percent of Total Runoff Volume Captured: | | 37 | % |
| Maximum Percentage of Storage: Volume Utilized [1] | | 63 | % |

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, 2,954 pounds of TSS and 34.60 pounds of TP were captured by the system. Over the past 10 years of monitoring, 110,490 pounds of TSS and 486 pounds of TP have been captured at the Beacon Bluff Site.

**Table 4-4: Beacon Bluff Load/Capture Summary**

| **Monitoring Period** | | 5/5/22 – 11/18/22 | | |
|---|---|---|---|---|
| **Total Rain** | | 12.72 | | |
| **Water Quality Parameter** | **Flow Weighted Average (mg/L)** | **Total Pollutant Load (lbs)** | **Load Captured (lbs)** | **Percent Reduction %** |
| Total Suspended Solids | 100.9 | 7,532 | 2,954 | 39 |
| Volatile Suspended Solids | 135.7 | 10,205 | 4,011 | 39 |
| Total Dissolved Solids | 58.8 | 4,363 | 2,150 | 49 |
| Total Phosphorus | 1.11 | 82.88 | 34.60 | 42 |
| Ortho-phosphate | 0.239 | 17.70 | 9.781 | 55 |
| Chloride | 6.5 | 487.3 | 217.9 | 45 |
| Total Kjeldahl Nitrogen | 7.0 | 522.6 | 204.4 | 39 |
| Nitrate + Nitrite as N | 0.41 | 30.5 | 11.5 | 38 |

## 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 0.5 ft to 2.3 ft throughout the 2022 season. Floatables 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 within the grooves of the corrugated pipe, along the bottom. 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 |
|---|---|---|---|---|
| BMP maintenance performed by City staff on 4/26/22 | | | | |
| 5/13/22 | 0.5 | NM | Yes | Large overflow on 5/11/22 |
| 6/30/22 | 2.3 | NM | Yes | 1.9 – 2.3 ft of sediment in pretreatment |
| 8/31/22 | 1.5 | NM | Yes | Damage to SAFL Baffle |
| 9/27/22 | 1.5 | NM | Yes | Trash in pretreatment chamber |
| 10/26/22 | 1.5 | NM | Yes | No water in rain garden |

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 in 2014, 2015, 2019, 2020, 2021, and 2022.

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 2022 water elevations and daily rainfall is provided on **Chart A.5** of **Appendix A**. Water level monitoring indicated that the infiltration gallery reached 100% capacity 1 time in 2022. 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 on **Chart A.6** of **Appendix A**. In 2022, the average infiltration rate of the BMP pipe was 14.0 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 |
| 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 |

## 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 2022, total runoff for the St. Albans Street system was 208,172 cu-ft. Of that volume, 186,255 cu-ft was captured and infiltrated by the system, resulting in a volume reduction of 89.5% (**Table 5-3**). Excluding a 1.87 inch rain event on May 11$^{th}$ 2022, which saw 21,917 cu-ft bypass the system, 100% of the water in the diversion manhole was sent to the BMP. The total water yield for the 25.2-acre drainage area is 8,261 cu-ft/acre which is equivalent to 2.28 inches of runoff resulting from 10.69 inches of rain (21%). The greatest volume infiltrated by the BMP was 25,319 cu-ft, which represents 81% 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** | 5/11/2022 – 11/10/22 | |
| **Total Rainfall** | 10.69 | in |
| **System Water Balance** | | |
| Aurora Runoff Volume: | 124,654 | cu-ft |
| Aurora Bypassed Volume: | 21,917 | cu-ft |
| St. Albans and University Volume | 83,518 | cu-ft |
| **St. Albans System Performance** | | |
| Total Runoff Volume | 208,172 | cu-ft |
| Runoff Yield | 2.28 | in/acre |
| Total Runoff Volume Captured | 186,255 | cu-ft |
| Percent of Runoff Volume Captured: | 89.5 | % |
| Maximum Volume Discharge to BMP | 25,319 | cu-ft |
| Maximum Percentage of Storage Volume Utilized[1] | 81 | % |

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, 482 pounds of TSS and 12.24 pounds of TP were captured by the system. Percent captured for all parameters was 81% in 2022.

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

| Monitoring Period | | 5/11/2022 – 11/10/22 | | |
|---|---|---|---|---|
| Total Rain | | 10.69 | | |
| **Water Quality Parameter** | **Flow Weighted Average (mg/L)** | **Total Pollutant Load (lbs)** | **Load Captured (lbs)** | **Percent Reduction %** |
| Total Suspended Solids | 41.5 | 595 | 482 | 81.0 |
| Volatile Suspended Solids | 18.8 | 270 | 219 | 81.0 |
| Total Dissolved Solids | 36.6 | 523 | 426 | 81.0 |
| Total Phosphorus | 0.25 | 3.63 | 2.94 | 81.0 |
| Ortho-phosphate | 0.061 | 0.872 | 0.706 | 81.0 |
| Chloride | 6.0 | 86.8 | 70.3 | 81.0 |
| Total Kjeldahl Nitrogen | 1.32 | 19.01 | 15.4 | 81.0 |
| Nitrate + Nitrite as N | 0.56 | 8.1 | 6.5 | 81.0 |

## 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 drawing 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 |
|---|---|---|---|---|
| 5/16/22 | 0.2 | 0.0 | No | Trash in pretreatment chamber |
| BMP maintenance performed by City staff on 6/8/22 | | | | |
| 6/30/22 | 0.2 | 0.0 | No | Mild sheen in pretreatment chamber |
| 8/31/22 | 0.1 | 0.0 | No | Trash in pretreatment chamber |
| 9/27/22 | 0.1 | 0.3 | No | Sediment around logger in BMP, minimal sediment otherwise |
| 10/31/22 | 0.1 | 0.3 | No | Sediment around logger in BMP, minimal sediment otherwise |

# 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 2022 are provided on **Chart A.8** and **A.9** of **Appendix A**. Water level within the BMP, ranged from 0 to 3.3 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 2022 level data, no flow discharged back to the sewer system. In 2022, infiltration rates dropped to similar rates from 2016-2019.

The 2022 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 10.93 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 2022 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 |
| Hampden Park BMP | 14.38 | 8.30 | 11.19 | 11.57 | 41.09 | 21.27 | 10.93 |

## 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 2022 flow rates and daily rainfall are depicted on **Chart B.3** of **Appendix B**. No discharge was observed at the system outlet therefore that data is not plotted.

In 2022, the total runoff was 112,573 cu-ft. Since 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 14,432 cu-ft/acre which is equivalent to 3.98 inches of runoff as a result of 10.26 inches of rain (39%). The greatest volume received by the BMP was 14,995 cu-ft as a result of a 1.99-inch rain event on May 11th to May 12$^{th}$, 2022. This volume represents 47% 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** | 5/11/22 – 11/10/22 | |
| **Total Rainfall** | 10.26 | in |
| **Hampden Park Water Balance** | | |
| Raymond/Hampden Runoff Volume | 112,573 | cu-ft |
| System Bypass Volume | 0 | cu-ft |
| **Hampden Park System Performance** | | |
| Total Runoff Volume | 112,573 | cu-ft |
| Runoff Yield | 3.98 | in/acre |
| Total Runoff Volume Captured | 112,573 | cu-ft |
| Percent of Runoff Volume Captured | 100 | % |
| Maximum Event Volume Captured by BMP | 14,995 | cu-ft |
| Maximum Percentage of Storage Volume Utilized[2] | 47 | % |

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, 459 pounds of TSS and 1.52 pounds of TP were captured by the system. Percent captured for all parameters were 100% in 2022.

**Table 6-4: Hampden Park/Capture Summary**

| Monitoring Period | | 5/11/22 – 11/9/22 | | |
|---|---|---|---|---|
| Total Rain | | 10.26 | | |
| **Water Quality Parameter** | **Flow Weighted Average (mg/L)** | **Total Pollutant Load (lbs)** | **Load Captured (lbs)** | **Percent Reduction %** |
| Total Suspended Solids | 65.3 | 459 | 459 | 100 |
| Volatile Suspended Solids | 23.5 | 165 | 165 | 100 |
| Total Dissolved Solids | 52.6 | 370 | 370 | 100 |
| Total Phosphorus | 0.22 | 1.52 | 1.52 | 100 |
| Ortho-phosphate | 0.039 | 0.27 | 0.27 | 100 |
| Chloride | 8.8 | 61.5 | 61.5 | 100 |
| Total Kjeldahl Nitrogen | 1.53 | 10.7 | 10.7 | 100 |
| Nitrate + Nitrite as N | 0.50 | 3.5 | 3.5 | 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 May 23.

**Table 6-5: Hampden Park BMP Maintenance Inspection**

| Date | Sediment Depth in Pre-treatment (ft) | Sediment Depth in Infiltration Gallery (ft)[1] | Standing water in Infiltration Gallery? | Observations |
|---|---|---|---|---|
| 5/13/22 | 1.9 | 0.3 | No | Sediment in larger pretreatment chamber |
| BMP maintenance performed by City staff on 5/23/22 | | | | |
| 6/23/22 | 0.4 | 0.4 | No | Muck only in larger pretreatment chamber |
| 8/31/22 | 0.1 | 0.3 | No | Dense mat of floating leaves in pretreatment chamber |
| 9/27/22 | 0.5 | 0.3 | No | Dense mat in pretreatment chamber |
| 10/31/22 | 0.6 | 0.3 | No | Stagnant water in pretreatment chamber |

# 7. Victoria Street

Victoria Street monitoring site is located just East of Orchard Recreation Center and includes a permeable paver parking lane. Stormwater runoff within the 19.1 acre subwatershed 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 the 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 2022, 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 2022 are provided on **Chart A.12** of **Appendix A**. Water level within the BMP, ranged from 0 to 5.2ft. 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 2022 level data, the system reached capacity one time.

The 2022 infiltration rates are presented on **Chart A.13** of **Appendix A** and are adjusted for incremental volume flow. The adjusted average infiltration rate for the BMP was 45.07 in/hr, which is greater than the design infiltration rate of 12.8 in/hr. Infiltration rates at the base of system during construction were calculated to be, on average, 95.9 in/hr using a Double Ring Infiltrometer (DRI). Infiltration rate trends are depicted on **Chart A.14**. Water level data shows that all 2022 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 |
| Victoria Street BMP | 46.56 | 48.04 | 21.08 | 48.80 | 25.52 | 45.07 |

## 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 2022 flow rates and daily rainfall are depicted on **Chart B.4** of **Appendix B**.

In 2022, the total run off to the Victoria Street system was 179,189 cu-ft. The system captured 85.1% of that volume (**Table 7-3**). The total water yield for the 19.1-acre drainage area is 9,382 cu-ft/acre which is equivalent to 2.58 inches of runoff as a result of 11.71 inches of rain (22%). The greatest volume infiltrated by the BMP was 19,069 cu-ft from a 1.18-inch rain event on August 12, 2022. This volume represents 114% of the total storage capacity of the system. One noteworthy rain event of 1.87 inches in under 3 hours on May 11, 2022, accounted for 26,482 out of the total 26,626 cu-ft of bypassed water. 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** | 4/29/22 – 11/10/22 | |
| **Total Rainfall** | 11.71 | in |
| **Victoria Street Water Balance** | | |
| Runoff Volume | 179,189 | |
| System Bypass Volume | 26,616 | |
| **Victoria Street System Performance** | | |
| Total Runoff Volume | 179,189 | cu-ft |
| Runoff Yield | 2.58 | in/acre |
| Total Runoff Volume Captured | 152,573 | cu-ft |
| Percent of Runoff Volume Captured | 85.1 | % |
| Maximum Event Volume Captured by BMP | 19,069 | cu-ft |
| Maximum Percentage of Storage Volume Utilized[1] | 114 | % |

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 ortho-phosphate. During the monitoring period, 701 pounds of TSS and 4.3 pounds of TP were captured by the system. Percent captured for all parameters was above 85% in 2022. Excluding the May $11^{th}$ storm even, the percent captured would have been 99.9% for all parameters.

**Table 7-4: Victoria Street Load/Capture Summary**

| Monitoring Period | | 4/29/22 – 11/10/22 | | |
|---|---|---|---|---|
| **Total Rainfall** | | 11.71 | | |
| **Water Quality Parameter** | **Flow Weighted Average (mg/L)** | **Total Pollutant Load (lbs)** | **Load Captured (lbs)** | **Percent Reduction %** |
| Total Suspended Solids | 73.6 | 823 | 701 | 85.1 |
| Volatile Suspended Solids | 34.3 | 384 | 327 | 85.1 |
| Total Dissolved Solids | 51.3 | 621 | 535 | 86.3 |
| Total Phosphorus | 0.40 | 5.0 | 4.3 | 86.6 |
| Ortho-phosphate | 0.186 | 2.521 | 2.211 | 87.7 |
| Chloride | 5.0 | 59.3 | 51.0 | 86.0 |
| Total Kjeldahl Nitrogen | 2.77 | 30.96 | 26.4 | 85.1 |
| Nitrate + Nitrite as N | 0.667 | 7.5 | 6.4 | 85.1 |

## 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)[1] | Standing water in Infiltration Gallery? | Observations |
|---|---|---|---|---|
| 5/16/22 | 0.2 | 0.0 | No | Grass and leaves in pretreatment chamber and BMP |
| 6/23/22 | 0.3 | 0.5 | No | Trash in BMP |
| BMP maintenance performed by City staff on 7/11/22 | | | | |
| 8/31/22 | 0.6 | 1.0 | No | Heavy sedimentation in BMP |
| 9/27/22 | 0.6 | 0.9 | No | Bottles and trash in pretreatment chamber and BMP |
| 10/31/22 | 0.7 | 0.9 | No | Trash present |

# 8. Shepard Ponds

The Shepard Road Ponds 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 2022.

## 8.1. West Shepard Pond

**Photo 8.1-1: West Shepard Pond**

### 8.1.1 Volume Monitoring

A job box housing a flow meter 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 2022 flow rates and daily rainfall are depicted on **Chart B.5** of **Appendix B**.

During the 2022 monitoring period, the total volume flowing to the West Shepard Pond system was 240,941 cu-ft, of which 227,902 was infiltrated by the pond. 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 27,694 cu-ft/acre. The greatest monitored event-based volume moving through the system was 23,903 cu-ft as a result of a 1.32-inch rain event on August 27$^{th}$-28$^{th}$, 2022.

**Table 8.1-2: West Shepard Volume Summary**

| | | |
|---|---|---|
| **Monitoring Period** | 6/6/2022 – 11/9/2022 | |
| **Total Rainfall** | 8.76 | in |
| **West Shepard Pond Water Balance** | | |
| Runoff Volume | 240,941 | cu-ft |
| System Bypass Volume | 13,039 | cu-ft |
| **West Shepard Pond System Performance** | | |
| Total Runoff Volume | 240,941 | cu-ft |
| Runoff Yield | 7.63 | in/acre |
| Total Runoff Volume Captured | 227,902 | cu-ft |
| Percent of Runoff Volume Captured | 94.6 | % |
| Maximum Event Volume Captured by BMP | 18,355 | cu-ft |

### 8.1.2 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 8.1-3: West Shepard Pond Pollutant Load Summary**

| | | | | |
|---|---|---|---|---|
| **Monitoring Period** | | 6/6/2022 – 11/9/2022 | | |
| **Total Rainfall** | | 8.76 | | |
| **Water Quality Parameter** | **Flow Weighted Average (mg/L)** | **Total Pollutant Load (lbs)** | **Load Captured (lbs)** | **Percent Reduction %** |
| Total Suspended Solids | 57.4 | 899 | 828 | 92.1 |
| Volatile Suspended Solids | 34.1 | 533 | 491 | 92.1 |
| Total Dissolved Solids | 89.3 | 1,406 | 1,281 | 91.1 |
| Total Phosphorus | 0.27 | 4.20 | 3.86 | 91.9 |
| Ortho-phosphate | 0.077 | 1.21 | 1.109 | 91.8 |
| Chloride | 19.9 | 312.4 | 286.5 | 91.7 |
| Total Kjeldahl Nitrogen | 1.14 | 18.0 | 16.4 | 91.1 |
| Nitrate + Nitrite as N | 0.54 | 8.5 | 7.7 | 90.6 |

## 8.2. East Shepard Pond

**Photo 8.2-1: East Shepard Pond.**

### 8.2.1 Volume Monitoring

Flow monitoring was conducted in the southeast inlet of the East Shepard Pond. Access to the monitoring location was difficult due to the tailwater condition of the pipe due to sediment accumulation. Due to challenging monitoring conditions at this site, monitoring will not be continued. There was a constant baseflow throughout the monitoring season entering through the pond through an inlet in the northwest corner of the pond near the outlet.

During the 2022 monitoring period, the total volume flowing to the East Shepard Pond system was 84,968 cu-ft, of which 72,632 was infiltrated by the pond. A summary of the system can be found below (**Table 8.2-1**). The total water yield for the 4.89-acre drainage area is 17,376 cu-ft/acre. The greatest monitored event-based volume moving through the system was 18,601cu-ft from a 0.61-inch rain event on August 7th-8th, 2022. An event-based volume reduction summary is provided in **Table C.11.**

**Table 8.2-1: East Shepard Volume Summary**

| | | |
|---|---|---|
| **Monitoring Period** | 6/24/22 – 8/8/22 | |
| **Total Rainfall** | 2.47 | in |
| **East Shepard Pond Water Balance** | | |
| Runoff Volume | 84,968 | cu-ft |
| System Bypass Volume | 20,128 | cu-ft |
| **East Shepard Pond System Performance** | | |
| Total Runoff Volume | 84,968 | cu-ft |
| Runoff Yield | 4.79 | in/acre |
| Total Runoff Volume Captured | 72,632 | cu-ft |
| Percent of Runoff Volume Captured | 70.2 | % |
| Maximum Event Volume Captured by BMP | 18,601 | cu-ft |

# 9. Bush-Desoto Pond

The Bush-Desoto Pond is an infiltration basin in the southern end of the Payne-Phalen Neighborhood. The stormwater inlet is on the east side and receives water from Bush Avenue. The outlet on the west side connects excess water back to the main storm sewer line. Some channelization between the outlet and the inlet has been noted. A possible retrofit of the pond could occur as early as 2023. This would in enlarge the bottom of the pond and a treatment value of 85,000 credits. The pond location is provided in **Figure 9-1**.

## 9.1. Water Level Monitoring

Water level was monitored by a logger placed directly in piezometer TB-2. This was done to specifically note the groundwater bounce in the spring of the year. Water levels varied between 90.86 to 94.49 SPCD throughout the course of the monitored period. Water level elevations and daily rainfall totals are presented on Chart A.1 and A.2 of Appendix A.

## 9.2. Volume Monitoring

One flow meter was installed inside of the 54-inch RCP pipe upstream of the infiltration basin. The metered drainage area consists of 27.1 acres of. The 2022 flow rates and daily rainfall are depicted on **Chart B.6** of **Appendix B**.

During the 2022 monitoring period, the total event volume moving through the system was 392,829 cu-ft (**Table 9-2**). The total water yield for the 19.1-acre drainage area is 20,567 cu-ft/acre. The greatest event-based volume moving through the system was 94,692 cu-ft as a result of a 0.9-inch rain event on May 11$^{th}$, 2022

**Table 9-2: Bush-Desoto Pond Volume Summary**

| | | |
|---|---|---|
| **Monitoring Period** | 5/11/22 – 11/9/22 | |
| **Total Rainfall** | 13.11 in | |
| **Bush-Desoto Pond Water Balance** | | |
| Total Volume | 395,280 | cu-ft |
| Maximum Event Volume | 94,880 | cu-ft |

## 9.3. Pollutant Monitoring

A water quality sampler was placed inside of the 54-inch RCP pipe upstream of the pond near the flow meter 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.12** and **C.13** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

**Table 9-3** below provides a pollutant load summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period 6,606 pounds of TSS and 10.78 pounds of TP passed through the monitored area during storm events.

**Table 9-3: Bush-Desoto Pond Pollutant Load Summary**

| **Monitoring Period** | | 5/11/22 – 11/9/22 |
|---|---|---|
| **Total Rainfall** | | 13.11 |
| **Water Quality Parameter** | **Flow Weighted Average (mg/L)** | **Total Pollutant Load (lbs)** |
| Total Suspended Solids | 272.5 | 6,723 |
| Volatile Suspended Solids | 74.7 | 1,842 |
| Total Dissolved Solids | 54.6 | 1,347 |
| Total Phosphorus | 0.44 | 10.83 |
| Ortho-phosphate | 0.032 | 0.791 |
| Chloride | 9.8 | 240.8 |
| Total Kjeldahl Nitrogen | 2.47 | 61.03 |
| Nitrate + Nitrite as N | 0.41 | 10.10 |

# 10. River Level Monitoring

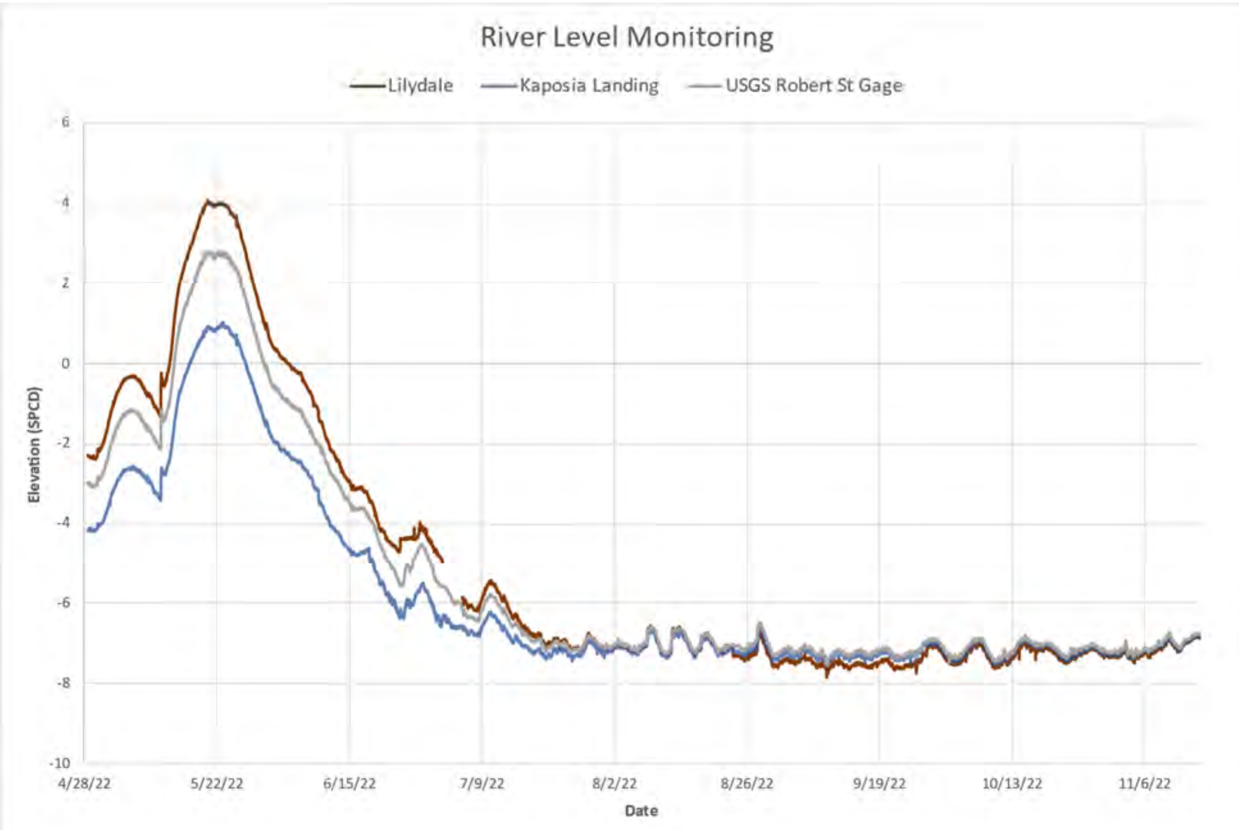
To determine elevations of the Mississippi River in relation to the United States Geological Survey (USGS) monitoring station at the Robert Street Bridge, two water level loggers were installed within the Mississippi River. One located near an outfall at Kaposia Landing and the other at the overflow of Pickerel Lake at Lilydale. A correlation between the three sites is difficult and seems to change based on the river height. The overall average river elevation at Lilydale was 0.30 feet above the USGS monitoring station and the elevation at Kaposia Landing was 0.51 feet below the USGS monitoring station. The greatest difference between sites occurred during the spring when the river level was the highest. During the summer months Lilydale 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 of the monitored water level measurements and compared to the continuous USGS monitoring station near Robert Street Bridge.

**Table 10-1**

| | Lilydale | USGS | Kaposia Landing |
|---|---|---|---|
| **Approximate River Mile** | 841.5 | 839.25 | 835.4 |
| **Mile Difference from USGS** | Upstream 2.25 miles | | Downstream 3.85 miles |
| **Difference from USGS** | 0.30 ft | | -0.51 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 is 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 and the Victoria Street pervious pavement BMP in August in 2022. Testing was also completed at the Hamline Midway Library pervious pavement in August 2022. This section presents the results of the 2022 infiltration testing. The Infiltration testing methodologies are described in **Section 2.5.** A photolog of infiltration testing is provided in **Appendix E**.

## 11.1. Victoria Street

The Victoria Street pervious surface consists of a parking area completed with permeable concrete pavers designed to receive stormwater runoff from Victoria Street and the properties adjacent to it. The pavers themselves are non-permeable and they are separated with aggregate fill (**Photo 11-1** and **11-2**). The spaces between the pavers allow stormwater runoff to infiltrate into the parking surface instead of running off and being collected by the storm sewer system. The pavers were installed in 2011 and infiltration rates have been monitored annually since 2012. The site and the infiltration test locations are provided on **Figure 11-1**.

**Photo 11-1: Victoria Street Pavers**

**Photo 11-2: Victoria Street Infiltration Testing**

**Infiltration Test Results and Observations**

Five locations were tested for infiltration at the Victoria Street site. In 2015, the exact test locations from 2014 could not be located, so new locations were established in the immediate area and identified as A-E (these locations were used since 2016). Those locations are depicted on **Figure 10-1** and the results of the testing are presented in **Table 11-1** and **Chart D.1** in **Appendix D**.

A summary of the infiltration test results throughout the years are provided below.

**Table 11-1: Victoria Street Infiltration Rate Summary**

| Infiltration Ring Location | 2012 Infil Rate (in/hr) | 2013 Infil Rate (in/hr) | 2014 Infil Rate (in/hr) | 2015 Infil Rate (in/hr) | | 2016 Infil Rate (in/hr) | | 2017 Infil Rate (in/hr) | | 2018 Infil Rate (in/hr) | | 2019 Infil Rate (in/hr) | | 2020 Infilt Rate (in/hr) | | 2021 Infilt Rate (in/hr) | | 2022 Infil Rate (in/hr) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IR-1 | 168.6 | 18.1 | 0.00 | E | 15.1 | E | 17.8 | E | 3.41 | E | 14.5 | E | 15.9 | E | 4.9 | E | 15.6 | E | 14.8 |
| IR-2 | 266.6 | 75.7 | 12.9 | A | 0.0 | A | 19.4 | A | 3.8 | A | 11.5 | A | 4.1 | A | 4.7 | A | 8.8 | A | 7.0 |
| IR-3 | 271.1 | 92.2 | 18.6 | B | 3.4 | B | 23.0 | B | 10.1 | B | 16.9 | B | 4.4 | B | 9.4 | B | 10.1 | B | 5.3 |
| IR-4 | 69.1 | 24.0 | 9.7 | C | 0.0 | C | 6.6 | C | 28.9 | C | 6.3 | C | 4.0 | C | 3.7 | C | 0.0 | C | 9.5 |
| IR-5 | 149.8 | 49.2 | 30.8 | D | 0.0 | D | 0.0 | D | 0.0 | D | 1.9 | D | 4.2 | D | 6.6 | D | 15.0 | D | 3.6 |
| **Average** | **185.04** | **51.84** | **14.40** | **3.71** | | **13.33** | | **9.23** | | **10.21** | | **6.51** | | **5.84** | | **9.91** | | **8.04** | |

- In 2022 (8.04 in/hr) compared to 2021 (9.91 in/hr) and 2020 (5.84 in/hr).
- The 2022 infiltration rates were, on average, less than 5 percent of 2012 (185.04 in/hr) infiltration rates.
- Infiltration rates have been between 5 and 10 in/hr for the last six years.
- Location C had no infiltration in 2021 but infiltrated at 9.5 in/hr in 2022.

**Photo 11-3: Location D Pre-Test**

**Photo 11-4: Location D Infiltration Test**

## 11.2. 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 11$^{th}$ 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. Routine sweeping occurred on April 27, 2022. 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 on **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**

**<u>Infiltration Test Results and Observations</u>**

The site was tested for infiltration in August 2022. The infiltration test results from the 18 locations are summarized in **Table 11-3** 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 11-4**, which presents an average infiltration rate based on the monitoring location traffic characterization. The infiltration test locations are depicted on **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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 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 |
| JS-3 | Jackson Street pedestrian cross 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 |
| 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 |
| 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 |
| 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 |
| JS-7 | Jackson Street pedestrian cross 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 |
| 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 |
| 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 |
| 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 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 |
| 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 |
| 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 |
| JS-15 | Firestone driveway, N of 2nd stripe from the S. | NE | NE | 100.0 | 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 |
| 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 |
| 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 |
| | **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 |
| | **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 |
| | **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 |

NE – Not Established

**Table 11-4: 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| **Medium:** Pedestrian cross walks or adjacent to large areas of impervious surface. | 550 | 334 | 360 | 187 | 101 | 35 | 45 | 21 | 14 | 4 | 0 | 0 |
| **High:** Driveways for parking or businesses, heavy vehicular traffic. | 457 | 8 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Due to rain/snowy conditions in late October, along with an early freeze, pervious pavement testing was unable to be conducted in the Fall off 2022. A summary of the 2022 infiltration testing completed at the Jackson Street Pervious Pavement Site is provided below:

- The overall site infiltration rate was 87.3 inches per hour (in/hr) in August 2022.
  - 13 of 18 locations showed no infiltration during the August testing.
  - Of the remaining five locations where infiltration occurred, August 2022 infiltrations rates ranged from 7.9 in/hr to 1174.0 in/hr.
- Low traffic areas had an average infiltration rate of 314 in/hr in August 2022.
  - The average infiltration rate in August 2022 was 15% of the infiltration rate observed in November 2016 at low traffic locations.
- Medium traffic areas had an average infiltration rate of 0.0 in/hr in August 2022.
  - 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 2022.
  - High traffic locations have not shown any infiltration since November 2017.

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

## 11.3. Hamline Midway Library

The Hamline Midway Library pervious surface consists of 920 square yards of porous asphalt within the two alleyways adjacent to the Hamline Midway Library and the center alleyway connecting the sections. The asphalt content of the mix is 6.3 percent, and the specific voids ratio is 18 percent. Prior to construction, the sub-surface soil infiltration rate was determined to be 29.0 inches per hour (in/hr) and 59.1 in/hr using a double ring infiltrometer. The asphalt was installed in 2012 and infiltration rate monitoring has been conducted from 2013 through 2022. After installation of the pavement, infiltration rates from 2013 to 2014 severely diminished at the site, with only two of nine locations exhibiting any infiltration. Photo documentation at the site confirmed areas with significant sediment accumulation and compaction within the pore space of the asphalt. Maintenance treatments were completed with the objective of determining if the pervious pavement could be restored. This years and prior years test results are shown in **Table 11-5**.

**Table 11-5: Hamline Midway Library Infiltration Rate Summary**

| Infiltration Ring Location | 2013 Infiltration Rate (in/hr) | 2014 Infiltration Rate (in/hr)[1] | 2015 Infiltration Rate (in/hr)[1] | 2019 Infiltration Rate (in/hr)[1] | 2020 Infiltration Rate (in/hr)[1] | 2021 Infiltration Rate (in/hr)[1] | 2022 Infiltration Rate (in/hr)[1] |
|---|---|---|---|---|---|---|---|
| IR-1 | 102.4 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| IR-2 | 14.9 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| IR-3 | 11.4 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| IR-4 | 172.7 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| IR-5 | 0.0 | 0.0 | 605.97 | 218.96 | 177.48 | 0 | 0 |
| IR-6 | 1125.3 | 206.4 | 502.41 | 10.30 | 0 | 19.80 | 0 |
| IR-7 | 290.2 | 73.1 | 0 | 0 | 0 | 0 | 0 |
| IR-8 | 28.4 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| IR-9 | 115.6 | 0.0 | 0 | 0 | 0 | 0 | 0 |
| **Average** | **206.8** | **31.1** | **123.15** | **25.47** | **19.72** | **2.20** | **0.0** |

**1 - Locations were monitored for a maximum of 25 minutes during the pre-wet test. If no infiltration was observed, no subsequent tests were completed, and infiltrations rates were documented to be 0.0 in/hr.**
**BLUE – Dry sweep maintenance**
**RED – Wet sweep maintenance**
**GREY– Power wash and vacuum sweep**


**Photo 11-8: Recently Constructed Hamline Midway Library Porous Asphalt (2012)**

**Photo 11-9: Hamline Midway Library Asphalt**

# 12. City-wide Loading Assessment

## 12.1. 2022 Pollutant Loading Calculations

Monitoring of major outfalls within the City of Saint Paul was completed by Capitol Region Watershed District (CRWD) in 2022. 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, Trout Brook, and Phalen Creek. 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 | Wilder |
| Beaver Lake | 192 | 0.33 | Wilder |
| Belt Line | 3014 | 0.55 | Wilder |
| Crosby | 1679 | 0.45 | Hampden Park Co-op |
| Davern | 1302 | 0.55 | Hampden Park Co-op |
| Downtown | 550 | 0.75 | Engine House 18 |
| East Kittsondale | 1872 | 0.62 | Engine House 18 |
| Fish Creek | 46 | 0.52 | Wilder |
| Goodrich/Western | 424 | 0.63 | Engine House 18 |
| Griffith/Pt. Douglas | 460 | 0.61 | Wilder |
| Hidden Falls | 313 | 0.55 | Hampden Park Co-op |
| Highwood | 1123 | 0.50 | Wilder |
| Lake Como | 1294 | 0.47 | Hampden Park Co-op |
| Lake Phalen | 1013 | 0.42 | Wilder |
| Mississippi River Blvd. | 2391 | 0.58 | Hampden Park Co-op |
| MRWMO | 135 | 0.70 | Hampden Park Co-op |
| Phalen Creek | 1405 | 0.62 | Wilder |
| Pigs Eye | 3001 | 0.40 | Wilder |
| Riverview | 1017 | 0.57 | Wilder |
| St. Anthony Hill | 2651 | 0.64 | Engine House 18 |
| St. Anthony Park | 2481 | 0.68 | Hampden Park Co-op |
| Trout Brook | 3963 | 0.62 | Wilder |
| Urban | 327 | 0.57 | Wilder |
| West Kittsondale | 1042 | 0.67 | Hampden Park Co-op |
| West Seventh | 451 | 0.60 | Fire House 18 |

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 | 140.2 | 2.9 | 0.51 | 0.57 | 186.6 | 65.0 |
| Q1 (Jan-Mar) | 341.5 | 3.7 | 0.63 | 0.83 | 134.8 | 45.6 |
| Q2 (Apr-Jun) | 51.3 | 2.5 | 0.43 | 0.49 | 218.5 | 81.8 |
| Q3 (Jul-Sep) | 16.7 | 2.3 | 0.46 | 0.39 | 217.5 | 69.1 |
| Q4 (Oct-Dec) | 145.2 | 1.6 | 0.52 | 0.43 | 132.3 | 47.7 |

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 show 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 | 390520 | 7966 | 1413 | 1586 | 519619 | 180991 |
| Beaver Lake | 41430 | 845 | 150 | 168 | 55125 | 19201 |
| Belt Line | 1083928 | 22111 | 3921 | 4402 | 1442254 | 502359 |
| Crosby | 432179 | 8816 | 1563 | 1755 | 575049 | 200298 |
| Davern | 409613 | 8356 | 1482 | 1664 | 545023 | 189840 |
| Downtown | 249327 | 5086 | 902 | 1013 | 331750 | 115553 |
| East Kittsondale | 190398 | 4532 | 863 | 747 | 308190 | 118153 |
| Fish Creek | 15641 | 319 | 57 | 64 | 20811 | 7249 |
| Goodrich/Western | 161455 | 3293 | 584 | 656 | 214829 | 74828 |
| Griffith/Pt. Douglas | 183477 | 3743 | 664 | 745 | 244131 | 85035 |
| Hidden Falls | 98471 | 2009 | 356 | 400 | 131023 | 45637 |
| Highwood | 367151 | 7489 | 1328 | 1491 | 488524 | 170160 |
| Lake Como | 347882 | 7096 | 1258 | 1413 | 462885 | 161230 |
| Lake Phalen | 278198 | 5675 | 1006 | 1130 | 370164 | 128934 |
| Mississippi River Blvd. | 793246 | 16181 | 2869 | 3222 | 1055477 | 367639 |
| MRWMO | 54055 | 1103 | 196 | 220 | 71924 | 25052 |
| Phalen Creek | 226734 | 4292 | 781 | 844 | 361245 | 119124 |
| Pigs Eye | 784911 | 16011 | 2839 | 3188 | 1044388 | 363776 |
| Riverview | 379045 | 7732 | 1371 | 1539 | 504350 | 175673 |
| St. Anthony Hill | 1025498 | 20919 | 3710 | 4165 | 1364508 | 475279 |
| St. Anthony Park | 311400 | 7306 | 1203 | 1859 | 558390 | 219637 |
| Trout Brook | 89389 | 4067 | 993 | 670 | 285181 | 91275 |
| Urban | 121876 | 2486 | 441 | 495 | 162165 | 56485 |
| West Kittsondale | 399340 | 8146 | 1445 | 1622 | 531354 | 185079 |
| West Seventh | 163558 | 3336 | 592 | 664 | 217628 | 75803 |

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

| Subwatershed | Cl | TKN | Total P | NO2+NO3 | TSS | VSS |
|---|---|---|---|---|---|---|
| Battle Creek | 165427 | 1782 | 303 | 400 | 65325 | 22084 |
| Beaver Lake | 17550 | 189 | 32 | 42 | 6930 | 2343 |
| Belt Line | 459158 | 4947 | 841 | 1109 | 181316 | 61296 |
| Crosby | 209276 | 2255 | 383 | 506 | 82640 | 27938 |
| Davern | 198349 | 2137 | 363 | 479 | 78325 | 26479 |
| Downtown | 114256 | 1231 | 209 | 276 | 45118 | 15253 |
| East Kittsondale | 171790 | 1622 | 215 | 239 | 73959 | 30143 |
| Fish Creek | 6625 | 71 | 12 | 16 | 2616 | 884 |
| Goodrich/Western | 73988 | 797 | 136 | 179 | 29217 | 9877 |
| Griffith/Pt. Douglas | 77722 | 837 | 142 | 188 | 30691 | 10376 |
| Hidden Falls | 47683 | 514 | 87 | 115 | 18829 | 6366 |
| Highwood | 155527 | 1676 | 285 | 376 | 61416 | 20762 |
| Lake Como | 168457 | 1815 | 309 | 407 | 66521 | 22488 |
| Lake Phalen | 117846 | 1270 | 216 | 285 | 46536 | 15732 |
| Mississippi River Blvd. | 384117 | 4139 | 704 | 928 | 151683 | 51278 |
| MRWMO | 26175 | 282 | 48 | 63 | 10336 | 3494 |
| Phalen Creek | 184841 | 1157 | 230 | 292 | 112173 | 32210 |
| Pigs Eye | 332493 | 3582 | 609 | 803 | 131297 | 44387 |
| Riverview | 160566 | 1730 | 294 | 388 | 63405 | 21435 |
| St. Anthony Hill | 469944 | 5063 | 861 | 1135 | 185575 | 62736 |
| St. Anthony Park | 194500 | 1164 | 139 | 422 | 64688 | 17522 |
| Trout Brook | 21816 | 668 | 124 | 63 | 45075 | 12920 |
| Urban | 51627 | 556 | 95 | 125 | 20387 | 6892 |
| West Kittsondale | 193374 | 2083 | 354 | 467 | 76361 | 25815 |
| West Seventh | 74952 | 808 | 137 | 181 | 29598 | 10006 |

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

| Subwatershed | Cl | TKN | Total P | NO2+NO3 | TSS | VSS |
|---|---|---|---|---|---|---|
| Battle Creek | 47591 | 2339 | 402 | 459 | 202933 | 75972 |
| Beaver Lake | 5049 | 248 | 43 | 49 | 21529 | 8060 |
| Belt Line | 132093 | 6493 | 1116 | 1275 | 563262 | 210869 |
| Crosby | 62295 | 3062 | 526 | 601 | 265632 | 99445 |
| Davern | 59042 | 2902 | 499 | 570 | 251762 | 94253 |
| Downtown | 32748 | 1610 | 277 | 316 | 139640 | 52277 |
| East Kittsondale | 10927 | 1772 | 325 | 277 | 134710 | 55330 |
| Fish Creek | 1906 | 94 | 16 | 18 | 8128 | 3043 |
| Goodrich/Western | 21206 | 1042 | 179 | 205 | 90426 | 33853 |
| Griffith/Pt. Douglas | 22359 | 1099 | 189 | 216 | 95344 | 35694 |
| Hidden Falls | 14194 | 698 | 120 | 137 | 60524 | 22658 |
| Highwood | 44743 | 2199 | 378 | 432 | 190789 | 71426 |
| Lake Como | 50144 | 2465 | 424 | 484 | 213821 | 80048 |
| Lake Phalen | 33903 | 1666 | 287 | 327 | 144565 | 54121 |
| Mississippi River Blvd. | 114339 | 5620 | 966 | 1104 | 487556 | 182527 |
| MRWMO | 7791 | 383 | 66 | 75 | 33224 | 12438 |
| Phalen Creek | 7719 | 861 | 150 | 191 | 62654 | 25113 |
| Pigs Eye | 95653 | 4702 | 808 | 924 | 407878 | 152698 |
| Riverview | 46192 | 2271 | 390 | 446 | 196970 | 73740 |
| St. Anthony Hill | 134693 | 6621 | 1138 | 1300 | 574350 | 215020 |
| St. Anthony Park | 42770 | 1996 | 320 | 462 | 204440 | 71069 |
| Trout Brook | 20711 | 1084 | 269 | 169 | 77410 | 25208 |
| Urban | 14852 | 730 | 126 | 143 | 63333 | 23710 |
| West Kittsondale | 57561 | 2829 | 486 | 556 | 245448 | 91889 |
| West Seventh | 21482 | 1056 | 182 | 207 | 91604 | 34294 |

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

| Subwatershed | Cl | TKN | Total P | NO2+NO3 | TSS | VSS |
|---|---|---|---|---|---|---|
| Battle Creek | 14830 | 2008 | 411 | 347 | 193205 | 61374 |
| Beaver Lake | 1573 | 213 | 44 | 37 | 20497 | 6511 |
| Belt Line | 41162 | 5575 | 1142 | 963 | 536261 | 170350 |
| Crosby | 10766 | 1458 | 299 | 252 | 140256 | 44554 |
| Davern | 10204 | 1382 | 283 | 239 | 132932 | 42228 |
| Downtown | 7934 | 1075 | 220 | 186 | 103366 | 32835 |
| East Kittsondale | 5317 | 980 | 182 | 188 | 81703 | 28833 |
| Fish Creek | 594 | 80 | 16 | 14 | 7738 | 2458 |
| Goodrich/Western | 5138 | 696 | 143 | 120 | 66936 | 21263 |
| Griffith/Pt. Douglas | 6968 | 944 | 193 | 163 | 90773 | 28835 |
| Hidden Falls | 2453 | 332 | 68 | 57 | 31957 | 10151 |
| Highwood | 13943 | 1888 | 387 | 326 | 181644 | 57701 |
| Lake Como | 8666 | 1174 | 240 | 203 | 112899 | 35864 |
| Lake Phalen | 10565 | 1431 | 293 | 247 | 137635 | 43721 |
| Mississippi River Blvd. | 19760 | 2676 | 548 | 462 | 257433 | 81777 |
| MRWMO | 1347 | 182 | 37 | 31 | 17542 | 5573 |
| Phalen Creek | 6253 | 2050 | 346 | 268 | 176292 | 56646 |
| Pigs Eye | 29807 | 4037 | 827 | 697 | 388326 | 123356 |
| Riverview | 14394 | 1949 | 399 | 337 | 187528 | 59571 |
| St. Anthony Hill | 32634 | 4420 | 905 | 763 | 425152 | 135055 |
| St. Anthony Park | 51793 | 3969 | 704 | 892 | 278316 | 51793 |
| Trout Brook | 35340 | 2008 | 482 | 377 | 125182 | 39235 |
| Urban | 4628 | 627 | 128 | 108 | 60297 | 19154 |
| West Kittsondale | 9948 | 1347 | 276 | 233 | 129598 | 41168 |
| West Seventh | 5205 | 705 | 144 | 122 | 67808 | 21540 |

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

| Subwatershed | Cl | TKN | Total P | NO2+NO3 | TSS | VSS |
|---|---|---|---|---|---|---|
| Battle Creek | 70158 | 793 | 251 | 210 | 63963 | 23058 |
| Beaver Lake | 7443 | 84 | 27 | 22 | 6786 | 2446 |
| Belt Line | 194732 | 2201 | 698 | 582 | 177535 | 64001 |
| Crosby | 88333 | 999 | 316 | 264 | 80532 | 29032 |
| Davern | 83720 | 946 | 300 | 250 | 76327 | 27516 |
| Downtown | 47765 | 540 | 171 | 143 | 43546 | 15698 |
| East Kittsondale | 2364 | 158 | 141 | 43 | 17818 | 3846 |
| Fish Creek | 2810 | 32 | 10 | 8 | 2562 | 924 |
| Goodrich/Western | 30931 | 350 | 111 | 92 | 28199 | 10166 |
| Griffith/Pt. Douglas | 32962 | 373 | 118 | 99 | 30051 | 10834 |
| Hidden Falls | 20126 | 228 | 72 | 60 | 18349 | 6615 |
| Highwood | 65960 | 746 | 236 | 197 | 60135 | 21679 |
| Lake Como | 71103 | 804 | 255 | 213 | 64824 | 23369 |
| Lake Phalen | 91867 | 1038 | 329 | 275 | 83754 | 30193 |
| Mississippi River Blvd. | 162131 | 1833 | 581 | 485 | 147813 | 53286 |
| MRWMO | 11048 | 125 | 40 | 33 | 10072 | 3631 |
| Phalen Creek | 27921 | 225 | 55 | 93 | 10126 | 5155 |
| Pigs Eye | 141012 | 1594 | 505 | 422 | 128559 | 46346 |
| Riverview | 68097 | 770 | 244 | 204 | 62083 | 22381 |
| St. Anthony Hill | 196459 | 2221 | 704 | 587 | 179109 | 64569 |
| St. Anthony Park | 22338 | 177 | 40 | 84 | 10946 | 22338 |
| Trout Brook | 11522 | 307 | 118 | 61 | 37514 | 13912 |
| Urban | 21895 | 248 | 78 | 65 | 19962 | 7196 |
| West Kittsondale | 81621 | 923 | 292 | 244 | 74413 | 26826 |
| West Seventh | 31334 | 354 | 112 | 94 | 28566 | 10298 |

# 13. 2022 Summary

In 2022, seven (7) stormwater BMPs were monitored along with two (2) locations that provide upstream stormwater data. All locations were evaluated for performance in 2022 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 2022 runoff and volume reduction data is presented in **Table 13-1** below.

**Table 13-1: Runoff Summary**

| BMP Site | Drainage Area (acres)[1] | Total Monitored Runoff (cf) | % Runoff Captured | Water Yield (in/acre)[1] | Water Yield (cu-ft/acre)[1] | Rainfall/Runoff Coefficient |
|---|---|---|---|---|---|---|
| Beacon Bluff | 143.6 | 1,123,251 | 37 | 2.26 | 7,822 | 0.18 |
| St. Albans | 25.2 | 208,172 | 89.5 | 2.28 | 8,261 | 0.21 |
| Hampden Park | 7.8 | 112,573 | 100.0 | 3.98 | 14,432 | 0.39 |
| Victoria Street | 19.1 | 179,189 | 85.1 | 2.58 | 9,382 | 0.22 |

1-For the Beacon Bluff and Hampden Park Sites, the drainage area and total runoff presented in the table includes the total for the BMP system. The water yield calculations were generated from the monitored/modeled runoff volume and the corresponding drainage area

Of the four sites, the Hampden Park site received the greatest amount of runoff per drainage acre, resulting in a rainfall to runoff coefficient of 0.39. Beacon Bluff's drainage area showed the least amount of runoff, having a coefficient of 0.18.

TSS and TP loads captured by the monitored BMPs are summarized in **Table 13-2**. TSS and TP loads were calculated using 2022 flow data and flow-weighted averages. Beacon Bluff has 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 4,596 pounds and 43.3 pounds, respectively.

**Table 13-2: Underground Infiltration System Pollutant Capture Summary**

| BMP Site | TSS Captured (pounds) | TP Captured (pounds) |
|---|---|---|
| Beacon Bluff | 4,106 | 24.6 |
| St. Albans | 532 | 2.9 |
| Hampden Park | 459 | 1.5 |
| Victoria Street | 701 | 4.3 |
| **Total** | **4,596** | **43.3** |

A summary of the 2022 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 37% of the total volume monitored.
- The 2022, St. Albans infiltration rate of 14.0 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 10.9 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, possibly due to low rain fall totals and less water moving through the pipe. 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 45.07 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 the Victoria Street permeable pavers, Jackson Street pervious asphalt, and Hamline Midway Library pervious asphalt sites in 2022. The Victoria Street 2022 average infiltration rate of 8.0 in/hr and is less than 5% of post-construction monitored infiltration rate.

The August 2022 infiltration rate at the Jackson Street Site was 87.3 in/hr, which is 13.2% of the infiltration rate observed during the first year of monitoring (2016). Low traffic areas were observed to have a significantly greater infiltration rates on average (314 in/hr) than medium traffic (0 in/hr) and high traffic (0 in/hr) areas.

## 13.3. 2023 Recommendations

The recommendations for the 2023 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.

# 14. References


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

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**Figures**

**Appendix A – Infiltration/Water Level Charts**

**Appendix B – Flow Rate Charts**

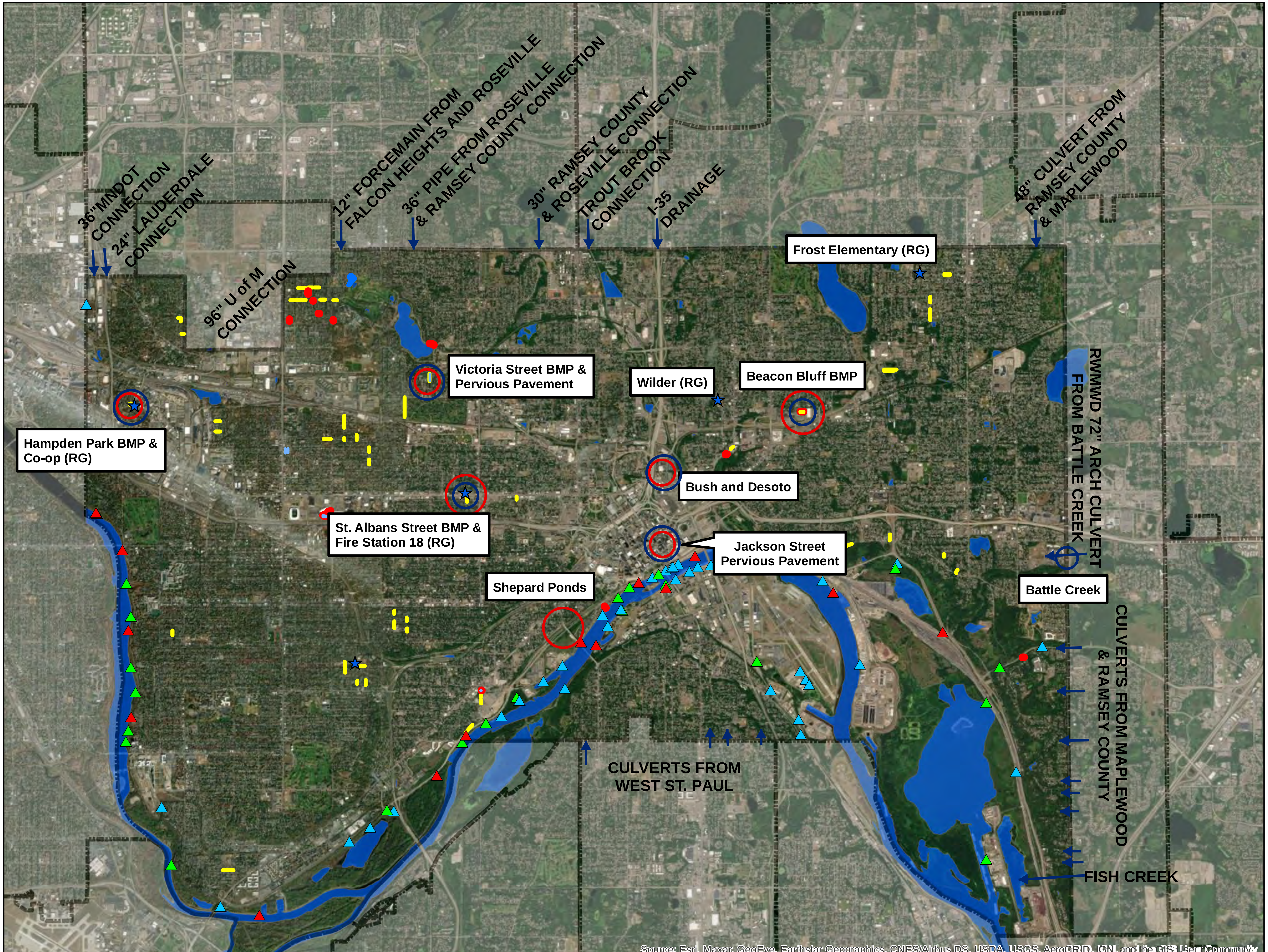
**Appendix C – Water Quality Summary and Pollutant Load Calculations**

**Appendix D – Pervious Pavement Infiltration Charts**

**Appendix E – Photolog**

**Appendix F – 2022 Monitoring Protocols**

**Appendix G – ASTM C170**




City of St. Paul

**2022 Water Quantity & Quality Monitoring Program**

SAINT PAUL MINNESOTA

**Figure 1-1**

# 2022 Monitoring Site Locations

N W E S

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
- 2021 Monitoring Locations
- 2022 Monitoring Locations
- Rain Gauge Locations

**Outfalls**

- 30" - 48"
- 50" - 72"
- > 72"

wsb

# City of St. Paul

**2022 Water Quantity and Quality Monitoring Program**

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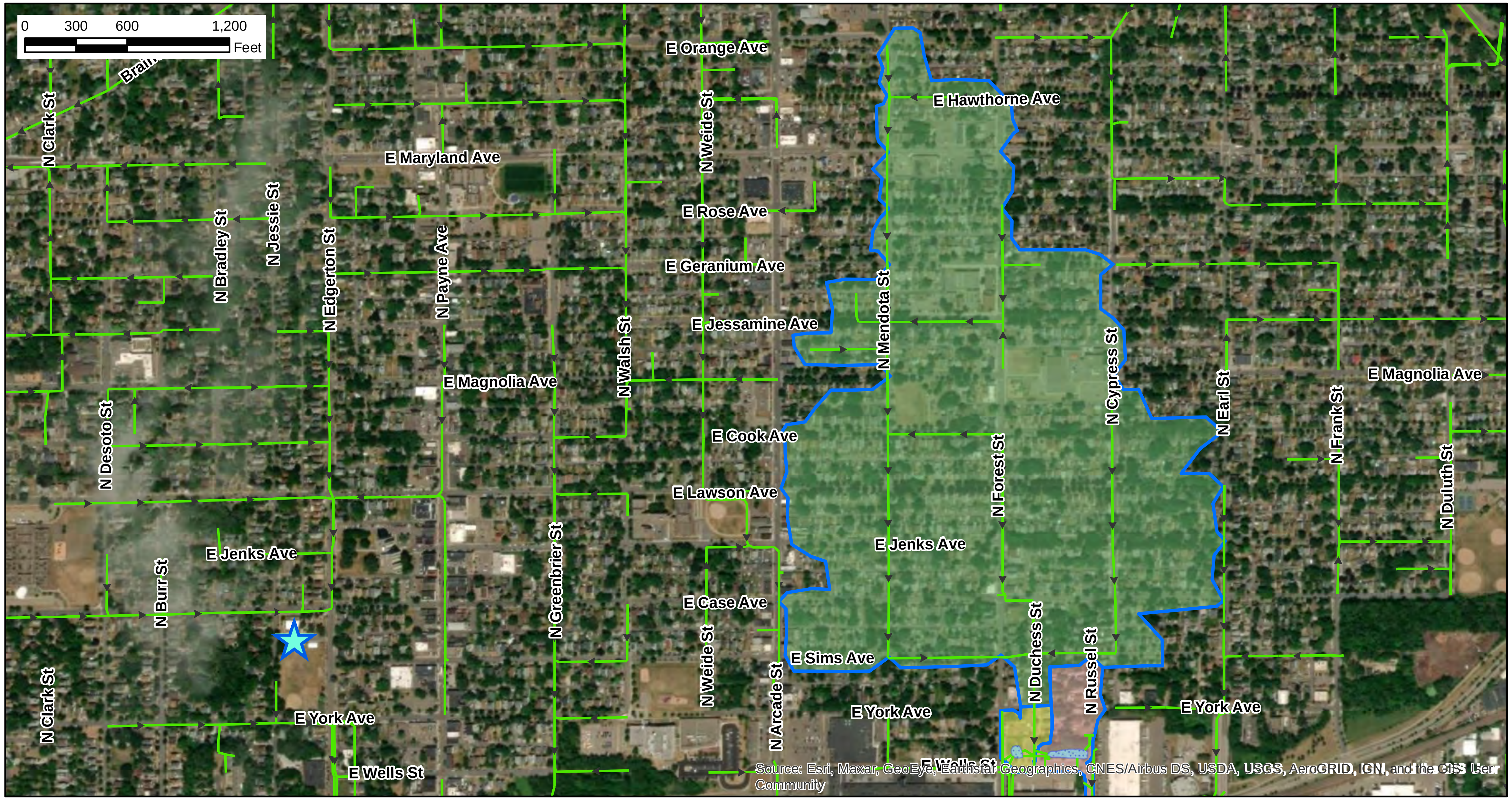
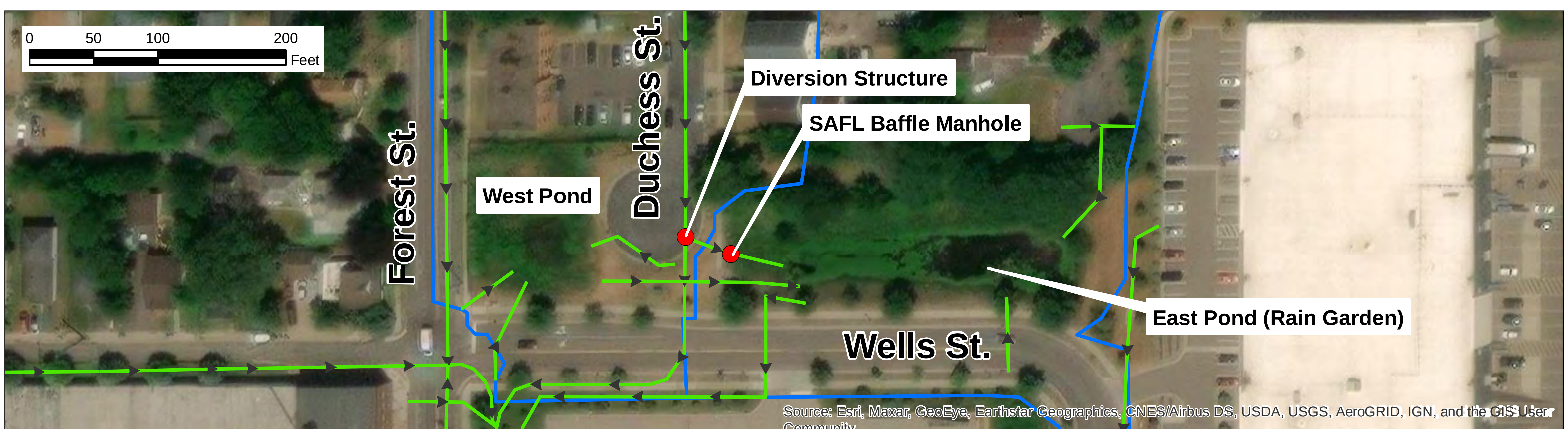
MINNESOTA

# FIGURE 4-1
## Beacon Bluff Infiltration BMP Drainage Areas




N
W E
S

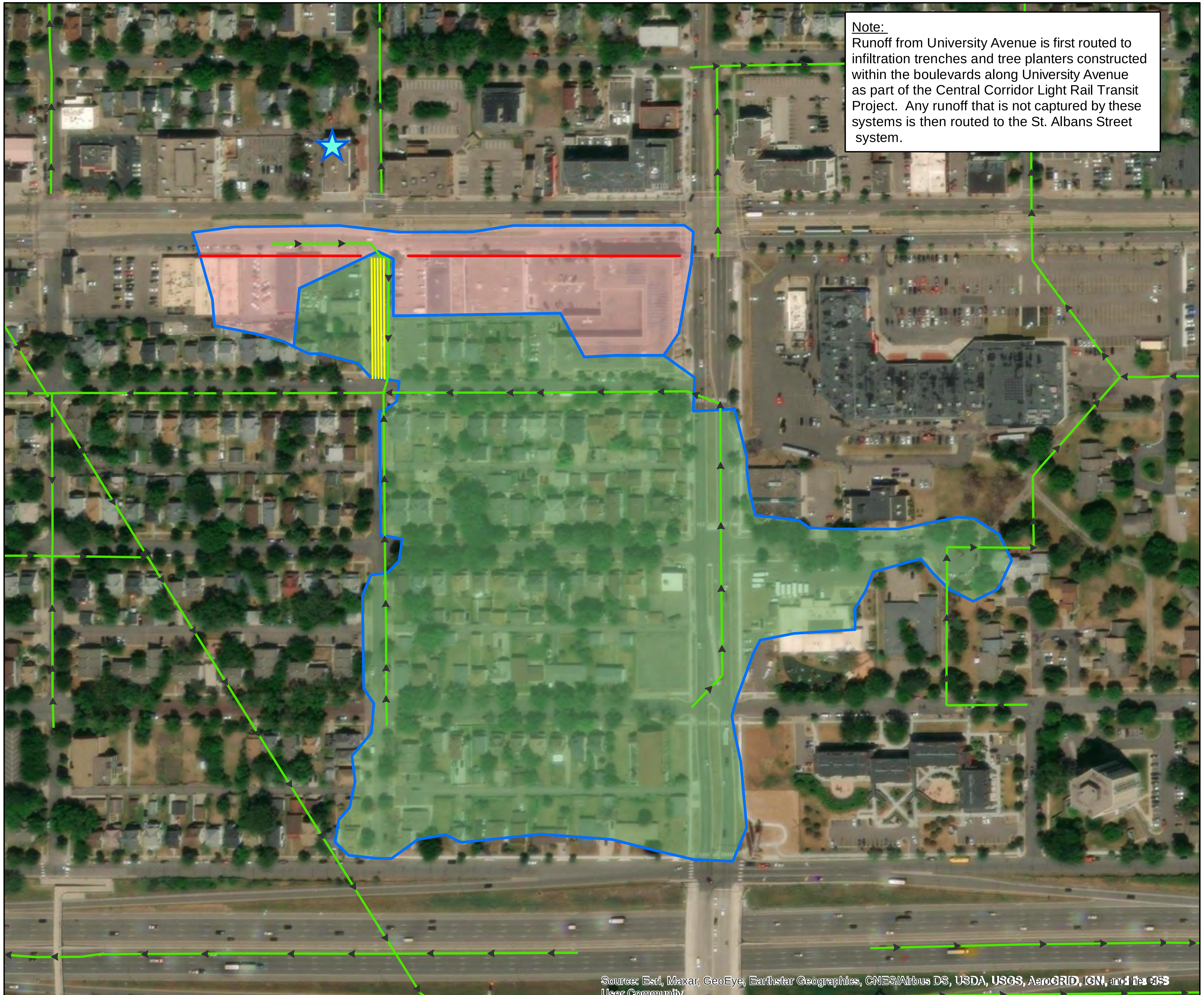
## Legend

- 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

## 2022 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


K:\01610-100\GIS\Maps\Figures\2022\Figure 6-1 - Hampden Park NEW.mxd

# City of St. Paul

**2022 Water Quantity and Quality Monitoring Program**

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# FIGURE 6-1 Hampden Park Infiltration BMP Drainage Area

N W E S

0 50100 200 300 400 Feet

## Legend

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

wsb


# City of St. Paul

**2022 Water Quantity and Quality Monitoring Program**

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## FIGURE 7-1
## Victoria Street Infiltration BMP Drainage Areas

N
W E
S

0 75 150 300
Feet

### Legend

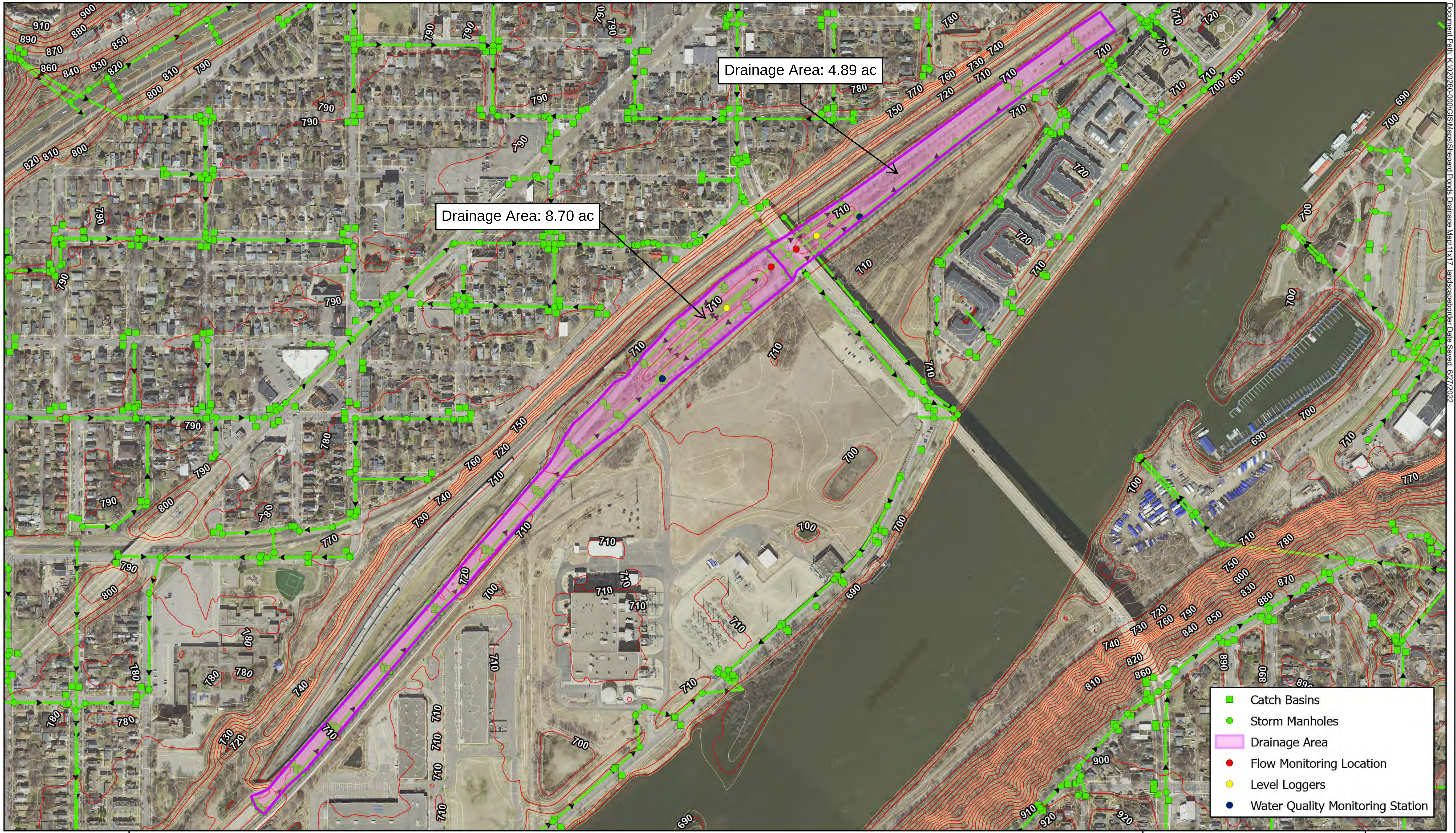
**Infiltration BMPs**

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

**Drainage Areas**

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

wsb

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# Shepard Ponds

2022 Water Quantity and Quality Monitoring Program

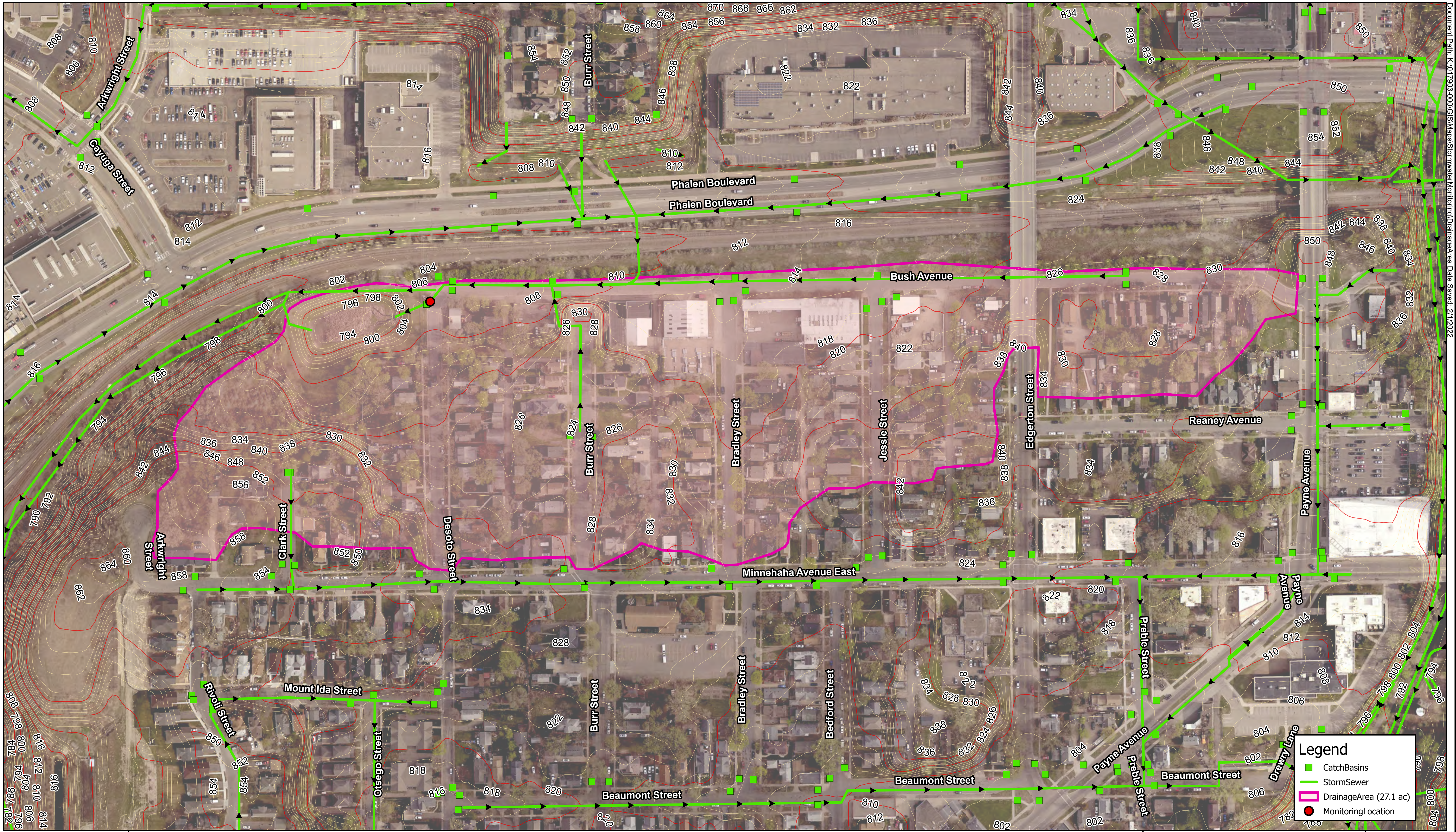
Figure 8-1

N

0 400 Feet

1 inch = 400 feet

wsb




**Bush-Desoto Pond**

2022 Water Quantity and Quality
Monitoring Program
Figure 9-1

N

0 200 Feet
1 inch = 200 feet

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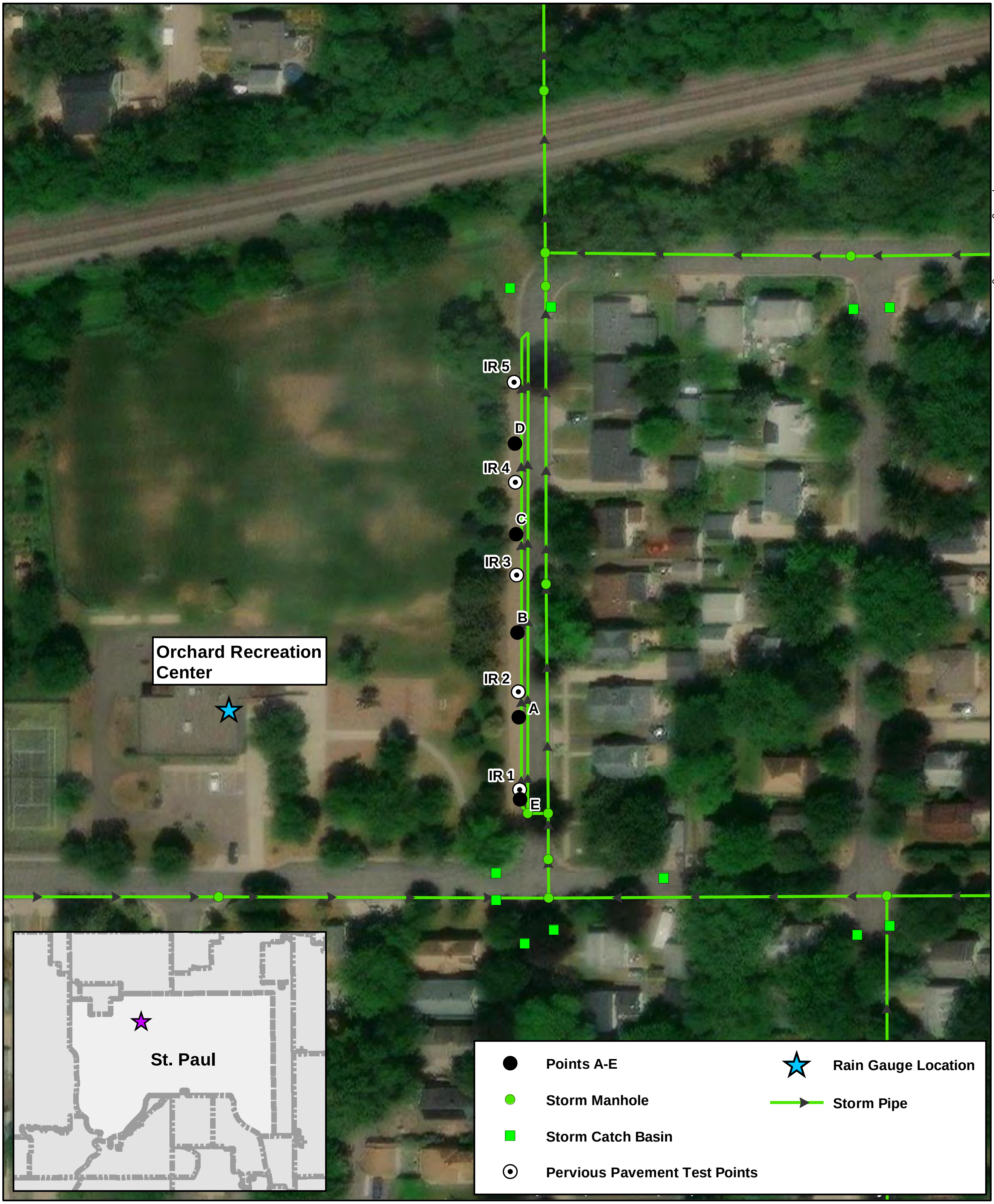
wsb




Document Path: K:\01610-100\GIS\Maps\Figures\2022\Figure 10-1 Victoria StreetPP.mxd Date Saved: 3/31/2023 3:21:23 PM

# Figure 10-1 - Victoria Street Pervious Pavement Test Locations

2022 Water Quantity and Quality Monitoring Program
City of St Paul, MN

N 0 30 60 120 Feet

wsb

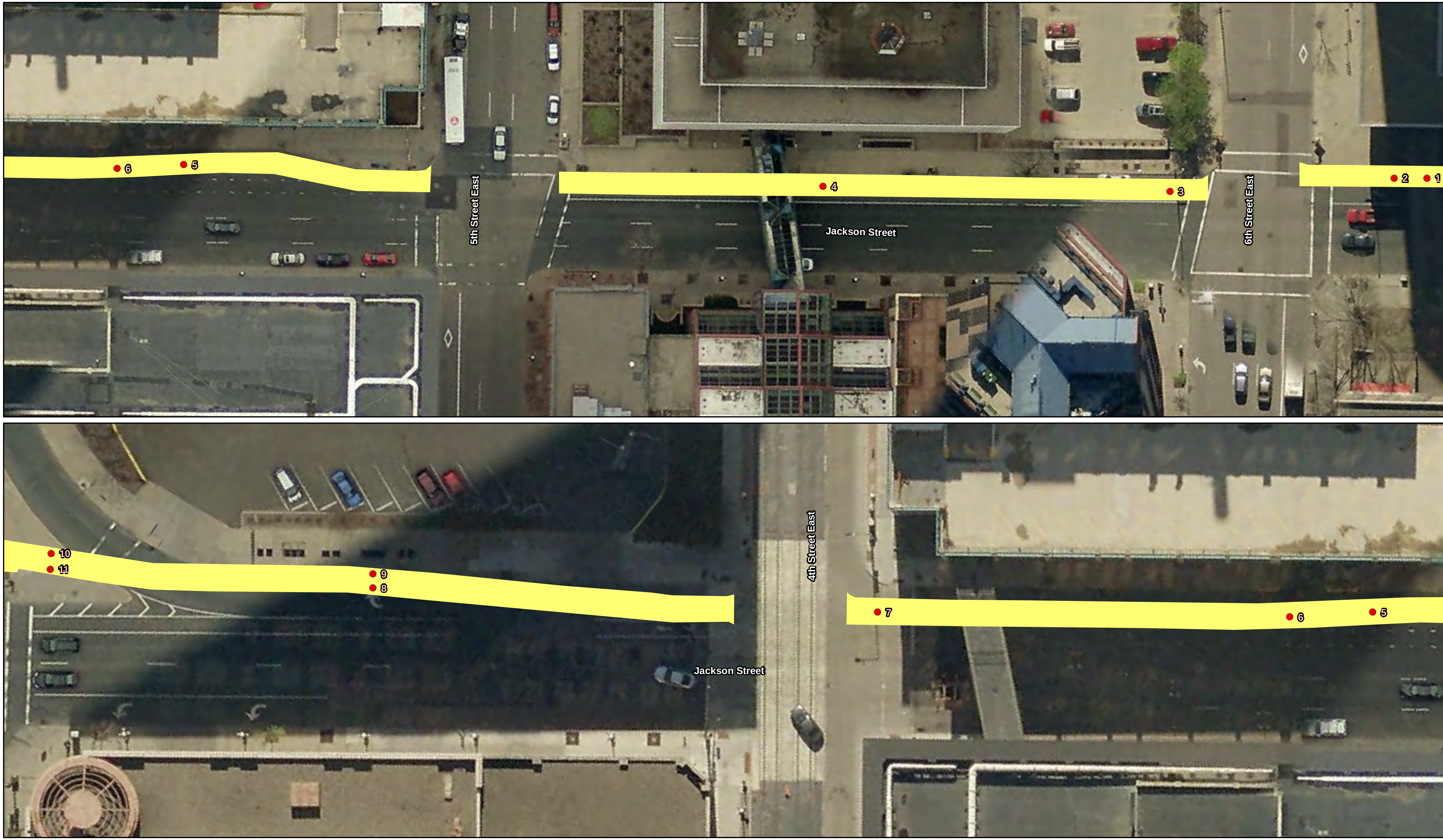



**Figure 10-2 Jackson Street (pg 1of2)**
**JS-1 - JS-11 Pervious Test Locations**
2022 Water Quantity and Quality Monitoring Program
City of Saint Paul, MN

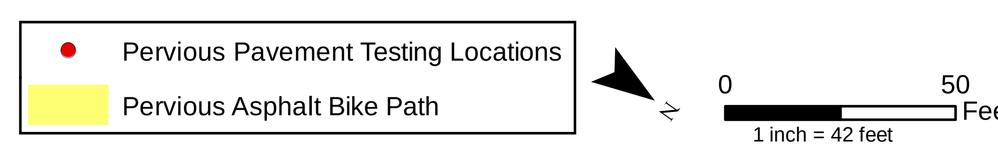
Pervious Pavement Testing Locations
Pervious Asphalt Bike Path

N
0 50 Feet
1 inch = 42 feet

wsb

Document Path: K:\01610-100\GIS\Maps\Figures\2022\Figure 10-2 JacksonStPerviousPavement.mxd Date Saved: 3/31/2023 3:28:51 PM


**Figure 10-2 Jackson Street (pg 2of2)**
**JS-12 - JS-18 Pervious Test Locations**
2022 Water Quantity and Quality Monitoring Program
City of Saint Paul, MN

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Document Path: K:\01610-100\GIS\Maps\Figures\2022\Figure 10-2 JacksonStPerviousPavement (sec 2).mxd Date Saved: 1/20/2022 11:15:14 AM

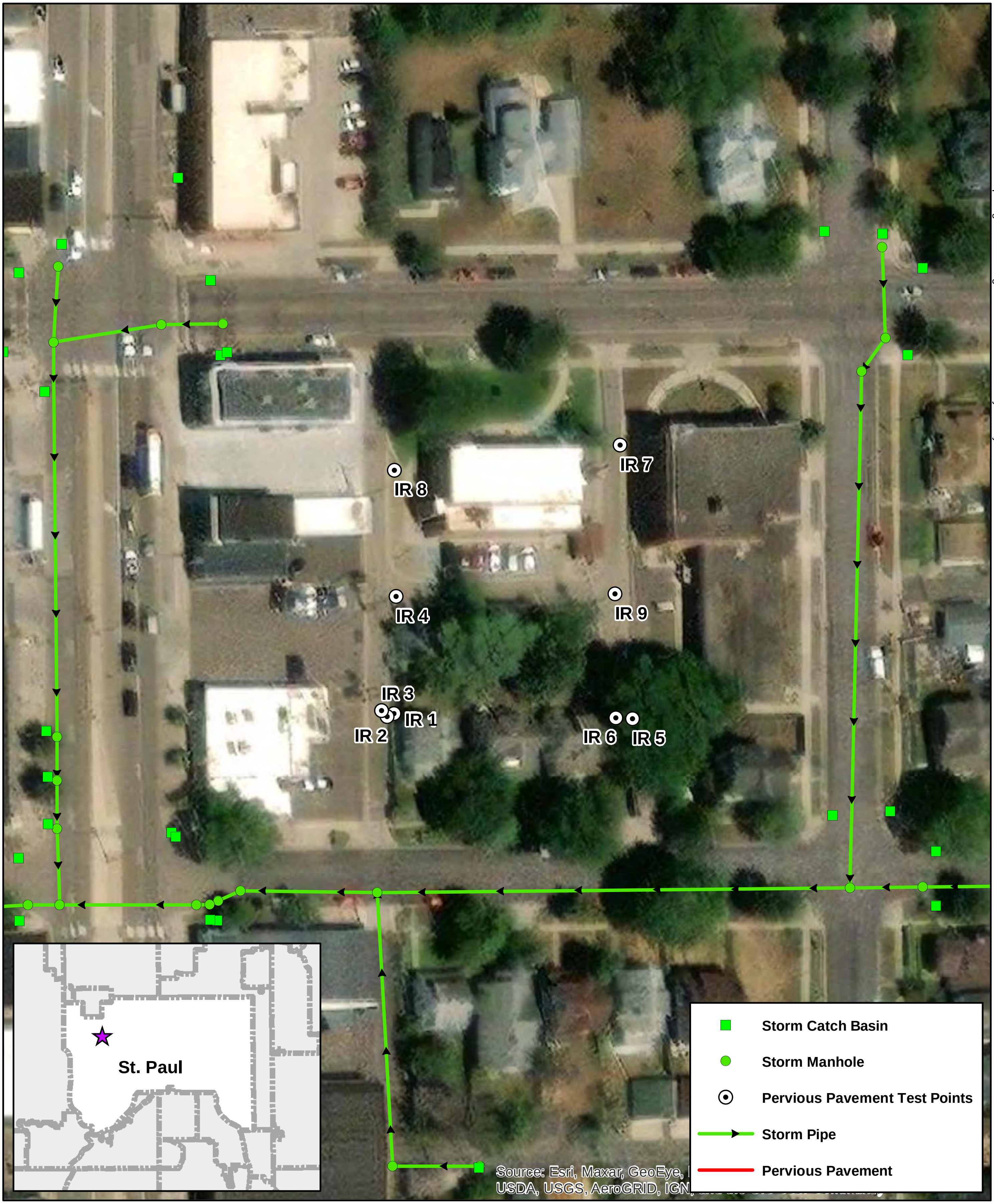





**Figure 10-3 - Hamline Midway Library Pervious Pavement Test Locations**

2022 Water Quantity and Quality Monitoring Program
City of St Paul, MN

N

0 20 40 80
Feet

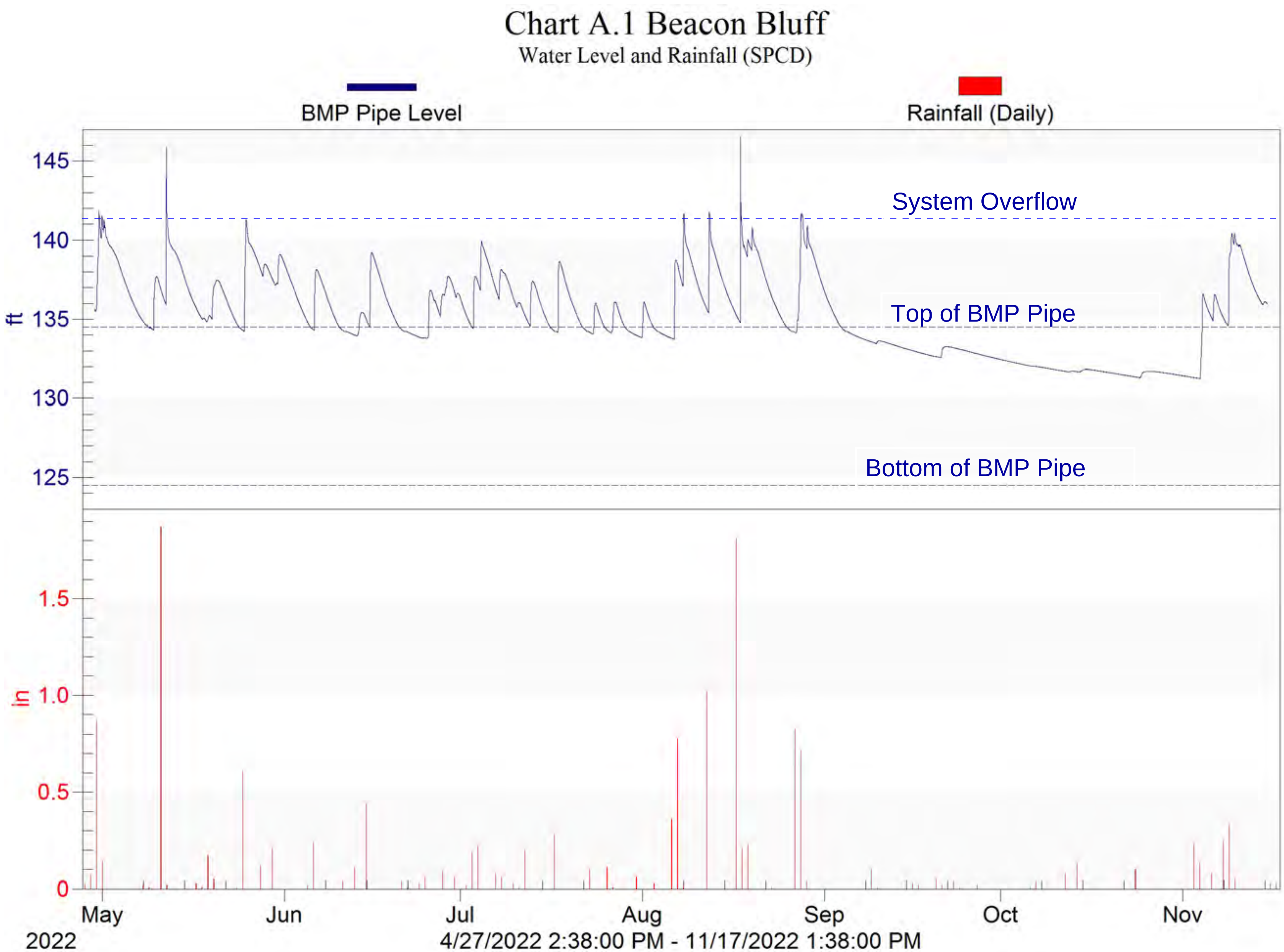
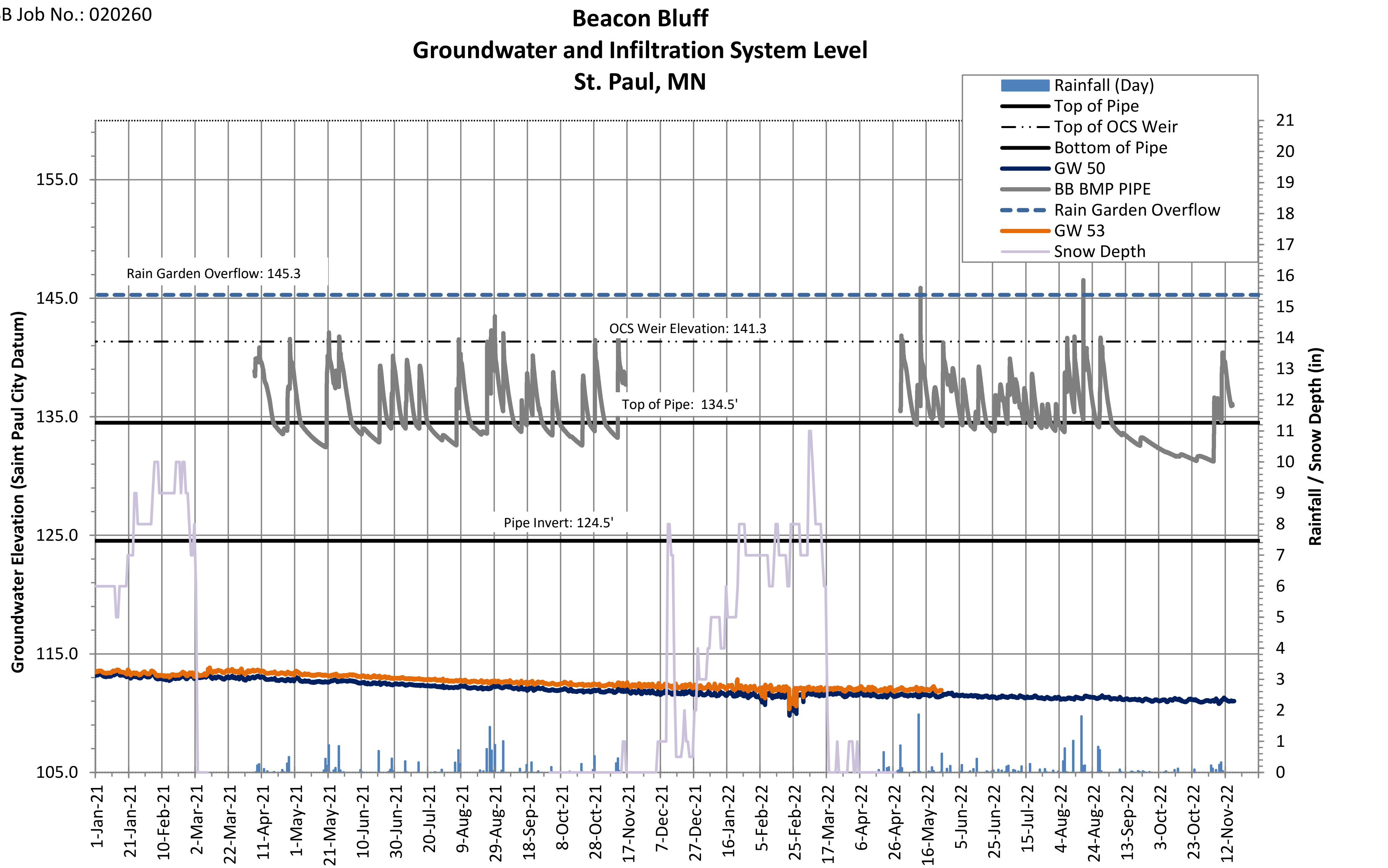
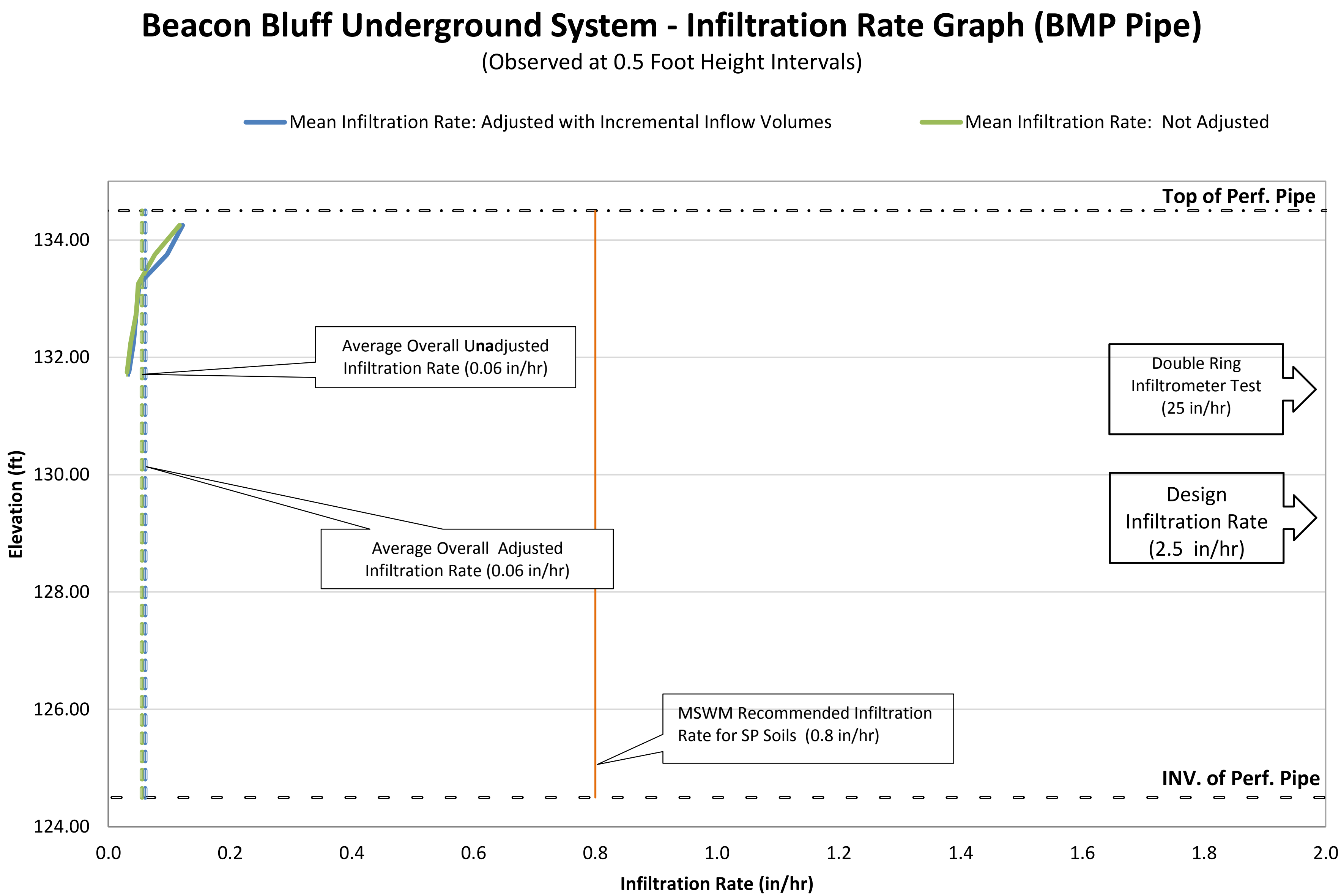


Chart A.1 Beacon Bluff
Water Level and Rainfall (SPCD)
BMP Pipe Level
Rainfall (Daily)
System Overflow
Top of BMP Pipe
Bottom of BMP Pipe
ft
145
140
135
130
125
in
1.5
1.0
0.5
0
May
Jun
Jul
Aug
Sep
Oct
Nov
2022
4/27/2022 2:38:00 PM - 11/17/2022 1:38:00 PM

City of Saint Paul
2022 Beacon Bluff Groundwater and System Level
Chart A.2
WSB Job No.: 020260

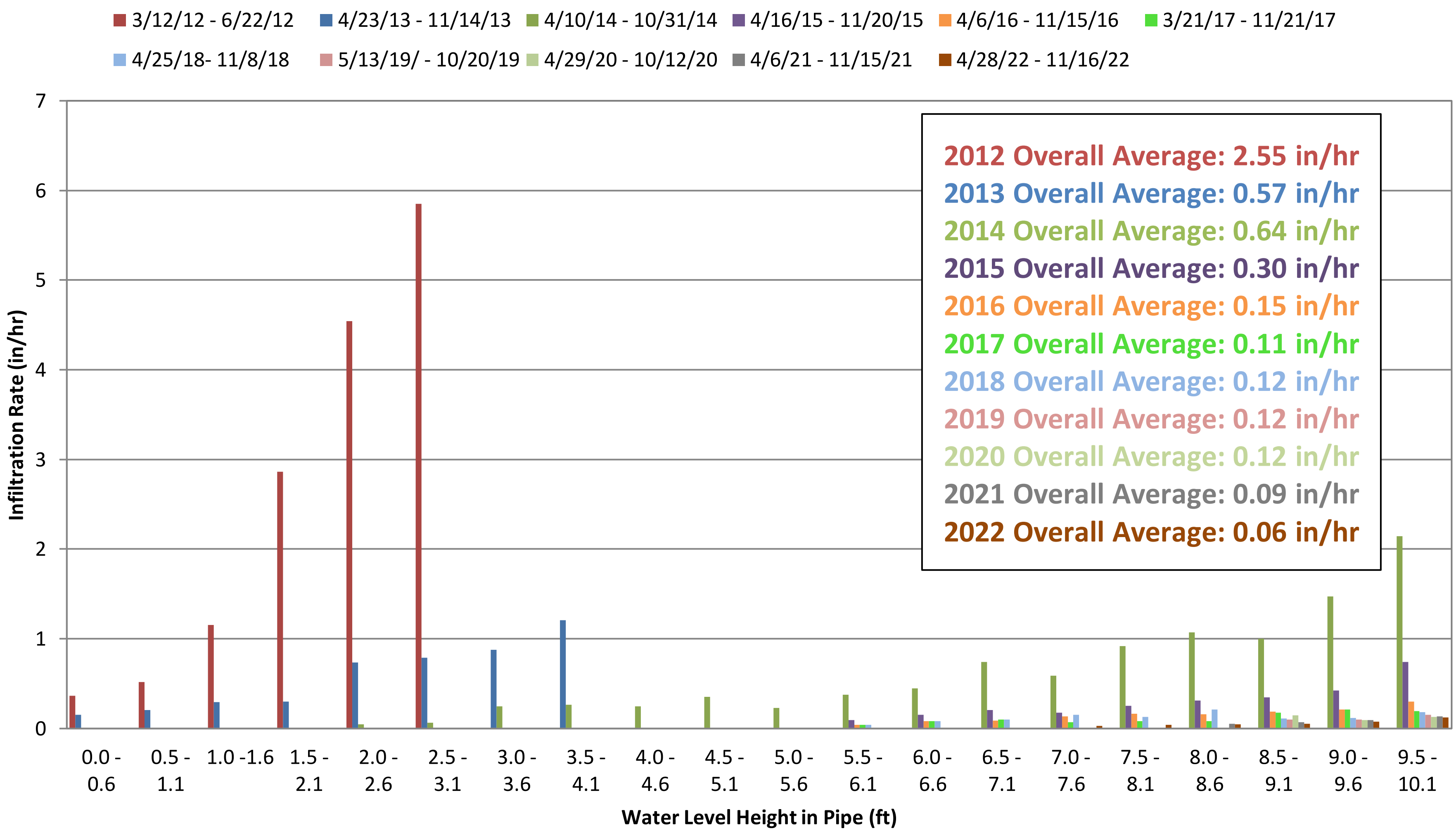


City of Saint Paul
2022 Water Quality and Quantity Report
Chart A.3
WSB Project No.: 020260




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

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



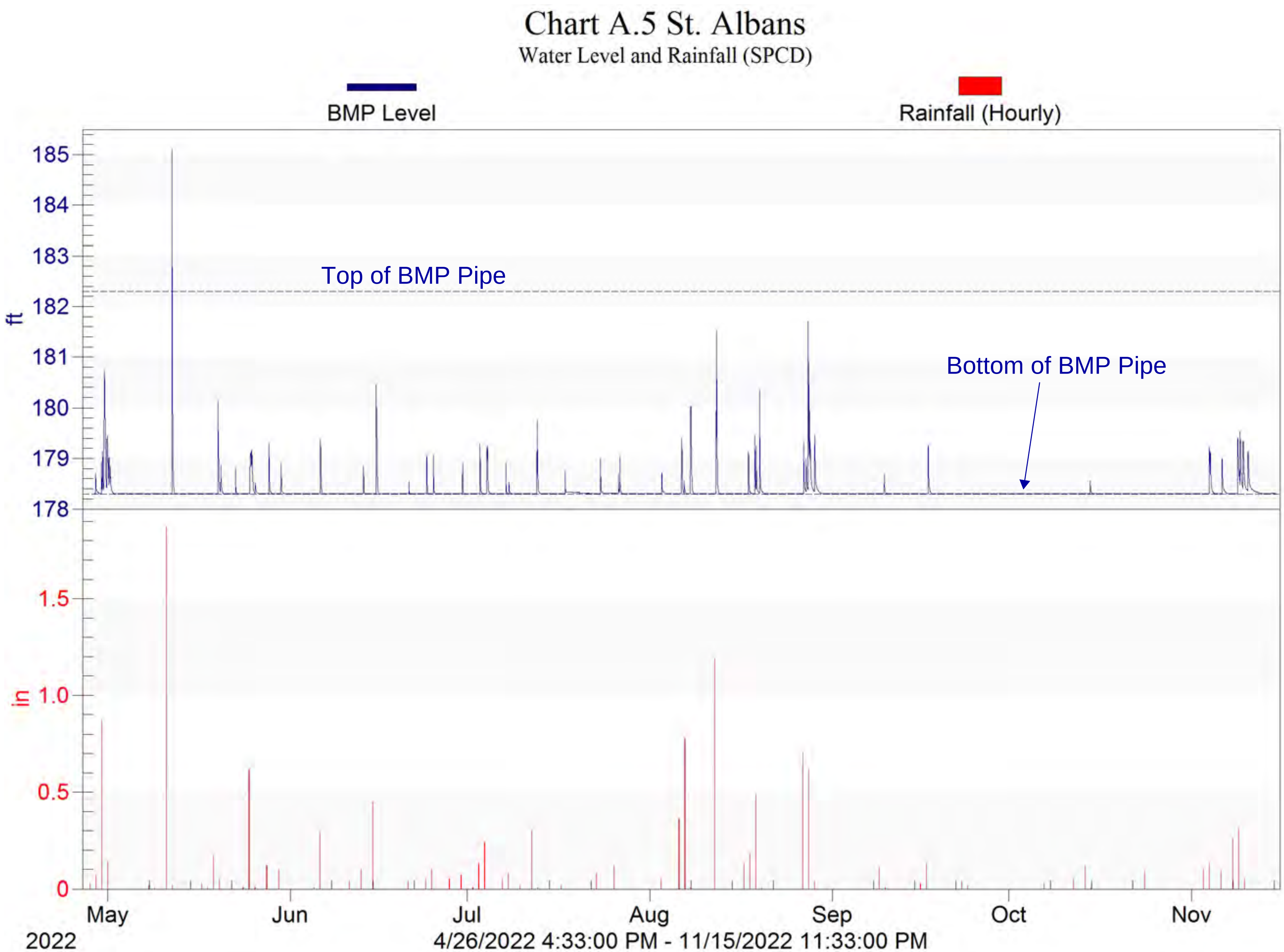
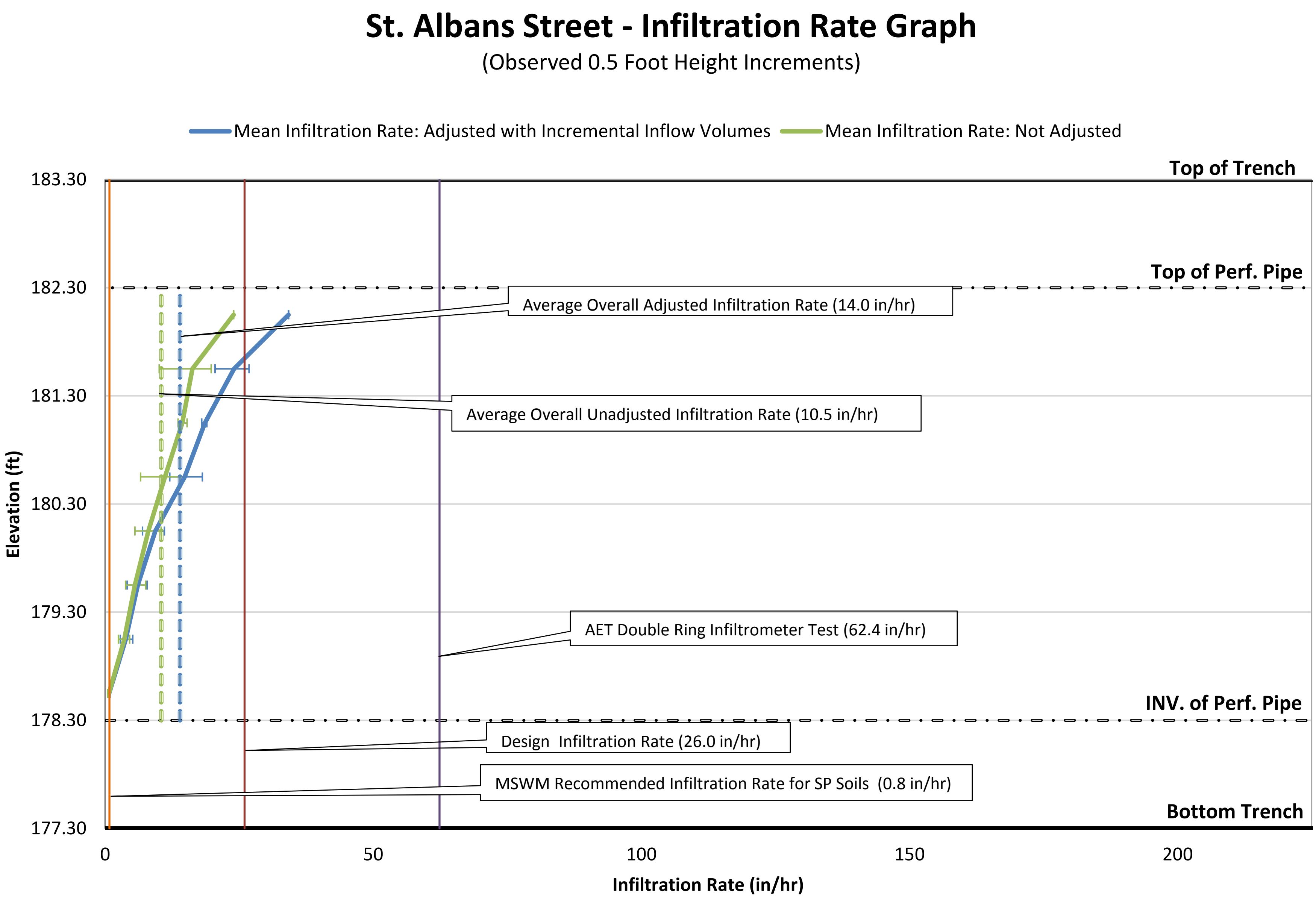
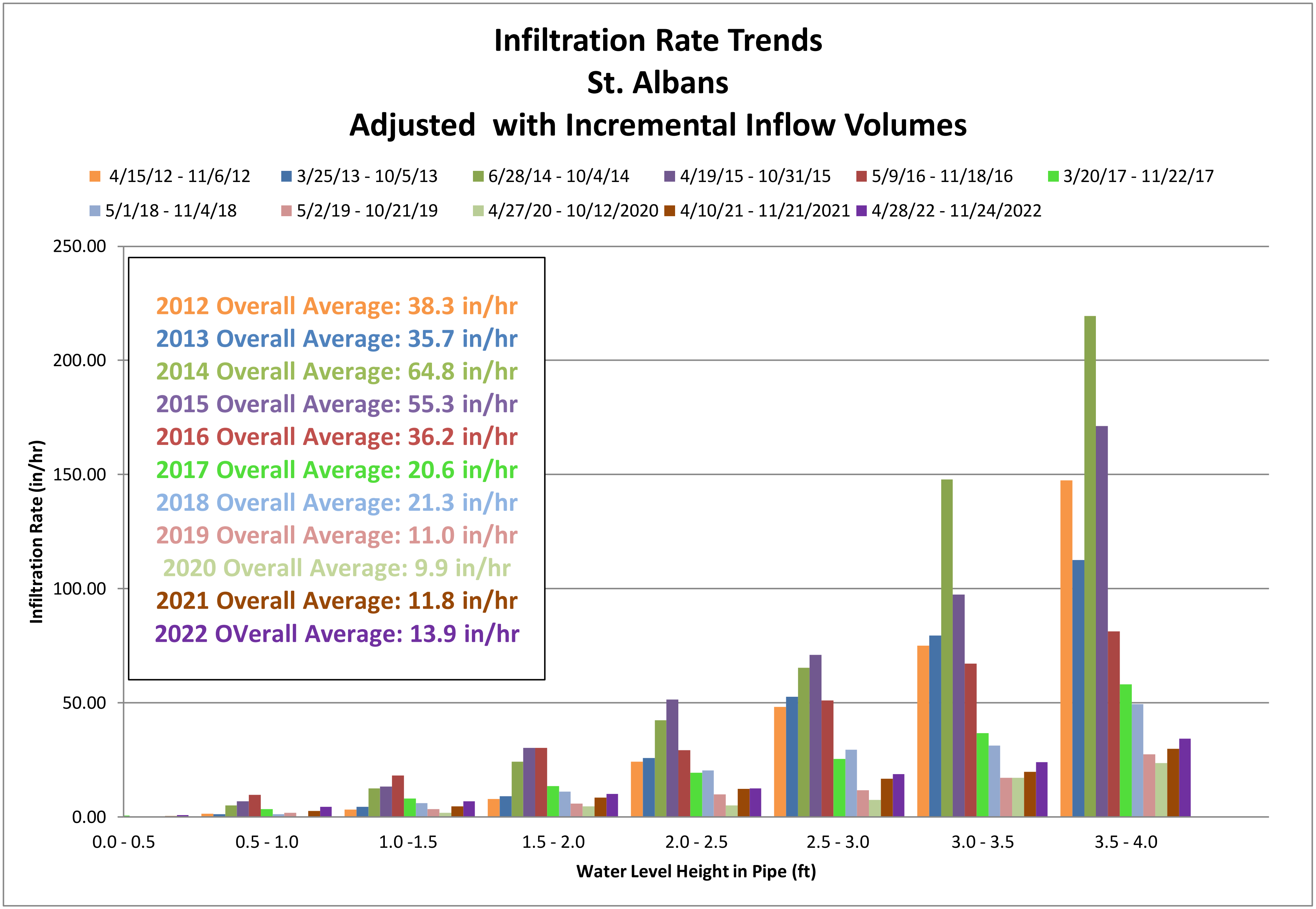


Chart A.5 St. Albans
Water Level and Rainfall (SPCD)
BMP Level
Rainfall (Hourly)
185
184
183
182
181
180
179
178
ft
Top of BMP Pipe
Bottom of BMP Pipe
1.5
1.0
0.5
0
in
May
Jun
Jul
Aug
Sep
Oct
Nov
2022
4/26/2022 4:33:00 PM - 11/15/2022 11:33:00 PM

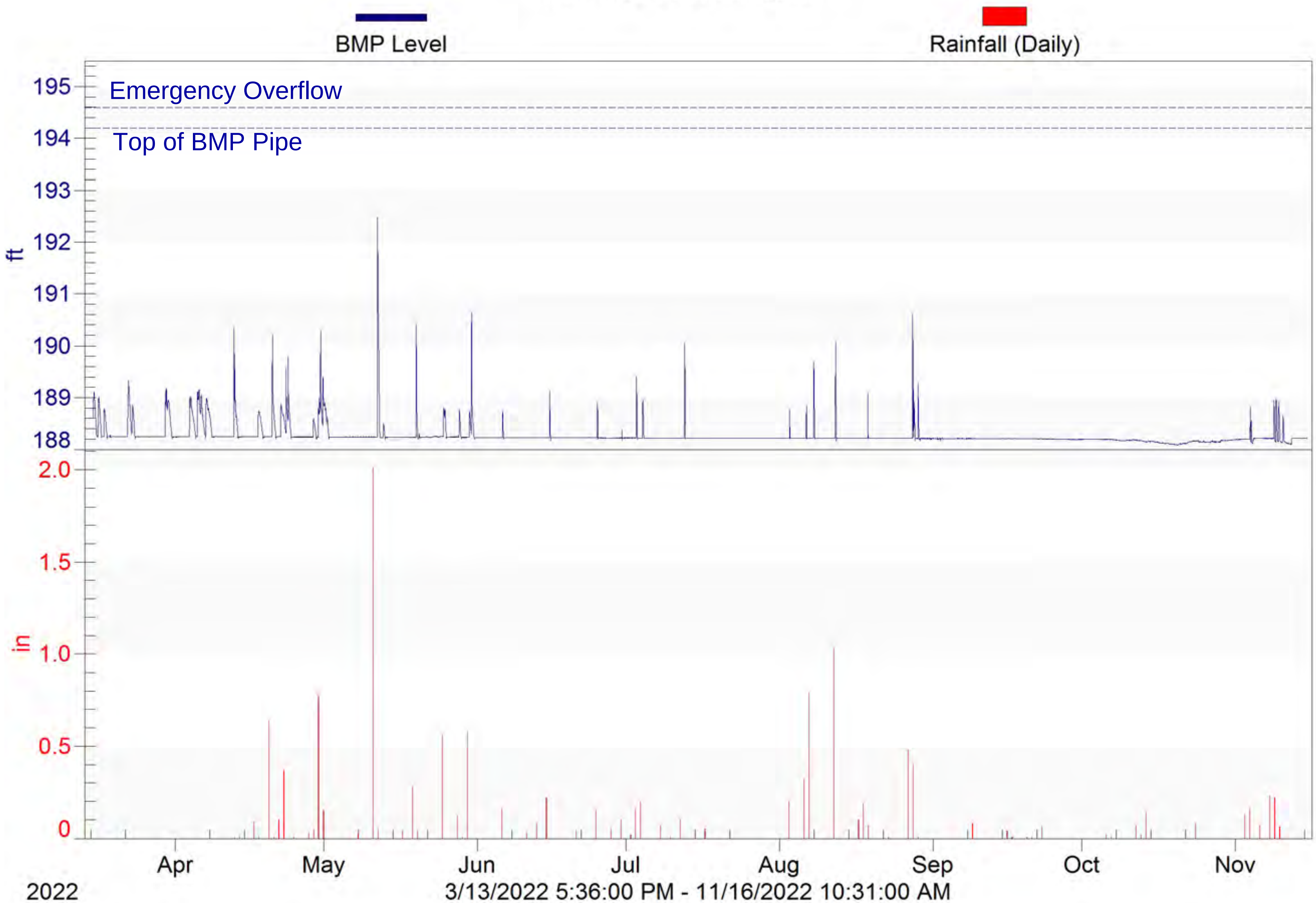



Note: Pipe Invert is 178.3'
Error Bars Represent 25th and 75th Percentiles
Pipe perforated w/ 2 rows of holes at Elev: 178.9' and 179.2'

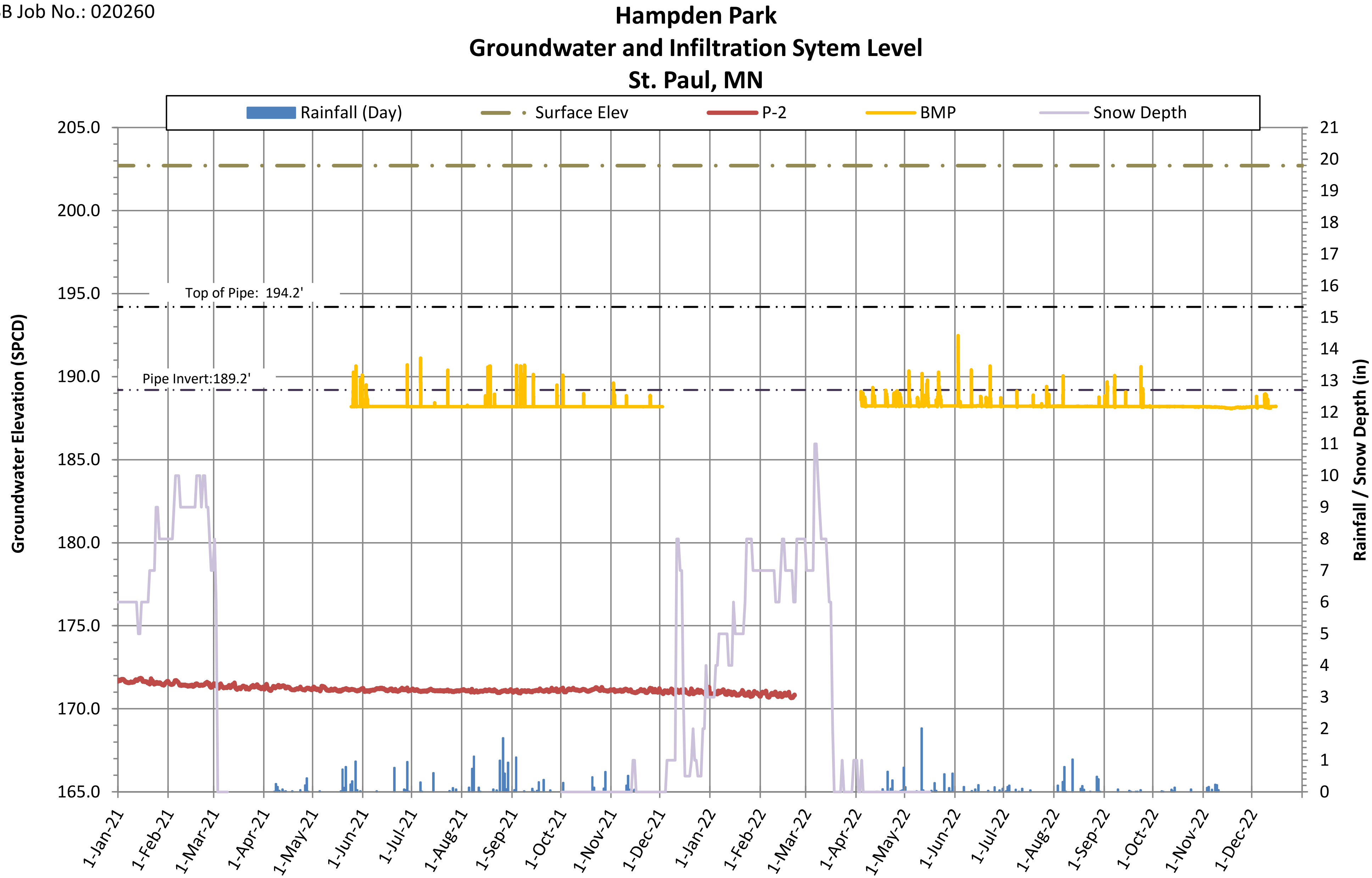

Infiltration Rate Trends
St. Albans
Adjusted with Incremental Inflow Volumes
4/15/12 - 11/6/12
3/25/13 - 10/5/13
6/28/14 - 10/4/14
4/19/15 - 10/31/15
5/9/16 - 11/18/16
3/20/17 - 11/22/17
5/1/18 - 11/4/18
5/2/19 - 10/21/19
4/27/20 - 10/12/2020
4/10/21 - 11/21/2021
4/28/22 - 11/24/2022
2012 Overall Average: 38.3 in/hr
2013 Overall Average: 35.7 in/hr
2014 Overall Average: 64.8 in/hr
2015 Overall Average: 55.3 in/hr
2016 Overall Average: 36.2 in/hr
2017 Overall Average: 20.6 in/hr
2018 Overall Average: 21.3 in/hr
2019 Overall Average: 11.0 in/hr
2020 Overall Average: 9.9 in/hr
2021 Overall Average: 11.8 in/hr
2022 OVerall Average: 13.9 in/hr
Infiltration Rate (in/hr)
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
Water Level Height in Pipe (ft)

# Chart A.8 Hampden Park

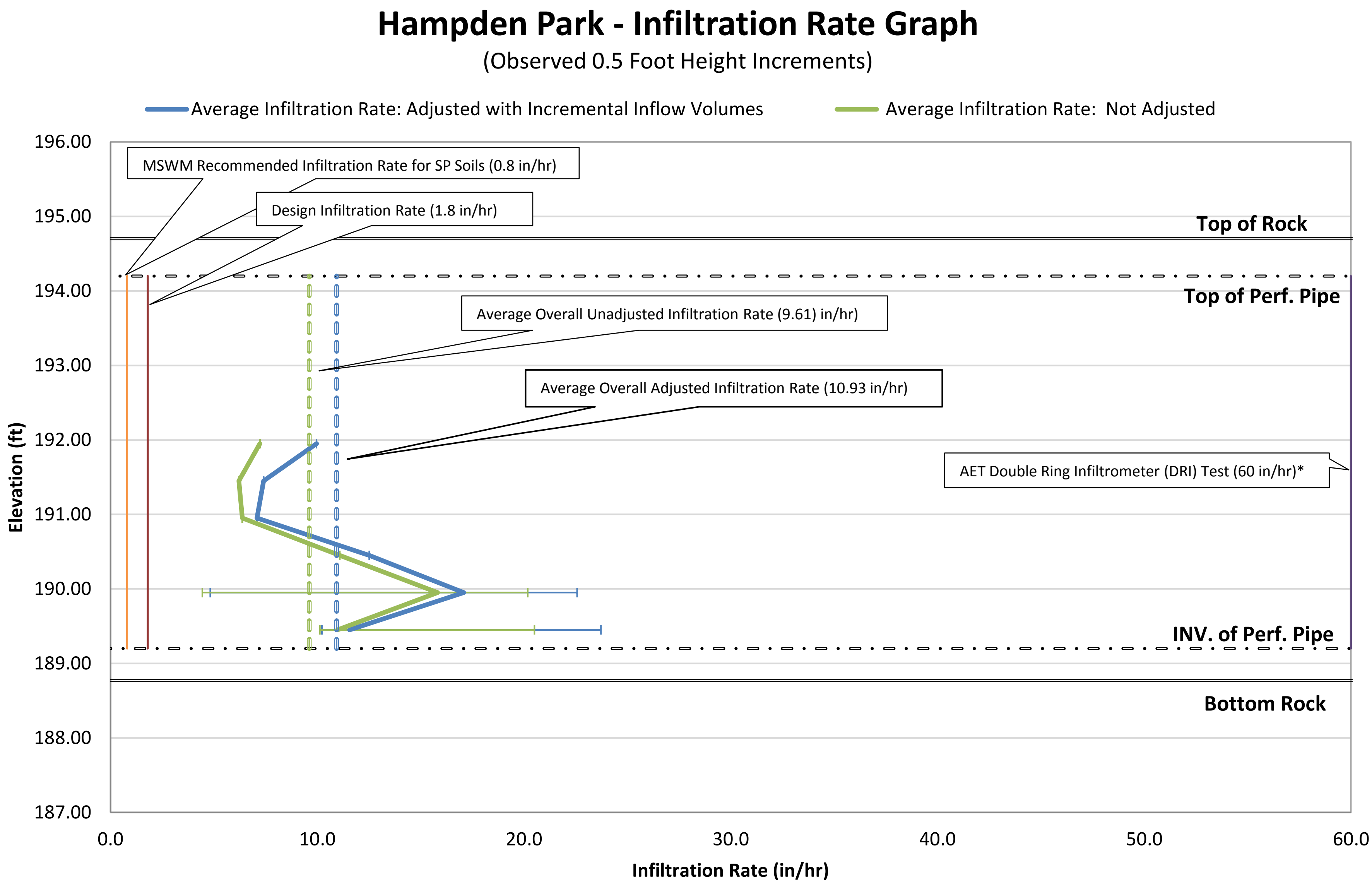
BMP Water Level and Rainfall



City of Saint Paul
2022 Water Quality and Quantity Report
Chart A.9
WSB Job No.: 020260

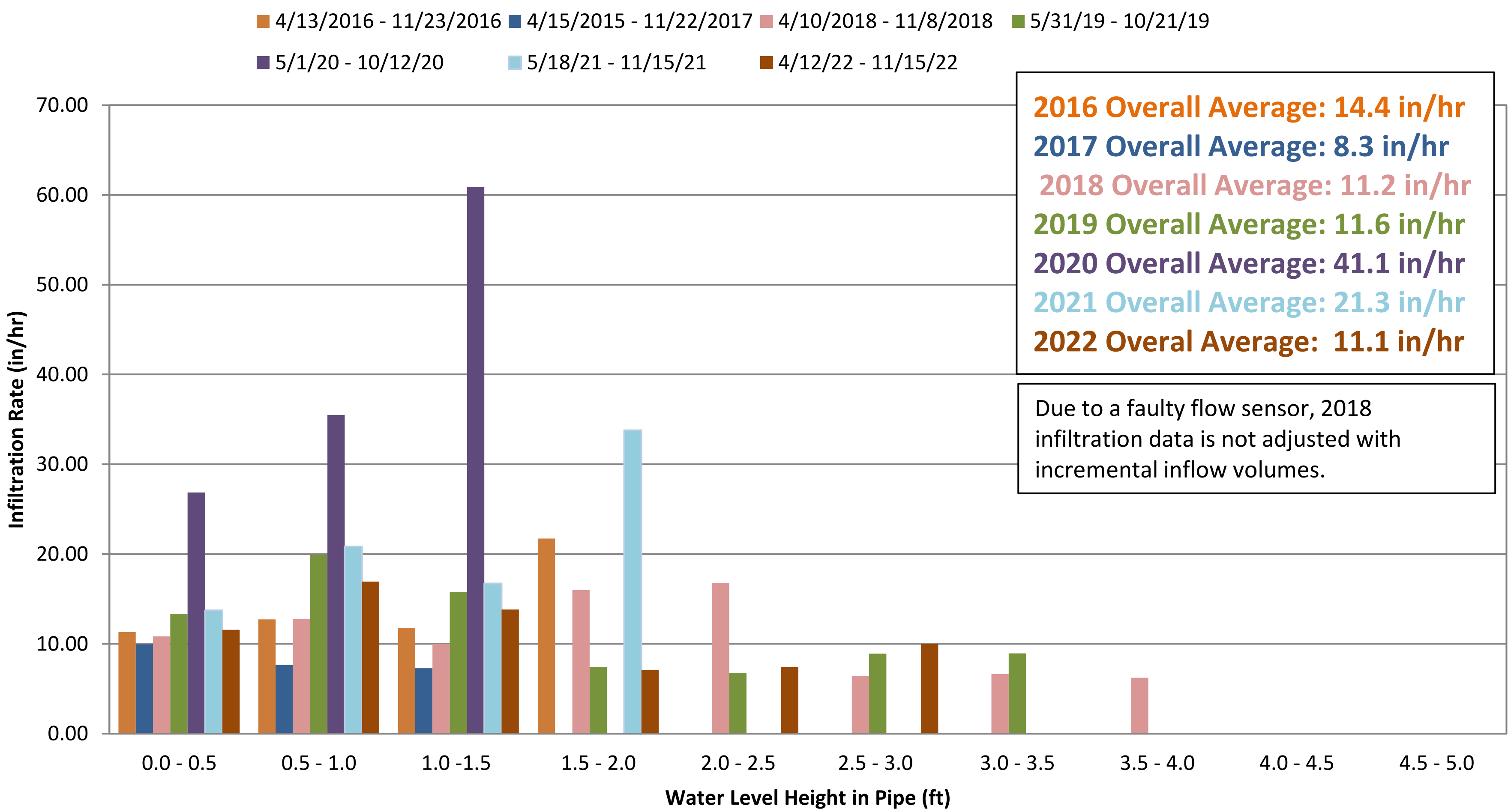


City of Saint Paul
2022 Water Quality and Quantity Monitoring
Chart A.10
WSB Job No.: 020260



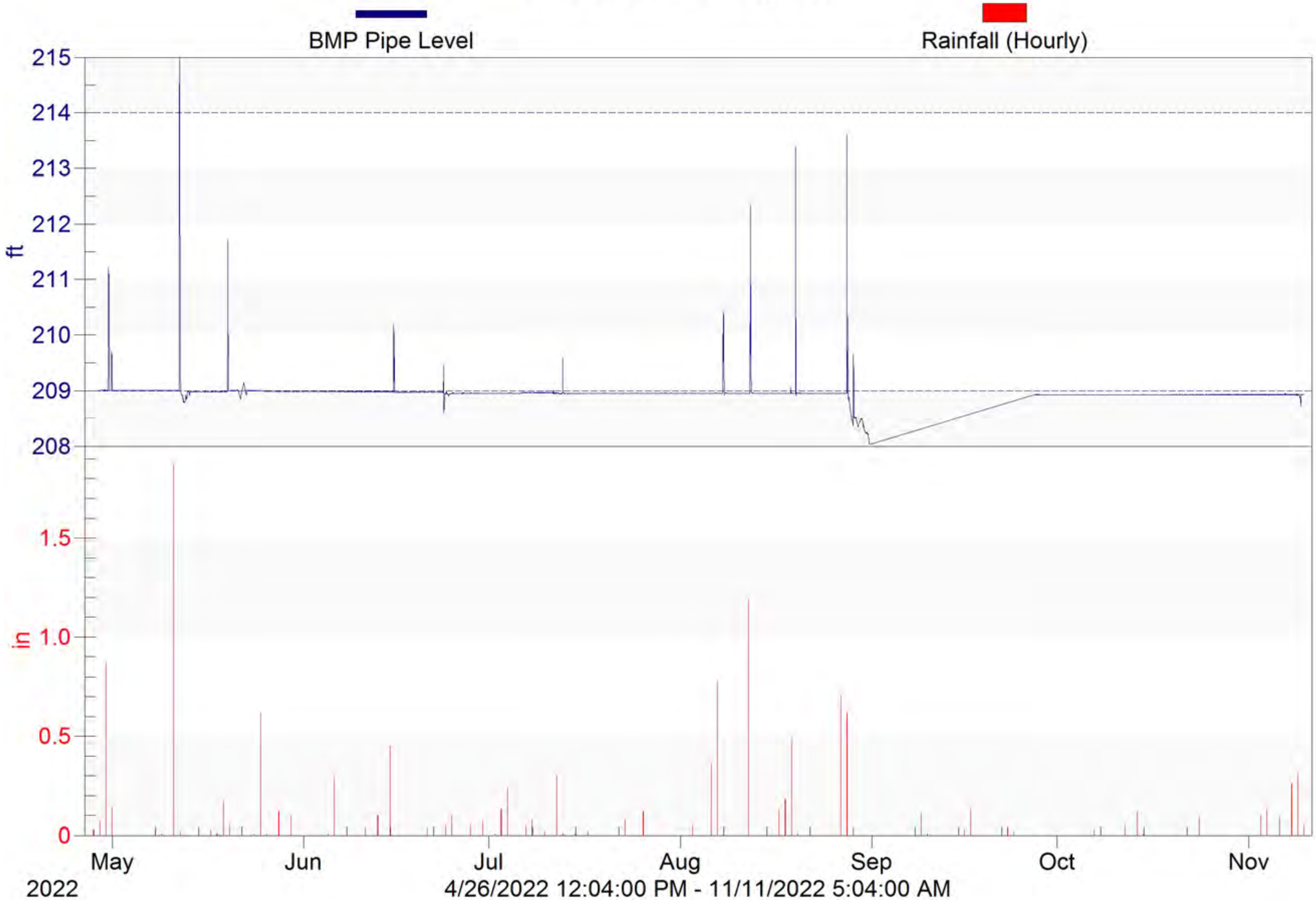

Note: Pipe Invert is 189.2'
Error Bars Represent 25th and 75th Percentiles
* The DRI testing was completed on top of a 5 ft layer of fine filter aggregate that was constructed above the native soils, per the design.

# Infiltration Rate Trends
# Hampden Park
# Adjusted with Incremental Inflow Volumes

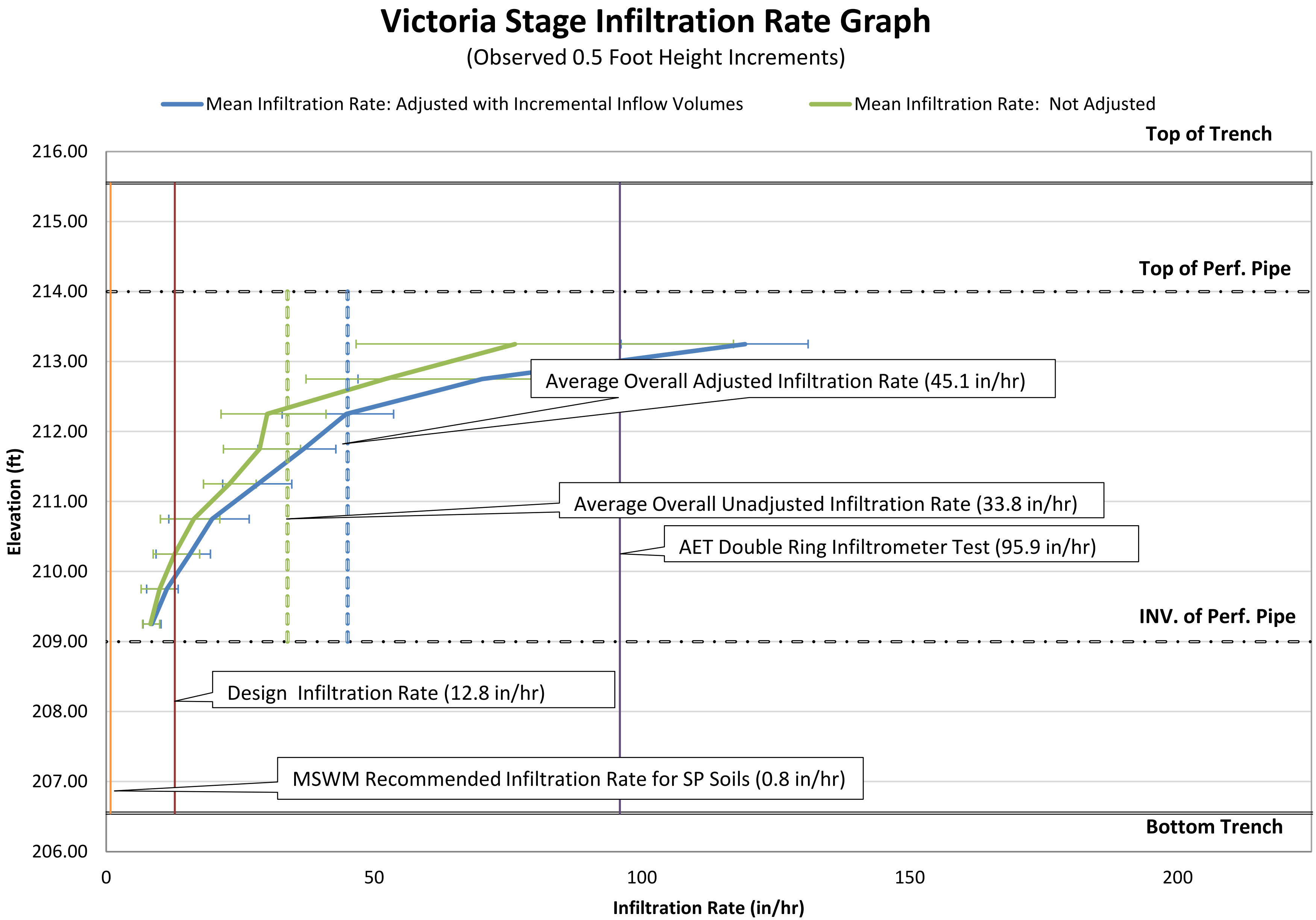


# Chart A.12 Victoria

Water Level and Rainfall (SPCD)

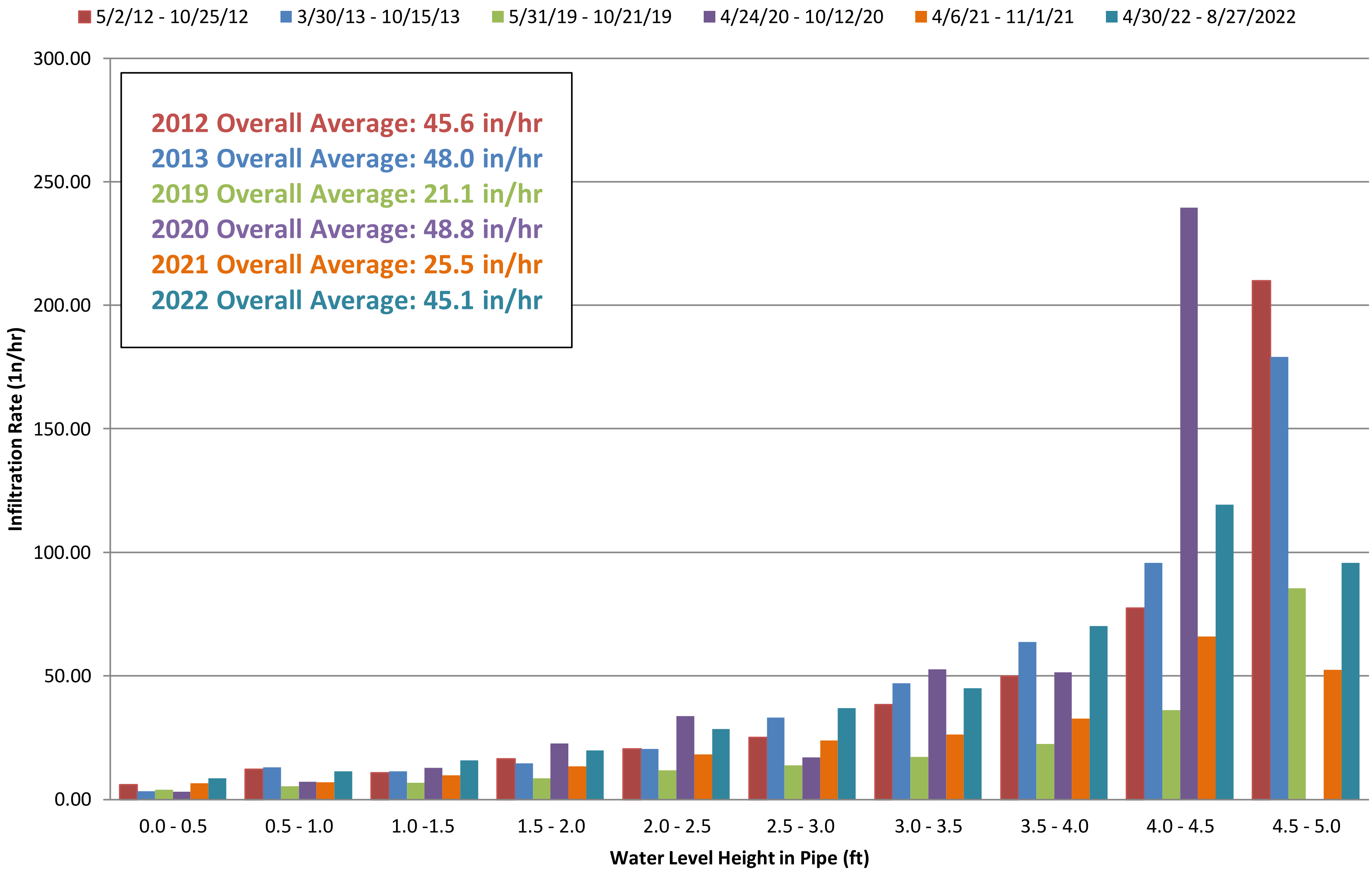


City of Saint Paul
2022 Water Quality and Quantity Report
Chart A.13
WSB Job No.: 020260



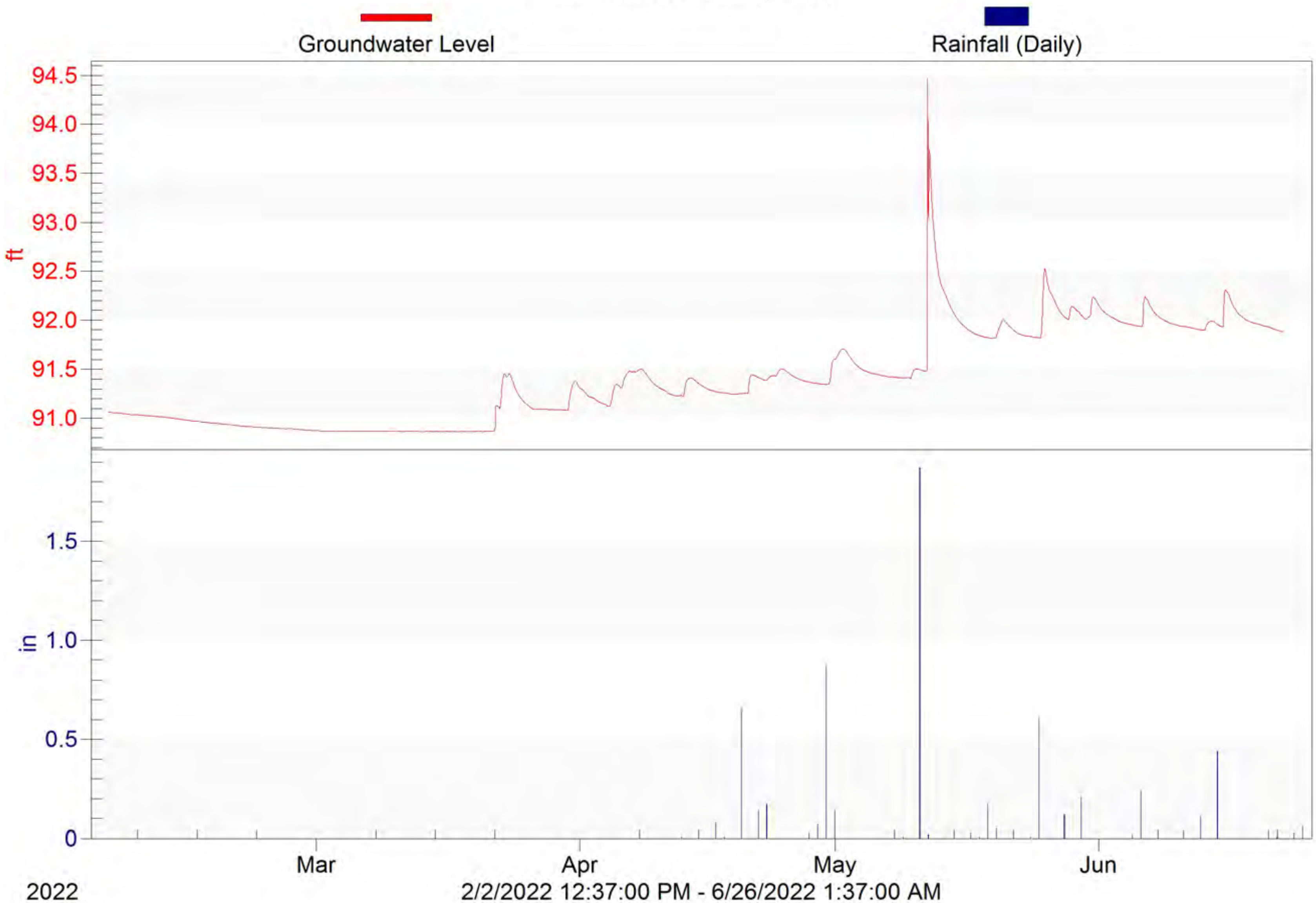

Pipe Invert is 209
Error Bars Represent 25th and 75th Percentiles

# Infiltration Rate
# Victoria
# Adjusted with Incremental Inflow Volumes



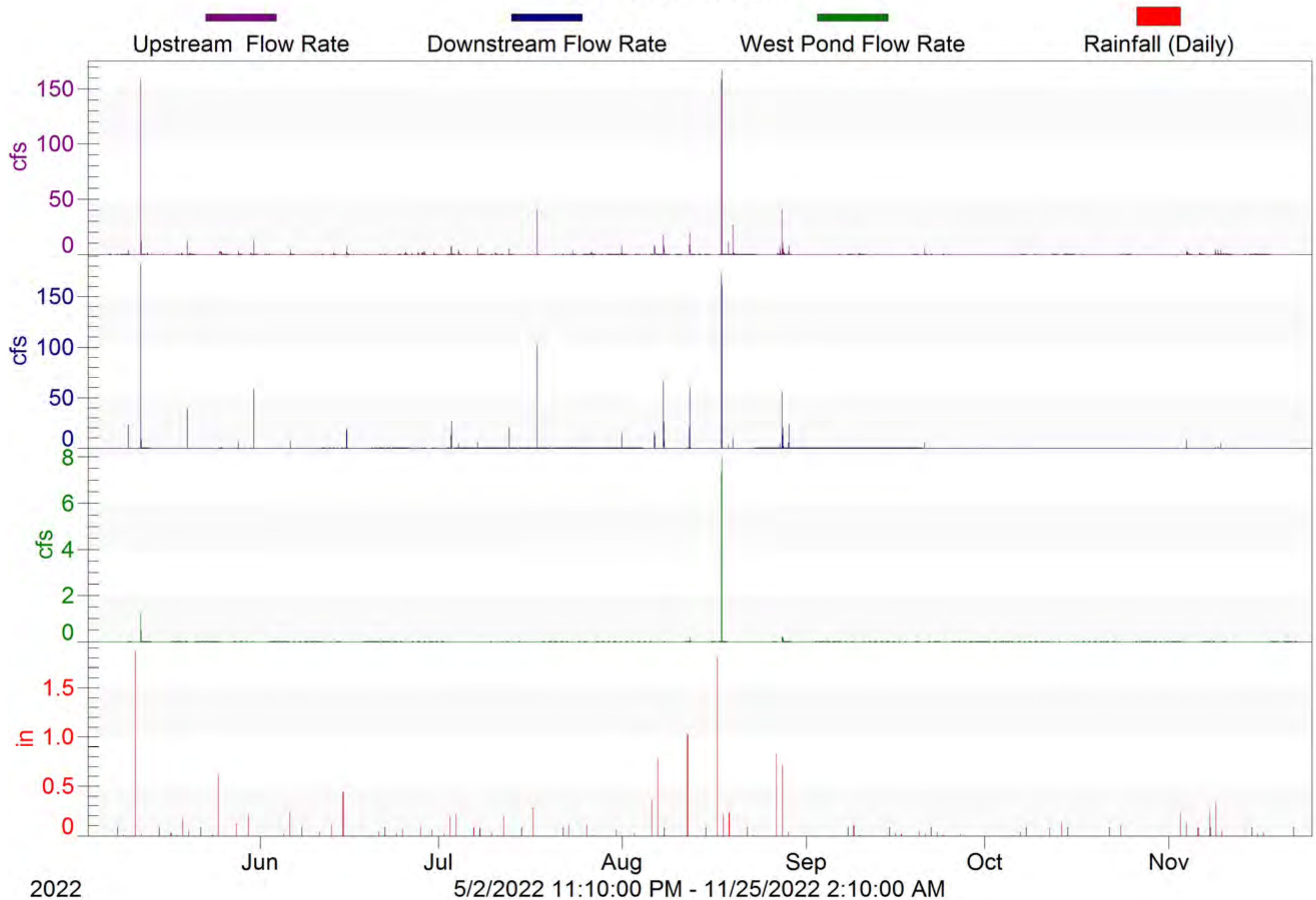
# Chart A.15 Bush-Desoto

Water Level and Rainfall (SPCD)



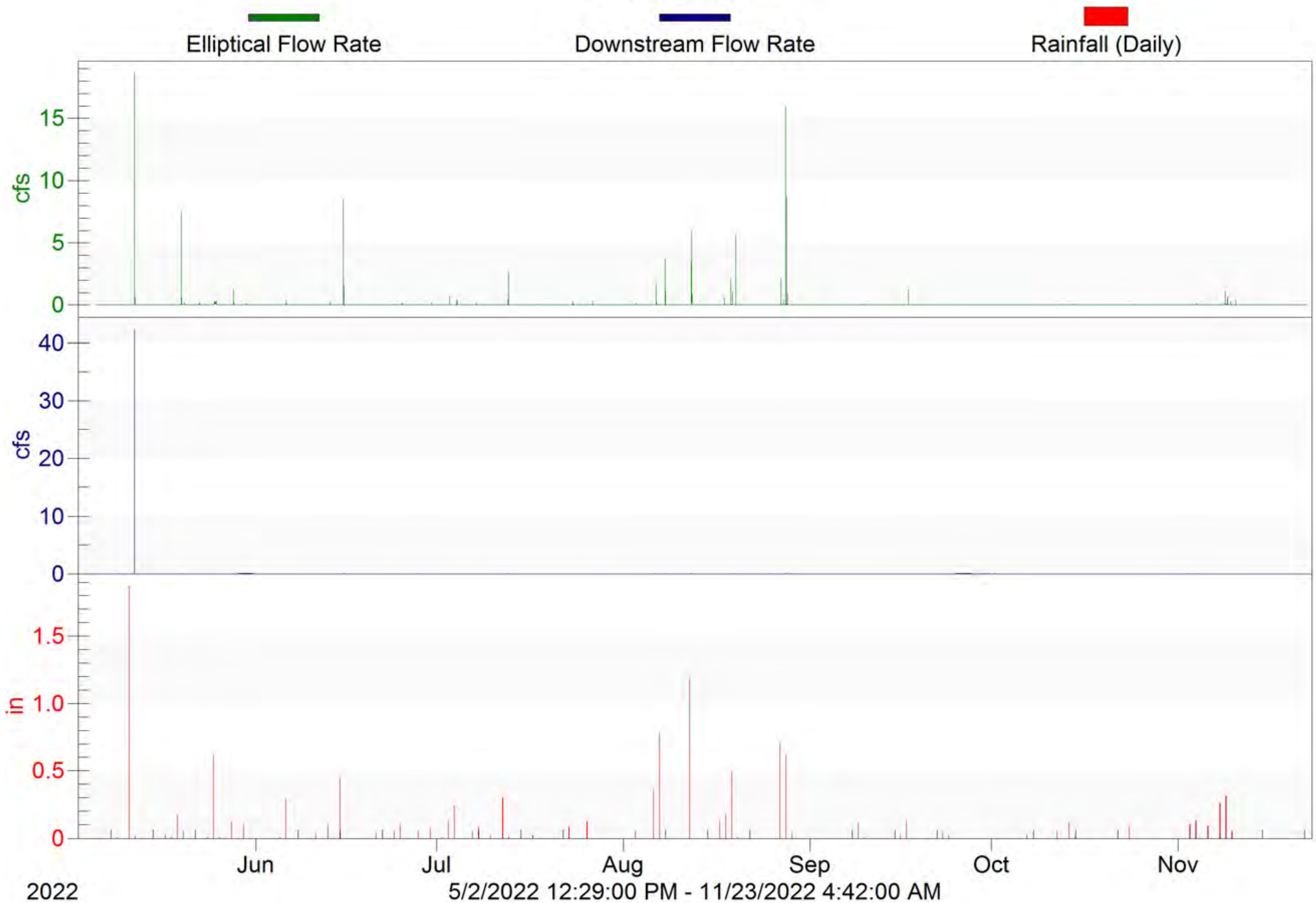
# Chart B.1 Beacon Bluff

Flow Rates and Rainfall



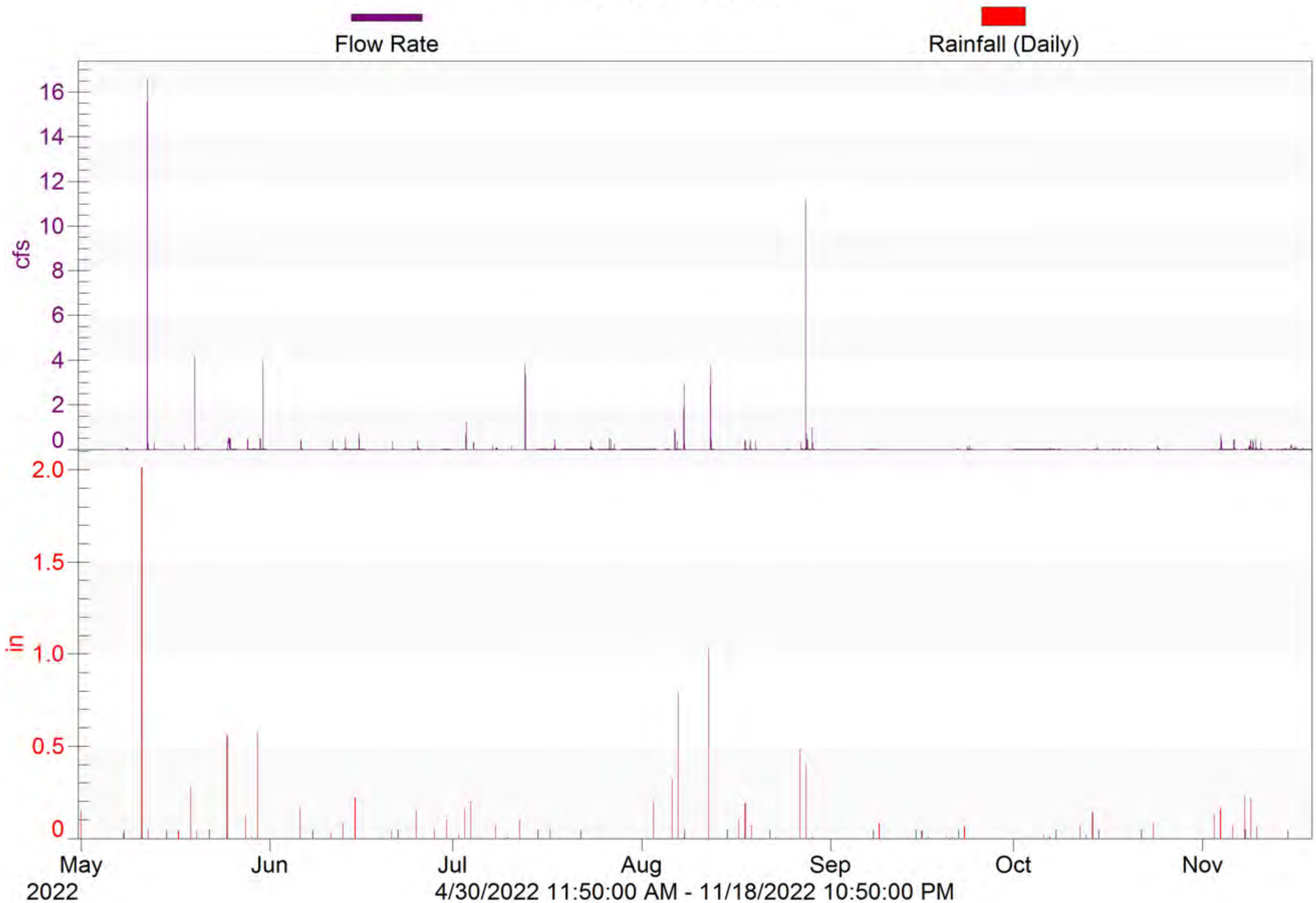
# Chart B.2 St. Albans

Flow Rates and Rainfall



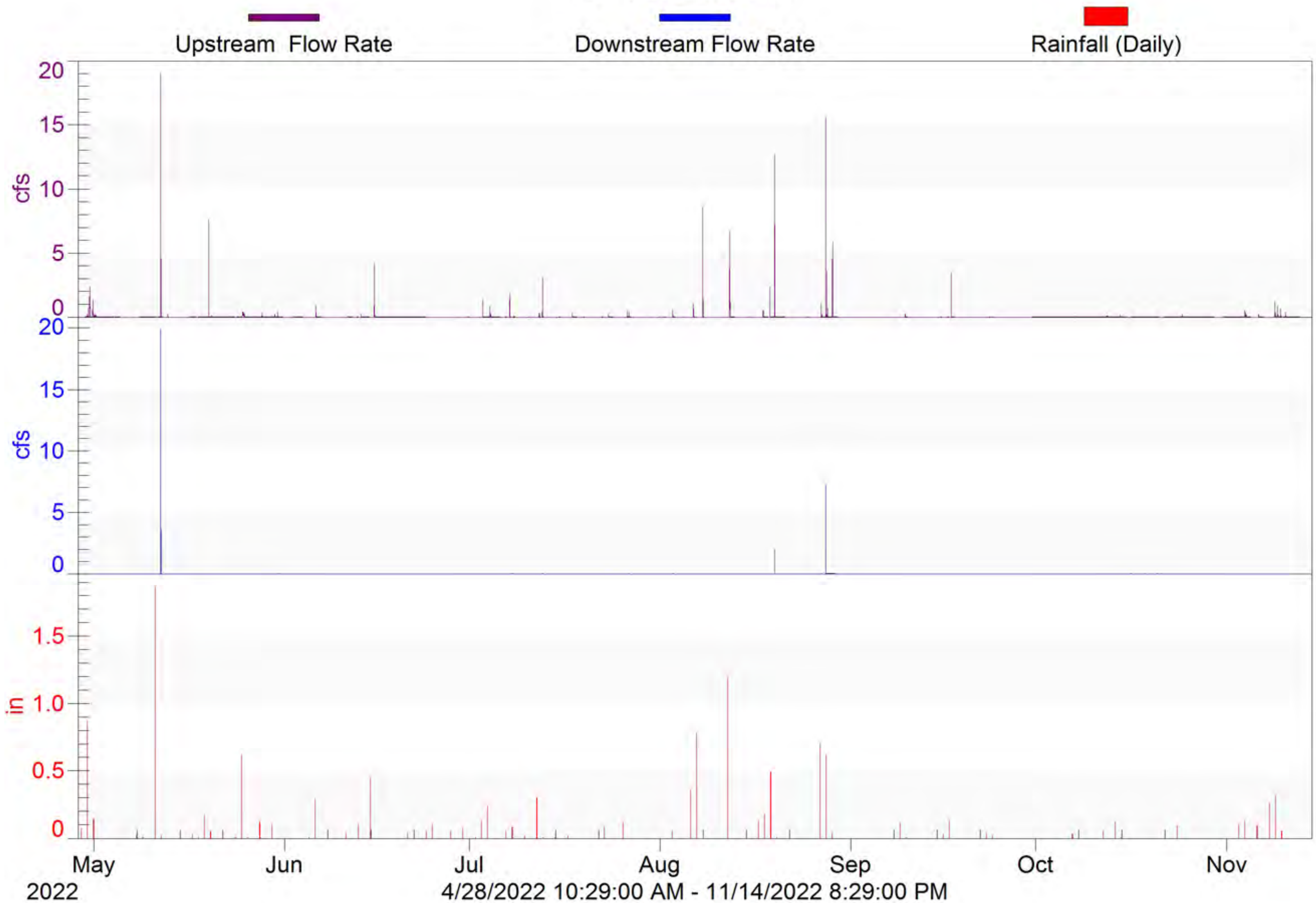
# Chart B.3 Hampden Park

Flow Rates and Rainfall

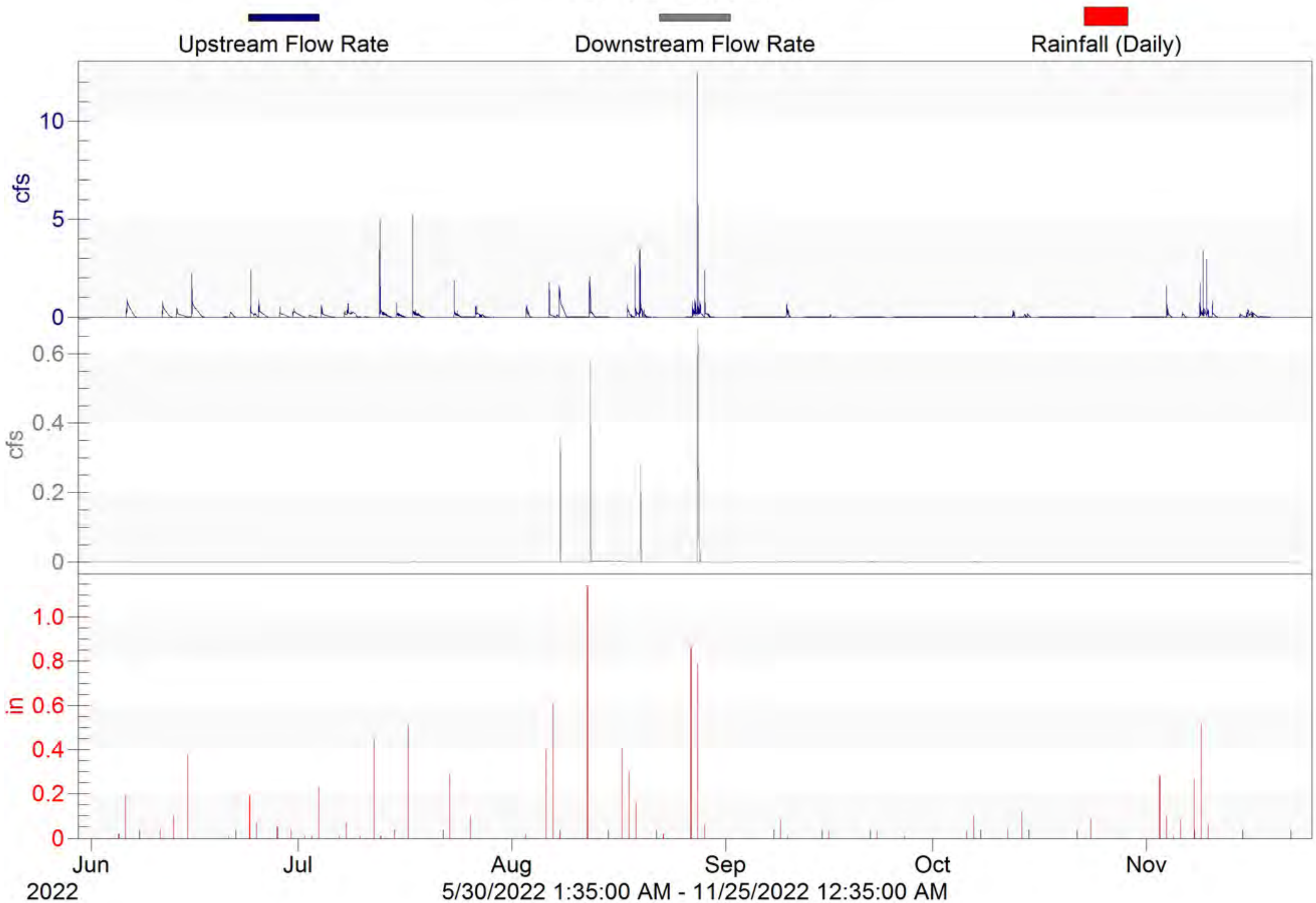


# Chart B.4 Victoria

Flow Rates and Rainfall



# Chart B.5 West Shepard Pond



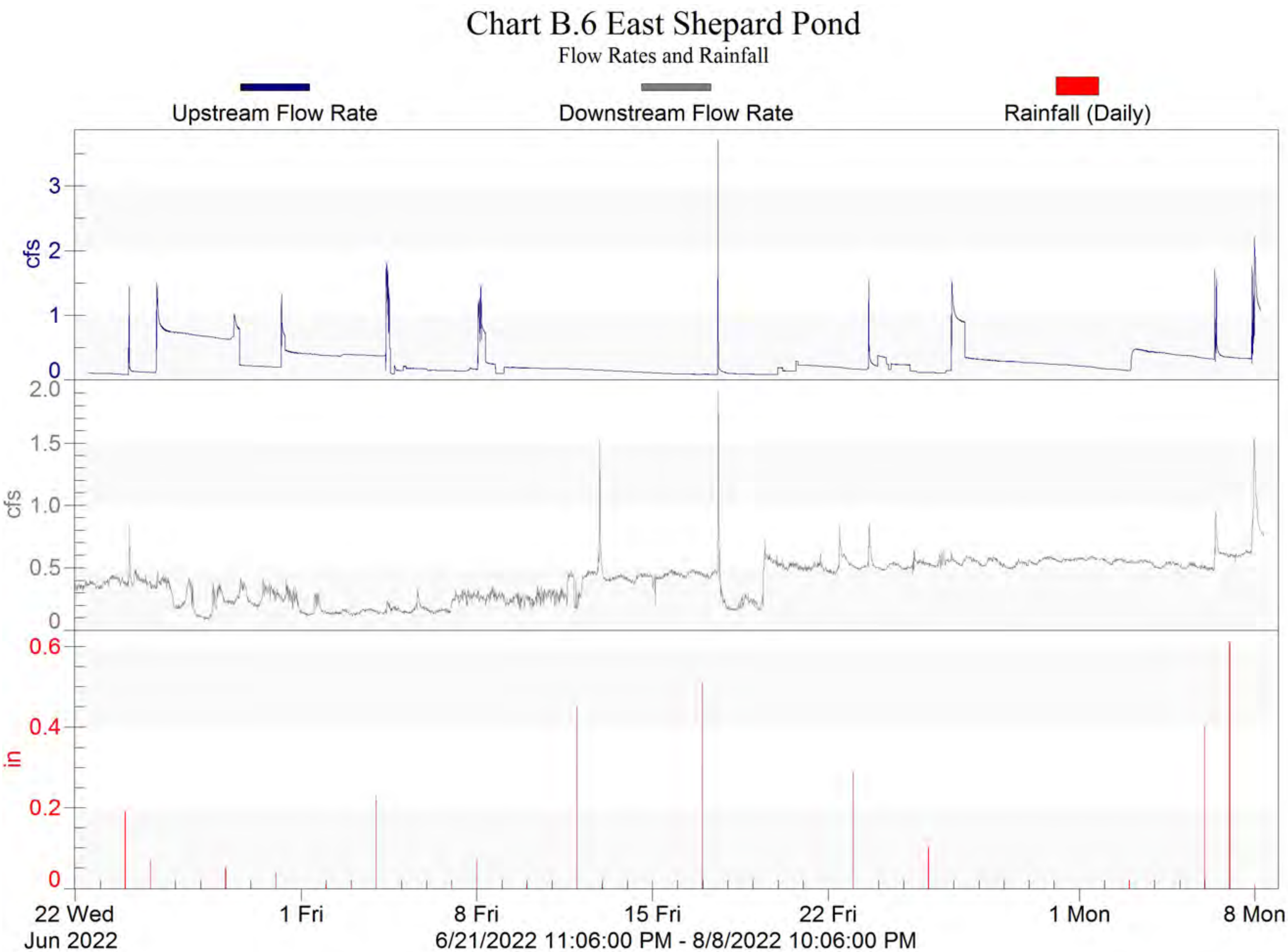
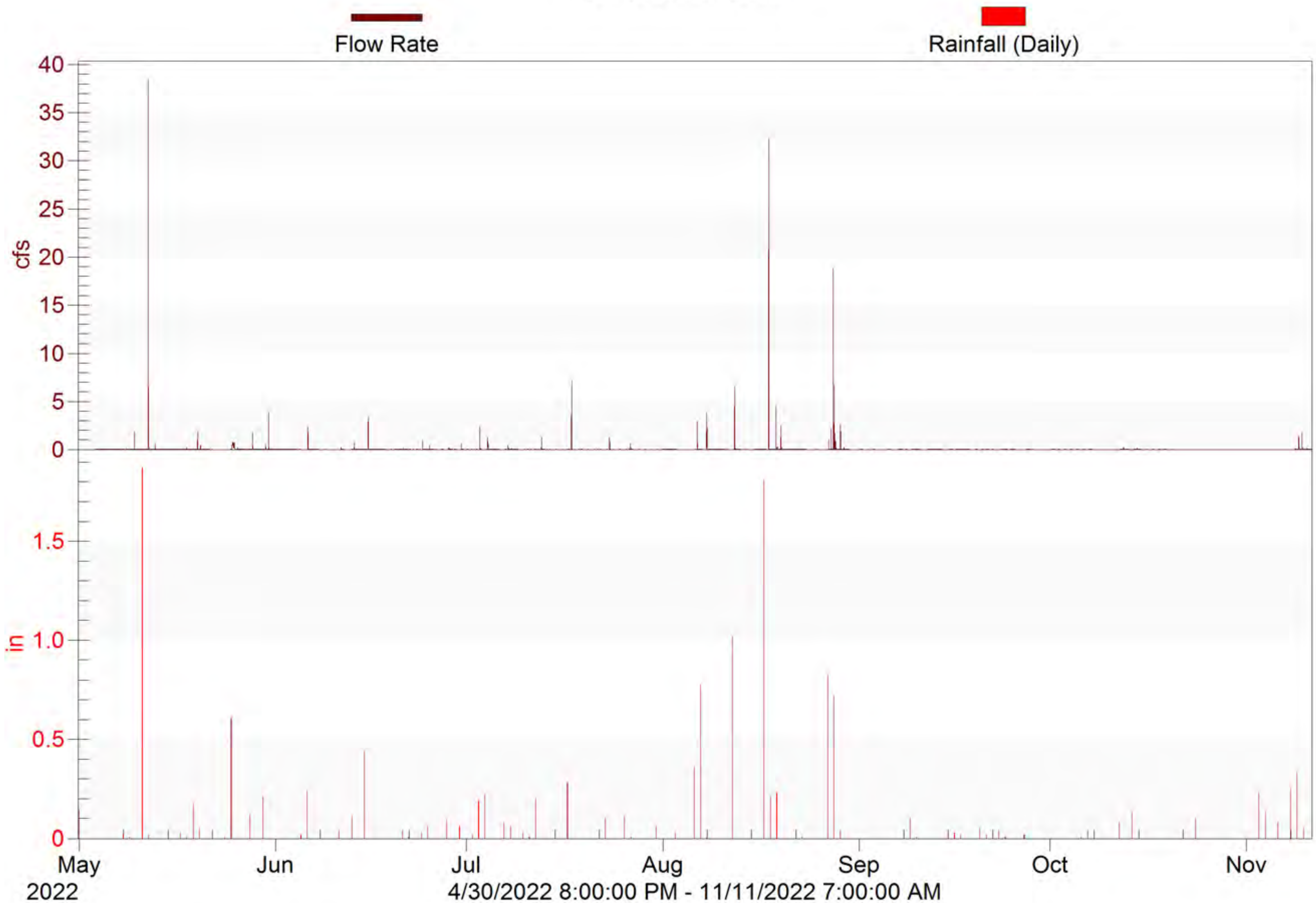


Chart B.6 East Shepard Pond
Flow Rates and Rainfall
Upstream Flow Rate
Downstream Flow Rate
Rainfall (Daily)
cfs
3
2
1
0
cfs
2.0
1.5
1.0
0.5
0
in
0.6
0.4
0.2
0
22 Wed
Jun 2022
1 Fri
8 Fri
15 Fri
22 Fri
1 Mon
8 Mon
6/21/2022 11:06:00 PM - 8/8/2022 10:06:00 PM

# Chart B.7 Desoto

Flow Rates and Rainfall



City of Saint Paul
2022 Water Quality and Quantity Report
Table C.1
WSB Project Number: 020260

# 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3045011 | 3/8/2022 10:15 | 3/8/2022 10:15 | 42.0 | 2200.0 | 24.0 | 0.37 | 0.196 | 1500.0 | 2.25 | 5.60 | 0.670 | 87 | 15.8 | 6.4 | 84.1 | 6.7 | 7.4 | 119.0 | 1553 |
| 3052667 | 4/6/2022 11:14 | 4/6/2022 11:14 | 15.0 | 80.0 | 7.0 | 0.19 | 0.080 | 13.9 | 0.30 | 0.81 | 0.400 < | 45 < | 6.3 | 9.1 | 31.1 | 5.5 | 9.3 | 26.0 | 387 |
| 3066978 | 5/25/2022 11:53 | 5/25/2022 11:53 | | | | | | | | | | | | | | | 6.9 | | 3000 |
| 3073237 | 6/15/2022 12:31 | 6/15/2022 15:47 | 152.0 | 37.0 | 78.0 | 0.96 | | 5.0 < | 0.06 < | 4.80 | 0.260 < | 45 < | 17.3 | 21.1 | 101.0 | | | 161.0 | |
| 3080459 | 7/12/2022 21:11 | 7/12/2022 22:45 | 356.0 | 96.0 < | 122.0 | 1.11 | 0.216 | 5.6 | 0.24 | 5.50 | 0.860 | 45 < | 39.8 | 40.3 | 188.0 | 17.0 | | 213.0 | |
| 3081770 | 7/17/2022 14:18 | 7/17/2022 15:44 | 359.0 | 50.0 | 128.0 | 0.89 | 0.234 | 5.0 < | 0.44 | 4.40 | 0.540 | 45 < | 30.1 | 44.0 | 154.0 | 12.3 | | 198.0 | |
| 3083755 | 7/23/2022 14:18 | 7/23/2022 15:50 | 50.0 | 151.0 | 30.0 | 0.85 | 0.396 | 11.7 | 0.97 | 4.60 | 0.260 < | 46 | 17.8 | 7.5 | 78.2 | 45.8 | | 177.0 | |
| 3085103 | 7/27/2022 15:41 | 7/27/2022 16:54 | | 97.0 | | 0.47 | 0.230 | 7.0 | 0.27 | 2.60 | 0.920 | 45 < | 11.8 | 4.8 | 44.3 | 30.2 | | 111.0 | |
| 3085105 | 7/27/2022 21:41 | 7/27/2022 23:10 | | 165.0 | | 0.78 | 0.391 | 15.4 | 1.04 | 4.20 | 0.260 < | 51 | 15.9 | 5.7 | 65.1 | 57.5 | | 176.0 | |
| 3088370 | 8/7/2022 21:01 | 8/7/2022 22:13 | 50.0 | 48.0 | 17.0 | 0.62 | 0.112 | 5.0 < | 0.18 | 3.10 | 0.640 < | 45 < | 21.0 | 28.6 | 113.0 | 7.9 | | 176.0 | |
| 3090130 | 8/12/2022 5:42 | 8/12/2022 8:17 | 58.0 | 44.0 | 23.0 | 0.27 | 0.092 | 5.0 < | 0.54 | 2.00 | 0.300 | 45 < | | | | 7.9 | | 42.0 | |
| 3089569 | 8/12/2022 8:52 | 8/12/2022 8:52 | | | | | | | | | | | | | | | 7.2 | | 7500 |
| 3091358 | 8/17/2022 16:02 | 8/17/2022 17:48 | | 29.0 | 237.0 | 1.46 | 0.080 | 5.0 < | 0.35 | 11.00 | 0.350 < | 45 < | | | | 2.9 | | 247.0 | |
| 3094688 | 8/27/2022 21:07 | 8/28/2022 1:10 | 44.0 | 30.0 | 14.0 | 0.39 | 0.082 | 5.0 < | 0.15 | 2.00 | 0.410 < | 45 < | 14.8 | 34.1 | 86.2 | 4.5 | | 63.0 | |
| 3114848 | 11/3/2022 22:50 | 11/4/2022 7:27 | 129.0 | 523.0 | 70.0 | 3.67 | 3.370 | 38.8 | 1.53 | 7.40 | 0.770 | 96 | 26.8 | 13.0 | 168.0 | 265.0 | | 746.0 | |
| 3116654 | 11/9/2022 18:12 | 11/9/2022 21:57 | 184.0 | 85.0 | 96.0 | 0.91 | 0.244 | 6.4 | 0.06 < | 4.20 | 0.260 < | 49 | 17.2 | 23.1 | 117.0 | 32.9 | | 266.0 | |
| 3124902 | 12/14/2022 9:35 | 12/14/2022 9:35 | | | | | | | | | | | | | | | | | 10800 |
| **MINIMUM** | | | **15.0** | **29.0** | **7.0** | **0.2** | **0.1** | **5.0** | **0.1** | **0.8** | **0.3** | **45.0** | **6.3** | **4.8** | **31.1** | **2.9** | **6.9** | **26.0** | **387.0** |
| **AVERAGE** | | | **130.8** | **259.6** | **70.5** | **0.9** | **0.4** | **116.3** | **0.6** | **4.4** | **0.5** | **52.4** | **19.6** | **19.8** | **102.5** | **38.2** | **7.7** | **194.4** | **4648.0** |
| **MEDIAN** | | | **58.0** | **82.5** | **50.0** | **0.8** | **0.2** | **6.0** | **0.3** | **4.3** | **0.4** | **45.0** | **17.3** | **17.1** | **93.6** | **12.3** | **7.3** | **176.0** | **3000.0** |
| **MAXIMUM** | | | **359.0** | **2200.0** | **237.0** | **3.7** | **3.4** | **1500.0** | **2.3** | **11.0** | **0.9** | **96.0** | **39.8** | **44.0** | **188.0** | **265.0** | **9.3** | **746.0** | **10800.0** |

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
# 2022 Beacon Bluff Pollutant Loading
# Table C.2
# WSB Job No.: 020260

## BEACON BLUFF VOLUME AND POLLUTANT REDUCTION SUMMARY

**Sampling Data**

| Event Time Interval: Start | End | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 5/9/2022 17:30 | 5/9/2022 18:56 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/11/2022 20:38 | 5/11/2022 23:52 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/12/2022 23:25 | 5/13/2022 0:45 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/17/2022 22:15 | 5/18/2022 0:30 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/19/2022 15:58 | 5/19/2022 17:01 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/20/2022 3:08 | 5/20/2022 4:42 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/25/2022 2:00 | 5/25/2022 13:19 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/25/2022 22:00 | 5/26/2022 1:07 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/28/2022 6:50 | 5/28/2022 10:18 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/30/2022 8:43 | 5/30/2022 11:02 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 5/30/2022 20:53 | 5/30/2022 22:38 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/6/2022 0:30 | 6/6/2022 4:58 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/11/2022 6:30 | 6/11/2022 9:30 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/13/2022 7:57 | 6/13/2022 11:00 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/15/2022 12:30 | 6/15/2022 15:45 | **152.0** | **37.0** | **78.0** | **0.96** | 0.239 | **5.0** < | **0.06** < | **4.8** | **0.26** < |
| 6/21/2022 2:45 | 6/21/2022 4:45 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/24/2022 3:12 | 6/24/2022 4:10 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/25/2022 5:31 | 6/25/2022 7:27 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/28/2022 3:42 | 6/28/2022 15:45 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 6/30/2022 4:53 | 6/30/2022 6:29 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 7/3/2022 3:59 | 7/3/2022 6:03 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 7/4/2022 8:15 | 7/4/2022 12:34 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 7/7/2022 13:35 | 7/7/2022 17:36 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 7/8/2022 3:00 | 7/8/2022 7:02 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 7/10/2022 13:30 | 7/10/2022 16:29 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 7/12/2022 21:11 | 7/12/2022 23:53 | **356.0** | **96.0** < | **122.0** | **1.11** | **0.216** | **5.6** | **0.24** | **5.5** | **0.86** |
| 7/17/2022 14:18 | 7/17/2022 15:20 | **359.0** | **50.0** | **128.0** | **0.89** | **0.234** | **5.0** < | **0.44** | **4.4** | **0.54** |
| 7/23/2022 13:15 | 7/23/2022 17:13 | **50.0** | **151.0** | **30.0** | **0.85** | **0.396** | **11.7** | **0.97** | **4.6** | **0.26** < |
| 7/26/2022 15:41 | 7/26/2022 19:01 | 101 | **97.0** | 135.7 | **0.47** | **0.230** | **7.0** | **0.27** | **2.6** | **0.92** |
| 7/26/2022 21:41 | 7/27/2022 0:46 | 101 | **165.0** | 135.7 | **0.78** | **0.391** | **15.4** | **1.04** | **4.2** | **0.26** < |
| 7/31/2022 20:39 | 7/31/2022 23:29 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 8/6/2022 9:19 | 8/6/2022 12:15 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 8/7/2022 21:00 | 8/8/2022 1:38 | **50.0** | **48.0** | **17.0** | **0.62** | **0.112** | **5.0** < | **0.18** | **3.1** | **0.64** < |
| 8/12/2022 5:41 | 8/12/2022 12:33 | **58.0** | **44.0** | **23.0** | **0.27** | **0.092** | **5.0** < | **0.54** | **2.0** | **0.30** |
| 8/17/2022 15:44 | 8/19/2022 16:08 | 101 | **29.0** | **237.0** | **1.46** | **0.080** | **5.0** < | **0.35** | **11.0** | **0.35** < |
| 8/19/2022 18:56 | 8/19/2022 20:06 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 8/27/2022 2:55 | 8/27/2022 5:22 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 8/27/2022 12:52 | 8/27/2022 14:10 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 8/27/2022 21:06 | 8/28/2022 9:30 | **44.0** | **30.0** | **14.0** | **0.39** | **0.082** | **5.0** | **0.15** | **2.0** | **0.41** |
| 8/28/2022 23:43 | 8/29/2022 2:45 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 9/9/2022 19:00 | 9/9/2022 21:58 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 9/20/2022 20:21 | 9/20/2022 23:30 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 10/12/2022 13:15 | 10/12/2022 16:45 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 10/14/2022 11:30 | 10/15/2022 2:30 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 10/24/2022 17:15 | 10/25/2022 1:00 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 11/3/2022 22:50 | 11/4/2022 7:56 | **129.0** | **523.0** | **70.0** | **3.67** | **3.370** | **38.8** | **1.53** | **7.4** | **0.77** |
| 11/6/2022 4:14 | 11/6/2022 9:35 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 11/8/2022 15:43 | 11/9/2022 0:47 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 11/9/2022 5:56 | 11/9/2022 12:04 | 101 | 59 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| 11/9/2022 18:00 | 11/9/2022 22:35 | **184.0** | **85.0** | **96.0** | **0.91** | **0.244** | **6.4** | **0.06** < | **4.2** | **0.26** < |
| **Sum** | | | | | | | | | | |
| **Average** | | 153.6 | 112.9 | 81.5 | 1.03 | 0.495 | 9.6 | 0.49 | 4.7 | 0.49 |
| **Weighted Ave** | | 100.9 | 58.8 | 135.7 | 1.11 | 0.239 | 6.5 | 0.38 | 7.0 | 0.41 |
| **STDEV** | | 126.1 | 136.9 | 69.2 | 0.89 | 0.960 | 9.8 | 0.46 | 2.5 | 0.25 |
| **Median** | | 129.0 | 67.5 | 74.0 | 0.87 | 0.230 | 5.3 | 0.31 | 4.3 | 0.38 |
| **Min** | | 44.0 | 29.0 | 14.0 | 0.27 | 0.080 | 5.0 | 0.06 | 2.0 | 0.26 |
| **Max** | | 359.0 | 523.0 | 237.0 | 3.67 | 3.370 | 38.8 | 1.53 | 11.0 | 0.92 |
| **Percent Capture of Total Runoff** | | | | | | | | | | |

**Event Loading and Volume Data[1]**

| Start | Interval Rain (In.) | Volume Directed from Diversion Structure into Surface Basin (1) (cf) | Inflow Volume from West Pond (Subwatershed B - Discharges to Underground System) (2) (cf) | Inflow Volume from Eastern Inlet (Subwatershed C - Discharges to Surface Basin)[3] (3) (cf) | Underground System Discharged Volume (4) (cf) | Volume Captured by BMP (1+2+3)-4 (cf) | % of Total Inflow to BMP from Diversion Structure | Overall Volume reduction | Captured TSS (lbs.) | Captured TDS (lbs.) | Captured VSS (lbs.) | Captured TP (lbs.) | Captured Ortho-P (lbs.) | Captured Chloride (lbs.) | Captured Ammonia as N (lbs.) | Captured Total Kjeldahl Nitrogen (lbs.) | Captured Nitrate + Nitrite as N (lbs.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/9/2022 17:30 | 0.01 | 2274 | 0 | 222 | 0 | 2496 | 91.1% | 51.3% | 15.7 | 9.2 | 21.1 | 0.17 | 0.04 | 1.0 | 0.06 | 1.08 | 0.06 |
| 5/11/2022 20:38 | 1.87 | 44974 | 4147 | 8227 | 49083 | 8265 | 76.7% | 4.5% | 52.1 | 30.3 | 70.0 | 0.57 | 0.12 | 3.4 | 0.20 | 3.59 | 0.21 |
| 5/12/2022 23:25 | 0.02 | 2908 | 12 | 139 | 0 | 3059 | 95.0% | 100.0% | 19.3 | 11.2 | 25.9 | 0.21 | 0.05 | 1.2 | 0.07 | 1.33 | 0.08 |
| 5/17/2022 22:15 | 0.03 | 647 | 3 | 31 | 0 | 680 | 95.0% | 100.0% | 4.3 | 2.5 | 5.8 | 0.05 | 0.01 | 0.3 | 0.02 | 0.30 | 0.02 |
| 5/19/2022 15:58 | 0.17 | 2848 | 0 | 526 | 0 | 3375 | 84.4% | 29.2% | 21.3 | 12.4 | 28.6 | 0.23 | 0.05 | 1.4 | 0.08 | 1.47 | 0.09 |
| 5/20/2022 3:08 | 0.03 | 2386 | 0 | 114 | 0 | 2500 | 95.4% | 100.0% | 15.7 | 9.2 | 21.2 | 0.17 | 0.04 | 1.0 | 0.06 | 1.09 | 0.06 |
| 5/25/2022 2:00 | 0.55 | 56074 | 1 | 2825 | 0 | 58901 | 95.2% | 95.0% | 371.1 | 216.1 | 498.9 | 4.07 | 0.88 | 24.1 | 1.40 | 25.59 | 1.50 |
| 5/25/2022 22:00 | 0.04 | 1945 | 0 | 93 | 0 | 2038 | 95.4% | 100.0% | 12.8 | 7.5 | 17.3 | 0.14 | 0.03 | 0.8 | 0.05 | 0.89 | 0.05 |
| 5/28/2022 6:50 | 0.12 | 5462 | 0 | 410 | 0 | 5872 | 93.0% | 65.3% | 37.0 | 21.5 | 49.7 | 0.41 | 0.09 | 2.4 | 0.14 | 2.55 | 0.15 |
| 5/30/2022 8:43 | 0.07 | 4504 | 0 | 215 | 0 | 4719 | 95.4% | 99.9% | 29.7 | 17.3 | 40.0 | 0.33 | 0.07 | 1.9 | 0.11 | 2.05 | 0.12 |
| 5/30/2022 20:53 | 0.12 | 3101 | 0 | 576 | 0 | 3677 | 84.3% | 29.1% | 23.2 | 13.5 | 31.1 | 0.25 | 0.05 | 1.5 | 0.09 | 1.60 | 0.09 |
| 6/6/2022 0:30 | 0.24 | 8282 | 0 | 876 | 0 | 9158 | 90.4% | 47.6% | 57.7 | 33.6 | 77.6 | 0.63 | 0.14 | 3.7 | 0.22 | 3.98 | 0.23 |
| 6/11/2022 6:30 | 0.04 | 373 | 0 | 18 | 0 | 391 | 95.3% | 99.9% | 2.5 | 1.4 | 3.3 | 0.03 | 0.01 | 0.2 | 0.01 | 0.17 | 0.01 |
| 6/13/2022 7:57 | 0.11 | 6960 | 0 | 339 | 0 | 7299 | 95.4% | 98.2% | 46.0 | 26.8 | 61.8 | 0.50 | 0.11 | 3.0 | 0.17 | 3.17 | 0.19 |
| 6/15/2022 12:30 | 0.44 | 5655 | 0 | 1006 | 0 | 6661 | 84.9% | 30.2% | 63.2 | 15.4 | 32.4 | 0.40 | 0.10 | 2.1 | 0.02 | 2.00 | 0.11 |
| 6/21/2022 2:45 | 0.04 | 391 | 0 | 19 | 0 | 410 | 95.4% | 99.8% | 2.6 | 1.5 | 3.5 | 0.03 | 0.01 | 0.2 | 0.01 | 0.18 | 0.01 |
| 6/24/2022 3:12 | 0.03 | 271 | 0 | 13 | 0 | 284 | 95.4% | 99.9% | 1.8 | 1.0 | 2.4 | 0.02 | 0.00 | 0.1 | 0.01 | 0.12 | 0.01 |
| 6/25/2022 5:31 | 0.06 | 1948 | 0 | 93 | 0 | 2041 | 95.4% | 100.0% | 12.9 | 7.5 | 17.3 | 0.14 | 0.03 | 0.8 | 0.05 | 0.89 | 0.05 |
| 6/28/2022 3:42 | 0.08 | 10181 | 8 | 497 | 0 | 10685 | 95.3% | 97.9% | 67.3 | 39.2 | 90.5 | 0.74 | 0.16 | 4.4 | 0.25 | 4.64 | 0.27 |
| 6/30/2022 4:53 | 0.05 | 2844 | 0 | 136 | 0 | 2980 | 95.4% | 100.0% | 18.8 | 10.9 | 25.2 | 0.21 | 0.04 | 1.2 | 0.07 | 1.29 | 0.08 |
| 7/3/2022 3:59 | 0.18 | 4218 | 0 | 635 | 0 | 4853 | 86.9% | 34.9% | 30.6 | 17.8 | 41.1 | 0.34 | 0.07 | 2.0 | 0.11 | 2.11 | 0.12 |
| 7/4/2022 8:15 | 0.22 | 17353 | 0 | 1251 | 0 | 18604 | 93.3% | 67.8% | 117.2 | 68.3 | 157.6 | 1.29 | 0.28 | 7.6 | 0.44 | 8.08 | 0.48 |
| 7/7/2022 13:35 | 0.08 | 3787 | 0 | 392 | 0 | 4179 | 90.6% | 48.6% | 26.3 | 15.3 | 35.4 | 0.29 | 0.06 | 1.7 | 0.10 | 1.82 | 0.11 |
| 7/8/2022 3:00 | 0.06 | 1456 | 0 | 70 | 0 | 1526 | 95.4% | 99.8% | 9.6 | 5.6 | 12.9 | 0.11 | 0.02 | 0.6 | 0.04 | 0.66 | 0.04 |
| 7/10/2022 13:30 | 0.03 | 2292 | 0 | 110 | 0 | 2401 | 95.4% | 99.9% | 15.1 | 8.8 | 20.3 | 0.17 | 0.04 | 1.0 | 0.06 | 1.04 | 0.06 |
| 7/12/2022 21:11 | 0.19 | 3610 | 0 | 450 | 0 | 4060 | 88.9% | 41.1% | 90.2 | 24.3 | 30.9 | 0.28 | 0.05 | 1.4 | 0.06 | 1.39 | 0.22 |
| 7/17/2022 14:18 | 0.28 | 2945 | 0 | 1116 | 0 | 4061 | 72.5% | 16.6% | 91.0 | 12.7 | 32.5 | 0.23 | 0.06 | 1.3 | 0.11 | 1.12 | 0.14 |
| 7/23/2022 13:15 | 0.09 | 7194 | 0 | 360 | 0 | 7555 | 95.2% | 95.5% | 23.6 | 71.2 | 14.1 | 0.40 | 0.19 | 5.5 | 0.46 | 2.17 | 0.12 |
| 7/26/2022 15:41 | 0.05 | 3650 | 0 | 175 | 0 | 3825 | 95.4% | 99.8% | 24.1 | 23.2 | 32.4 | 0.11 | 0.05 | 1.7 | 0.06 | 0.62 | 0.22 |
| 7/26/2022 21:41 | 0.06 | 4488 | 0 | 215 | 0 | 4703 | 95.4% | 99.8% | 29.6 | 48.4 | 39.8 | 0.23 | 0.11 | 4.5 | 0.31 | 1.23 | 0.08 |
| 7/31/2022 20:39 | 0.06 | 3664 | 0 | 417 | 0 | 4081 | 89.8% | 44.6% | 25.7 | 15.0 | 34.6 | 0.28 | 0.06 | 1.7 | 0.10 | 1.77 | 0.10 |
| 8/6/2022 9:19 | 0.33 | 13325 | 0 | 1432 | 0 | 14757 | 90.3% | 47.0% | 93.0 | 54.1 | 125.0 | 1.02 | 0.22 | 6.0 | 0.35 | 6.41 | 0.38 |
| 8/7/2022 21:00 | 0.79 | 8538 | 68 | 3179 | 9235 | 2550 | 72.3% | 3.7% | 8.0 | 7.6 | 2.7 | 0.10 | 0.02 | 0.8 | 0.03 | 0.49 | 0.10 |
| 8/12/2022 5:41 | 0.99 | 8253 | 813 | 3973 | 0 | 13039 | 60.9% | 14.8% | 47.2 | 35.8 | 18.7 | 0.22 | 0.07 | 4.1 | 0.44 | 1.63 | 0.24 |
| 8/17/2022 15:44 | 2.22 | 72866 | 13470 | 14210 | 0 | 100545 | 68.2% | 30.9% | 633.5 | 182.0 | 1487.6 | 9.16 | 0.50 | 31.4 | 2.20 | 69.04 | 2.20 |
| 8/19/2022 18:56 | 0.02 | 1871 | 0 | 89 | 0 | 1961 | 95.4% | 100.0% | 12.4 | 7.2 | 16.6 | 0.14 | 0.03 | 0.8 | 0.05 | 0.85 | 0.05 |
| 8/27/2022 2:55 | 0.07 | 2670 | 0 | 133 | 0 | 2803 | 95.3% | 96.1% | 17.7 | 10.3 | 23.7 | 0.19 | 0.04 | 1.1 | 0.07 | 1.22 | 0.07 |
| 8/27/2022 12:52 | 0.12 | 6211 | 0 | 425 | 0 | 6636 | 93.6% | 71.2% | 41.8 | 24.3 | 56.2 | 0.46 | 0.10 | 2.7 | 0.16 | 2.88 | 0.17 |
| 8/27/2022 21:06 | 1.06 | 26049 | 1118 | 3305 | 16941 | 13531 | 84.9% | 18.4% | 37.2 | 25.3 | 11.8 | 0.33 | 0.07 | 4.2 | 0.13 | 1.69 | 0.35 |
| 8/28/2022 23:43 | 0.27 | 3773 | 8 | 659 | 0 | 4441 | 84.9% | 30.7% | 28.0 | 16.3 | 37.6 | 0.31 | 0.07 | 1.8 | 0.11 | 1.93 | 0.11 |
| 9/9/2022 19:00 | 0.09 | 2269 | 0 | 116 | 0 | 2385 | 95.1% | 93.5% | 15.0 | 8.8 | 20.2 | 0.16 | 0.04 | 1.0 | 0.06 | 1.04 | 0.06 |
| 9/20/2022 20:21 | 0.05 | 6086 | 0 | 409 | 0 | 6495 | 93.7% | 72.4% | 40.9 | 23.8 | 55.0 | 0.45 | 0.10 | 2.7 | 0.15 | 2.82 | 0.17 |
| 10/12/2022 13:15 | 0.08 | 858 | 0 | 41 | 0 | 899 | 95.4% | 100.0% | 5.7 | 3.3 | 7.6 | 0.06 | 0.01 | 0.4 | 0.02 | 0.39 | 0.02 |
| 10/14/2022 11:30 | 0.13 | 1723 | 0 | 82 | 0 | 1806 | 95.4% | 100.0% | 11.4 | 6.6 | 15.3 | 0.12 | 0.03 | 0.7 | 0.04 | 0.78 | 0.05 |
| 10/24/2022 17:15 | 0.10 | 803 | 0 | 38 | 0 | 841 | 95.4% | 100.0% | 5.3 | 3.1 | 7.1 | 0.06 | 0.01 | 0.3 | 0.02 | 0.37 | 0.02 |
| 11/3/2022 22:50 | 0.34 | 20657 | 0 | 1178 | 0 | 21836 | 94.6% | 84.5% | 175.8 | 712.9 | 95.4 | 5.00 | 4.59 | 52.9 | 2.09 | 10.09 | 1.05 |
| 11/6/2022 4:14 | 0.07 | 4553 | 0 | 217 | 0 | 4771 | 95.4% | 100.0% | 30.1 | 17.5 | 40.4 | 0.33 | 0.07 | 1.9 | 0.11 | 2.07 | 0.12 |
| 11/8/2022 15:43 | 0.25 | 19533 | 0 | 995 | 0 | 20528 | 95.1% | 94.0% | 129.3 | 75.3 | 173.9 | 1.42 | 0.31 | 8.4 | 0.49 | 8.92 | 0.52 |
| 11/9/2022 5:56 | 0.18 | 18868 | 0 | 984 | 0 | 19852 | 95.0% | 92.0% | 125.1 | 72.8 | 168.1 | 1.37 | 0.30 | 8.1 | 0.47 | 8.62 | 0.51 |
| 11/9/2022 18:00 | 0.14 | 11492 | 0 | 621 | 0 | 12113 | 94.9% | 88.9% | 139.1 | 64.3 | 72.6 | 0.68 | 0.18 | 4.8 | 0.05 | 3.18 | 0.20 |
| **Sum** | 12.72 | 449,083 | 19,649 | 53,654 | 75,259 | **447,127** | | | **2,954** | **2,150** | **4,011** | **34.60** | **9.781** | **217.9** | **11.9** | **204.4** | **11.5** |
| **Average** | | | | | | | | | | | | | | | | | |
| **Weighted Ave** | | | | | | | | | | | | | | | | | |
| **STDEV** | | | | | | | | | | | | | | | | | |
| **Median** | | | | | | | | | | | | | | | | | |
| **Min** | | | | | | | | | | | | | | | | | |
| **Max** | | | | | | | | | | | | | | | | | |
| **Percent Capture of Total Runoff** | | | | | | **37%** | | | **39%** | **49%** | **39%** | **42%** | **55%** | **45%** | **42%** | **39%** | **38%** |

< 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)
* Flow events under 1000 cf runoff volume without samples are hidden from chart, but included in totals

City of Saint Paul
2022 Water Quality and Quantity Report
Table C.3
WSB Project Number: 020260

# 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3045020 | 3/8/2022 13:03 | 3/8/2022 13:03 | 72.0 | 1980.0 | 34.0 | 0.40 | 0.217 | 1340.0 | 1.32 | 3.80 | 0.400 | 71 | 29.5 | 12.6 | 156.0 | 8.2 | 7.40 | 435.0 | 23 |
| 3052665 | 4/6/2022 9:20 | 4/6/2022 9:20 | 5.0 | 51.0 | 3.0 | 0.06 | 0.053 | 6.3 | 0.25 | 0.50 | 0.460 < | 45 < | 5.6 | 2.6 | 30.9 | 3.0 | 9.2 | 15.0 < | 816 |
| 3066984 | 5/25/2022 12:32 | 5/25/2022 12:32 | | | | | | | | | | | | | | | 6.70 | | 13400 |
| 3067367 | 5/25/2022 2:35 | 5/25/2022 11:35 | 32.0 | 78.0 | 23.0 | 0.49 | 0.060 | 7.6 | 0.06 < | 2.40 | 0.340 < | 45 < | 15.3 | 3.4 | 75.7 | 21.9 | | 92.0 | |
| 3068417 | 5/28/2022 7:20 | 5/28/2022 9:35 | 70.0 | | 26.0 | | | | | | | | | | | | | | |
| 3068421 | 5/30/2022 9:20 | 5/30/2022 10:05 | 27.0 | | 17.0 | | | | | | | | | | | | | | |
| 3073244 | 6/15/2022 13:05 | 6/15/2022 15:05 | 83.0 | 25.0 | 33.0 | 0.38 | 0.066 | 5.0 < | 0.13 | 2.00 | 0.860 < | 45 < | 14.3 | 17.0 | 80.3 | 9.5 | | 77.0 | |
| 3088374 | 8/7/2022 21:06 | 8/8/2022 0:21 | 28.0 | 38.0 | 13.0 | 0.16 | 0.053 | 5.0 < | 0.06 < | 0.70 | 0.510 < | 45 < | 9.2 | 5.5 | 35.6 | 5.0 | | 32.0 | |
| 3089571 | 8/12/2022 5:51 | 8/12/2022 9:21 | 38.0 | 24.0 < | 16.0 | 3.27 | 0.078 | 5.0 < | 0.44 | 26.00 | 0.480 < | 45 < | 7.8 | 7.0 | 38.4 | 5.4 | | 22.0 | |
| 3091366 | 8/17/2022 18:36 | 8/17/2022 22:38 | 60.0 | | 35.0 | 0.42 | 0.040 | 7.0 | 0.16 | 3.20 | 0.820 | | | | | | | | |
| 3091792 | 8/18/2022 19:51 | 8/19/2022 1:21 | 36.0 | 52.0 | 18.0 | 0.18 | 0.052 | 5.0 < | 0.13 | 1.30 | 0.940 < | 45 < | | | | 9.0 | | 45.0 | |
| 3094686 | 8/29/2022 0:51 | 8/29/2022 1:11 | 31.0 | 24.0 < | 13.0 | 0.14 | 0.056 | 5.0 < | 0.08 | 0.66 | 0.360 < | 45 < | 6.4 | 8.4 | 29.3 | 3.0 | | 44.0 | |
| 3116574 | 11/8/2022 21:22 | 11/9/2022 8:36 | 68.0 | 65.0 | 31.0 | 0.33 | 0.031 | 16.4 | 0.06 < | 2.00 | 1.260 < | 45 < | 29.8 | 10.6 | 100.0 | 18.9 | | 97.0 | |
| 3124901 | 12/14/2022 8:26 | 12/14/2022 8:26 | | | | | | | | | | | | | | | | | 1046 |
| **MINIMUM** | | | **5.0** | **24.0** | **3.0** | **0.1** | **0.0** | **5.0** | **0.1** | **0.5** | **0.3** | **45.0** | **5.6** | **2.6** | **29.3** | **3.0** | **6.7** | **15.0** | **23** |
| **AVERAGE** | | | **45.8** | **259.7** | **21.8** | **0.6** | **0.1** | **140.2** | **0.3** | **4.3** | **0.6** | **47.9** | **14.7** | **8.4** | **68.3** | **9.3** | **7.8** | **95.4** | **3821** |
| **MEDIAN** | | | **37.0** | **51.0** | **20.5** | **0.4** | **0.1** | **5.7** | **0.1** | **2.0** | **0.5** | **45.0** | **11.8** | **7.7** | **57.1** | **8.2** | **7.4** | **45.0** | **931** |
| **MAXIMUM** | | | **83.0** | **1980.0** | **35.0** | **3.3** | **0.2** | **1340.0** | **1.3** | **26.0** | **1.3** | **71.0** | **29.8** | **17.0** | **156.0** | **21.9** | **9.2** | **435.0** | **13400** |

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
2022 St. Albans Volume Reduction Pollutant Loading
Table C.4
WSB Project No.: 020260

# SAINT ALBANS INFILTRATION SYSTEM VOLUME REDUCTION AND POLLUTANT LOADING

## Sampling Data

| Event Time Interval | | TSS | TDS | VSS | TP | Ortho-P | Chloride | Ammonia as N | Total 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 |
| 5/11/22 20:30 | 5/11/22 23:57 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 5/19/22 15:56 | 5/19/22 17:24 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 5/20/22 3:11 | 5/20/22 8:30 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 5/25/22 1:56 | 5/25/22 16:30 | **32.0** | **78.0** | **23.0** | **0.49** | **0.060** | **7.6** | **0.06** < | **2.40** | **0.34** < |
| 5/25/22 19:15 | 5/26/22 3:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 5/28/22 7:11 | 5/28/22 10:30 | **70.0** | 36.6 | **26.0** | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 5/30/22 8:30 | 5/30/22 11:07 | **27.0** | 36.6 | **17.0** | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 6/6/22 0:30 | 6/6/22 4:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 6/13/22 7:30 | 6/13/22 9:38 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 6/15/22 12:56 | 6/15/22 15:19 | **83.0** | **25.0** | **33.0** | **0.38** | **0.066** | **5.0** < | **0.13** | **2.00** | **0.86** < |
| 6/21/22 2:30 | 6/21/22 3:15 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 6/24/22 3:06 | 6/24/22 3:50 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 6/25/22 5:26 | 6/25/22 7:45 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 6/28/22 3:45 | 6/28/22 9:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 6/30/22 4:45 | 6/30/22 5:45 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/3/22 3:45 | 7/3/22 6:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/4/22 8:21 | 7/4/22 12:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/7/22 13:21 | 7/7/22 14:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/8/22 1:00 | 7/8/22 7:30 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/12/22 19:36 | 7/12/22 21:48 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/17/22 14:26 | 7/17/22 15:30 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/23/22 13:15 | 7/23/22 16:30 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/26/22 15:45 | 7/26/22 17:15 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 7/26/22 21:30 | 7/26/22 23:45 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/3/22 0:45 | 8/3/22 5:15 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/6/22 9:10 | 8/6/22 13:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/6/22 19:15 | 8/6/22 20:30 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/7/22 21:00 | 8/8/22 0:57 | **28.0** | **38.0** | **13.0** | **0.16** | **0.053** | **5.0** < | **0.06** < | **0.70** | **0.51** < |
| 8/12/22 5:41 | 8/12/22 9:45 | **38.0** | **24.0** < | **16.0** | 0.3 | **0.078** | **5.0** < | **0.44** | 1.32 | **0.48** < |
| 8/17/22 17:56 | 8/17/22 22:45 | **60.0** | 36.6 | **35.0** | **0.42** | **0.040** | **7.0** | **0.16** | **3.20** | **0.82** |
| 8/18/22 19:29 | 8/19/22 2:30 | **36.0** | **52.0** | **18.0** | **0.18** | **0.052** | **5.0** < | **0.13** | **1.30** | **0.94** < |
| 8/19/22 14:36 | 8/19/22 16:11 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/27/22 2:51 | 8/27/22 5:05 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/27/22 12:49 | 8/27/22 13:31 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/27/22 21:06 | 8/27/22 23:02 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 8/28/22 0:30 | 8/28/22 5:34 | **31.0** | **24.0** < | **13.0** | **0.14** | **0.056** | **5.0** < | **0.08** | **0.66** | **0.36** < |
| 9/9/22 15:17 | 9/9/22 21:30 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 9/17/22 6:30 | 9/17/22 7:30 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 10/12/22 13:30 | 10/12/22 15:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 10/14/22 12:00 | 10/14/22 22:15 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 10/24/22 17:45 | 10/24/22 20:45 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 11/3/22 23:15 | 11/4/22 4:38 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 11/6/22 4:15 | 11/6/22 6:15 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 11/8/22 16:30 | 11/9/22 9:00 | **68.0** | **65.0** | **31.0** | **0.33** | **0.031** | **16.4** | **0.06** < | **2.00** | **1.26** < |
| 11/9/22 17:26 | 11/9/22 19:45 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| 11/10/22 13:30 | 11/10/22 15:00 | 41.5 | 36.6 | 19 | 0.3 | 0.06 | 6 | 0.2 | 1.32 | 0.6 |
| **Sum** | | | | | | | | | | |
| **Average** | | 47.3 | 43.7 | 22.5 | 0.30 | 0.055 | 7.0 | 0.14 | 1.75 | 0.70 |
| **Weighted Avg** | | 41.5 | 36.6 | 18.8 | 0.25 | 0.061 | 6.0 | 0.18 | 1.32 | 0.56 |
| **STDEV** | | 20.8 | 21.8 | 8.3 | 0.14 | 0.015 | 3.9 | 0.13 | 0.93 | 0.33 |
| **Min** | | 27.0 | 24.0 | 13.0 | 0.14 | 0.031 | 5.0 | 0.06 | 0.66 | 0.34 |
| **Max** | | 83.0 | 78.0 | 35.0 | 0.49 | 0.078 | 16.4 | 0.44 | 3.20 | 1.26 |
| **Percent Capture** | | | | | | | | | | |

## Event Loading and Volume Data

| Start | 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 Ammonia as N | Captured Total Kjeldahl Nitrogen | Captured Nitrate + Nitrite as N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In. | cu-ft | cu-ft | cu-ft | cu-ft | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 5/11/22 20:30 | 1.87 | 21998.4 | 14739 | 21917 | 14820.1 | 38.4 | 33.9 | 17.4 | 0.23 | 0.056 | 5.6 | 0.2 | 1.2 | 0.5 |
| 5/19/22 15:56 | 0.17 | 5007.8 | 3355 | 0 | 8363.0 | 21.6 | 19.1 | 9.8 | 0.13 | 0.032 | 3.2 | 0.1 | 0.7 | 0.3 |
| 5/20/22 3:11 | 0.05 | 654.6 | 439 | 0 | 1093.1 | 2.8 | 2.5 | 1.3 | 0.02 | 0.004 | 0.4 | 0.0 | 0.1 | 0.0 |
| 5/25/22 1:56 | 0.58 | 6138.9 | 4113 | 0 | 10251.9 | 20.5 | 49.9 | 14.7 | 0.32 | 0.038 | 4.9 | 0.0 | 1.5 | 0.2 |
| 5/25/22 19:15 | 0.05 | 480.1 | 322 | 0 | 801.8 | 2.1 | 1.8 | 0.9 | 0.01 | 0.003 | 0.3 | 0.0 | 0.1 | 0.0 |
| 5/28/22 7:11 | 0.12 | 1633.5 | 1094 | 0 | 2727.9 | 11.9 | 6.2 | 4.4 | 0.04 | 0.010 | 1.0 | 0.0 | 0.2 | 0.1 |
| 5/30/22 8:30 | 0.08 | 547.3 | 367 | 0 | 914.0 | 1.5 | 2.1 | 1.0 | 0.01 | 0.003 | 0.3 | 0.0 | 0.1 | 0.0 |
| 6/6/22 0:30 | 0.29 | 1195.5 | 801 | 0 | 1996.4 | 5.2 | 4.6 | 2.3 | 0.03 | 0.008 | 0.8 | 0.0 | 0.2 | 0.1 |
| 6/13/22 7:30 | 0.1 | 514.7 | 345 | 0 | 859.6 | 2.2 | 2.0 | 1.0 | 0.01 | 0.003 | 0.3 | 0.0 | 0.1 | 0.0 |
| 6/15/22 12:56 | 0.45 | 5722.1 | 3834 | 0 | 9555.9 | 49.5 | 14.9 | 19.7 | 0.23 | 0.039 | 3.0 | 0.1 | 1.2 | 0.5 |
| 6/21/22 2:30 | 0.04 | 84.1 | 56 | 0 | 140.5 | 0.4 | 0.3 | 0.2 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 6/24/22 3:06 | 0.05 | 108.1 | 72 | 0 | 180.5 | 0.5 | 0.4 | 0.2 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 6/25/22 5:26 | 0.1 | 408.2 | 273 | 0 | 681.7 | 1.8 | 1.6 | 0.8 | 0.01 | 0.003 | 0.3 | 0.0 | 0.1 | 0.0 |
| 6/28/22 3:45 | 0.05 | 82.2 | 55 | 0 | 137.3 | 0.4 | 0.3 | 0.2 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 6/30/22 4:45 | 0.06 | 199.4 | 134 | 0 | 333.0 | 0.9 | 0.8 | 0.4 | 0.01 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 7/3/22 3:45 | 0.13 | 827.8 | 555 | 0 | 1382.4 | 3.6 | 3.2 | 1.6 | 0.02 | 0.005 | 0.5 | 0.0 | 0.1 | 0.0 |
| 7/4/22 8:21 | 0.24 | 1795.0 | 1203 | 0 | 2997.6 | 7.8 | 6.8 | 3.5 | 0.05 | 0.011 | 1.1 | 0.0 | 0.2 | 0.1 |
| 7/7/22 13:21 | 0.04 | 182.4 | 122 | 0 | 304.5 | 0.8 | 0.7 | 0.4 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 7/8/22 1:00 | 0.08 | 93.2 | 62 | 0 | 155.6 | 0.4 | 0.4 | 0.2 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 7/12/22 19:36 | 0.29 | 2114.5 | 1417 | 0 | 3531.1 | 9.1 | 8.1 | 4.2 | 0.06 | 0.013 | 1.3 | 0.0 | 0.3 | 0.1 |
| 7/17/22 14:26 | 0.02 | 122.2 | 82 | 0 | 204.2 | 0.5 | 0.5 | 0.2 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 7/23/22 13:15 | 0.08 | 573.6 | 384 | 0 | 958.0 | 2.5 | 2.2 | 1.1 | 0.02 | 0.004 | 0.4 | 0.0 | 0.1 | 0.0 |
| 7/26/22 15:45 | 0.03 | 93.3 | 62 | 0 | 155.8 | 0.4 | 0.4 | 0.2 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 7/26/22 21:30 | 0.09 | 675.8 | 453 | 0 | 1128.6 | 2.9 | 2.6 | 1.3 | 0.02 | 0.004 | 0.4 | 0.0 | 0.1 | 0.0 |
| 8/3/22 0:45 | 0.05 | 454.7 | 305 | 0 | 759.4 | 2.0 | 1.7 | 0.9 | 0.01 | 0.003 | 0.3 | 0.0 | 0.1 | 0.0 |
| 8/6/22 9:10 | 0.32 | 3241.9 | 2172 | 0 | 5413.9 | 14.0 | 12.4 | 6.4 | 0.09 | 0.021 | 2.0 | 0.1 | 0.4 | 0.2 |
| 8/6/22 19:15 | 0.03 | 164.1 | 110 | 0 | 274.0 | 0.7 | 0.6 | 0.3 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 8/7/22 21:00 | 0.78 | 9454.9 | 6335 | 0 | 15789.7 | 27.6 | 37.5 | 12.8 | 0.15 | 0.052 | 4.9 | 0.1 | 0.7 | 0.5 |
| 8/12/22 5:41 | 1.18 | 15160.8 | 10158 | 0 | 25318.5 | 60.1 | 37.9 | 25.3 | 0.40 | 0.123 | 7.9 | 0.7 | 2.1 | 0.8 |
| 8/17/22 17:56 | 0.11 | 862.7 | 578 | 0 | 1440.7 | 5.4 | 3.3 | 3.1 | 0.04 | 0.004 | 0.6 | 0.0 | 0.3 | 0.1 |
| 8/18/22 19:29 | 0.26 | 3160.0 | 2117 | 0 | 5277.3 | 11.9 | 17.1 | 5.9 | 0.06 | 0.017 | 1.6 | 0.0 | 0.4 | 0.3 |
| 8/19/22 14:36 | 0.39 | 5817.2 | 3898 | 0 | 9714.7 | 25.1 | 22.2 | 11.4 | 0.15 | 0.037 | 3.7 | 0.1 | 0.8 | 0.3 |
| 8/27/22 2:51 | 0.12 | 1772.6 | 1188 | 0 | 2960.3 | 7.7 | 6.8 | 3.5 | 0.05 | 0.011 | 1.1 | 0.0 | 0.2 | 0.1 |
| 8/27/22 12:49 | 0.03 | 515.2 | 345 | 0 | 860.3 | 2.2 | 2.0 | 1.0 | 0.01 | 0.003 | 0.3 | 0.0 | 0.1 | 0.0 |
| 8/27/22 21:06 | 0.54 | 13031.7 | 8731 | 0 | 21762.9 | 56.3 | 49.7 | 25.6 | 0.34 | 0.082 | 8.2 | 0.2 | 1.8 | 0.8 |
| 8/28/22 0:30 | 0.44 | 12996.7 | 8708 | 0 | 21704.4 | 42.0 | 32.5 | 17.6 | 0.19 | 0.076 | 6.8 | 0.1 | 0.9 | 0.5 |
| 9/9/22 15:17 | 0.11 | 286.2 | 192 | 0 | 478.0 | 1.2 | 1.1 | 0.6 | 0.01 | 0.002 | 0.2 | 0.0 | 0.0 | 0.0 |
| 9/17/22 6:30 | 0.1 | 610.6 | 409 | 0 | 1019.6 | 2.6 | 2.3 | 1.2 | 0.02 | 0.004 | 0.4 | 0.0 | 0.1 | 0.0 |
| 10/12/22 13:30 | 0.05 | 74.2 | 50 | 0 | 123.9 | 0.3 | 0.3 | 0.1 | 0.00 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10/14/22 12:00 | 0.12 | 263.4 | 177 | 0 | 439.9 | 1.1 | 1.0 | 0.5 | 0.01 | 0.002 | 0.2 | 0.0 | 0.0 | 0.0 |
| 10/24/22 17:45 | 0.09 | 174.9 | 117 | 0 | 292.1 | 0.8 | 0.7 | 0.3 | 0.00 | 0.001 | 0.1 | 0.0 | 0.0 | 0.0 |
| 11/3/22 23:15 | 0.23 | 623.6 | 418 | 0 | 1041.5 | 2.7 | 2.4 | 1.2 | 0.02 | 0.004 | 0.4 | 0.0 | 0.1 | 0.0 |
| 11/6/22 4:15 | 0.08 | 67.3 | 45 | 0 | 112.3 | 0.3 | 0.3 | 0.1 | 0.00 | 0.000 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11/8/22 16:30 | 0.44 | 3696.2 | 2476 | 0 | 6172.7 | 26.2 | 25.0 | 11.9 | 0.13 | 0.012 | 6.3 | 0.0 | 0.8 | 0.5 |
| 11/9/22 17:26 | 0.11 | 712.7 | 478 | 0 | 1190.3 | 3.1 | 2.7 | 1.4 | 0.02 | 0.005 | 0.4 | 0.0 | 0.1 | 0.0 |
| 11/10/22 13:30 | 0.05 | 260.0 | 174 | 0 | 434.2 | 1.1 | 1.0 | 0.5 | 0.01 | 0.002 | 0.2 | 0.0 | 0.0 | 0.0 |
| **Sum** | 10.69 | 124654 | 83518 | 21917 | **186255** | 482 | 426 | 219 | 2.94 | 0.706 | 70.3 | 2.1 | 15.4 | 6.5 |
| **Average** | | | | | | | | | | | | | | |
| **Weighted Avg** | | | | | | | | | | | | | | |
| **STDEV** | | | | | | | | | | | | | | |
| **Min** | | | | | | | | | | | | | | |
| **Max** | | | | | | | | | | | | | | |
| **Percent Capture** | | | | | **89.5%** | **81.0%** | **81.0%** | **81.0%** | **81.0%** | **81.0%** | **81.0%** | **81.0%** | **81.0%** | **81.0%** |

< 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 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
2022 Water Quality and Quantity Report
Table C.5
WSB Project Number: 020260

# 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3045013 | 3/8/2022 12:07 | 3/8/2022 12:07 | 51.0 | 908.0 | 21.0 | 0.49 | 0.364 | 634.0 | 1.26 | 3.00 | 0.300 | 55 | 15.0 | 4.8 | 72.9 | 7.3 | 7.80 | 90.0 | 53 |
| 3056719 | 4/20/2022 13:59 | 4/20/2022 13:59 | 149.0 | 103.0 | 54.0 | 0.25 | 0.051 | 32.0 | 1.24 | 3.00 | 0.430 | 45 < | 23.3 | 11.4 | 195.0 | 9.4 | 9.20 | 43.0 | 7 |
| 3066980 | 5/25/2022 13:11 | 5/25/2022 13:11 | | | | | | | | | | | | | | | 7.1 | | 326 |
| 3081772 | 7/17/2022 17:21 | 7/17/2022 18:04 | 111.0 | 128.0 | 38.0 | 0.24 | 0.010 | 16.8 | 0.07 | 2.20 | 0.960 | 45 < | 15.3 | 4.2 | 88.7 | 27.6 | | 137.0 | |
| 3083757 | 7/23/2022 13:33 | 7/23/2022 16:07 | 87.0 | | 47.0 | 0.29 | 0.059 | 39.1 | 0.34 | 3.80 | 0.620 | 82 | 21.6 | 4.3 | 92.2 | 61.7 | | 208.0 | |
| 3088372 | 8/7/2022 20:51 | 8/8/2022 0:04 | 57.0 | 27.0 | 17.0 | 0.13 | 0.026 | 5.0 < | 0.12 | 0.77 | 0.270 < | 45 < | 6.3 | 3.9 | 50.3 | 3.7 | | 32.0 | |
| 3089570 | 8/12/2022 9:37 | 8/12/2022 9:37 | | | | | | | | | | | | | | | 7.10 | | 13400 |
| 3089573 | 8/12/2022 5:18 | 8/12/2022 8:57 | 53.0 | 27.0 | 18.0 | 0.15 | 0.045 | 5.0 < | 0.54 | 1.40 | 0.470 < | 45 < | 9.2 | 5.2 | 68.9 | 6.7 | | 38.0 | |
| 3091360 | 8/17/2022 22:38 | 8/18/2022 0:25 | 15.0 | 123.0 | 9.0 | 0.21 | 0.043 | 14.8 | 0.11 | 1.70 | 0.840 | 45 < | | | | | | 96.0 | |
| 3091796 | 8/18/2022 18:35 | 8/18/2022 20:07 | 40.0 | 79.0 | 16.0 | 0.21 | 0.042 | 9.6 | 0.26 | 1.30 | 0.590 | 45 < | | | | 11.7 | | 64.0 | |
| 3094690 | 8/28/2022 23:12 | 8/29/2022 0:48 | 25.0 | | 10.0 | | | | | | | | | | | | | | |
| 3094692 | 8/27/2022 20:58 | 8/28/2022 5:19 | 76.0 | 48.0 | 25.0 | 0.26 | 0.038 | 5.0 < | 0.14 | 1.10 | 0.430 < | 45 < | 8.5 | 8.6 | 58.8 | 5.5 | | 55.0 | |
| 3116570 | 11/8/2022 19:43 | 11/9/2022 8:36 | 50.0 | 66.0 | 19.0 | 0.22 | 0.042 | 5.0 | 0.12 | 1.40 | 0.530 < | 45 | 8.8 | 4.6 | 72.0 | 16.2 | | 76.0 0.0 | |
| 3116656 | 11/9/2022 18:09 | 11/9/2022 20:18 | 114.0 | 96.0 | 37.0 | 0.30 | 0.010 < | 5.5 | 0.43 | 1.90 | 0.400 | 56 | 15.6 | 9.3 | 140.0 | 14.3 | | 132.0 | |
| 3124903 | 12/14/2022 9:05 | 12/14/2022 9:05 | | | | | | | | | | | | | | | | | 185 |
| **MINIMUM** | | | **15.0** | **27.0** | **9.0** | **0.1** | **0.0** | **5.0** | **0.1** | **0.8** | **0.3** | **45.0** | **6.3** | **3.9** | **50.3** | **3.7** | **7.1** | **32.0** | **7.0** |
| **AVERAGE** | | | **69.0** | **160.5** | **25.9** | **0.2** | **0.1** | **70.2** | **0.4** | **2.0** | **0.5** | **50.3** | **13.7** | **6.3** | **93.2** | **16.4** | **7.8** | **88.3** | **2794.2** |
| **MEDIAN** | | | **55.0** | **87.5** | **20.0** | **0.2** | **0.0** | **9.6** | **0.3** | **1.7** | **0.5** | **45.0** | **15.0** | **4.8** | **72.9** | **10.6** | **7.5** | **76.0** | **185.0** |
| **MAXIMUM** | | | **149.0** | **908.0** | **54.0** | **0.5** | **0.4** | **634.0** | **1.3** | **3.8** | **1.0** | **82.0** | **23.3** | **11.4** | **195.0** | **61.7** | **9.2** | **208.0** | **13400.0** |

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 | Ammonia as N | 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 Ammonia as N | 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 | mg/L | In. | cu-ft | cu-ft | cu-ft | cu-ft | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 5/11/22 20:25 | 5/12/22 1:30 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 1.99 | 12871 | 2124 | 0 | 14995 | 100% | 61.1 | 49.2 | 22.0 | 0.20 | 0.036 | 8.19 | 0.27 | 1.43 | 0.46 |
| 5/12/22 23:13 | 5/13/22 2:15 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.04 | 510 | 84 | 0 | 594 | 100% | 2.4 | 2.0 | 0.9 | 0.01 | 0.001 | 0.32 | 0.01 | 0.06 | 0.02 |
| 5/17/22 21:30 | 5/18/22 0:30 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.04 | 650 | 107 | 0 | 757 | 100% | 3.1 | 2.5 | 1.1 | 0.01 | 0.002 | 0.41 | 0.01 | 0.07 | 0.02 |
| 5/19/22 15:49 | 5/19/22 17:15 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.28 | 1690 | 279 | 0 | 1969 | 100% | 8.0 | 6.5 | 2.9 | 0.03 | 0.005 | 1.08 | 0.04 | 0.19 | 0.06 |
| 5/20/22 3:08 | 5/20/22 5:20 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.03 | 287 | 47 | 0 | 334 | 100% | 1.4 | 1.1 | 0.5 | 0.00 | 0.001 | 0.18 | 0.01 | 0.03 | 0.01 |
| 5/25/22 1:49 | 5/25/22 13:03 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.54 | 12870 | 2124 | 0 | 14994 | 100% | 61.1 | 49.2 | 22.0 | 0.20 | 0.036 | 8.19 | 0.27 | 1.43 | 0.46 |
| 5/25/22 22:30 | 5/26/22 1:11 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.02 | 185 | 30 | 0 | 215 | 100% | 0.9 | 0.7 | 0.3 | 0.00 | 0.001 | 0.12 | 0.00 | 0.02 | 0.01 |
| 5/28/22 7:00 | 5/28/22 9:34 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.11 | 1191 | 197 | 0 | 1388 | 100% | 5.7 | 4.6 | 2.0 | 0.02 | 0.003 | 0.76 | 0.02 | 0.13 | 0.04 |
| 5/30/22 8:27 | 5/30/22 11:34 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.08 | 1719 | 284 | 0 | 2003 | 100% | 8.2 | 6.6 | 2.9 | 0.03 | 0.005 | 1.09 | 0.04 | 0.19 | 0.06 |
| 5/30/22 19:48 | 5/30/22 23:00 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.49 | 4026 | 664 | 0 | 4690 | 100% | 19.1 | 15.4 | 6.9 | 0.06 | 0.011 | 2.56 | 0.08 | 0.45 | 0.15 |
| 6/6/22 0:53 | 6/6/22 6:00 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.15 | 2083 | 344 | 0 | 2427 | 100% | 9.9 | 8.0 | 3.6 | 0.03 | 0.006 | 1.33 | 0.04 | 0.23 | 0.08 |
| 6/11/22 6:18 | 6/11/22 7:39 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.03 | 642 | 106 | 0 | 748 | 100% | 3.0 | 2.5 | 1.1 | 0.01 | 0.002 | 0.41 | 0.01 | 0.07 | 0.02 |
| 6/13/22 7:30 | 6/13/22 10:16 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.08 | 1314 | 217 | 0 | 1530 | 100% | 6.2 | 5.0 | 2.2 | 0.02 | 0.004 | 0.84 | 0.03 | 0.15 | 0.05 |
| 6/15/22 12:54 | 6/15/22 15:56 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.22 | 2341 | 386 | 0 | 2727 | 100% | 11.1 | 9.0 | 4.0 | 0.04 | 0.007 | 1.49 | 0.05 | 0.26 | 0.08 |
| 6/21/22 2:24 | 6/21/22 3:45 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.04 | 298 | 49 | 0 | 347 | 100% | 1.4 | 1.1 | 0.5 | 0.00 | 0.001 | 0.19 | 0.01 | 0.03 | 0.01 |
| 6/25/22 5:11 | 6/25/22 6:25 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.15 | 710 | 117 | 0 | 827 | 100% | 3.4 | 2.7 | 1.2 | 0.01 | 0.002 | 0.45 | 0.01 | 0.08 | 0.03 |
| 7/3/22 3:43 | 7/3/22 4:25 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.15 | 633 | 104 | 0 | 737 | 100% | 3.0 | 2.4 | 1.1 | 0.01 | 0.002 | 0.40 | 0.01 | 0.07 | 0.02 |
| 7/4/22 8:11 | 7/4/22 12:00 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.20 | 1771 | 292 | 0 | 2063 | 100% | 8.4 | 6.8 | 3.0 | 0.03 | 0.005 | 1.13 | 0.04 | 0.20 | 0.06 |
| 7/8/22 1:10 | 7/8/22 7:00 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.07 | 1011 | 167 | 0 | 1178 | 100% | 4.8 | 3.9 | 1.7 | 0.02 | 0.003 | 0.64 | 0.02 | 0.11 | 0.04 |
| 7/12/22 19:22 | 7/12/22 22:00 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.10 | 2192 | 362 | 0 | 2554 | 100% | 10.4 | 8.4 | 3.7 | 0.03 | 0.006 | 1.40 | 0.05 | 0.24 | 0.08 |
| 7/17/22 14:15 | 7/17/22 22:45 | **111** | **128** | **38** | **0.24** | **0.010** | **16.8** | **0.07** | **2.20** | **0.96** | 0.05 | 1338 | 221 | 0 | 1558 | 100% | 10.8 | 12.5 | 3.7 | 0.02 | 0.001 | 1.63 | 0.01 | 0.21 | 0.09 |
| 7/23/22 12:45 | 7/24/22 1:20 | **87** | 53 | **47** | **0.29** | **0.059** | **39.1** | **0.34** | **3.80** | **0.62** | 0.80 | 2505 | 413 | 0 | 2918 | 100% | 15.8 | 9.6 | 8.6 | 0.05 | 0.011 | 7.12 | 0.06 | 0.69 | 0.11 |
| 7/26/22 15:00 | 7/27/22 2:00 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.12 | 1940 | 320 | 0 | 2260 | 100% | 9.2 | 7.4 | 3.3 | 0.03 | 0.005 | 1.24 | 0.04 | 0.22 | 0.07 |
| 8/3/22 0:30 | 8/3/22 1:55 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.16 | 152 | 25 | 0 | 177 | 100% | 0.7 | 0.6 | 0.3 | 0.00 | 0.000 | 0.10 | 0.00 | 0.02 | 0.01 |
| 8/6/22 9:01 | 8/6/22 13:42 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.29 | 4955 | 818 | 0 | 5773 | 100% | 23.5 | 19.0 | 8.5 | 0.08 | 0.014 | 3.15 | 0.10 | 0.55 | 0.18 |
| 8/6/22 18:53 | 8/6/22 20:13 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.03 | 541 | 89 | 0 | 630 | 100% | 2.6 | 2.1 | 0.9 | 0.01 | 0.002 | 0.34 | 0.01 | 0.06 | 0.02 |
| 8/7/22 20:51 | 8/8/22 0:45 | **57** | **27** | **17** | **0.13** | **0.026** | **5.0** < | **0.12** | **0.77** | **0.27** < | 0.78 | 2176 | 359 | 0 | 2535 | 100% | 9.0 | 4.3 | 2.7 | 0.02 | 0.004 | 0.79 | 0.02 | 0.12 | 0.04 |
| 8/12/22 5:15 | 8/12/22 10:13 | **53** | **27** | **18** | **0.15** | **0.045** | **5.0** < | **0.54** | **1.40** | **0.47** < | 1.01 | 9243 | 1525 | 0 | 10768 | 100% | 35.6 | 18.1 | 12.1 | 0.10 | 0.030 | 3.36 | 0.36 | 0.94 | 0.32 |
| 8/17/22 17:57 | 8/18/22 4:45 | **15** | **123** | **9** | **0.21** | **0.043** | **14.8** | **0.11** | **1.70** | **0.84** | 0.10 | 1195 | 197 | 0 | 1393 | 100% | 1.3 | 10.7 | 0.8 | 0.02 | 0.004 | 1.29 | 0.01 | 0.15 | 0.07 |
| 8/18/22 18:29 | 8/18/22 23:45 | **40** | **79** | **16** | **0.21** | **0.042** | **9.6** | **0.26** | **1.30** | **0.59** | 0.18 | 1152 | 190 | 0 | 1342 | 100% | 3.4 | 6.6 | 1.3 | 0.02 | 0.004 | 0.80 | 0.02 | 0.11 | 0.05 |
| 8/19/22 14:45 | 8/19/22 16:45 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.06 | 563 | 93 | 0 | 656 | 100% | 2.7 | 2.2 | 1.0 | 0.01 | 0.002 | 0.36 | 0.01 | 0.06 | 0.02 |
| 8/27/22 3:08 | 8/27/22 4:30 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.02 | 357 | 59 | 0 | 416 | 100% | 1.7 | 1.4 | 0.6 | 0.01 | 0.001 | 0.23 | 0.01 | 0.04 | 0.01 |
| 8/27/22 20:59 | 8/28/22 6:36 | **76** | **48** | **25** | **0.26** | **0.038** | **5.0** < | **0.14** | **1.10** | **0.43** < | 0.65 | 9408 | 1552 | 0 | 10960 | 100% | 52.0 | 32.8 | 17.1 | 0.18 | 0.026 | 3.42 | 0.10 | 0.75 | 0.29 |
| 8/28/22 23:13 | 8/29/22 1:15 | **25** | 53 | **10** | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.16 | 1073 | 177 | 0 | 1250 | 100% | 2.0 | 4.1 | 0.8 | 0.02 | 0.003 | 0.68 | 0.02 | 0.12 | 0.04 |
| 9/23/22 11:19 | 9/23/22 21:33 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.05 | 595 | 98 | 0 | 693 | 100% | 2.8 | 2.3 | 1.0 | 0.01 | 0.002 | 0.38 | 0.01 | 0.07 | 0.02 |
| 10/12/22 12:45 | 10/12/22 19:15 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.06 | 122 | 20 | 0 | 142 | 100% | 0.6 | 0.5 | 0.2 | 0.00 | 0.000 | 0.08 | 0.00 | 0.01 | 0.00 |
| 10/14/22 16:20 | 10/14/22 21:20 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.14 | 125 | 21 | 0 | 146 | 100% | 0.6 | 0.5 | 0.2 | 0.00 | 0.000 | 0.08 | 0.00 | 0.01 | 0.00 |
| 10/24/22 14:37 | 10/24/22 23:30 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.07 | 943 | 156 | 0 | 1099 | 100% | 4.5 | 3.6 | 1.6 | 0.01 | 0.003 | 0.60 | 0.02 | 0.10 | 0.03 |
| 11/3/22 23:07 | 11/4/22 5:05 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.29 | 3293 | 543 | 0 | 3836 | 100% | 15.6 | 12.6 | 5.6 | 0.05 | 0.009 | 2.10 | 0.07 | 0.37 | 0.12 |
| 11/8/22 14:45 | 11/9/22 1:08 | **50** | **66** | **19** | **0.22** | **0.042** | **5.0** | **0.12** | **1.40** | **0.53** < | 0.23 | 2861 | 472 | 0 | 3333 | 100% | 10.4 | 13.7 | 4.0 | 0.05 | 0.009 | 1.04 | 0.02 | 0.29 | 0.11 |
| 11/9/22 5:55 | 11/9/22 11:20 | **114** | **96** | **37** | **0.30** | **0.010** < | **5.5** | **0.43** | **1.90** | **0.40** | 0.13 | 1876 | 309 | 0 | 2185 | 100% | 15.6 | 13.1 | 5.0 | 0.04 | 0.001 | 0.75 | 0.06 | 0.26 | 0.05 |
| 11/9/22 18:00 | 11/9/22 21:05 | 65 | 53 | 23 | 0.2 | 0.04 | 9 | 0.3 | 1.5 | 0.5 | 0.07 | 1225 | 202 | 0 | 1427 | 100% | 5.8 | 4.7 | 2.1 | 0.02 | 0.003 | 0.78 | 0.03 | 0.14 | 0.04 |
| **Sum** | | | | | | | | | | | 10.26 | 96629 | 15944 | 0 | **112573** | 100% | 459 | 370 | 165 | 1.52 | 0.27 | 61.5 | 2.0 | 10.7 | 3.5 |
| **Average** | | 62.8 | 74.3 | 23.6 | 0.22 | 0.035 | 11.8 | 0.24 | 1.73 | 0.57 | | | | | | | | | | | | | | | |
| **Weighted Avg** | | 65.3 | 52.6 | 23.5 | 0.22 | 0.039 | 8.8 | 0.29 | 1.53 | 0.50 | | | | | | | | | | | | | | | |
| **STDEV** | | 33.7 | 39.6 | 12.9 | 0.06 | 0.017 | 11.2 | 0.17 | 0.88 | 0.22 | | | | | | | | | | | | | | | |
| **Min** | | 15.0 | 27.0 | 9.0 | 0.13 | 0.010 | 5.0 | 0.07 | 0.77 | 0.27 | | | | | | | | | | | | | | | |
| **Max** | | 114.0 | 128.0 | 47.0 | 0.30 | 0.059 | 39.1 | 0.54 | 3.80 | 0.96 | | | | | | | | | | | | | | | |
| **Percent Capture** | | | | | | | | | | | | | | | 100% | | 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 drainage areas.
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
2022 Water Quality and Quantity Report
Table C.7
WSB Project Number: 020260

# 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3045022 | 3/8/2022 12:39 | 3/8/2022 12:39 | 36.0 | 5970.0 | 20.0 | 0.43 | 0.302 | 517.0 | 1.98 | 4.20 | 0.450 | 66 | 8.7 | 5.2 | 45.7 | 8.4 | 7.8 | 90.0 | 206 |
| 3052661 | 4/6/2022 9:34 | 4/6/2022 9:34 | 7.0 | 56.0 | 4.0 | 0.15 | 0.103 | 9.6 | 0.37 | 0.78 | 0.260 < | 45 < | 3.2 | 2.6 | 14.4 | 5.0 | 8.3 | 18.0 | 548 |
| 3066990 | 5/25/2022 12:52 | 5/25/2022 12:52 | | | | | | | | | | | | | | | 6.6 | | 3100 |
| 3089575 | 8/12/2022 5:32 | 8/12/2022 6:32 | 56.0 | 49.0 | 24.0 | 0.38 | 0.192 | 5.0 < | 0.65 | 2.40 | 0.680 < | 45 < | 5.6 | 7.2 | 36.8 | 12.7 | | 63.0 | |
| 3091798 | 8/18/2022 19:27 | 8/18/2022 19:38 | 207.0 | 67.0 | 106.0 | 0.55 | 0.147 | 5.0 < | 0.59 | 3.70 | 0.720 | 45 < | | | | 15.9 | | 133.0 | |
| 3116566 | 11/6/2022 4:22 | 11/6/2022 6:33 | 42.0 | 800.0 | 34.0 | 7.89 | 7.140 | 58.9 | 0.15 | 7.20 | 0.270 < | 200 | 19.3 | 6.6 | 123.0 | 390.0 | | 1180.0 | |
| 3124908 | 12/14/2022 8:38 | 12/14/2022 8:38 | | | | | | | | | | | | | | | | | 6300 |
| **MINIMUM** | | | **7.0** | **49.0** | **4.0** | **0.1** | **0.1** | **5.0** | **0.2** | **0.8** | **0.3** | **45.0** | **3.2** | **2.6** | **14.4** | **5.0** | **6.6** | **18.0** | **206.0** |
| **AVERAGE** | | | **69.6** | **1388.4** | **37.6** | **1.9** | **1.6** | **119.1** | **0.7** | **3.7** | **0.5** | **80.2** | **9.2** | **5.4** | **55.0** | **86.4** | **7.6** | **296.8** | **2538.5** |
| **MEDIAN** | | | **42.0** | **67.0** | **24.0** | **0.4** | **0.2** | **9.6** | **0.6** | **3.7** | **0.5** | **45.0** | **7.2** | **5.9** | **41.3** | **12.7** | **7.8** | **90.0** | **1824.0** |
| **MAXIMUM** | | | **207.0** | **5970.0** | **106.0** | **7.9** | **7.1** | **517.0** | **2.0** | **7.2** | **0.7** | **200.0** | **19.3** | **7.2** | **123.0** | **390.0** | **8.3** | **1180.0** | **6300.0** |

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
2022 Victoria Volume Reduction Pollutant Monitoring
Table C.8
WSB Project No.: 020260

# VICTORIA VOLUME AND POLLUTANT REDUCTION SUMMARY

| Event Time Interval | | Sampling Data | | | | | | | | | | | | Rain | Event Loading and Volume Data | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TSS | TDS | VSS | TP | | Ortho-P | Chloride | | Ammonia as N | Total Kjeldahl Nitrogen | Nitrate + Nitrite as N | | Amount | 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 Ammonia as N | 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 | mg/L | | (in) | cu-ft | cu-ft | cu-ft | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 4/29/2022 19:30 | 4/30/2022 11:30 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.66 | 13976 | 0 | 13976 | 64.2 | 44.7 | 29.9 | 0.4 | 0.163 | 4.4 | 0.54 | 2.4 | 0.6 |
| 4/30/2022 14:15 | 5/1/2022 10:45 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.41 | 8112 | 0 | 8112 | 37.3 | 26.0 | 17.4 | 0.2 | 0.094 | 2.5 | 0.31 | 1.4 | 0.3 |
| 5/8/2022 9:30 | 5/9/2022 19:15 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.03 | 193 | 0 | 193 | 0.9 | 0.6 | 0.4 | 0.0 | 0.002 | 0.1 | 0.01 | 0.0 | 0.0 |
| 5/11/2022 20:30 | 5/11/2022 23:15 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 1.87 | 30794 | 26482 | 4312 | 19.8 | 13.8 | 9.2 | 0.1 | 0.050 | 1.3 | 0.17 | 0.7 | 0.2 |
| 5/12/2022 23:21 | 5/13/2022 0:00 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.02 | 292 | 0 | 292 | 1.3 | 0.9 | 0.6 | 0.0 | 0.003 | 0.1 | 0.01 | 0.1 | 0.0 |
| 5/17/2022 22:30 | 5/18/2022 6:00 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.04 | 101 | 0 | 101 | 0.5 | 0.3 | 0.2 | 0.0 | 0.001 | 0.0 | 0.00 | 0.0 | 0.0 |
| 5/19/2022 15:56 | 5/19/2022 17:00 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.17 | 7498 | 4 | 7494 | 34.4 | 24.0 | 16.1 | 0.2 | 0.087 | 2.3 | 0.29 | 1.3 | 0.3 |
| 5/20/2022 3:15 | 5/20/2022 6:45 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.05 | 257 | 0 | 257 | 1.2 | 0.8 | 0.5 | 0.0 | 0.003 | 0.1 | 0.01 | 0.0 | 0.0 |
| 5/25/2022 2:15 | 5/25/2022 13:15 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.58 | 6643 | 0 | 6643 | 30.5 | 21.3 | 14.2 | 0.2 | 0.077 | 2.1 | 0.26 | 1.1 | 0.3 |
| 5/25/2022 19:15 | 5/26/2022 3:00 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.05 | 104 | 0 | 104 | 0.5 | 0.3 | 0.2 | 0.0 | 0.001 | 0.0 | 0.00 | 0.0 | 0.0 |
| 5/28/2022 7:10 | 5/28/2022 8:58 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.12 | 763 | 0 | 763 | 3.5 | 2.4 | 1.6 | 0.0 | 0.009 | 0.2 | 0.03 | 0.1 | 0.0 |
| 5/30/2022 8:36 | 5/30/2022 10:40 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.08 | 749 | 0 | 748 | 3.4 | 2.4 | 1.6 | 0.0 | 0.009 | 0.2 | 0.03 | 0.1 | 0.0 |
| 5/30/2022 19:57 | 5/30/2022 21:36 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.02 | 658 | 0 | 658 | 3.0 | 2.1 | 1.4 | 0.0 | 0.008 | 0.2 | 0.03 | 0.1 | 0.0 |
| 6/6/2022 0:46 | 6/6/2022 4:09 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.30 | 2887 | 0 | 2887 | 13.3 | 9.2 | 6.2 | 0.1 | 0.034 | 0.9 | 0.11 | 0.5 | 0.1 |
| 6/11/2022 6:34 | 6/11/2022 7:48 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.04 | 118 | 0 | 118 | 0.5 | 0.4 | 0.3 | 0.0 | 0.001 | 0.0 | 0.00 | 0.0 | 0.0 |
| 6/13/2022 8:15 | 6/13/2022 10:21 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.10 | 630 | 0 | 630 | 2.9 | 2.0 | 1.4 | 0.0 | 0.007 | 0.2 | 0.02 | 0.1 | 0.0 |
| 6/15/2022 12:57 | 6/15/2022 15:54 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.45 | 4637 | 1 | 4637 | 21.3 | 14.8 | 9.9 | 0.1 | 0.054 | 1.4 | 0.18 | 0.8 | 0.2 |
| 7/3/2022 3:50 | 7/3/2022 5:06 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.13 | 1335 | 0 | 1335 | 6.1 | 4.3 | 2.9 | 0.0 | 0.016 | 0.4 | 0.05 | 0.2 | 0.1 |
| 7/4/2022 8:24 | 7/4/2022 11:48 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.24 | 2139 | 0 | 2139 | 9.8 | 6.8 | 4.6 | 0.1 | 0.025 | 0.7 | 0.08 | 0.4 | 0.1 |
| 7/7/2022 13:21 | 7/7/2022 14:19 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.04 | 1395 | 0 | 1395 | 6.4 | 4.5 | 3.0 | 0.0 | 0.016 | 0.4 | 0.05 | 0.2 | 0.1 |
| 7/8/2022 1:30 | 7/8/2022 6:09 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.08 | 307 | 0 | 307 | 1.4 | 1.0 | 0.7 | 0.0 | 0.004 | 0.1 | 0.01 | 0.1 | 0.0 |
| 7/12/2022 19:32 | 7/12/2022 22:09 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.30 | 2636 | 7 | 2630 | 12.1 | 8.4 | 5.6 | 0.1 | 0.031 | 0.8 | 0.10 | 0.5 | 0.1 |
| 7/17/2022 17:19 | 7/17/2022 18:37 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.02 | 273 | 0 | 273 | 1.3 | 0.9 | 0.6 | 0.0 | 0.003 | 0.1 | 0.01 | 0.0 | 0.0 |
| 7/23/2022 14:22 | 7/23/2022 15:24 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.08 | 219 | 0 | 219 | 1.0 | 0.7 | 0.5 | 0.0 | 0.003 | 0.1 | 0.01 | 0.0 | 0.0 |
| 7/26/2022 15:48 | 7/26/2022 18:26 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.03 | 779 | 0 | 779 | 3.6 | 2.5 | 1.7 | 0.0 | 0.009 | 0.2 | 0.03 | 0.1 | 0.0 |
| 7/26/2022 21:15 | 7/26/2022 23:40 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.09 | 881 | 0 | 881 | 4.0 | 2.8 | 1.9 | 0.0 | 0.010 | 0.3 | 0.03 | 0.2 | 0.0 |
| 8/3/2022 0:43 | 8/3/2022 6:23 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.05 | 1208 | 0 | 1208 | 5.5 | 3.9 | 2.6 | 0.0 | 0.014 | 0.4 | 0.05 | 0.2 | 0.1 |
| 8/6/2022 9:14 | 8/6/2022 11:53 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.32 | 3139 | 1 | 3138 | 14.4 | 10.0 | 6.7 | 0.1 | 0.036 | 1.0 | 0.12 | 0.5 | 0.1 |
| 8/7/2022 20:57 | 8/8/2022 0:41 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.78 | 10527 | 13 | 10515 | 48.3 | 33.7 | 22.5 | 0.3 | 0.122 | 3.3 | 0.41 | 1.8 | 0.4 |
| 8/12/2022 5:37 | 8/12/2022 9:53 | **56.0** | **49.0** | **24.0** | **0.38** | # | **0.192** | **5.0** | < | **0.65** | **2.40** | **0.680** | < | 1.18 | 19093 | 24 | 19069 | 66.7 | 58.3 | 28.6 | 0.5 | 0.229 | 6.0 | 0.77 | 2.9 | 0.8 |
| 8/17/2022 15:44 | 8/17/2022 21:05 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.11 | 1572 | 0 | 1572 | 7.2 | 5.0 | 3.4 | 0.0 | 0.018 | 0.5 | 0.06 | 0.3 | 0.1 |
| 8/18/2022 19:24 | 8/18/2022 20:55 | **207.0** | **67.0** | **106.0** | **0.55** | | **0.147** | **5.0** | < | **0.59** | **3.70** | **0.720** | | 0.18 | 2756 | 2 | 2753 | 35.6 | 11.5 | 18.2 | 0.1 | 0.025 | 0.9 | 0.10 | 0.6 | 0.1 |
| 8/19/2022 14:21 | 8/19/2022 16:11 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.39 | 10806 | 9 | 10797 | 49.6 | 34.6 | 23.1 | 0.3 | 0.126 | 3.4 | 0.42 | 1.9 | 0.4 |
| 8/27/2022 2:48 | 8/27/2022 7:37 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.11 | 1987 | 0 | 1987 | 9.1 | 6.4 | 4.3 | 0.0 | 0.023 | 0.6 | 0.08 | 0.3 | 0.1 |
| 8/27/2022 21:00 | 8/27/2022 22:23 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.54 | 11283 | 9 | 11274 | 51.8 | 36.1 | 24.2 | 0.3 | 0.131 | 3.5 | 0.44 | 1.9 | 0.5 |
| 8/28/2022 0:28 | 8/28/2022 3:18 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.35 | 5182 | 64 | 5118 | 23.5 | 16.4 | 11.0 | 0.1 | 0.060 | 1.6 | 0.20 | 0.9 | 0.2 |
| 8/28/2022 4:14 | 8/28/2022 5:03 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.08 | 288 | 0 | 288 | 1.3 | 0.9 | 0.6 | 0.0 | 0.003 | 0.1 | 0.01 | 0.0 | 0.0 |
| 8/28/2022 23:38 | 8/29/2022 0:20 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.19 | 3234 | 1 | 3233 | 14.9 | 10.3 | 6.9 | 0.1 | 0.038 | 1.0 | 0.13 | 0.6 | 0.1 |
| 9/9/2022 15:37 | 9/9/2022 21:01 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.11 | 475 | 0 | 475 | 2.2 | 1.5 | 1.0 | 0.0 | 0.006 | 0.1 | 0.02 | 0.1 | 0.0 |
| 9/17/2022 6:34 | 9/17/2022 7:53 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.13 | 1971 | 0 | 1971 | 9.1 | 6.3 | 4.2 | 0.0 | 0.023 | 0.6 | 0.08 | 0.3 | 0.1 |
| 10/7/2022 9:39 | 10/7/2022 10:17 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.02 | 43 | 0 | 43 | 0.2 | 0.1 | 0.1 | 0.0 | 0.000 | 0.0 | 0.00 | 0.0 | 0.0 |
| 10/12/2022 13:26 | 10/12/2022 18:08 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.05 | 575 | 0 | 575 | 2.6 | 1.8 | 1.2 | 0.0 | 0.007 | 0.2 | 0.02 | 0.1 | 0.0 |
| 10/14/2022 11:12 | 10/14/2022 19:34 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.12 | 541 | 0 | 541 | 2.5 | 1.7 | 1.2 | 0.0 | 0.006 | 0.2 | 0.02 | 0.1 | 0.0 |
| 10/24/2022 17:29 | 10/24/2022 21:00 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.09 | 1008 | 0 | 1008 | 4.6 | 3.2 | 2.2 | 0.0 | 0.012 | 0.3 | 0.04 | 0.2 | 0.0 |
| 11/3/2022 23:18 | 11/4/2022 6:05 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.22 | 2988 | 0 | 2988 | 13.7 | 9.6 | 6.4 | 0.1 | 0.035 | 0.9 | 0.12 | 0.5 | 0.1 |
| 11/6/2022 4:07 | 11/6/2022 9:00 | **42.0** | **800.0** | **34.0** | **7.89** | | **7.140** | **58.9** | | **0.15** | **7.20** | **0.270** | < | 0.09 | 1006 | 0 | 1006 | 2.6 | 50.2 | 2.1 | 0.5 | 0.448 | 3.7 | 0.01 | 0.5 | 0.0 |
| 11/8/2022 16:51 | 11/9/2022 2:59 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.27 | 5012 | 0 | 5012 | 23.0 | 16.0 | 10.7 | 0.1 | 0.058 | 1.6 | 0.19 | 0.9 | 0.2 |
| 11/9/2022 6:01 | 11/9/2022 12:00 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.18 | 3042 | 0 | 3042 | 14.0 | 9.7 | 6.5 | 0.1 | 0.035 | 0.9 | 0.12 | 0.5 | 0.1 |
| 11/9/2022 16:36 | 11/9/2022 22:47 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.10 | 2630 | 0 | 2630 | 12.1 | 8.4 | 5.6 | 0.1 | 0.031 | 0.8 | 0.10 | 0.5 | 0.1 |
| 11/10/2022 14:23 | 11/10/2022 17:00 | 74 | 51 | 34 | 0.4 | | 0.19 | 5 | | 0.6 | 2.8 | 0.67 | | 0.05 | 449 | 0 | 449 | 2.1 | 1.4 | 1.0 | 0.0 | 0.005 | 0.1 | 0.02 | 0.1 | 0.0 |
| **Sum** | | | | | | | | | | | | | | 11.71 | 179,189 | 26,616 | 152,573 | **701** | **535** | **327** | **4.3** | **2.211** | **51.0** | **5.91** | **26.4** | **6.4** |
| **Average** | | 101.7 | 58.0 | 54.7 | 0.47 | | 0.170 | 5.0 | | 0.46 | 4.43 | 0.557 | | | | | | | | | | | | | | |
| **Weighted Ave*** | | 73.6 | 51.3 | 34.3 | 0.40 | | 0.186 | 5.0 | | 0.62 | 2.77 | 0.667 | | | | | | | | | | | | | | |
| **STDEV** | | 15.8 | 12.7 | 44.7 | 0.12 | | 0.004 | 0.0 | | 0.27 | 2.48 | 0.249 | | | | | | | | | | | | | | |
| **Median** | | 56.0 | 58.0 | 34.0 | 0.47 | 0 | 0.189 | 5.0 | | 0.59 | 3.70 | 0.680 | | | | | | | | | | | | | | |
| **Min** | | 42.0 | 49.0 | 24.0 | 0.38 | 0 | 0.186 | 5.0 | | 0.15 | 2.40 | 0.270 | | | | | | | | | | | | | | |
| **Max** | | 73.6 | 67.0 | 106.0 | 0.55 | 0 | 0.192 | 5.0 | | 0.65 | 7.20 | 0.720 | | | | | | | | | | | | | | |
| **Percent Capture** | | | | | | | | | | | | | | | | | 85.1% | **85.1%** | **86.3%** | **85.1%** | **86.6%** | **87.7%** | **86.0%** | **85.1%** | **85.1%** | **85.1%** |

< 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

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

City of Saint Paul
2022 Water Quality and Quantity Report
Table C.9
WSB Project Number: 020260

# 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3056715 | 4/20/2022 14:31 | 4/20/2022 14:31 | 158.0 | 164.0 | 34.0 | 0.21 | 0.047 | 72.9 | 0.30 | 1.30 | 0.260 < | 45 < | 21.3 | 7.9 | 174.0 | 3.4 | 8.50 | 15.0 < | 13 |
| 3066986 | 5/25/2022 13:47 | 5/25/2022 13:47 | | | | | | | | | | | | | | | 7.00 | | 210 |
| 3088376 | 8/6/2022 9:29 | 8/6/2022 11:14 | 86.0 | 70.0 | 49.0 | 0.20 | 0.112 | 15.3 | 0.27 | 0.74 | 0.350 < | 45 < | 3.8 | 0.7 | 35.1 | 4.4 | | 19.0 | |
| 3089591 | 8/12/2022 9:19 | 8/12/2022 9:19 | | | | | | | | | | | | | | | 7.20 | | 150 |
| 3090132 | 8/12/2022 6:00 | 8/13/2022 2:14 | 7.0 | 44.0 | 4.0 | 0.06 | 0.019 | 5.9 | 0.17 | 0.58 | 0.360 < | 45 < | | | | 2.8 | | 15.0 < | |
| 3091362 | 8/17/2022 18:14 | 8/18/2022 10:59 | 20.0 | 180.0 | 13.0 | 0.42 | 0.087 | 41.0 | 0.27 | 1.90 | 2.560 | 45 < | | | | 14.1 | | 62.0 | |
| 3091794 | 8/18/2022 19:29 | 8/19/2022 3:29 | 61.0 | 114.0 | 31.0 | 0.24 | 0.023 | 34.2 | 0.11 | 1.50 | 0.370 | 45 < | | | | 6.0 | | 52.0 | |
| 3094694 | 8/27/2022 3:15 | 8/27/2022 15:44 | 19.0 | 179.0 | 13.0 | 0.26 | 0.025 | 49.5 | 0.40 | 1.80 | 1.840 | 45 < | 5.5 | 1.4 | 26.3 | 12.9 | | 53.0 | |
| 3114846 | 11/3/2022 23:14 | 11/4/2022 3:14 | 246.0 | 215.0 | 156.0 | 0.84 | 0.272 | 63.8 | 0.50 | 3.30 | 0.520 < | 47 | 12.6 | 3.9 | 81.2 | 29.7 | | 149.0 | |
| 3116576 | 11/8/2022 17:59 | 11/9/2022 11:44 | 25.0 | 76.0 | 12.0 | 0.24 | 0.093 | 9.8 | 0.06 < | 0.86 | 0.580 < | 45 < | 6.7 | 1.6 | 34.0 | 9.2 | | 37.0 | |
| 3116650 | 11/9/2022 16:14 | 11/10/2022 0:59 | 24.0 | 65.0 | 11.0 | 0.50 | 0.010 < | 8.6 | 0.06 < | 0.79 | 0.340 < | 45 < | 6.4 | 2.7 | 34.1 | 5.5 | | 30.0 | |
| 3124899 | 12/14/2022 9:57 | 12/14/2022 9:57 | | | | | | | | | | | | | | | | | 93 |
| **MINIMUM** | | | **7.0** | **44.0** | **4.0** | **0.1** | **0.0** | **5.9** | **0.1** | **0.6** | **0.3** | **45.0** | **3.8** | **0.7** | **26.3** | **2.8** | **7.0** | **15.0** | **13.0** |
| **AVERAGE** | | | **71.8** | **123.0** | **35.9** | **0.3** | **0.1** | **33.4** | **0.2** | **1.4** | **0.8** | **45.2** | **9.4** | **3.0** | **64.1** | **9.8** | **7.6** | **48.0** | **116.5** |
| **MEDIAN** | | | **25.0** | **114.0** | **13.0** | **0.2** | **0.0** | **34.2** | **0.3** | **1.3** | **0.4** | **45.0** | **6.6** | **2.2** | **34.6** | **6.0** | **7.2** | **37.0** | **121.5** |
| **MAXIMUM** | | | **246.0** | **215.0** | **156.0** | **0.8** | **0.3** | **72.9** | **0.5** | **3.3** | **2.6** | **47.0** | **21.3** | **7.9** | **174.0** | **29.7** | **8.5** | **149.0** | **210.0** |

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
2022 West Shepard Volume Reduction Pollutant Loading
Table C.10
WSB Project No.: 020260

# WEST SHEPARD POND VOLUME REDUCTION AND POLLUTANT LOADING

## Sampling Data

| Event Time Interval | | TSS | TDS | VSS | TP | Ortho-P | Chloride | Ammonia as N | Total 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 |
| 6/6/22 0:06 | 6/6/22 5:38 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 6/11/22 6:30 | 6/11/22 11:01 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 6/13/22 7:34 | 6/13/22 11:42 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 6/15/22 12:45 | 6/15/22 15:42 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 6/24/22 3:00 | 6/24/22 4:24 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 6/25/22 5:27 | 6/25/22 11:37 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 6/28/22 7:15 | 6/28/22 16:21 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 6/30/22 4:45 | 6/30/22 9:35 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 7/4/22 8:29 | 7/5/22 0:00 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 7/7/22 22:37 | 7/8/22 13:54 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 7/12/22 19:36 | 7/12/22 22:35 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 7/17/22 14:24 | 7/17/22 15:34 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 7/23/22 14:21 | 7/23/22 18:33 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 7/26/22 21:14 | 7/27/22 0:30 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 8/6/22 9:15 | 8/6/22 13:05 | **86** | **70** | **49** | **0.20** | **0.112** | **15.3** | **0.27** | **0.74** | **0.35** < |
| 8/7/22 20:59 | 8/8/22 0:14 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 8/12/22 5:47 | 8/12/22 10:28 | **7** | **44** | **4** | **0.06** | **0.019** | **5.9** | **0.17** | **0.58** | **0.36** < |
| 8/17/22 18:00 | 8/17/22 19:54 | **20** | **180** | **13** | **0.42** | **0.087** | **41.0** | **0.27** | **1.90** | **2.56** |
| 8/18/22 19:25 | 8/18/22 21:07 | **61** | **114** | **31** | **0.24** | **0.023** | **34.2** | **0.11** | **1.50** | **0.37** |
| 8/19/22 12:38 | 8/19/22 19:18 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 8/27/22 2:45 | 8/27/22 5:02 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 8/27/22 12:37 | 8/27/22 14:10 | **19** | **179** | **13** | **0.26** | **0.025** | **49.5** | **0.40** | **1.80** | **1.84** |
| 8/27/22 21:00 | 8/28/22 9:01 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 8/28/22 23:37 | 8/29/22 1:53 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 9/9/22 15:45 | 9/10/22 3:21 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 10/7/22 0:00 | 10/7/22 6:30 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 10/12/22 13:32 | 10/12/22 18:13 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 10/14/22 10:56 | 10/14/22 21:36 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 11/3/22 22:42 | 11/4/22 6:05 | **246** | **215** | **156** | **0.84** | **0.272** | **63.8** | **0.50** | **3.30** | **0.52** < |
| 11/6/22 4:11 | 11/6/22 8:51 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 11/8/22 16:17 | 11/8/22 22:48 | **25** | **76** | **12** | **0.24** | **0.093** | **9.8** | **0.06** < | **0.86** | **0.58** < |
| 11/9/22 5:45 | 11/9/22 9:06 | 57 | 89 | 34 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| 11/9/22 17:54 | 11/9/22 21:39 | **24** | **65** | **11** | **0.50** | **0.010** < | **8.6** | **0.06** < | **0.79** | **0.34** < |
| **Sum** | | | | | | | | | | |
| **Average** | | 61.0 | 117.9 | 36.1 | 0.34 | 0.080 | 28.5 | 0.23 | 1.43 | 0.87 |
| **Weighted Avg** | | 57.4 | 89.3 | 34.1 | 0.27 | 0.077 | 19.9 | 0.21 | 1.14 | 0.54 |
| **STDEV** | | 79.2 | 64.7 | 50.5 | 0.24 | 0.087 | 21.7 | 0.16 | 0.91 | 0.85 |
| **Min** | | 7.0 | 44.0 | 4.0 | 0.06 | 0.010 | 5.9 | 0.06 | 0.58 | 0.34 |
| **Max** | | 246.0 | 215.0 | 156.0 | 0.84 | 0.272 | 63.8 | 0.50 | 3.30 | 2.56 |
| **Percent Capture** | | | | | | | | | | |

## Event Loading and Volume Data

| Start | End | Interval Rain | South Inlet Volume (1) | Noth Inlet Volume 1 Volume (2) | Bypass Volume (3) | Volume Captured (1+2-3) | Captured TSS | Captured TDS | Captured VSS | Captured TP | Captured Ortho-P | Captured Chloride | Captured Ammonia as N | Captured Total Kjeldahl Nitrogen | Captured Nitrate + Nitrite as N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | In. | cu-ft | cu-ft | cu-ft | cu-ft | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 6/6/22 0:06 | 6/6/22 5:38 | 0.21 | 9764 | 976 | 0 | 10740 | 38.5 | 59.9 | 22.8 | 0.18 | 0.052 | 13.4 | 0.1 | 0.8 | 0.4 |
| 6/11/22 6:30 | 6/11/22 11:01 | 0.04 | 7306 | 731 | 0 | 8036 | 28.8 | 44.8 | 17.1 | 0.13 | 0.039 | 10.0 | 0.1 | 0.6 | 0.3 |
| 6/13/22 7:34 | 6/13/22 11:42 | 0.10 | 3769 | 377 | 0 | 4146 | 14.9 | 23.1 | 8.8 | 0.07 | 0.020 | 5.2 | 0.1 | 0.3 | 0.1 |
| 6/15/22 12:45 | 6/15/22 15:42 | 0.36 | 5208 | 521 | 0 | 5729 | 20.5 | 31.9 | 12.2 | 0.10 | 0.028 | 7.1 | 0.1 | 0.4 | 0.2 |
| 6/24/22 3:00 | 6/24/22 4:24 | 0.19 | 3067 | 307 | 0 | 3373 | 12.1 | 18.8 | 7.2 | 0.06 | 0.016 | 4.2 | 0.0 | 0.2 | 0.1 |
| 6/25/22 5:27 | 6/25/22 11:37 | 0.06 | 8985 | 898 | 1 | 9882 | 35.4 | 55.1 | 21.0 | 0.17 | 0.048 | 12.3 | 0.1 | 0.7 | 0.3 |
| 6/28/22 7:15 | 6/28/22 16:21 | 0.05 | 5574 | 557 | 1 | 6130 | 22.0 | 34.2 | 13.0 | 0.10 | 0.029 | 7.6 | 0.1 | 0.4 | 0.2 |
| 6/30/22 4:45 | 6/30/22 9:35 | 0.03 | 3666 | 367 | 1 | 4032 | 14.4 | 22.5 | 8.6 | 0.07 | 0.019 | 5.0 | 0.1 | 0.3 | 0.1 |
| 7/4/22 8:29 | 7/5/22 0:00 | 0.21 | 9073 | 907 | 3 | 9978 | 35.7 | 55.6 | 21.2 | 0.17 | 0.048 | 12.4 | 0.1 | 0.7 | 0.3 |
| 7/7/22 22:37 | 7/8/22 13:54 | 0.08 | 13828 | 1383 | 3 | 15208 | 54.5 | 84.8 | 32.3 | 0.25 | 0.073 | 18.9 | 0.2 | 1.1 | 0.5 |
| 7/12/22 19:36 | 7/12/22 22:35 | 0.44 | 5961 | 596 | 6 | 6552 | 23.5 | 36.5 | 13.9 | 0.11 | 0.031 | 8.1 | 0.1 | 0.5 | 0.2 |
| 7/17/22 14:24 | 7/17/22 15:34 | 0.51 | 3610 | 361 | 2 | 3969 | 14.2 | 22.1 | 8.4 | 0.07 | 0.019 | 4.9 | 0.1 | 0.3 | 0.1 |
| 7/23/22 14:21 | 7/23/22 18:33 | 0.28 | 4873 | 487 | 7 | 5353 | 19.2 | 29.8 | 11.4 | 0.09 | 0.026 | 6.7 | 0.1 | 0.4 | 0.2 |
| 7/26/22 21:14 | 7/27/22 0:30 | 0.08 | 2658 | 266 | 3 | 2921 | 10.5 | 16.3 | 6.2 | 0.05 | 0.014 | 3.6 | 0.0 | 0.2 | 0.1 |
| 8/6/22 9:15 | 8/6/22 13:05 | 0.39 | 8901 | 890 | 7 | 9784 | 52.5 | 42.8 | 29.9 | 0.12 | 0.068 | 9.3 | 0.2 | 0.5 | 0.2 |
| 8/7/22 20:59 | 8/8/22 0:14 | 0.60 | 13961 | 1396 | 297 | 15061 | 53.9 | 84.0 | 32.0 | 0.25 | 0.072 | 18.7 | 0.2 | 1.1 | 0.5 |
| 8/12/22 5:47 | 8/12/22 10:28 | 1.14 | 19814 | 1981 | 3609 | 18187 | 7.9 | 50.0 | 4.5 | 0.07 | 0.022 | 6.7 | 0.2 | 0.7 | 0.4 |
| 8/17/22 18:00 | 8/17/22 19:54 | 0.41 | 2021 | 202 | 0 | 2223 | 2.8 | 25.0 | 1.8 | 0.06 | 0.012 | 5.7 | 0.0 | 0.3 | 0.4 |
| 8/18/22 19:25 | 8/18/22 21:07 | 0.29 | 3229 | 323 | 0 | 3552 | 13.5 | 25.3 | 6.9 | 0.05 | 0.005 | 7.6 | 0.0 | 0.3 | 0.1 |
| 8/19/22 12:38 | 8/19/22 19:18 | 0.11 | 12886 | 1289 | 1143 | 13031 | 46.7 | 72.6 | 27.7 | 0.22 | 0.063 | 16.2 | 0.2 | 0.9 | 0.4 |
| 8/27/22 2:45 | 8/27/22 5:02 | 0.07 | 2668 | 267 | 1 | 2935 | 10.5 | 16.4 | 6.2 | 0.05 | 0.014 | 3.6 | 0.0 | 0.2 | 0.1 |
| 8/27/22 12:37 | 8/27/22 14:10 | 0.15 | 1938 | 194 | 0 | 2132 | 2.5 | 23.8 | 1.7 | 0.03 | 0.003 | 6.6 | 0.1 | 0.2 | 0.2 |
| 8/27/22 21:00 | 8/28/22 9:01 | 1.32 | 23903 | 2390 | 7938 | 18355 | 65.7 | 102.3 | 39.0 | 0.31 | 0.088 | 22.8 | 0.2 | 1.3 | 0.6 |
| 8/28/22 23:37 | 8/29/22 1:53 | 0.13 | 3020 | 302 | 0 | 3322 | 11.9 | 18.5 | 7.1 | 0.06 | 0.016 | 4.1 | 0.0 | 0.2 | 0.1 |
| 9/9/22 15:45 | 9/10/22 3:21 | 0.09 | 8649 | 865 | 4 | 9510 | 34.1 | 53.0 | 20.2 | 0.16 | 0.046 | 11.8 | 0.1 | 0.7 | 0.3 |
| 10/7/22 0:00 | 10/7/22 6:30 | 0.10 | 395 | 39 | 13 | 421 | 1.5 | 2.3 | 0.9 | 0.01 | 0.002 | 0.5 | 0.0 | 0.0 | 0.0 |
| 10/12/22 13:32 | 10/12/22 18:13 | 0.03 | 2506 | 251 | 0 | 2757 | 9.9 | 15.4 | 5.9 | 0.05 | 0.013 | 3.4 | 0.0 | 0.2 | 0.1 |
| 10/14/22 10:56 | 10/14/22 21:36 | 0.12 | 2927 | 293 | 0 | 3220 | 11.5 | 17.9 | 6.8 | 0.05 | 0.015 | 4.0 | 0.0 | 0.2 | 0.1 |
| 11/3/22 22:42 | 11/4/22 6:05 | 0.38 | 6575 | 658 | 0 | 7233 | 111.1 | 97.1 | 70.4 | 0.38 | 0.123 | 28.8 | 0.2 | 1.5 | 0.2 |
| 11/6/22 4:11 | 11/6/22 8:51 | 0.06 | 2702 | 270 | 0 | 2972 | 10.6 | 16.6 | 6.3 | 0.05 | 0.014 | 3.7 | 0.0 | 0.2 | 0.1 |
| 11/8/22 16:17 | 11/8/22 22:48 | 0.25 | 6548 | 655 | 0 | 7202 | 11.2 | 34.2 | 5.4 | 0.11 | 0.042 | 4.4 | 0.0 | 0.4 | 0.3 |
| 11/9/22 5:45 | 11/9/22 9:06 | 0.26 | 4652 | 465 | 0 | 5117 | 18.3 | 28.5 | 10.9 | 0.09 | 0.025 | 6.4 | 0.1 | 0.4 | 0.2 |
| 11/9/22 17:54 | 11/9/22 21:39 | 0.22 | 4397 | 440 | 0 | 4836 | 7.2 | 19.6 | 3.3 | 0.15 | 0.003 | 2.6 | 0.0 | 0.2 | 0.1 |
| **Sum** | | 8.76 | 219037 | 21904 | 13039 | **227902** | 828 | 1281 | 491 | 3.86 | 1.109 | 286.5 | 3.0 | 16.4 | 7.7 |
| **Average** | | | | | | | | | | | | | | | |
| **Weighted Avg** | | | | | | | | | | | | | | | |
| **STDEV** | | | | | | | | | | | | | | | |
| **Min** | | | | | | | | | | | | | | | |
| **Max** | | | | | | | | | | | | | | | |
| **Percent Capture** | | | | | | **94.6%** | **92.1%** | **91.1%** | **92.1%** | **91.9%** | **91.8%** | **91.7%** | **90.3%** | **91.1%** | **90.6%** |

< 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

City of Saint Paul
2022 East Shepard Volume Reduction Pollutant Monitoring
Table C.11
WSB Project No.: 020260

# *EAST SHEPARD VOLUME REDUCTION SUMMARY*

| Event Time Interval | | Event Loading and Volume Data | | | | |
|---|---|---|---|---|---|---|
| | | Interval Rain | Runoff Volume (1) | North Inlet Modeled Inflow Volume 1 (2) | Bypassed Volume (3) | Volume Captured by BMP (1+2-3) |
| **Start** | **End** | In. | cu-ft | | cu-ft | cu-ft |
| 6/24/2022 2:58 | 6/24/2022 4:05 | 0.19 | 2882 | 749 | 1205 | 2717 |
| 6/25/2022 5:26 | 6/25/2022 7:16 | 0.06 | 7351 | 1911 | 585 | 8804 |
| 6/28/2022 7:25 | 6/28/2022 9:38 | 0.05 | 7689 | 1999 | 34 | 9654 |
| 7/4/2022 8:30 | 7/4/2022 13:11 | 0.22 | 17718 | 4607 | 819 | 21505 |
| 7/8/2022 0:50 | 7/8/2022 4:18 | 0.07 | 12183 | 3168 | 50 | 15300 |
| 7/17/2022 14:19 | 7/17/2022 15:07 | 0.51 | 3782 | 983 | 3190 | 2440 |
| 7/23/2022 14:20 | 7/23/2022 15:25 | 0.29 | 2745 | 714 | 1838 | 2638 |
| 7/26/2022 21:29 | 7/26/2022 23:29 | 0.08 | 7990 | 2077 | 189 | 9912 |
| 8/6/2022 9:15 | 8/6/2022 11:34 | 0.39 | 6612 | 1719 | 2739 | 5593 |
| 8/7/2022 20:38 | 8/8/2022 0:48 | 0.61 | 18405 | 4785 | 9479 | 15487 |
| **Sum** | | 2.47 | 87,357 | 22,713 | 20,128 | **94,050** |
| **Average** | | | | | | |
| **Weighted Ave*** | | | | | | |
| **STDEV** | | | | | | |
| **Median** | | | | | | |
| **Min** | | | | | | |
| **Max** | | | | | | |
| **Percent Capture** | | | | | | **77.0%** |

1 - Additional stormwater is conveyed to the system from the north via a pipe along Shepard Road.
This flow is modeled using the monitored flow from the south inlet and the ratio of drainage areas.

# BUSH-DESOTO POND VOLUME AND POLLUTANT SUMMARY

| 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 | Volume | TSS | TDS | VSS | TP | Ortho-P | Chloride | Ammonia as N | Total 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 | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 5/11/22 20:44 | 5/12/22 1:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 1.87 | 94879.8 | 1613.8 | 323.4 | 442.2 | 2.60 | 0.190 | 57.81 | 1.98 | 14.65 | 2.42 |
| 5/12/22 23:15 | 5/13/22 1:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.02 | 1351.1 | 23.0 | 4.6 | 6.3 | 0.04 | 0.003 | 0.82 | 0.03 | 0.21 | 0.03 |
| 5/17/22 22:15 | 5/18/22 2:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.03 | 801.8 | 13.6 | 2.7 | 3.7 | 0.02 | 0.002 | 0.49 | 0.02 | 0.12 | 0.02 |
| 5/19/22 16:00 | 5/19/22 18:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.17 | 3903.8 | 66.4 | 13.3 | 18.2 | 0.11 | 0.008 | 2.38 | 0.08 | 0.60 | 0.10 |
| 5/20/22 3:15 | 5/20/22 7:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.05 | 1408.2 | 24.0 | 4.8 | 6.6 | 0.04 | 0.003 | 0.86 | 0.03 | 0.22 | 0.04 |
| 5/25/22 2:00 | 5/25/22 15:45 | **77.0** | **63.0** | **34.0** | **0.44** | **0.046** | **12.4** | **0.06** < | **1.60** | **0.280** < | 0.56 | 19003.2 | 91.3 | 74.7 | 40.3 | 0.52 | 0.055 | 14.71 | 0.07 | 1.90 | 0.33 |
| 5/25/22 21:45 | 5/26/22 3:30 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.05 | 1412.6 | 24.0 | 4.8 | 6.6 | 0.04 | 0.003 | 0.86 | 0.03 | 0.22 | 0.04 |
| 5/28/22 6:45 | 5/28/22 11:15 | **11.0** | 54.6 | **5.0** | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.12 | 4223.3 | 2.9 | 14.4 | 1.3 | 0.12 | 0.008 | 2.57 | 0.09 | 0.65 | 0.11 |
| 5/30/22 8:45 | 5/30/22 12:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.07 | 2023.0 | 34.4 | 6.9 | 9.4 | 0.06 | 0.004 | 1.23 | 0.04 | 0.31 | 0.05 |
| 5/30/22 20:45 | 5/30/22 23:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.13 | 5229.2 | 88.9 | 17.8 | 24.4 | 0.14 | 0.010 | 3.19 | 0.11 | 0.81 | 0.13 |
| 6/6/22 0:45 | 6/6/22 4:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.25 | 8084.0 | 137.5 | 27.6 | 37.7 | 0.22 | 0.016 | 4.93 | 0.17 | 1.25 | 0.21 |
| 6/11/22 6:45 | 6/11/22 12:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.04 | 533.2 | 9.1 | 1.8 | 2.5 | 0.01 | 0.001 | 0.32 | 0.01 | 0.08 | 0.01 |
| 6/13/22 7:30 | 6/13/22 11:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.11 | 2527.0 | 43.0 | 8.6 | 11.8 | 0.07 | 0.005 | 1.54 | 0.05 | 0.39 | 0.06 |
| 6/15/22 12:45 | 6/15/22 18:00 | **1080.0** | **50.0** | **304.0** | **0.77** | **0.010** < | **10.9** | **0.06** < | **4.30** | **0.260** < | 0.44 | 12642.2 | 852.4 | 39.5 | 239.9 | 0.61 | 0.008 | 8.60 | 0.05 | 3.39 | 0.21 |
| 6/21/22 2:30 | 6/21/22 3:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.04 | 252.4 | 4.3 | 0.9 | 1.2 | 0.01 | 0.001 | 0.15 | 0.01 | 0.04 | 0.01 |
| 6/24/22 3:00 | 6/24/22 5:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.03 | 1635.6 | 27.8 | 5.6 | 7.6 | 0.04 | 0.003 | 1.00 | 0.03 | 0.25 | 0.04 |
| 6/25/22 5:45 | 6/25/22 7:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.06 | 1095.3 | 18.6 | 3.7 | 5.1 | 0.03 | 0.002 | 0.67 | 0.02 | 0.17 | 0.03 |
| 6/28/22 3:40 | 6/28/22 8:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.09 | 954.6 | 16.2 | 3.3 | 4.4 | 0.03 | 0.002 | 0.58 | 0.02 | 0.15 | 0.02 |
| 6/30/22 4:30 | 6/30/22 6:30 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.06 | 1280.4 | 21.8 | 4.4 | 6.0 | 0.04 | 0.003 | 0.78 | 0.03 | 0.20 | 0.03 |
| 7/3/22 4:00 | 7/3/22 6:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.18 | 4649.5 | 79.1 | 15.8 | 21.7 | 0.13 | 0.009 | 2.83 | 0.10 | 0.72 | 0.12 |
| 7/4/22 8:30 | 7/4/22 12:30 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.22 | 6467.4 | 110.0 | 22.0 | 30.1 | 0.18 | 0.013 | 3.94 | 0.14 | 1.00 | 0.17 |
| 7/7/22 13:45 | 7/7/22 17:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.08 | 1252.6 | 21.3 | 4.3 | 5.8 | 0.03 | 0.003 | 0.76 | 0.03 | 0.19 | 0.03 |
| 7/8/22 1:45 | 7/8/22 7:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.16 | 888.8 | 15.1 | 3.0 | 4.1 | 0.02 | 0.002 | 0.54 | 0.02 | 0.14 | 0.02 |
| 7/12/22 19:45 | 7/12/22 22:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.20 | 1926.3 | 32.8 | 6.6 | 9.0 | 0.05 | 0.004 | 1.17 | 0.04 | 0.30 | 0.05 |
| 7/17/22 14:30 | 7/17/22 15:30 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.28 | 7343.4 | 124.9 | 25.0 | 34.2 | 0.20 | 0.015 | 4.47 | 0.15 | 1.13 | 0.19 |
| 7/23/22 13:15 | 7/23/22 15:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.09 | 2137.9 | 36.4 | 7.3 | 10.0 | 0.06 | 0.004 | 1.30 | 0.04 | 0.33 | 0.05 |
| 7/26/22 16:00 | 7/26/22 17:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.05 | 252.1 | 4.3 | 0.9 | 1.2 | 0.01 | 0.001 | 0.15 | 0.01 | 0.04 | 0.01 |
| 7/26/22 21:45 | 7/26/22 23:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.06 | 1072.3 | 18.2 | 3.7 | 5.0 | 0.03 | 0.002 | 0.65 | 0.02 | 0.17 | 0.03 |
| 8/6/22 9:17 | 8/6/22 12:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.33 | 8596.7 | 146.2 | 29.3 | 40.1 | 0.24 | 0.017 | 5.24 | 0.18 | 1.33 | 0.22 |
| 8/7/22 21:00 | 8/8/22 1:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.79 | 20387.9 | 346.8 | 69.5 | 95.0 | 0.56 | 0.041 | 12.42 | 0.43 | 3.15 | 0.52 |
| 8/12/22 6:00 | 8/12/22 10:00 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.99 | 30914.1 | 525.8 | 105.4 | 144.1 | 0.85 | 0.062 | 18.84 | 0.65 | 4.77 | 0.79 |
| 8/17/22 15:45 | 8/17/22 19:45 | **197.0** | **45.0** | **50.0** | **0.39** | **0.022** | **8.9** | **0.48** | **2.50** | **0.460** < | 1.80 | 66974.5 | 823.7 | 188.1 | 209.1 | 1.63 | 0.092 | 37.21 | 2.01 | 10.45 | 1.92 |
| 8/18/22 19:30 | 8/18/22 21:30 | **136.0** | **63.0** | **49.0** | **0.27** | **0.010** < | **13.3** | **0.31** | **2.00** | **0.520** < | 0.19 | 6184.6 | 52.5 | 24.3 | 18.9 | 0.10 | 0.004 | 5.13 | 0.12 | 0.77 | 0.20 |
| 8/19/22 13:15 | 8/19/22 16:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.19 | 6131.8 | 104.3 | 20.9 | 28.6 | 0.17 | 0.012 | 3.74 | 0.13 | 0.95 | 0.16 |
| 8/27/22 2:53 | 8/27/22 4:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.07 | 1563.6 | 26.6 | 5.3 | 7.3 | 0.04 | 0.003 | 0.95 | 0.03 | 0.24 | 0.04 |
| 8/27/22 13:00 | 8/27/22 14:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.12 | 3459.0 | 58.8 | 11.8 | 16.1 | 0.09 | 0.007 | 2.11 | 0.07 | 0.53 | 0.09 |
| 8/27/22 21:15 | 8/28/22 9:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 1.09 | 40591.2 | 690.4 | 138.3 | 189.2 | 1.11 | 0.081 | 24.73 | 0.85 | 6.27 | 1.04 |
| 8/28/22 23:45 | 8/29/22 2:15 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 1.16 | 6165.5 | 104.9 | 21.0 | 28.7 | 0.17 | 0.012 | 3.76 | 0.13 | 0.95 | 0.16 |
| 9/9/22 16:00 | 9/9/22 21:30 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.09 | 613.5 | 10.4 | 2.1 | 2.9 | 0.02 | 0.001 | 0.37 | 0.01 | 0.09 | 0.02 |
| 10/12/22 13:15 | 10/12/22 17:30 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.08 | 1312.3 | 22.3 | 4.5 | 6.1 | 0.04 | 0.003 | 0.80 | 0.03 | 0.20 | 0.03 |
| 10/14/22 11:30 | 10/14/22 19:45 | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | 0.12 | 431.5 | 7.3 | 1.5 | 2.0 | 0.01 | 0.001 | 0.26 | 0.01 | 0.07 | 0.01 |
| 11/8/22 14:45 | 11/9/22 12:45 | **261.0** | **86.0** | **50.0** | **0.39** | **0.114** | **7.0** | **0.22** | **1.70** | **0.500** | 0.44 | 8255.0 | 134.5 | 44.3 | 25.8 | 0.20 | 0.059 | 3.61 | 0.11 | 0.88 | 0.26 |
| 11/9/22 17:00 | 11/9/22 22:30 | **407.0** | **106.0** | **115.0** | **0.55** | **0.065** | **8.4** | **0.34** | **2.70** | **0.300** < | 0.14 | 4468.2 | 113.5 | 29.6 | 32.1 | 0.15 | 0.018 | 2.3 | 0.09 | 0.75 | 0.08 |
| | **Sum** | | | | | | | | | | 13.11 | 395280 | 6723 | 1347 | 1842 | 10.83 | 0.791 | 240.8 | 8.25 | 61.03 | 10.10 |
| | **Average** | 309.9 | 68.8 | 86.7 | 0.47 | 0.045 | 10.2 | 0.25 | 2.47 | 0.387 | | | | | | | | | | | |
| | **Weighted Avg** | 272.5 | 54.6 | 74.7 | 0.44 | 0.032 | 9.8 | 0.33 | 2.47 | 0.409 | | | | | | | | | | | |
| | **STDEV** | 363.2 | 23.1 | 101.3 | 0.17 | 0.040 | 2.5 | 0.17 | 1.00 | 0.119 | | | | | | | | | | | |
| | **Min** | 11.0 | 45.0 | 5.0 | 0.27 | 0.010 | 7.0 | 0.06 | 1.60 | 0.260 | | | | | | | | | | | |
| | **Max** | 1080.0 | 106.0 | 304.0 | 0.77 | 0.114 | 13.3 | 0.48 | 4.30 | 0.520 | | | | | | | | | | | |

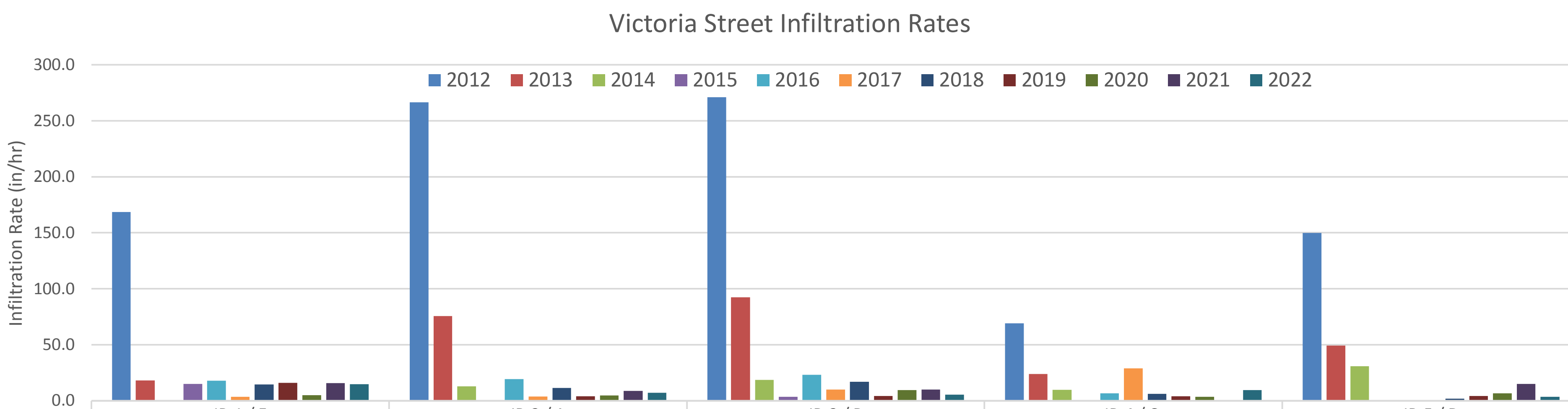
< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
**BOLD** Sampling event

# BUSH-DESOTO POND VOLUME AND POLLUTANT SUMMARY

| 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 | Volume | TSS | TDS | VSS | TP | Ortho-P | Chloride | Ammonia as N | Total 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 | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 5/11/22 20:44 | 5/12/22 2:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 1.87 | 94962 | 1597.0 | 317.6 | 442.0 | 2.61 | 0.177 | 58.60 | 1.98 | 13.00 | 2.23 |
| 5/12/22 23:12 | 5/13/22 0:44 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.02 | 1271 | 21.4 | 4.3 | 5.9 | 0.03 | 0.002 | 0.78 | 0.03 | 0.17 | 0.03 |
| 5/17/22 22:15 | 5/18/22 2:00 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.03 | 802 | 13.5 | 2.7 | 3.7 | 0.02 | 0.001 | 0.49 | 0.02 | 0.11 | 0.02 |
| 5/19/22 16:00 | 5/20/22 12:45 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.22 | 5904 | 99.3 | 19.7 | 27.5 | 0.16 | 0.011 | 3.64 | 0.12 | 0.81 | 0.14 |
| 5/25/22 2:00 | 5/26/22 2:44 | **77.0** | **63.0** | **34.0** | **0.44** | **0.046** | **12.4** | **0.06** < | **1.60** | **0.28** < | 0.62 | 20737 | 99.7 | 81.6 | 44.0 | 0.57 | 0.060 | 16.05 | 0.08 | 2.07 | 0.36 |
| 5/28/22 6:45 | 5/28/22 10:30 | **11.0** | *54* | **5.0** | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.12 | 4163 | 2.9 | 13.9 | 1.3 | 0.11 | 0.008 | 2.57 | 0.09 | 0.57 | 0.10 |
| 5/30/22 8:45 | 5/30/22 23:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.20 | 7700 | 129.5 | 25.8 | 35.8 | 0.21 | 0.014 | 4.75 | 0.16 | 1.05 | 0.18 |
| 6/6/22 0:45 | 6/7/22 1:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.26 | 8558 | 143.9 | 28.6 | 39.8 | 0.23 | 0.016 | 5.28 | 0.18 | 1.17 | 0.20 |
| 6/11/22 6:41 | 6/11/22 12:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.04 | 533 | 9.0 | 1.8 | 2.5 | 0.01 | 0.001 | 0.33 | 0.01 | 0.07 | 0.01 |
| 6/13/22 7:30 | 6/13/22 12:00 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.11 | 2552 | 42.9 | 8.5 | 11.9 | 0.07 | 0.005 | 1.57 | 0.05 | 0.35 | 0.06 |
| 6/15/22 12:45 | 6/15/22 18:00 | **1080.0** | **50.0** | **304.0** | **0.77** | **0.010** < | **10.9** | **0.06** < | **4.30** | **0.260<** | 0.44 | 12642 | 852.4 | 39.5 | 239.9 | 0.61 | 0.008 | 8.60 | 0.05 | 3.39 | ND |
| 6/21/22 2:30 | 6/21/22 3:45 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.04 | 252 | 4.2 | 0.8 | 1.2 | 0.01 | 0.000 | 0.16 | 0.01 | 0.03 | 0.01 |
| 6/24/22 3:00 | 6/24/22 4:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.03 | 1600 | 26.9 | 5.4 | 7.4 | 0.04 | 0.003 | 1.0 | 0.03 | 0.22 | 0.04 |
| 6/25/22 5:45 | 6/25/22 8:00 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.06 | 1108 | 18.6 | 3.7 | 5.2 | 0.03 | 0.002 | 0.7 | 0.02 | 0.15 | 0.03 |
| 6/28/22 3:40 | 6/28/22 8:45 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.09 | 955 | 16.1 | 3.2 | 4.4 | 0.03 | 0.002 | 0.6 | 0.02 | 0.13 | 0.02 |
| 6/30/22 4:45 | 6/30/22 11:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.06 | 1398 | 23.5 | 4.7 | 6.5 | 0.04 | 0.003 | 0.9 | 0.03 | 0.19 | 0.03 |
| 7/3/22 3:59 | 7/3/22 6:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.17 | 4658 | 78.3 | 15.6 | 21.7 | 0.13 | 0.009 | 2.9 | 0.10 | 0.64 | 0.11 |
| 7/4/22 8:29 | 7/4/22 13:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.22 | 6504 | 109.4 | 21.8 | 30.3 | 0.18 | 0.012 | 4.0 | 0.14 | 0.89 | 0.15 |
| 7/7/22 13:44 | 7/7/22 17:45 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.08 | 1253 | 21.1 | 4.2 | 5.8 | 0.03 | 0.002 | 0.8 | 0.03 | 0.17 | 0.03 |
| 7/8/22 2:00 | 7/8/22 8:00 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.06 | 920 | 15.5 | 3.1 | 4.3 | 0.03 | 0.002 | 0.6 | 0.02 | 0.13 | 0.02 |
| 7/10/22 15:00 | 7/10/22 19:00 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.03 | 83 | 1.4 | 0.3 | 0.4 | 0.00 | 0.000 | 0.1 | 0.00 | 0.01 | 0.00 |
| 7/11/22 19:00 | 7/12/22 22:45 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.20 | 2058 | 34.6 | 6.9 | 9.6 | 0.06 | 0.004 | 1.3 | 0.04 | 0.28 | 0.05 |
| 7/17/22 14:29 | 7/17/22 15:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.16 | 7343 | 123.5 | 24.6 | 34.2 | 0.20 | 0.014 | 4.5 | 0.15 | 1.01 | 0.17 |
| 7/23/22 13:15 | 7/23/22 15:45 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.09 | 2138 | 36.0 | 7.1 | 10.0 | 0.06 | 0.004 | 1.3 | 0.04 | 0.29 | 0.05 |
| 7/26/22 16:06 | 7/26/22 22:45 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.11 | 1320 | 22.2 | 4.4 | 6.1 | 0.04 | 0.002 | 0.8 | 0.03 | 0.18 | 0.03 |
| 7/31/22 20:51 | 8/5/22 11:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.09 | 83 | 1.4 | 0.3 | 0.4 | 0.00 | 0.000 | 0.1 | 0.00 | 0.01 | 0.00 |
| 8/6/22 9:17 | 8/6/22 12:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.33 | 8597 | 144.6 | 28.8 | 40.0 | 0.24 | 0.016 | 5.3 | 0.18 | 1.18 | 0.20 |
| 8/7/22 20:59 | 8/8/22 1:00 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.79 | 20372 | 342.6 | 68.1 | 94.8 | 0.56 | 0.038 | 12.6 | 0.42 | 2.79 | 0.48 |
| 8/12/22 5:45 | 8/12/22 10:00 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.98 | 30609 | 514.8 | 102.4 | 142.5 | 0.84 | 0.057 | 18.9 | 0.64 | 4.19 | 0.72 |
| 8/17/22 15:44 | 8/17/22 19:45 | **197.0** | **45.0** | **50.0** | **0.39** | **0.022** | **8.9** | **0.48** | **2.50** | **0.46** < | 1.80 | 66974 | 823.7 | 188.1 | 209.1 | 1.63 | 0.092 | 37.2 | 2.01 | 10.45 | 1.92 |
| 8/18/22 19:30 | 8/18/22 21:30 | **136.0** | **63.0** | **49.0** | **0.27** | **0.010** < | **13.3** | **0.31** | **2.00** | **0.52** < | 0.19 | 6185 | 52.5 | 24.3 | 18.9 | 0.10 | 0.004 | 5.1 | 0.12 | 0.77 | 0.20 |
| 8/19/22 13:04 | 8/19/22 20:05 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.21 | 6609 | 111.1 | 22.1 | 30.8 | 0.18 | 0.012 | 4.1 | 0.14 | 0.90 | 0.16 |
| 8/27/22 2:53 | 8/28/22 6:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 1.26 | 45257 | 761.1 | 151.4 | 210.7 | 1.24 | 0.084 | 27.9 | 0.94 | 6.20 | 1.06 |
| 8/28/22 23:41 | 8/29/22 2:10 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.27 | 6151 | 103.4 | 20.6 | 28.6 | 0.17 | 0.011 | 3.8 | 0.13 | 0.84 | 0.14 |
| 9/9/22 15:45 | 9/9/22 21:27 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.09 | 251 | 4.2 | 0.8 | 1.2 | 0.01 | 0.000 | 0.2 | 0.01 | 0.03 | 0.01 |
| 9/20/22 22:15 | 9/21/22 5:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.05 | 21 | 0.3 | 0.1 | 0.1 | 0.00 | 0.000 | 0.0 | 0.00 | 0.00 | 0.00 |
| 10/7/22 2:15 | 10/7/22 5:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.04 | 64 | 1.1 | 0.2 | 0.3 | 0.00 | 0.000 | 0.0 | 0.00 | 0.01 | 0.00 |
| 10/12/22 13:15 | 10/12/22 17:15 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.08 | 1021 | 17.2 | 3.4 | 4.8 | 0.03 | 0.002 | 0.6 | 0.02 | 0.14 | 0.02 |
| 10/14/22 11:30 | 10/14/22 19:30 | *269* | *54* | *75* | *0.4* | *0.03* | *10* | *0.3* | *2.2* | *0.4* | 0.12 | 338 | 5.7 | 1.1 | 1.6 | 0.01 | 0.001 | 0.2 | 0.01 | 0.05 | 0.01 |
| 11/8/22 15:00 | 11/9/22 9:01 | **261.0** | **86.0** | **50.0** | **0.39** | **0.114** | **7.0** | **0.22** | **1.70** | **0.50** | 0.43 | 5014 | 81.7 | 26.9 | 15.7 | 0.12 | 0.036 | 2.2 | 0.07 | 0.53 | 0.16 |
| 11/9/22 17:14 | 11/9/22 20:00 | **407.0** | **106.0** | **115.0** | **0.55** | **0.065** | **8.4** | **0.34** | **2.70** | **0.30** < | 0.14 | 3871 | 98.4 | 25.6 | 27.8 | 0.13 | 0.016 | 2.0 | 0.08 | 0.65 | 0.07 |
| | **Sum** | | | | | | | | | | 12.20 | 392829 | 6606 | 1314 | 1829 | 10.78 | 0.731 | 242.4 | 8.18 | 55.86 | 9.24 |
| | **Average** | 309.9 | 68.8 | 86.7 | 0.47 | 0.045 | 10.2 | 0.25 | 2.47 | 0.41 | | | | | | | | | | | |
| | **Weighted Avg** | 269.4 | 53.6 | 74.6 | 0.44 | 0.030 | 9.9 | 0.33 | 2.19 | 0.38 | | | | | | | | | | | |
| | **STDEV** | 363.2 | 23.1 | 101.3 | 0.17 | 0.040 | 2.5 | 0.17 | 1.00 | 0.11 | | | | | | | | | | | |
| | **Min** | 11.0 | 45.0 | 5.0 | 0.27 | 0.010 | 7.0 | 0.06 | 1.60 | 0.28 | | | | | | | | | | | |
| | **Max** | 1080.0 | 106.0 | 304.0 | 0.77 | 0.114 | 13.3 | 0.48 | 4.30 | 0.52 | | | | | | | | | | | |

< 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

City of Saint Paul
2022 Water Quality and Quantity Report
Chart D.1
WSB Project No.: 020260

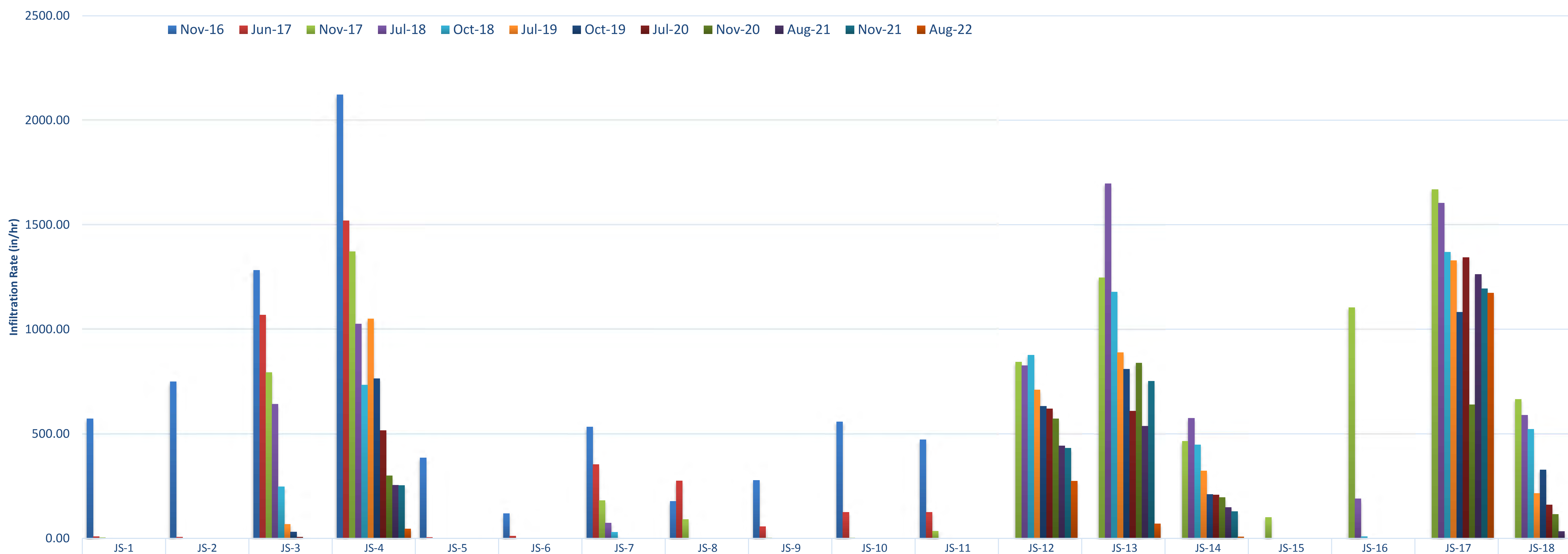



| | IR-1 / E | IR-2 / A | IR-3 / B | IR-4 / C | IR-5 / D |
|---|---|---|---|---|---|
| 2012 | 168.6 | 266.6 | 271.1 | 69.1 | 149.8 |
| 2013 | 18.1 | 75.7 | 92.2 | 24.0 | 49.2 |
| 2014 | 0.0 | 12.9 | 18.6 | 9.7 | 30.8 |
| 2015 | 15.1 | 0.0 | 3.4 | 0.0 | 0.0 |
| 2016 | 17.8 | 19.4 | 23.0 | 6.5 | 0.0 |
| 2017 | 3.4 | 3.8 | 10.1 | 28.9 | 0.0 |
| 2018 | 14.5 | 11.5 | 16.9 | 6.2 | 1.9 |
| 2019 | 15.9 | 4.1 | 4.4 | 4.0 | 4.2 |
| 2020 | 4.9 | 4.7 | 9.4 | 3.7 | 6.6 |
| 2021 | 15.6 | 8.8 | 10.1 | 0.0 | 15.0 |
| 2022 | 14.8 | 7.0 | 5.3 | 9.5 | 3.6 |

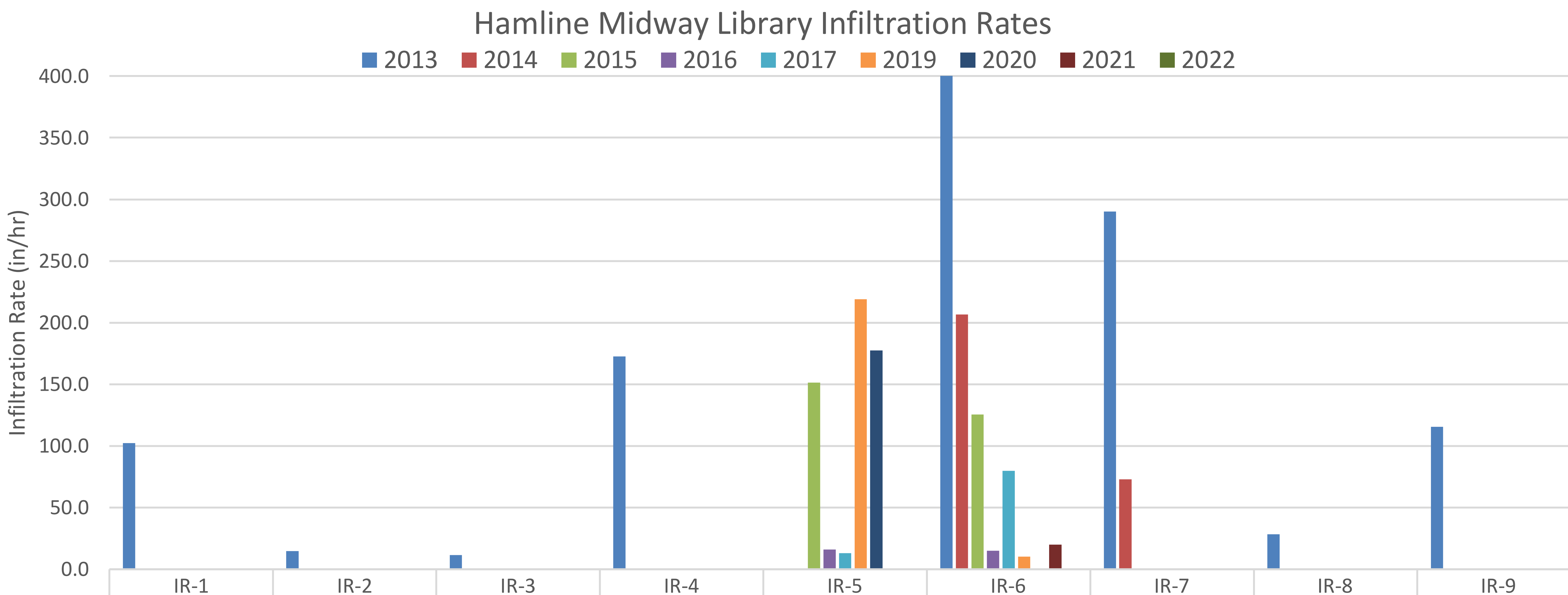
Monitoring Location

City of Saint Paul
2021 Water Quality and Quantity Report
Chart D.2
WSB Project No.: 017903

## Jackson Street Infiltration Rates




| | 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 |



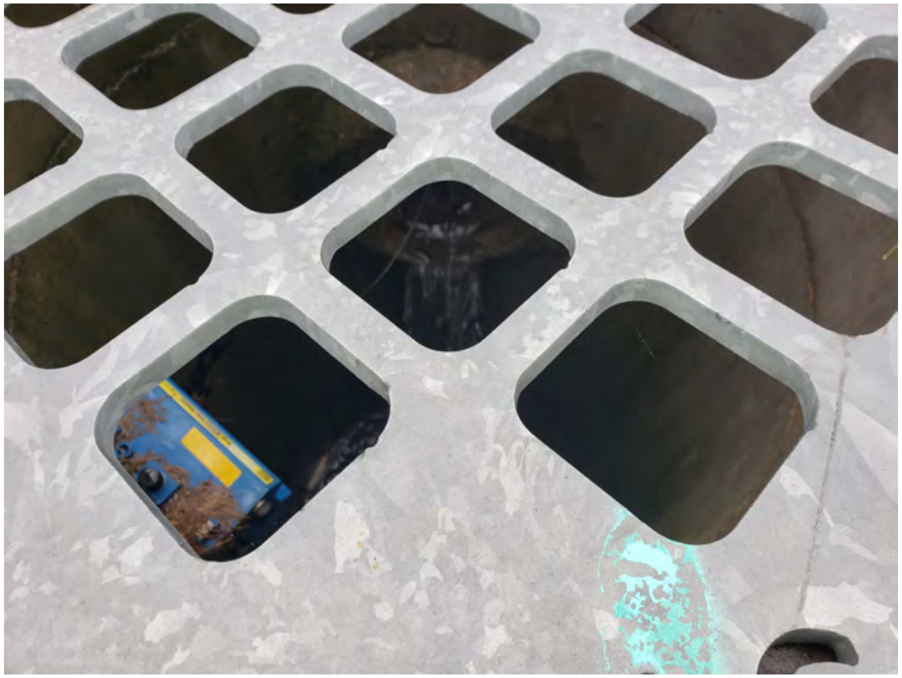

| | IR-1 | IR-2 | IR-3 | IR-4 | IR-5 | IR-6 | IR-7 | IR-8 | IR-9 |
|---|---|---|---|---|---|---|---|---|---|
| 2013 | 102.4 | 14.9 | 11.4 | 172.7 | 0.0 | 1125.3 | 290.2 | 28.4 | 115.6 |
| 2014 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 206.7 | 73.0 | 0.0 | 0.0 |
| 2015 | 0.0 | 0.0 | 0.0 | 0.0 | 151.5 | 125.6 | 0.0 | 0.0 | 0.0 |
| 2016 | 0.0 | 0.0 | 0.0 | 0.0 | 16.0 | 15.0 | 0.0 | 0.0 | 0.0 |
| 2017 | 0.0 | 0.0 | 0.0 | 0.0 | 13.1 | 79.9 | 0.0 | 0.0 | 0.0 |
| 2019 | 0.0 | 0.0 | 0.0 | 0.0 | 219.0 | 10.3 | 0.0 | 0.0 | 0.0 |
| 2020 | 0.0 | 0.0 | 0.0 | 0.0 | 177.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2021 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 19.8 | 0.0 | 0.0 | 0.0 |
| 2022 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Beacon Bluff Rain Garden - 4/6/22

Beacon Bluff SAFL Baffle and Rain Garden - 5/13/22

# Beacon Bluff Rain Garden – 8/12/22

Beacon Bluff Outlet Control Structure and West Pond Outlet – 8/12/22



# Beacon Bluff OCS, Rain Garden and SAFL Baffle - 8/18/22

Beacon Bluff – 8/31/22

Sensor Damage at Beacon Bluff – 8/18/22

Beacon Bluff SAFL Baffle– 9/27/22

Beacon Bluff  Rain Garden and SAFL Baffle – 10/26/22

# Bush-Desoto Pond – 4/13/22

Bush-Desoto Pond - 8/23/22

# Hampden Park BMP – 5/12/22



# Hampden Park BMP - 8/31/23

# Hampden Park BMP - 9/27/22

Hamline-Midway Library 8/15/22

# Saint Albans BMP – 8/31/22

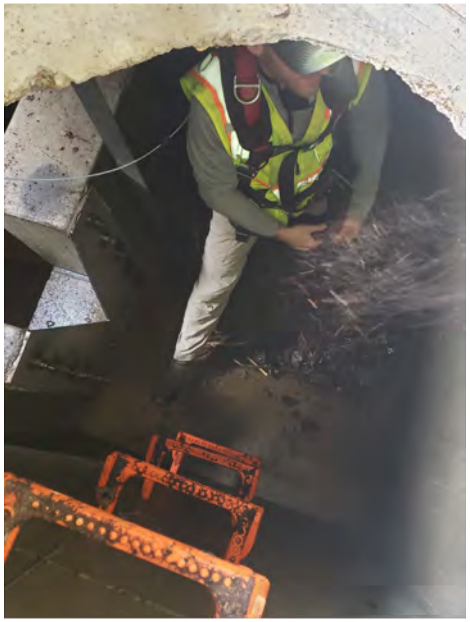
Saint Albans BMP – 9/27/22

Baseflow at East Shepard Pond 4/13/22

East Shepard Pond 4/20/23

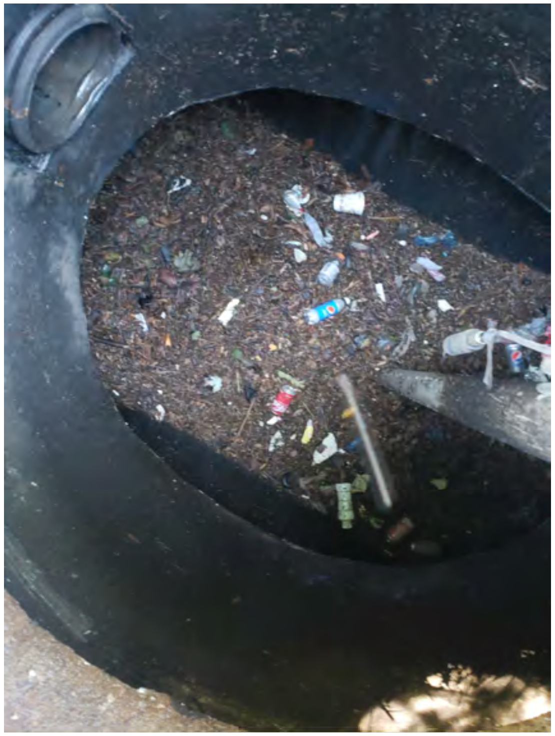
West Shepard Pond 4/20/22

East Shepard Pond Outlet – 5/19/22



# West Shepard Job Box and Reconfigure – 7/29/22


Victoria BMP – 8/31/22



# Victoria BMP – 9/27/22

Victoria BMP – 10/31/22

# STORMWATER MONITORING PROTOCOL

**2022 Stormwater Monitoring Program**
**Field Standard Operating Procedures**

**FOR THE CITY OF**
**ST. PAUL, MINNESOTA**

wsb

# 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. <u>Lightning safety is especially important due to the likelihood of thunderstorms during stormwater sampling events</u>
- 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:

<u>Permits/Notifications:</u>

- 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 <u>Entering and Working in Confined Spaces</u>, 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 Shepard Road Ponds:

The Shepher Road Ponds are two clay-lined ponds that receive water from the east and west along Shepard, just under the Smith Avenue Bridge. The water from each pond then flow to the main sewer line.

Equipment:

- 4 – ISCO 2150 Area Velocity Sensors
- 2 – Level Troll 500
  - East and West Pond
- 2 – 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 Bush-Desoto Pond:**

The Bush-Desoto Pond receives flow from a 54" pipe flowing under Bush in East St. Paul. On the opposite end of the field is another pipe drains any water that doesn't infiltrate in the field. The current condition of the field has a channel connecting the two pipes.

Equipment:

1 – ISCO 2150 Area Velocity Sensor (54" pipe)
1 – ISCO 6712 Portable Water Quality Sampler

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 SystemsFrequency:
- Once per month

Visual Inspection:
- 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

Manual Data Collection:
- 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

Required Equipment:
- Measuring rod
- Digital camera

Required Forms:
- Infiltration BMP Inspection and Maintenance Form

### V.1 Pervious Pavement Infiltration Tests

Frequency:
- Once per year

Visual Inspection:
- 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:

Sampling Locations:

- Man holes up stream of the automatic samplers

Procedures:

- 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

Required Equipment:

- 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

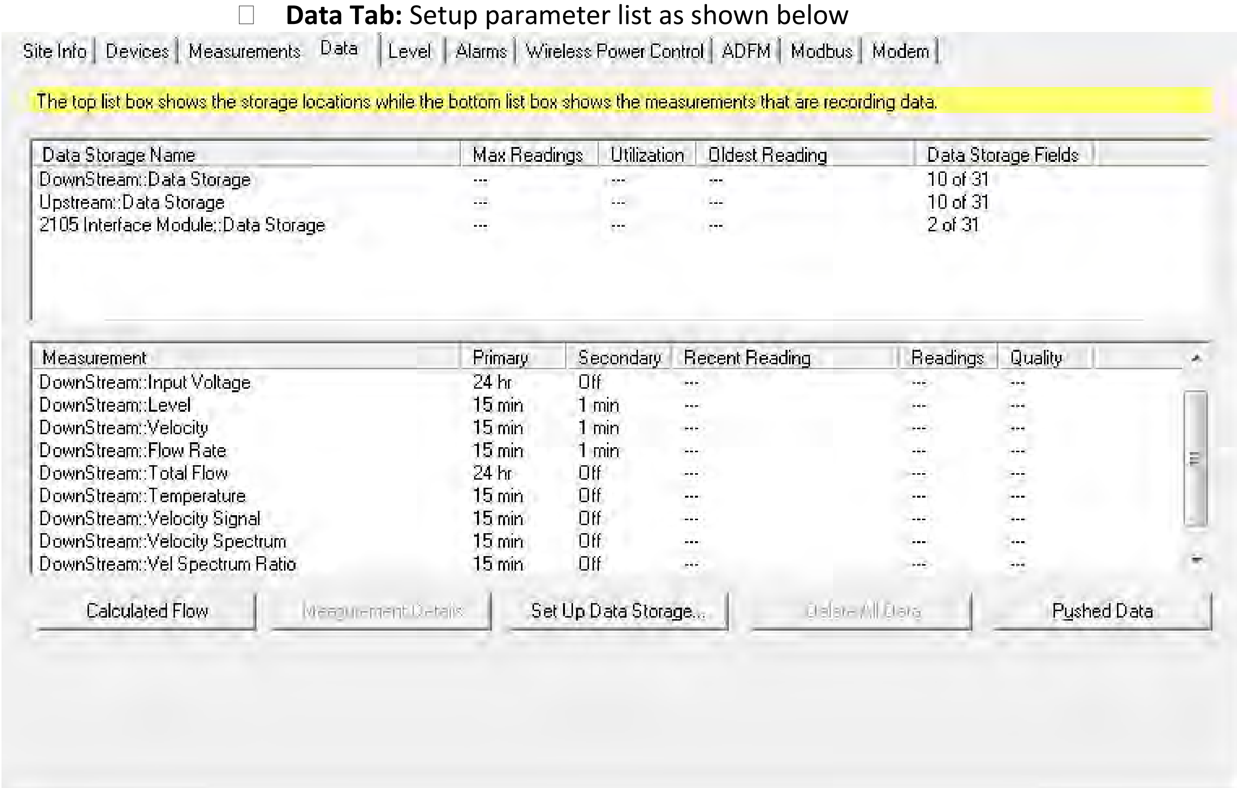
# VII. Operation and Maintenance of Monitoring Equipment

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]:

<u>Setup/Initialization:</u>

- **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*

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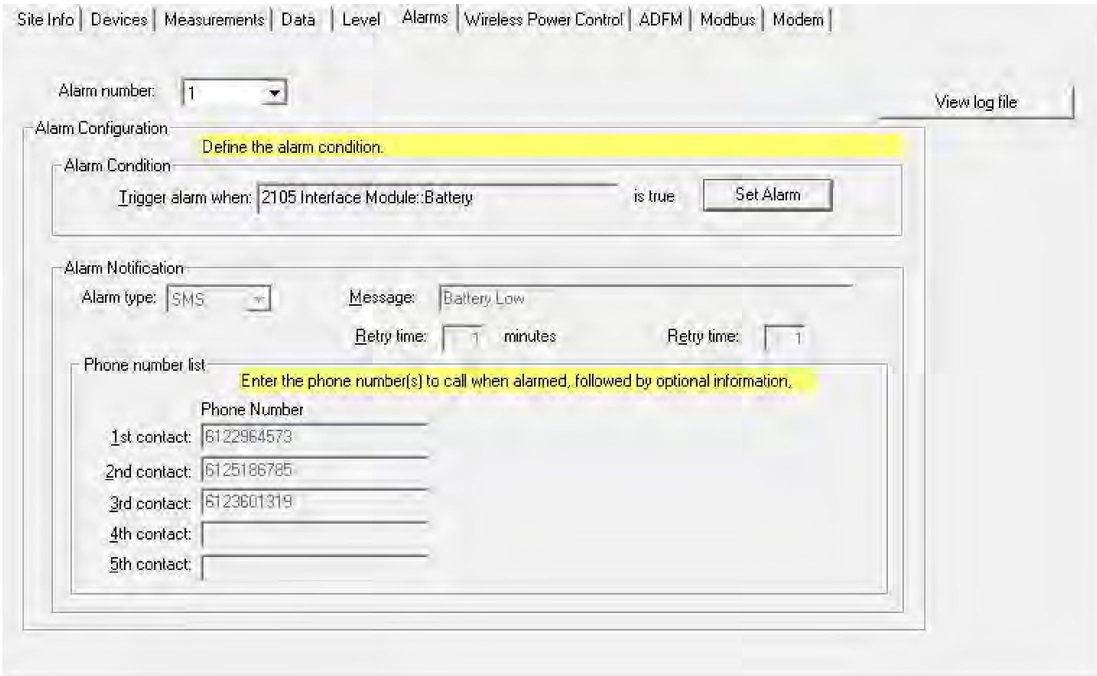
[3] See <u>2150 Area Velocity Flow Module and Sensor – Installation and Operation Guide</u>, Teledyne ISCO, Rev. March 9, 2011.

[4] See <u>2105 Interface Module – Installation and Operation Guide</u>, 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:**
  - o **Set Up Data Storage:** Select “Enable Logging”
  - o **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
  - o **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:

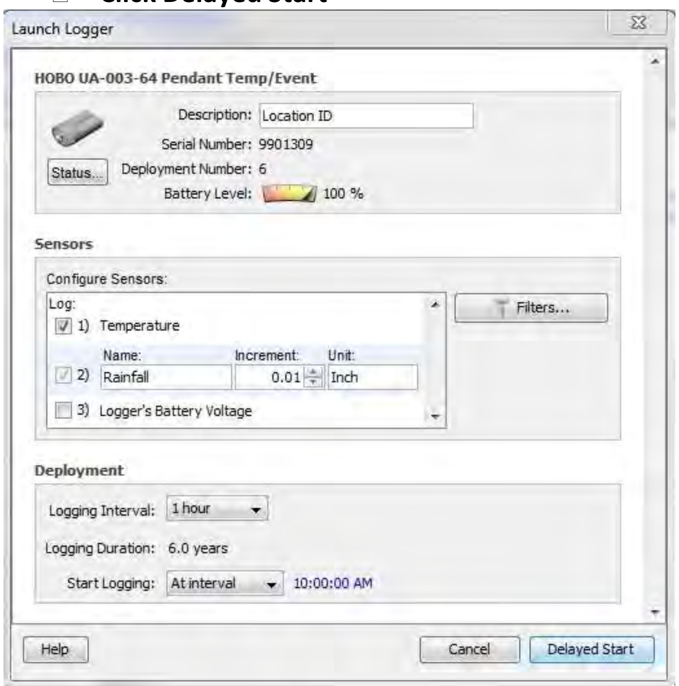
[5] See 6712 Portable Samplers – Installation and Operation Guide, Teledyne ISCO, Rev. April 11, 2011.

- **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)

Designation: C1701/C1701M – 09

# Standard Test Method for Infiltration Rate of In Place Pervious Concrete[1]

This standard is issued under the fixed designation C1701/C1701M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of the field water infiltration rate of in place pervious concrete.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 The text of this standard references notes that provide explanatory material. These notes shall not be considered as requirements of the standard.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

C125 Terminology Relating to Concrete and Concrete Aggregates

C920 Specification for Elastomeric Joint Sealants

2.2 *Other Standards*

Federal Specification A-A-3110 (TT-P-1536A) Plumbing Fixture Setting Compound[3]

## 3. Terminology

3.1 *Definitions:*

3.1.1 The terms used in this test method are defined in Terminology C125.

## 4. Summary of Test Method

4.1 An infiltration ring is temporarily sealed to the surface of a pervious pavement. After prewetting the test location, a given mass of water is introduced into the ring and the time for the water to infiltrate the pavement is recorded. The infiltration rate is calculated in accordance with 9.1.

## 5. Significance and Use

5.1 Tests performed at the same location across a span of years may be used to detect a reduction of infiltration rate of the pervious concrete, thereby identifying the need for remediation.

5.2 The infiltration rate obtained by this method is valid only for the localized area of the pavement where the test is conducted. To determine the infiltration rate of the entire pervious pavement multiple locations must be tested and the results averaged.

5.3 The field infiltration rate is typically established by the design engineer of record and is a function of the design precipitation event.

5.4 This test method does not measure the influence on in-place infiltration rate due to sealing of voids near the bottom of the pervious concrete slab. Visual inspection of concrete cores is the best approach for determining sealing of voids near the bottom of the pervious concrete slab.

## 6. Apparatus

6.1 *Infiltration Ring*—A cylindrical ring, open at both ends (See Fig. 1). The ring shall be watertight, sufficiently rigid to retain its form when filled with water, and shall have a diameter of 300 ± 10 mm [12.0 ± 0.5 in.] with a minimum height of 50 mm [2.0 in.]. The bottom edge of the ring shall be even. The inner surface of the ring shall be marked or scored with two lines at a distance of 10 and 15 mm [0.40 and 0.60 in.] from the bottom of the ring. Measure and record the inner diameter of the ring to the nearest 1 mm [0.05 in.].

NOTE 1—Ring materials that have been found to be suitable include steel, aluminum, rigid plastic, and PVC.

6.2 *Balance*—A balance or scale accurate to 10 g [0.02 lb].

6.3 *Container*—A cylindrical container typically made of plastic having a volume of at least 20 L [5 gal], and from which water may be easily poured at a controlled rate into the infiltration ring.

6.4 *Stop Watch*—Accurate to 0.1 s.

6.5 *Plumbers Putty (Non-Hardening)*—Meeting Specification C920 or Federal Specification A-A-3110.

6.6 *Water*—Potable water.

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.49 on Pervious Concrete.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] http://www.everyspec.com

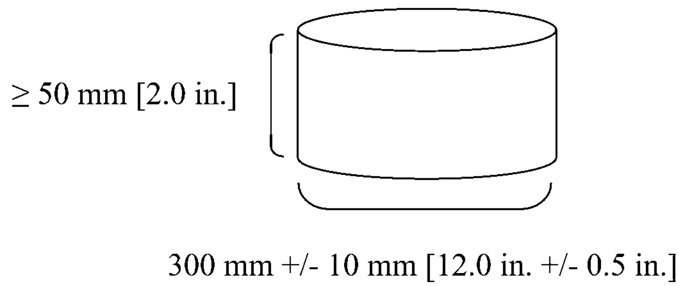


**FIG. 1 Dimensions of Infiltration Ring**

## 7. Test Locations

7.1 Perform tests at multiple locations at a site as requested by the purchaser of testing services. Unless otherwise specified, use the following to determine the number of tests to perform:

7.1.1 Three test locations for areas up to 2,500 $m^2$ [25,000 $ft^2$].

7.1.2 Add one test location for each additional 1,000 $m^2$ [10,000 $ft^2$] or fraction thereof.

7.2 Provide at least 1 m [3 ft] clear distance between test locations, unless at least 24 h have elapsed between tests.

7.3 Do not test if there is standing water on top of the pervious concrete. Do not test within 24 h of the last precipitation.

## 8. Procedure

8.1 *Infiltration Ring Installation*—Clean the pavement surface by only brooming off trash, debris, and other non-seated material. Apply plumbers putty around the bottom edge of the ring and place the ring onto the pervious concrete surface being tested. Press the putty into the surface and around the bottom edge of the ring to create a watertight seal. Place additional putty as needed

NOTE 2—In a hot environment where the surface temperature is over 38 °C [100 °F] plumbers putty may not adhere to the concrete surface easily. Therefore it is advisable to perform this test during cooler temperature.

8.2 *Prewetting*—Pour water into the ring at a rate sufficient to maintain a head between the two marked lines. Use a total of 3.60 ± 0.05 kg [8.0 ± 0.1 lb] of water. Begin timing as soon as the water impacts the pervious concrete surface. Stop timing when free water is no longer present on the pervious surface. Record the amount of elapsed time to the nearest 0.1 s.

8.3 *Test*—The test shall be started within 2 min after the completion of the prewetting. If the elapsed time in the prewetting stage is less than 30 s, then use a total of 18.00 ± 0.05 kg [40.00 ± 0.1 lb] of water. If the elapsed time in the prewetting stage is greater than or equal to 30 s, then use a total of 3.60 ± 0.05 kg [8.0 ± 0.1 lb] of water. Record the weight of water to the nearest 10 g [0.02 lb] (M). Pour the water into the ring at a rate sufficient to maintain a head between the two marked lines and until the measured amount of water has been used. Begin timing as soon as the water impacts the pervious concrete surface. Stop timing when free water is no longer present on the pervious surface. Record the testing duration (t) to the nearest 0.1 s.

NOTE 3—If a sloped pavement is being measured, maintain head between the two marked lines at the lowest point of the slope.

8.4 If a test is repeated at the same location, the repeat test does not require pre-wetting if conducted within 5 min after completion of the first test. If more than one test is conducted at a location on a given day, the infiltration rate at that location on that day shall be calculated as the average of the two tests. Do not repeat this test more than twice at the same location on a given day.

## 9. Calculation

9.1 Calculate the infiltration rate ($I$) using consistent units as follows:

$$I = \frac{KM}{(D^2 * t)}$$

where:

$I$ = Infiltration rate, mm/h [in./h],
$M$ = Mass of infiltrated water, kg [lb],
$D$ = Inside diameter of infiltration ring, mm [in.],
$t$ = time required for measured amount of water to infiltrate the concrete, s, and
$K$ = 4 583 666 000 in SI units or 126 870 in [inch-pound] units.

NOTE 4—The factor $K$ has units of $(mm^3s)/(kgh)$ $[(in.^3s)/(lbh)]$ and is needed to convert the recorded data ($W$, $D$, and $t$) to the infiltration rate $I$ in mm/h [in./h].

## 10. Report

10.1 Report the following information:

10.1.1 Identification number,

10.1.2 Location,

10.1.3 Date of test,

10.1.4 Age and thickness of concrete (label Unknown if not known),

10.1.5 Time elapsed during prewetting, s,

10.1.6 Amount of rain during last event, if known, mm [in.],

10.1.7 Weight of infiltrated water, kg [lb],

10.1.8 Inside diameter of infiltration ring, mm [in.],

10.1.9 Time elapsed during infiltration test, s,

10.1.10 Infiltration rate, mm/h [in./h], and

10.1.11 Number of tests performed at each location, if applicable.

## 11. Precision and Bias

11.1 Repeatability testing was performed by a single laboratory by making 2 replicate measurements at three locations on a newly placed pervious concrete pavement. The replicate measurements were repeated daily from day 1 to day 10. The single-operator coefficient of variation of the infiltration rate at one test location was found to be 4.7 %.

11.2 The multi-operator variability data has not been developed. The reproducibility of this test method is being determined and will be available on or before October 1, 2014.

11.3 This test method has no bias because the infiltration rate of in-place pervious concrete is defined only in terms of this test method.

## 12. Keywords

12.1 concrete; infiltration; pervious; water