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Annual Monitoring Report 2014



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Annual Monitoring Report 2014

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Front Cover: River Sampling on Bridge (left), Bathymetric Mapping (top center), Mississippi River at Upper Saint Anthony Falls (top right), River Gauge Installation at North Mississippi Park Regional Park Boat Launch (bottom right).

Photographs by B. Faust and B. Jastram, MWMO



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Abstract

In 2014, the Mississippi Watershed Management Organization (MWMO) continued monitoring precipitation, bacteria in the Mississippi River, water quantity and water quality of stormwater drainage systems, and water quality of three wetlands (a.k.a. Kasota Ponds). In fall of 2014, a new stormwater monitoring site was added in the city of Fridley. The MWMO contracted the Anoka Conservation District to carry out water level monitoring activities on Sullivan Lake in Columbia Heights.

The MWMO continued monitoring the Mississippi River at five locations (cross-sections) in three different reaches to develop methods to fill hydraulic mixing data gaps in the 14-mile stretch of the Mississippi River in the MWMO. Staff also began collecting water quality samples from the Mississippi River. Samples were collected from three different reaches and near the upstream and downstream boundaries of the MWMO watershed. Bathymetry data were also collected between the Coon Rapids Dam and Lock & Dam No. 1 in fall 2014.



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Acronyms and Abbreviations

1NE	stormwater outfall near the Excel Riverside Plant in northeastern Minneapolis at RM 857.2E
2NNBC	Old Bassett's Creek Tunnel outlet at RM 854.8W
4PP	stormwater outfall near the I-35W Bridge at RM 853.2W
6UMN	stormwater outfall near the University of Minnesota Coal Storage Facility at RM 853.0E
7LSTU	Bridal Veil Tunnel outlet at RM 851.6E
10SA	Saint Anthony Village stormwater drainage system sampling location, the outlet to the river is several miles away at RM 853.2E
11CHF	stormwater outfall near the Minneapolis Public Works Fridley Water Treatment Plant's property in the Anoka County Riverfront Regional Park. at RM 859E
µS	micro Siemens
a.k.a.	also known as
ACD	Anoka Conservation District
BMP	best management practice
C	celsius
cf	cubic foot
cfs	cubic feet per second
CFU	colony forming unit
cm	centimeter
D.O.	dissolved oxygen
DI	deionized
<i>E. coli</i>	<i>Escherichia coli</i>
EPA	Environmental Protection Agency
EQuIS	MPCA's water quality database
F	fahrenheit
ft	foot
GIS	geographic information system
GPS	global positioning system
in	inch
in/hr	inches per hour
KP	Kasota Ponds
L	liter
m	meter
MCES	Metropolitan Council Environmental Services
mg	milligram
mL	milliliter
MPCA	Minnesota Pollution Control Agency
MPN	most probable number
MPRB	Minneapolis Park and Recreation Board
MR	Mississippi River

MS4	municipal separate storm sewer system
MWMO	Mississippi Watershed Management Organization
n/a	not applicable
NAVD88	North American Vertical Datum, 1988
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PCBs	polychlorinated biphenyls
ppt	parts per trillion
PVC	polyvinyl chloride
RM	river mile upstream from the confluence of the Mississippi and Ohio Rivers in Cairo, IL
SAFL	Saint Anthony Falls Laboratory at the University of Minnesota
TCMA	Twin Cities Metropolitan Area
TMDL	total maximum daily load
USACE	United States Army Corps of Engineers

Glossary

Automatic sampler: equipment that is programmed to collect water samples based on the parameters in the program. It allows for the collection of samples without staff being present during a precipitation or snow melt event

Baseflow: sustained flow in the stormwater drainage system that is the result of groundwater seepage or permitted discharge into the system

Best Management Practice: technique, measure, or structural control that is used to manage the quantity and improve the quality of stormwater runoff

Composite sample: a water sample that contains water collected during a precipitation or snow melt event at specific intervals throughout the event

Confined space: a space defined by the existence of all of the following conditions:

- Is large enough and so configured that an employee can bodily enter and perform assigned work
- Has limited or restricted means for entry or exit (for example, manholes)
- Is not designed for continuous employee occupancy

Discharge: rate of flow in a pipe or stream, expressed as a volume per unit time, most commonly cubic feet per second (cfs)

Field data: data collected at a monitoring site

Flow-paced: water samples collected with the automated sampler after a specific volume of water has passed by the area velocity sensor

Grab sample: a single water sample submitted for analysis

Illicit discharge: any discharge to the stormwater drainage system that is not composed entirely of stormwater, except for discharges allowed under a NPDES permit or water used for firefighting operations

Lab data: data that are a result of laboratory processing of a sample (i.e. nutrients, solids, and metals)

Outfall: the end of a stormwater pipe, where the stormwater enters the receiving waterbody

Pipeshed: an area of land where water from precipitation or snow melt drains into a waterbody through a man-made conveyance system of stormwater pipes (as opposed to natural systems such as streams). A pipeshed is not as elevation- and landscape-driven as a watershed

Rain duration: the number of hours of sustained precipitation. Discrete events need to be separated by eight or more hours. In rare cases, insignificant (<0.02 in) precipitation fell many hours after the main event. This was counted as a separate event

Rain event: greater than 0.01 inches of rain, eight or more hours after the last precipitation. In rare cases, insignificant (<0.02 in) precipitation that occurred less than eight hours after the last precipitation, but after many dry hours, were eliminated from the dataset

Rain intensity: calculated as the total rain event precipitation divided by the rain duration

Real-time data: data that are relayed from a monitoring site to a server and the internet where they can be viewed by MWMO staff as they are measured.

Secchi tube: a modified transparency tube that is designed to function like the traditional Secchi disk used in lake monitoring

Secondary parameters: parameters in a water sample that are measured at the monitoring site. These parameters are not analyzed at a laboratory (i.e. temperature, D.O., pH, conductivity, and transparency)

Stormflow: water flowing in stormwater pipes during storm (precipitation) and snow melt events. Stormflow in pipes is typically short in duration and has a high velocity

Stormwater: water that is not infiltrated during and immediately following a rain or snow melt event

Stormwater drainage system: a series of roadways, curbs, catch basins, pipes, and tunnels that carry stormwater or snow melt from the surface to a receiving waterbody

Stormwater tunnel: a large diameter walkable pipe designed to carry rain and melt event water to the nearest receiving waterbody. Note: sanitary and stormwater pipes are typically separated in Minnesota

Tailwater: a condition where the Mississippi River water level is high enough to enter outfalls and interfere with data collection

Total Maximum Daily Load: a calculation of the maximum amount of a pollutant that a waterbody can receive daily and still safely meet water quality standards

Watershed: an area of land where surface water (from rain or snow melt) runoff and groundwater drain into a waterbody. Watershed boundaries are defined by elevation

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Annual Monitoring Report 2014

Executive Summary

The annual monitoring report details the monitoring activities and results of the Mississippi Watershed Management Organization's (MWMO) 2014 monitoring season. Each year, MWMO staff complete an annual monitoring report summarizing the year's monitoring activities and results and outlining the next year's work plan. Current and past reports are available on the MWMO website at www.mwmo.org.

The MWMO monitors water quality in the watershed's stormwater drainage system, the Mississippi River, and wetlands. Within these systems, major factors influencing water quality include the amount of precipitation, timing of precipitation events, and land use practices in the watershed. Long-term monitoring is necessary to characterize the impact of various land use practices on surface water runoff within the MWMO and, ultimately, the Mississippi River. Water quality in the Mississippi River is also influenced by precipitation and land use practices in the entire Mississippi River basin upstream of the MWMO. Long-term monitoring of the river will aid the understanding of upstream weather patterns and land use impacts on the MWMO watershed.

The 2014 monitoring season included: collection of precipitation data from eight monitoring locations, collection of bacteria samples from seven locations in the Mississippi River and seven stormwater drainage system sites, automated collection of water quantity and water quality data from five stormwater outfall sites draining to the Mississippi River and one stormwater pipe at the jurisdictional boundary of the Cities of Saint Anthony Village and Minneapolis, collection of water quality samples from the Mississippi River, and collection of water quality samples from three wetlands. The Anoka Conservation District (ACD) collected water elevation data at Sullivan Lake for the MWMO.

Portions of the 14-mile stretch of the Mississippi River in the MWMO are listed on the Federal Clean Water Act's Section 303(d) list of impaired waters for fecal coliform. The Minnesota Pollution Control Agency (MPCA) has moved from a fecal coliform standard to an *Escherichia coli* (*E. coli*) standard, therefore all fecal coliform impairments are now evaluated with *E. coli* data. Between April and November, bacteria samples were collected at least twice per month from seven monitoring locations in the Mississippi River and seven stormwater sampling sites within the MWMO watershed. Long-term monitoring of both the river and the stormwater drainage system is necessary to evaluate *E. coli* inputs from within the watershed compared to those inputs from upstream sources. The MPCA initiated the Upper Mississippi River Bacteria Total Maximum Daily Load (TMDL) Project in 2008 to develop daily *E. coli* load limits for the Mississippi River (MPCA, 2012). In early 2013, the MPCA released its Draft Upper Mississippi River Bacteria TMDL Study and Protection Plan (MPCA, 2013). This document designated the stretch of the Mississippi River within the MWMO as a Protection Reach and deferred it for a TMDL study.

In 2014, the MWMO continued monitoring the Mississippi River at five locations (cross-sections) in three different reaches to develop methods to fill hydraulic mixing data gaps in the 14-mile stretch of the Mississippi River in the MWMO. Beginning in April, staff visited each cross-section once or twice a month until November.

Each cross-section was divided into five lateral points equally spaced across the width of the river. Water temperature, pH, dissolved oxygen, salinity, and specific conductivity measurements were taken at each point by using a multiparameter sonde. Measurements were taken at three-foot increments starting at the water surface and ending at the bottom of the river.

MWMO staff began collecting water quality samples from the Mississippi River during 2014. The purpose of monitoring the water quality of the Mississippi River is to establish baseline water quality data that can be used for the management of the river. Water quality measurements and samples were collected monthly in November and December of 2014 at six sites. Monitoring sites on the Mississippi River and within the MWMO's boundary were selected to represent three distinct reaches of the river. Each site is located either within, at the beginning of, or at the end of a river reach. Samples were collected once a month from the middle of the river at three feet below the water surface and were analyzed for nutrients, sediment, inorganics, organics, and metals.

The MWMO continued monitoring water quantity and water quality of the watershed's stormwater drainage system by monitoring baseflow, snow melt events, and rain events in seven stormwater tunnels draining to the Mississippi River. Samples were analyzed for nutrients, sediment, inorganics, organics, and metals. Water quality standards do not exist for stormwater; therefore, data were not compared to standards but are presented in subsequent sections of the annual monitoring report. The MWMO will continue to monitor stormwater drainage systems to develop a record of baseline data with which to characterize stormwater quality within the watershed. The MWMO also provided stormwater data to the MPCA for TMDL projects within the watershed.

The MWMO contracted the ACD to conduct water level monitoring activities on Sullivan Lake in Columbia Heights. A volunteer, in coordination with ACD, conducted weekly water level monitoring during 2014 between April 16 and November 5. Lake water elevation was measured 30 times during 2014. Sullivan Lake water elevations fluctuate dramatically because it receives a large amount of stormwater relative to its size and its outlet releases water in all but the lowest water conditions.

The MWMO also continued monitoring three wetlands known as Kasota Ponds. Samples were collected for nutrients, sediment, inorganics, and metals analyses. The MPCA water quality criteria indicate that wetland water quality should maintain background conditions. Background water quality has not yet been determined for MWMO wetlands.

MWMO staff collected bathymetric data on the Mississippi River between Lock & Dam No. 1 (Ford Dam) and the Coon Rapids Dam. The purpose of collecting Mississippi River bathymetric data is to provide baseline data on the morphology of the river bed.

Introduction

The annual monitoring report details the monitoring activities and results of the MWMO's 2014 monitoring season. During the first three months of the year, MWMO staff complete an annual monitoring report summarizing the previous year's monitoring activities and results and outlining the current year's work plan. Current and past reports are available on the MWMO website at www.mwmo.org.

The MWMO established the monitoring program to provide a scientific basis for identifying and evaluating water quality and quantity issues, implementing solutions to improve water quality, and reestablishing natural water regimes in the watershed. The objectives of the monitoring program are to:

- Monitor biological, chemical, and physical parameters of water resources in the watershed
- Monitor water quality within the watershed
 - Develop a record of baseline data to characterize water quality and identify pollutants that exceed water quality standards
 - Assess water resources for pollutants listed on the Minnesota Impaired Waters list for the TMDL process
- Collect rate and volume data for the Mississippi River and key subwatersheds
- Monitor performance of stormwater management practices
- Collaborate with stakeholders to identify and apply a standardized data collection and assessment approach
- Develop partnerships and collaborate with other organizations and/or agencies, both inside and outside the watershed boundaries, to improve water quality in the Mississippi River
- Assess land use impact on water quality
- Participate in the technical development and update of statewide monitoring databases
- Make data accessible to the public and public entities and to MWMO staff for use as an education tool (e.g. BMP performance data)
- Develop an emergency monitoring plan in case of emergencies affecting water resources

The 2014 monitoring season included: collection of water quality samples from eight locations in the Mississippi River and seven stormwater drainage system sites for bacteria monitoring, collection of water quality samples from six locations in the Mississippi River, automated collection of water quantity and water quality data from five stormwater outfall sites draining to the Mississippi River and one stormwater pipe at the jurisdictional boundary of the Cities of Saint Anthony Village and Minneapolis, and collection of water quality samples from three wetlands. The MWMO also contracted the ACD to carry out water level monitoring activities on Sullivan Lake in Columbia Heights.

In 2014, the MWMO continued monitoring the Mississippi River at five cross-sections in three different reaches to develop methods to fill hydraulic mixing data gaps in the MWMO's 14-mile stretch of the Mississippi River. From April until November, staff visited each of the cross-sections once or twice a month. Each cross-section was divided into five lateral points equally spaced across the width of the river. Water temperature, pH, D.O., salinity, and specific conductivity measurements were taken at each point by using a multiparameter sonde. Measurements were taken at three-foot increments starting at the water surface and ending at the bottom of the river.

Refer to Figure A.1 in Appendix A for a map of the MWMO boundary. Descriptions of the sampling sites are found in subsequent sections of this report.

Background

The MWMO was established in 1985 by a Joint Powers Agreement among member organizations. In 2012, the MWMO boundaries expanded to include portions of the Cities of Fridley and Columbia Heights and the City of Hilltop. The MWMO watershed boundaries are shown in Figure A.1 in Appendix A. The MWMO is a unique organization in that it includes a reach of the Mississippi River. Other local watershed districts and organizations include land and water resources up to the river's shore, but not extending into the river itself. The reach of the Mississippi River included in the MWMO extends from upstream of the Interstate-694 (I-694) bridge in Fridley downstream to Lock & Dam No. 1 (Ford Dam) in south Minneapolis. There are three lakes within the MWMO's boundaries: Loring Pond in Minneapolis, and Sullivan Lake (formerly known as Sandy Lake) and Highland Lake in Columbia Heights.

Minnesota regulations require that the MWMO protect water quality in the watershed. Minnesota Rules Chapter 7050 requires that all waterbodies comply with state water quality standards. Furthermore, section 303(d) of the Federal Water Pollution Control Act (commonly known as the Clean Water Act) requires states to develop TMDLs for waters with impaired uses. Impaired waters are those waters that exceed water quality standards for their classified use. Some typical classifications include drinking water and aquatic life and recreation (swimming and fishing). According to Minnesota Rules Chapter 7050, the stretch of the Mississippi River within the MWMO watershed is divided into two reaches for classification. Table 1 highlights the most restrictive classifications.

The MWMO's stretch of the Mississippi River is listed on MPCA's 303(d) list of impaired waters for fecal coliform, mercury, and polychlorinated biphenyls (PCBs). The MPCA divided the stretch of the Mississippi River flowing through the MWMO into three reaches. Table 2 lists the impaired reaches of the river and the corresponding pollutants of concern. The MPCA has written a statewide TMDL for mercury (MPCA, 2007). Both Sullivan Lake and Highland Lake are listed on the 303(d) list of impaired water for nutrient/eutrophication and biological indicators. All three of the Kasota Ponds and Loring Pond are listed on the 2014 Proposed Impaired Waters List that has not yet been approved by the United States Environmental Protection Agency (EPA), for chloride impairments.

Protecting water quality in the Mississippi River is a complicated task. The Mississippi River flowing through the MWMO is densely urbanized with commercial, industrial, residential, park lands, and downtown Minneapolis land uses contributing to the volume and quality of the water entering the river through the stormwater drainage systems. The MWMO monitors stormwater drainage systems to determine the water quantity and water quality contributions of surface runoff from the watershed to the river. However, the entire Mississippi River basin upstream of the MWMO watershed boundary also contributes to water quality in the MWMO's stretch of the river.

Table 1. Water use classifications for waterbodies in the MWMO

Waterbody	Water Use Classification
Mississippi River, MWMO upstream boundary to Upper Saint Anthony Falls	1C, Domestic consumption (drinking water) 2Bd Aquatic life and recreation and source of drinking water
Mississippi River, Upper Saint Anthony Falls to Lock & Dam 1 (Ford Dam)	2B Aquatic life and recreation
Loring Pond	2B Aquatic life and recreation
Sullivan (Sandy) Lake	2B Aquatic life and recreation
Highland (Unnamed) Lake	2B Aquatic life and recreation
Mallard Marsh	2D Aquatic life and recreation
Kasota Pond North	2D Aquatic life and recreation
Kasota Pond West	2D Aquatic life and recreation

Table 2. Pollutants in impaired waters

Impaired Waterbody	Pollutant
Mississippi River, MWMO upstream boundary to Upper Saint Anthony Falls	Fecal coliform, mercury in fish tissue, polychlorinated biphenyls (PCBs) in fish tissue
Mississippi River, Upper Saint Anthony Falls to Lower Saint Anthony Falls	Mercury in fish tissue, PCBs in fish tissue
Mississippi River, Lower Saint Anthony Falls to Lock & Dam 1 (Ford Dam)	Fecal coliform, mercury in fish tissue
Loring Pond	Chloride
Sullivan (Sandy) Lake	Nutrient/eutrophication biological indicators
Highland (Unnamed) Lake	Nutrient/eutrophication biological indicators
Mallard Marsh	Chloride
Kasota Pond North	Chloride
Kasota Pond West	Chloride

The Upper Mississippi River is a large, dynamic river system that includes runoff from forested areas near the source at Lake Itasca, agricultural runoff from the central region of Minnesota, and the urbanized areas of Saint Cloud and the Twin Cities Metro area. Since precipitation produces surface runoff, precipitation differences throughout the upper Mississippi River basin can affect water flow and water quality in the MWMO's stretch of the Mississippi River.

Thus, if large amounts of rainfall have washed pollutants from the land upstream into the river, it is possible that flows could increase and water quality could decline, even though it has not rained in the MWMO watershed. In cooperation with other federal and state agencies as well as watershed management organizations and districts, the MWMO plans to investigate the upstream impact on water quality to discern the effect precipitation in other portions of the state has on water quality in the MWMO's stretch of the Mississippi River.

Further complicating the investigation of water volume and quality in the river are the inputs of groundwater and the recharge to groundwater from the river. Groundwater may carry pollutants from upstream in the Mississippi

River basin to the MWMO's stretch of the river. Pollutants may also leach from the river into the groundwater system. It is quite difficult to track potential groundwater inputs from an area as large as the Mississippi River basin upstream of the MWMO to the MWMO's stretch of the river. The MWMO has long-term plans to coordinate with organizations and agencies in the upper portion of the basin to improve water quality in the Mississippi River.

Precipitation Monitoring

Precipitation determines surface runoff and is arguably the greatest factor controlling surface water quality. As stated in the Background section of this monitoring report, water quality in the MWMO's stretch of the Mississippi River is affected by precipitation in the entire Mississippi River basin upstream of the MWMO, including tributary watersheds to the river.

The MWMO collects precipitation data from a variety of sources, including gauges installed and operated by external entities as well as those operated by the MWMO itself. Figure 1 shows locations of those precipitation gauges. Tables 3 and 4 show 2014 monthly precipitation values for several locations in the Upper Mississippi River Basin between St. Cloud and the Minneapolis St. Paul International Airport. Table 3 includes data from non-MWMO gauges only. Precipitation data at the St. Anthony Falls Laboratory (SAFL) site were collected by SAFL personnel. Precipitation at Lock & Dam No. 1 was measured by the United States Army Corps of Engineers (USACE). Precipitation data from precipitation monitoring sites in St. Cloud, Becker, Elk River, New Hope, Chanhassen, and the Minneapolis St. Paul International Airport were downloaded from either http://www.dnr.state.mn.us/climate/historical/acis_stn_meta.html or <http://climate.umn.edu/mapClim2007/MNlocApp.asp>.

Table 4 shows monthly precipitation data from the MWMO network of precipitation gauges, located primarily within the MWMO watershed. Precipitation data at sites 1NE, 10SA, 11CHF, Edison High School, Columbia Golf Course, Waite Park Elementary School, and the MWMO Weather Station were collected by the MWMO. In May 2014, the MWMO installed a heated rain gauge with a data logger at the Waite Park Elementary School to complete its planned deployment of four heated rain gauges in and around the 1NE pipeshed. Precipitation data at site 6th ST NE were recorded and submitted by a MWMO citizen volunteer. Figure 2 shows 2014 monthly precipitation at the 1NE site in comparison to the 30-year monthly normal precipitation at Minneapolis St. Paul International Airport.

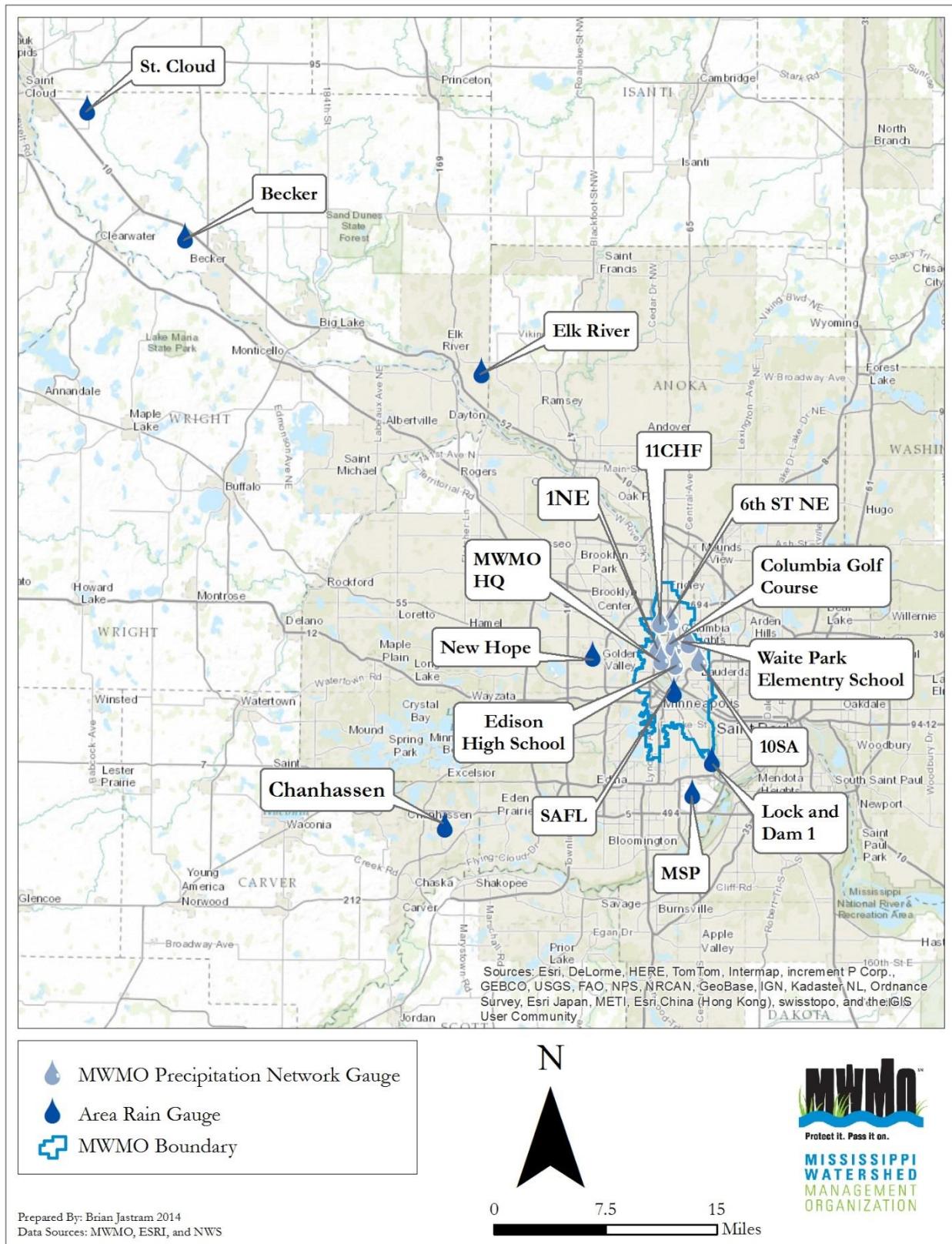


Figure 1. Precipitation gauges in the Upper Mississippi River Basin

Table 3. 2014 monthly precipitation (inches) at several locations in the Upper Mississippi River basin

	St. Becker²	Elk Cloud¹	New River³	SAFL⁵	Lock & Dam No. 1⁶	Chanhassen⁷	Minneapolis St. Paul International Airport⁸	MSP 30 YR MO Normal⁹	
January	1.34	1.21	0.99	1.47	0.10		1.32	1.42	0.90
February	1.17	1.24	1.58	1.45	0.10		1.59	1.41	0.77
March	1.20	1.01	0.87	0.89	0.15		0.70	0.82	1.89
April	5.90	7.06	6.65	7.79	4.83	4.18	7.07	6.27	2.66
May	6.74	7.42	6.28	4.79	3.40	4.48	6.81	4.55	3.36
June	6.18	6.64	9.09	8.38	7.47	11.78	8.90	11.36	4.25
July	1.25	3.48	2.02	4.07	2.46	2.05	3.26	2.27	4.04
August	5.59	5.03	3.06	2.31	2.50	3.14	2.88	2.90	4.30
September	4.06	2.35	2.52	1.89	1.73	1.99	1.41	0.92	3.08
October	0.65	0.75	0.74	1.08	1.02	2.02	0.79	1.75	2.43
November	1.89	2.54	1.55	1.30	0.20	0.37	0.73	0.87	1.77
December	0.75	0.89	1.18	1.14	0.56	0.45	0.97	0.86	1.16
Total	36.72	39.62	36.53	36.56	24.51	30.46	36.43	35.40	30.61

¹ Location: Latitude 45.54413 Longitude -94.07082, Source: http://www.dnr.state.mn.us/climate/historical/acis_stn_meta.html

² Location: Latitude 45.42064 Longitude -93.93335, Source: http://climate.umn.edu/hidradius/radius_new.asp

³ Location: Latitude 45.52726 Longitude -93.71100, Source: http://www.dnr.state.mn.us/climate/historical/acis_stn_meta.html

⁴ Location: Latitude 45.0167 Longitude -93.3667, Source: http://www.dnr.state.mn.us/climate/historical/acis_stn_meta.html

⁵ Location: Latitude 44.9823 Longitude -93.2549, Source: Personal communication with C Ellis, Saint Anthony Falls Laboratory (SAFL)

⁶ Location: Latitude 44.91497 Longitude -93.254932, Source: <http://www.mvp-wc.usace.army.mil/projects/Lock1.shtml>

⁷ Location: Latitude 44.8514 Longitude -93.5650, Source: http://www.dnr.state.mn.us/climate/historical/acis_stn_meta.html

⁸ Location: Latitude 44.88306 Longitude: -93.22889, Source: http://www.dnr.state.mn.us/climate/historical/acis_stn_meta.html

⁹ Location: Latitude 44.88306 Longitude: -93.22889, Source: http://www.ncdc.noaa.gov/cdo-web/search?datasetid=NORMAL_MLY

Table 4. 2014 monthly precipitation (inches) at several locations in the MWMO precipitation monitoring network

	1NE¹	10SA²	11CHF³	Edison	Columbia	Waite Park	6th ST	MWMO
				High School⁴	Golf Course⁵	Elementary School⁶	NE⁷	Weather Station⁸
January	0.51	0.29		0.49	0.69		0.81	0.14
February	0.80	0.30		0.88	1.07		0.80	0.12
March	0.61	1.00		0.72	0.65		0.65	0.45
April	6.30	5.23		6.75	6.70		5.69	4.41
May	3.85	3.69		4.27	4.24	2.64	3.71	2.88
June	8.01	7.16		8.70	5.83	8.26	7.01	8.67
July	2.67	2.78		2.89	3.50	3.50	2.16	0.98
August	3.08	1.61		3.31	3.66	3.89	2.74	2.67
September	1.48	1.47		1.85	1.62	1.54	1.13	1.77
October	0.98	1.00	0.87	1.18	1.17	1.16	0.88	1.15
November	0.79	0.44	0.23	0.72	0.65	0.77	1.10	0.22
December	0.50	0.67	0.43	0.57	0.67	0.62	0.88	0.48
Total	29.58	25.64	1.53	32.33	30.45	22.38	27.56	23.94

¹ Location: Latitude 45.02389 Longitude -93.2772, Source: MWMO data, 1NE

² Location: Latitude 45.01278 Longitude -93.2203, Source: MWMO data, 10SA

³ Location: Latitude 45.050 Longitude -93.274, Source: MWMO data, 11CHF

⁴ Location: Latitude 45.012 Longitude -93.22, Source: MWMO Data, Edison High School

⁵ Location: Latitude 45.027 Longitude -93.255, Source: MWMO Data, Columbia Golf Course

⁶ Location: Latitude 45.030 Longitude -93.234, Source: MWMO Data, Waite Park Elementary School

⁷ Location: Latitude 45.053 Longitude -93.259, Source: Citizen Volunteer, Minneapolis MN

⁸ Location: Latitude 45.013 Longitude -93.272, Source: MWMO Data, MWMO Weather Station

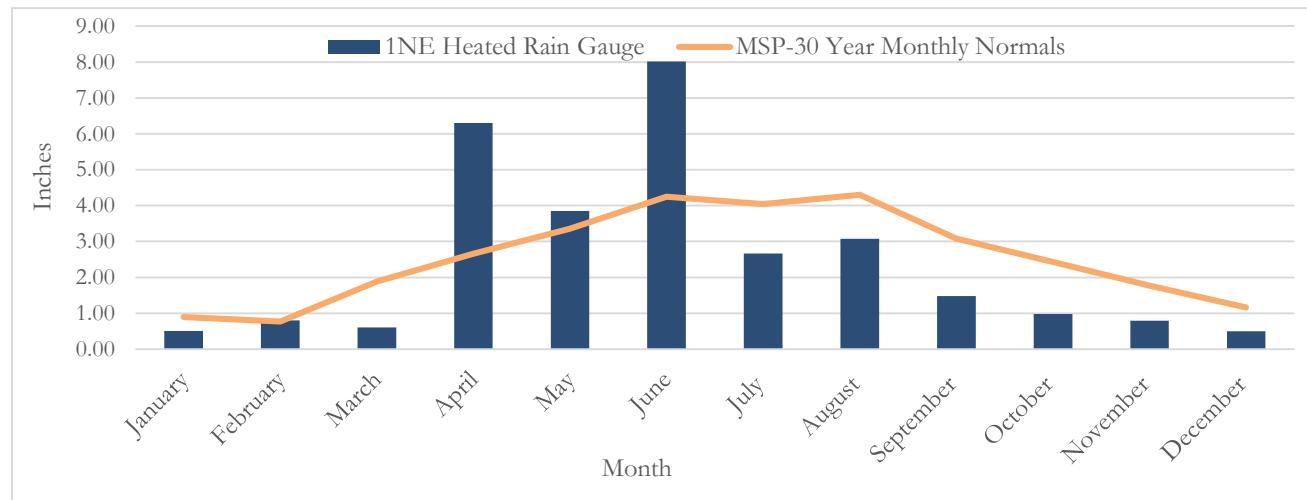


Figure 2. Monthly precipitation totals at the 1NE heated rain gauge compared to 30-year monthly precipitation normals at the Minneapolis St. Paul International Airport

The MWMO acknowledges a link between precipitation and Mississippi River water quality. However, the MWMO does not support quantitative analysis of this relationship because the precipitation data are not representative of the entire Mississippi River basin contributing to the MWMO watershed. Table B.1 in Appendix B shows which precipitation events were sampled at each stormwater monitoring site.

Stormwater Monitoring

The MWMO monitors water quantity and quality at six stormwater outfalls into the Mississippi River and one stormwater pipe at the jurisdictional boundary of the Cities of Saint Anthony Village and Minneapolis. The monitored locations were chosen because they are the most extensive stormwater drainage systems (pipesheds) within the watershed and they are accessible. A stormwater drainage system refers to the area that drains to one stormwater outfall. Land uses in the stormwater drainage systems affect water quality. The amount of impervious surface and potential pollution differs between industrial, residential, and commercial land uses. Refer to Figure 3 for a map of the MWMO's stormwater sampling sites and pipesheds.

Site descriptions and water quantity data for each stormwater site are provided in the following pages. Six of the MWMO's stormwater sites are monitored for real-time level and discharge measurements as well as water quality during both storm and baseflow conditions. Water quality data from the stormwater sites are discussed in this section and shown in Tables F.1 through F.7 in Appendix F.

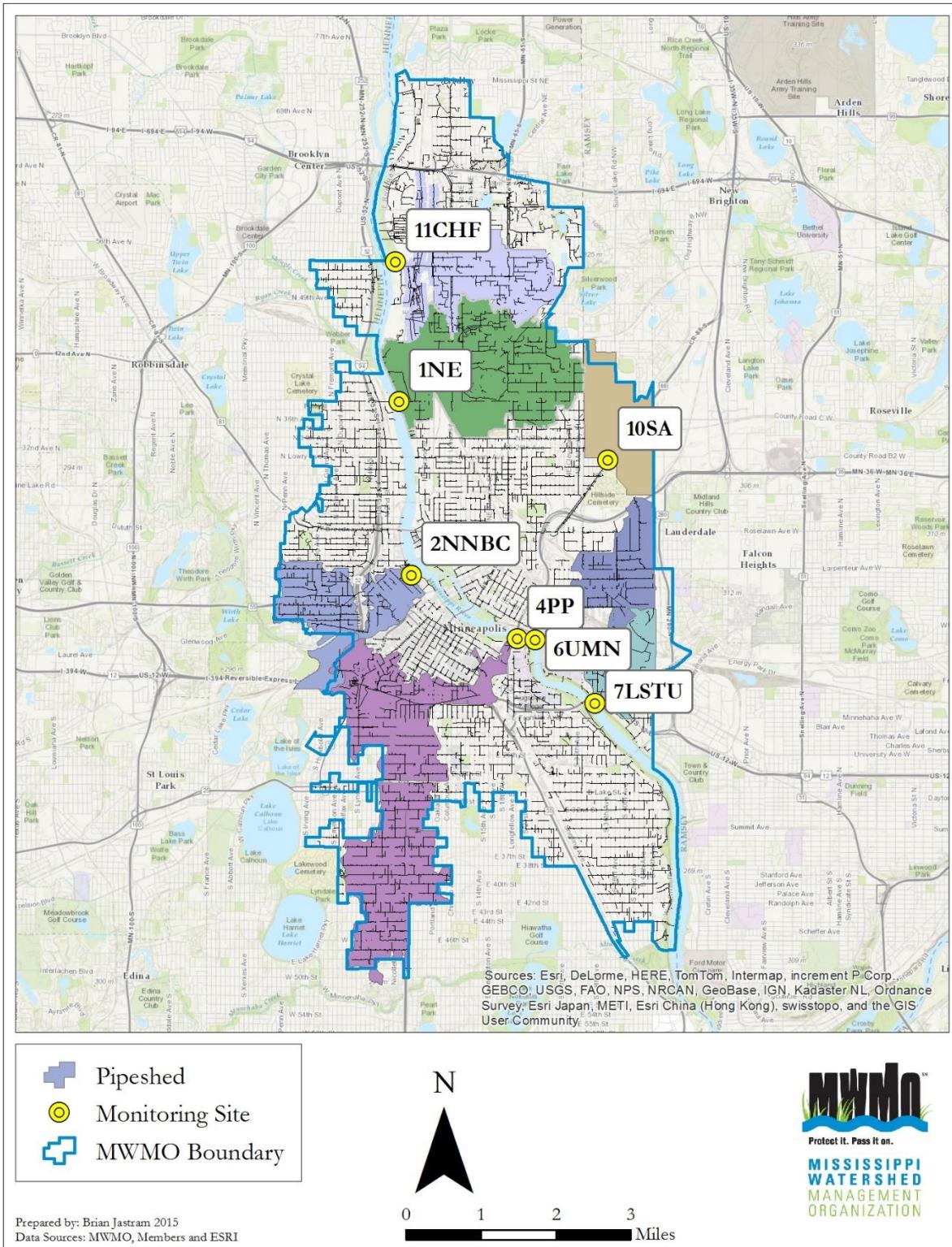


Figure 3. Stormwater pipesheds monitored by the MWMO and corresponding monitoring site locations

Methodology

Water Level and Discharge Monitoring

Water level in a stormwater pipe is very different from water level in the Mississippi River. Stormwater pipes respond quickly to rainfall, so water levels may rise many feet within a few minutes, depending on the size and intensity of the storm event. Some stormwater pipes only contain water during precipitation events, while others have baseflow throughout the year. Most stormwater pipes monitored by the MWMO have varying levels of baseflow year round.

Six MWMO stormwater monitoring sites are equipped with ISCO 6712 automatic samplers (Teledyne Isco, Inc., Lincoln, NE). An ISCO Area/Velocity sensor is installed in each of the six pipes and connected via cable to an ISCO 750 Area/Velocity Flow Module which is attached to the automated sampler. The sensor and flow module provide water level and velocity data which are then used with pipe area dimensions to compute discharge from the stormwater pipe. A typical automated stormwater site set-up is shown in Figures 4 and 5.



Figure 4. Example of a typical MWMO stormwater monitoring site cabinet set up including automated sampling and real-time monitoring equipment.



Figure 5. Typical area/velocity sensor (black rectangle) and cable configuration in a monitored stormwater tunnel

Sample Collection, Handling, and Preservation

Grab and composite samples were collected from seven stormwater sites in the MWMO watershed. Staff followed sampling procedures outlined in the MWMO's Standard Operating Procedure for Stormwater Sampling (2011). For the majority of analytes, samples were collected in laboratory-cleansed (non-sterile) eight-liter plastic bottles. Samples were either collected directly into the bottle as grab samples or with automatic samplers as described below. For all samples, bottles were capped after filled, with headspace included.

The ISCO 6712 automatic samplers house twenty-four one-liter plastic bottles for composite sample collection. Samplers were programmed such that once the water level reached a certain level above baseflow, the sampler triggered to start sampling. Once triggered, the sampler rinsed the sample tubing before drawing the sample into the containers. Samples were collected on a flow-paced basis. Once collected, the bottles were composited by pouring an equal amount of water from each sampler bottle into a two-gallon plastic bottle by a monitoring specialist. Stormwater samples were labeled and placed in a cooler for transport to the laboratory by a monitoring specialist. Samples were dropped off at the laboratory after collection of the last sample. Laboratory personnel split the sample and preserved it as needed for various analyses.

Dissolved oxygen, conductivity, salinity, temperature, and pH data were measured in the field using a YSI ProPlus sonde (YSI Inc., Yellow Springs, OH). The data were measured directly in the stormwater drainage system or in a separate container of stormwater. Transparency was measured using a Secchi tube.

Stormwater samples were collected for a minimum of three precipitation events per month, as long as that many events occurred. If baseflow conditions were present, samples were collected twice per month from March to November, and at least once per month during the winter months to assess baseflow concentration of parameters.

Sampling Quality Control

The MWMO staff followed the quality control protocol outlined in the MWMO Ambient Surface Water Monitoring Quality Assurance Project Plan (MPCA, 2010). Blank samples of DI water were submitted to laboratories once a month to verify that sample containers were clean and samples were not contaminated during travel. In addition, ten percent of all samples were collected in duplicate to verify that sampling and laboratory procedures did not jeopardize the data. The ISCO bottles were rinsed twice with tap water and once with DI water between sample events.

Laboratory Analyses

Samples were analyzed at the Metropolitan Council Environmental Services (MCES) Laboratory. The laboratory followed strict protocols for quality assurance and quality control. Information regarding laboratory protocol is available from MWMO staff. Refer to Table C.1 in Appendix C for a list of sample parameters, the laboratories used for analysis, the analysis methods, and information regarding certification.

Parameter Information

The MWMO has conducted extensive research regarding the parameters of concern. Parameter information includes definitions, sources, impact on various organisms, and water quality standards. Refer to the MWMO 2006 Annual Monitoring Report (MWMO, 2007) for the comprehensive list of parameters.

Data Analysis

The following data cleaning techniques were used to ensure quality data:

- Suspect data were flagged and verified with the laboratory
- Statistical regression techniques were used to interpolate automated flow data that were missing due to equipment problems (MWMO, 2013)

Remote Data Access Network

The MWMO designed and deployed a remote data access network in 2008. The network was designed to collect real-time monitoring data from the stormwater sites. The network provides continuous data about stormwater level, velocity, flow, precipitation, and automated sample collection. The data are available instantaneously from any computer, allowing MWMO staff to respond more quickly to sample collection and equipment problems.

The network uses radios to link six automatic water samplers to the internet, enabling the MWMO staff to view stormwater and rainfall data, along with automated sample collection, from the office. Repeater radios are located at three additional locations: the SAFL roof, the Moos Tower roof on the University of Minnesota East Bank Campus, and the Xcel Riverside Generating Plant roof. Repeater radios provide line-of-sight communication between all of the monitoring sites. Refer to Figure 6 for a map of the real-time monitoring network. Details about the specific equipment and software used in the remote data access network are included in the MMWO Annual Monitoring Report 2013 (MWMO, 2014).

Stormwater Water Quality Monitoring Results

The MPCA does not have water quality criteria for stormwater drainage systems; therefore, data are not compared with standards. The MWMO monitors stormwater to characterize surface runoff in the watershed and determine land contributions to water quality in the Mississippi River. Samples are collected for bacteria, nutrients, sediment, inorganics, organics, and metals analyses. The MWMO will not draw conclusions or make assumptions based on this data until 3 - 5 years of accurate flow-weighted composite data are available. The MWMO has begun calculating annual pollutant loads at some stormwater monitoring sites where several years of data do exist. The 2014 water quality data are presented in Tables F.1 – F.7 in Appendix F. Bacteria data are discussed in the Bacteria Monitoring section of this report. Specific information regarding individual stormwater sites can be found in the following pages.

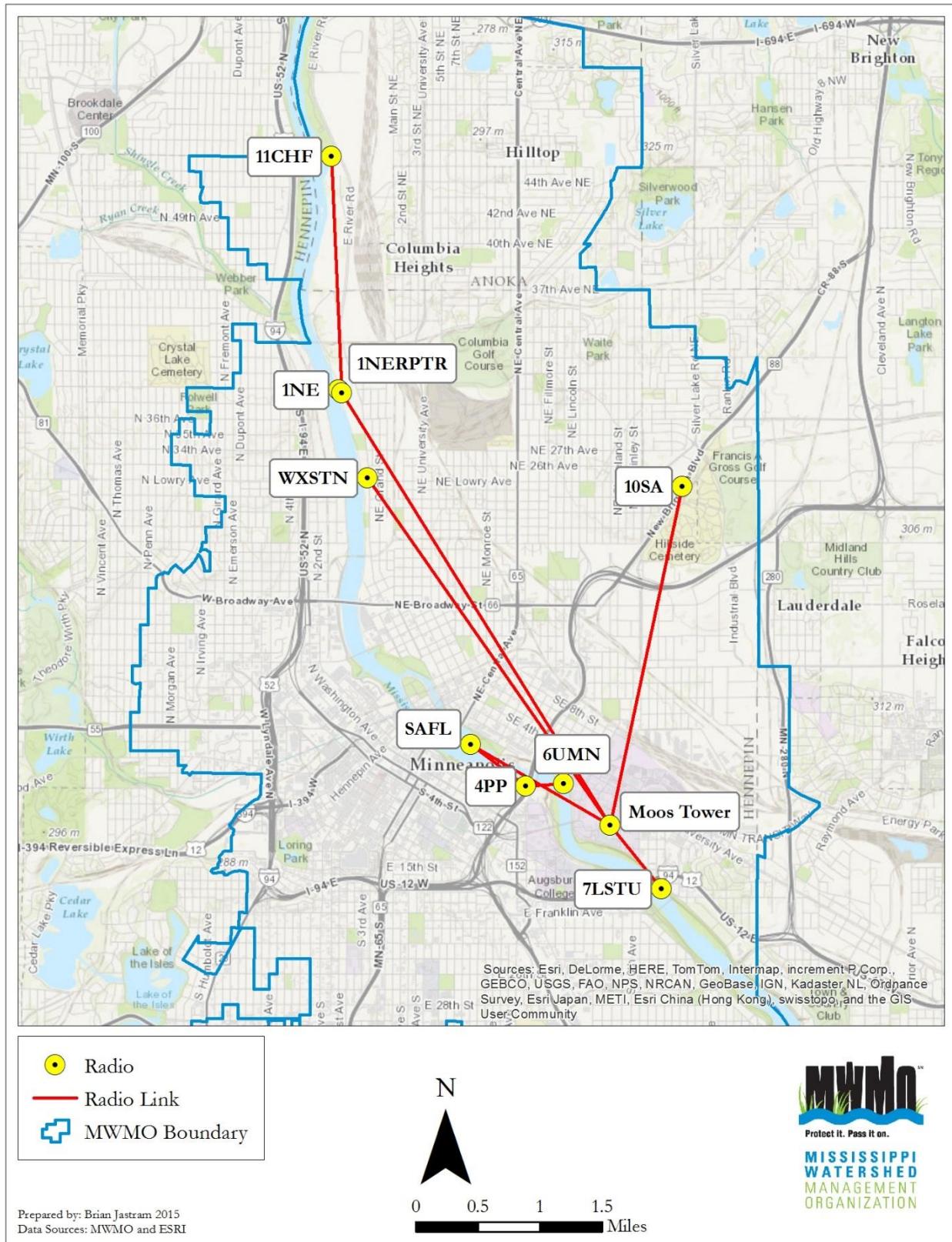


Figure 6. Remote access real-time data monitoring network

Stormwater Site Descriptions and Water Quantity Results

11CHF

11CHF is the new, northernmost outfall monitored by the MWMO. Installation of the site was completed in October of 2014. The outfall is located on the east bank of the Mississippi River at RM 859, about 50 feet upstream from the northernmost edge of the Minneapolis Public Works Fridley Water Treatment Plant's property in the Anoka County Riverfront Regional Park. The outfall is an eight-foot diameter, round concrete pipe (Figure 7). The nearest intersection is 44th Ave NE and East River Road. The monitoring equipment is located 1880 feet up the tunnel from the outfall on BAE Systems Inc. property just west of the Burlington Northern Santa Fe rail yard and north of the associated stormwater reservoir. This stormwater drainage system drains water from approximately 1310 acres of parts of the cities Columbia Heights, Hilltop, and Fridley (Figure 8). The piped area includes mainly industrial and residential land uses. The stormwater drainage system has continuous baseflow.



Figure 7. Site 11CHF outfall to the river

The MWMO began recording level and discharge data in October of 2014. Data are affected by periodic, controlled releases of water from a stormwater reservoir into the tunnel through a small pipe located just upstream of the area/velocity sensor location. An automated precipitation gauge is also operated at this site. Level, discharge, and precipitation data are shown in Figure 9. Cold weather in November and December caused the automated sampler to shut off occasionally, resulting in short gaps in level and discharge data.

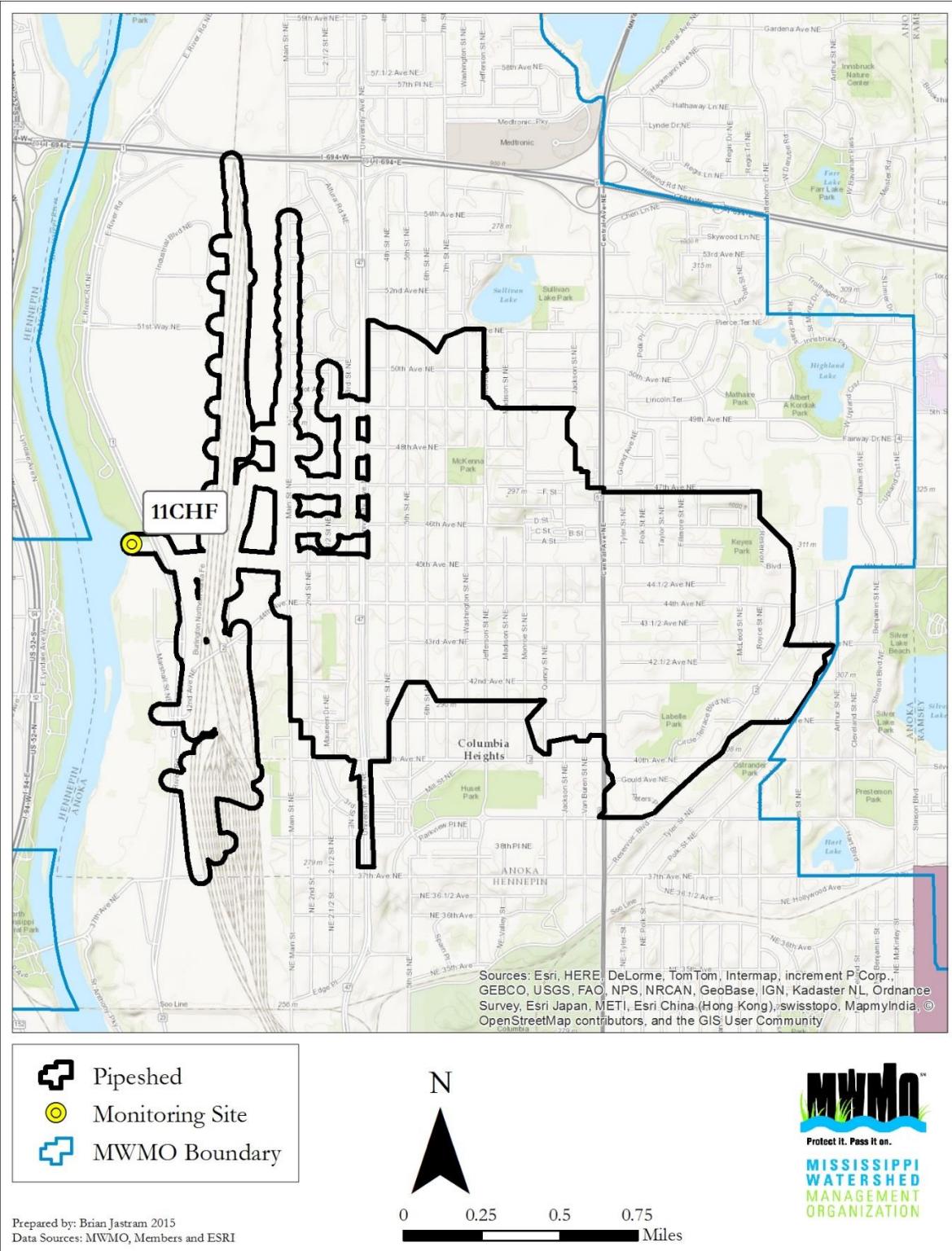


Figure 8. 11CHF pipeshed boundary and monitoring site location

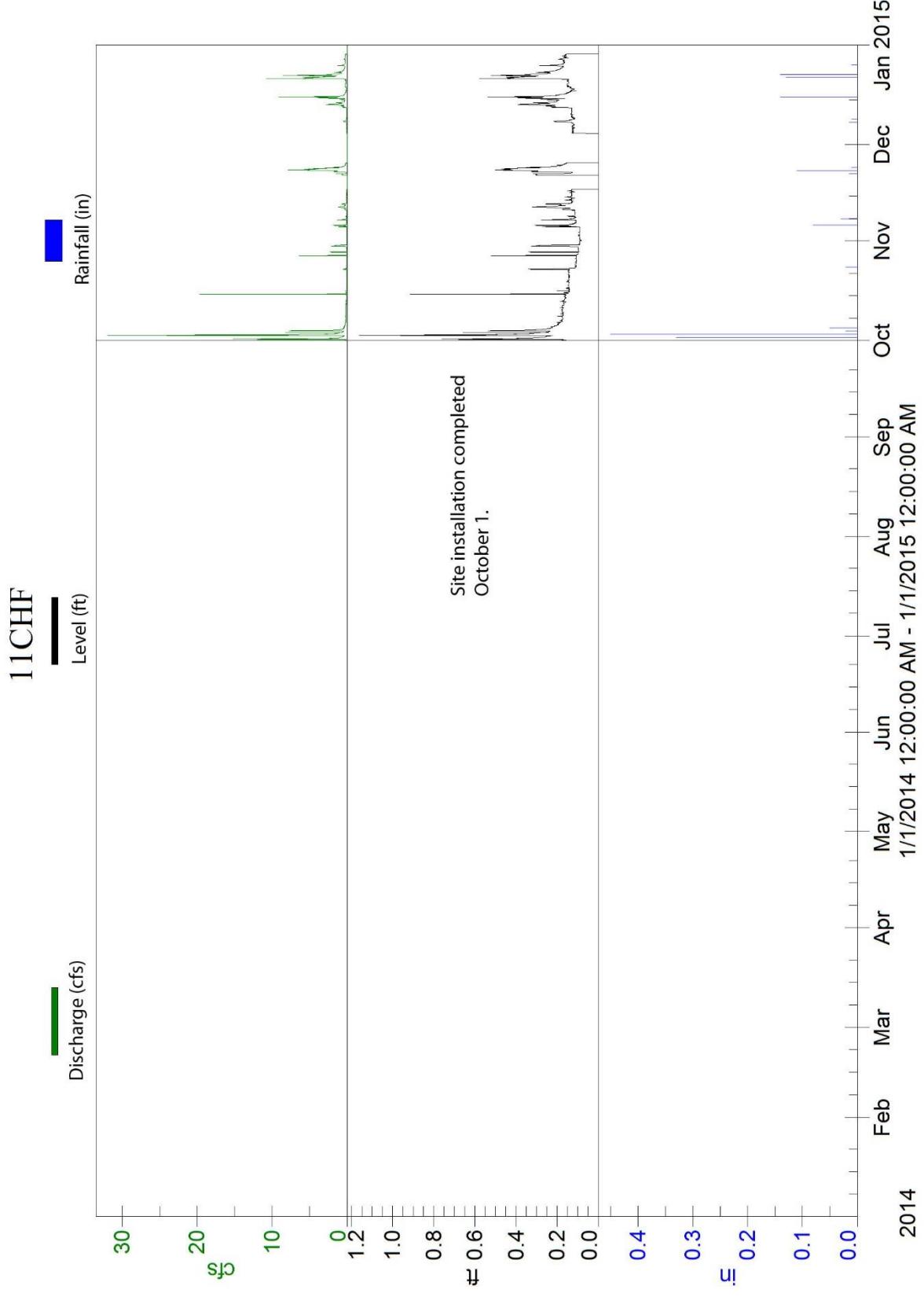


Figure 9. Discharge, level, and precipitation data for the 11CHF monitoring site in 2014

1NE (Xcel Riverside Plant)

Prior to installation of 11CHF in the fall of 2014, 1NE was the northernmost outfall monitored by the MWMO. Equipment was initially installed at the site in 2006. The outfall is located on the east bank of the Mississippi River on the Xcel Riverside Power Plant property at RM 857.2 and is a 96-inch diameter, corrugated iron pipe (Figure 10). The stormwater drainage system drains water from approximately 2,240 acres of the Northeast Minneapolis Neighborhood as well as portions of Columbia Heights and Fridley (Figure 11). The pipeshed includes mainly residential and industrial land uses. The stormwater drainage system has continuous baseflow.



Figure 10. Outfall to the river for the 1NE pipeshed. Monitoring cabinet can be seen in the upper right corner (green box)

Water level, discharge, and precipitation data collected with automated equipment are presented in Figure 12. It should be noted that, as the Mississippi River water level rose above the base of the stormwater outfall, river tailwater affected the water level in the stormwater pipe. This greatly impacted stormwater levels during 2014, as rainfall in spring and early summer (Table 4) resulted in tailwater in several of the stormwater outfalls from late April through mid-July, in some cases. Water levels at 1NE show Mississippi River tailwater in the pipe from April 13 to April 18, again between April 28 and May 28, and from May 31 to July 3 (Figure 12).



Figure 11. 1NE pipeshed boundary and monitoring site location

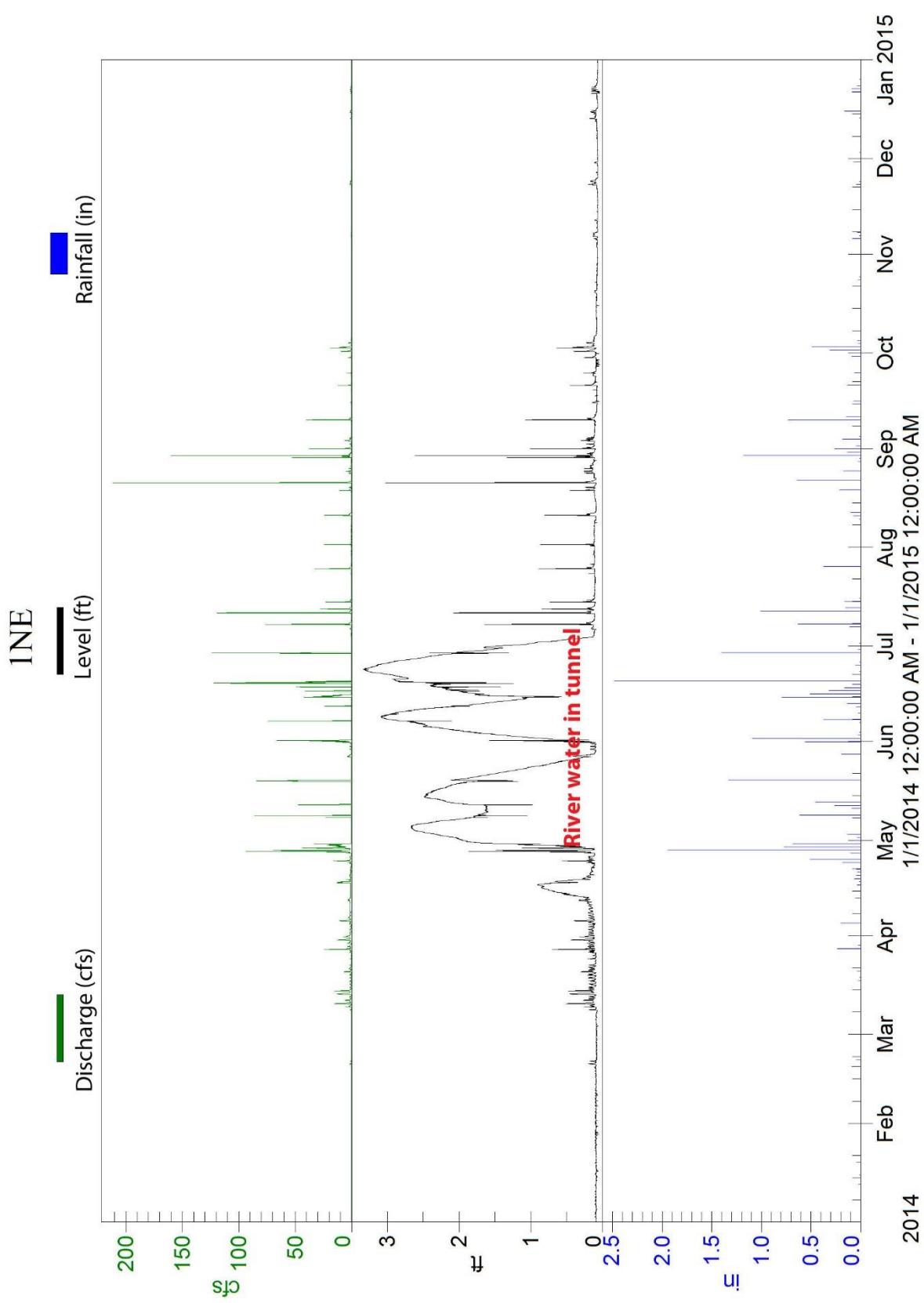


Figure 12. Discharge, level, and precipitation at the 1NE monitoring site in 2014

2NNBC (Old Bassett's Creek Tunnel Outlet)

The 2NNBC outfall drains water from 1067 acres of the Near North Minneapolis Neighborhoods and Bassett's Creek overflow. It enters the river in a park in the North Loop Neighborhood of Minneapolis on the west bank of the Mississippi River at RM 854.8. Land use is primarily residential and commercial. There are paths leading from a parking lot to the outfall. The semi-elliptical outfall is approximately 11 feet high and 15 feet wide (Figure 13). Bassett's Creek was buried and routed through this tunnel in 1890. In 1992, the creek was rerouted through a new tunnel that enters the Mississippi River below the surface water level, just downstream from Upper Saint Anthony Falls. Water from Bassett's Creek only flows through the original outfall during overflow periods. The 2NNBC pipeshed is shown in Figure 14.



Figure 13. The 2NNBC outfall to the original Bassett's Creek channel before it enters the Mississippi River

The 2NNBC site does not have an automated sampler or area/velocity sensor but grab samples are collected during rain events and baseflow when possible. Throughout much of 2014, river water was present in the tunnel. Samples were not collected during that time unless, during precipitation or melt events, stormwater pushed the river water out of the tunnel such that stormwater could be sampled. An In-Situ Level Troll 500 (In-Situ Inc., Ft. Collins, CO) was installed at the outfall in October 2014 in order to obtain hourly water level measurements at the outfall.

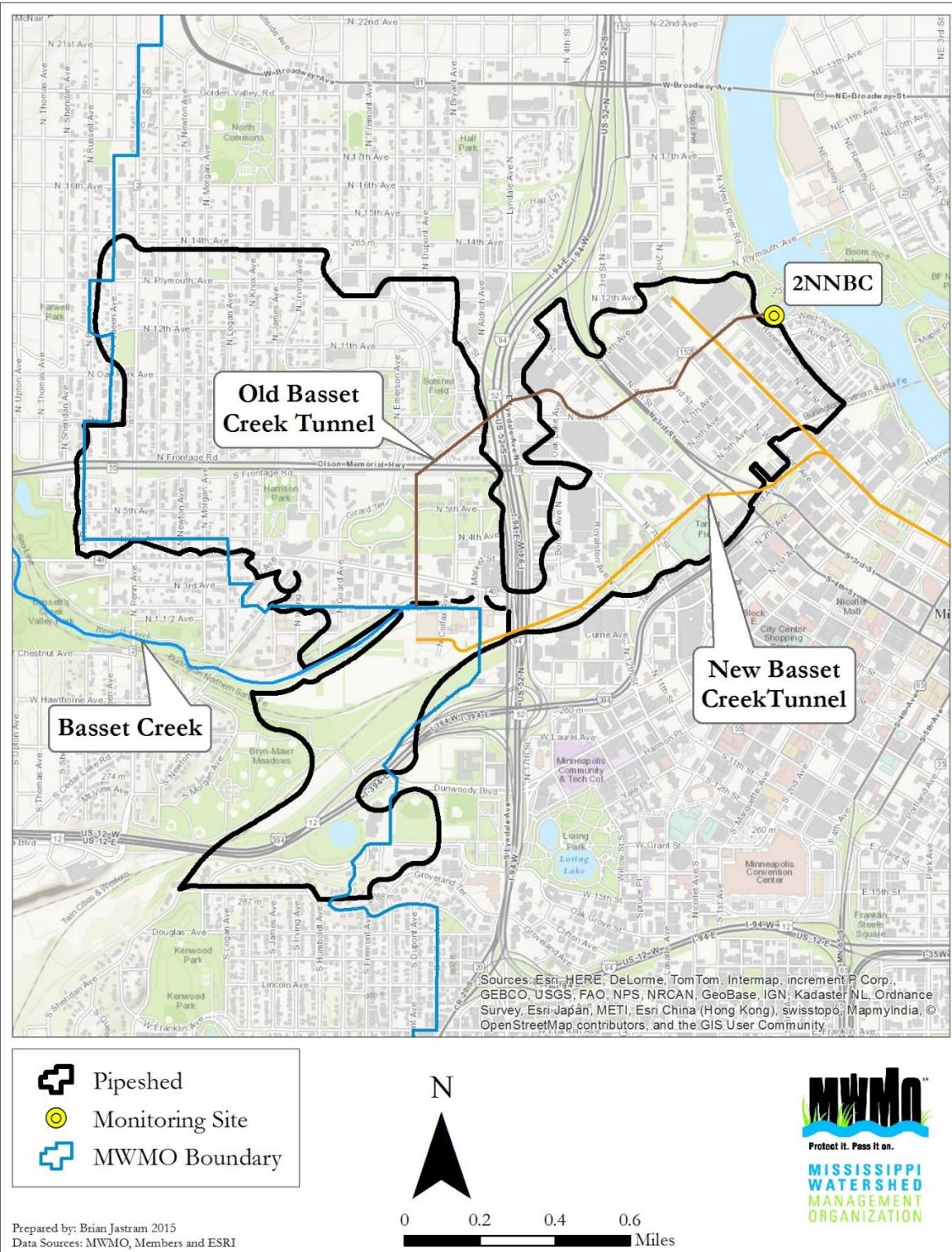


Figure 14. 2NNBC pipeshed boundary and monitoring site location

10SA (Saint Anthony Village)

The 10SA monitoring site was established in 2007. 10SA differs from the other MWMO stormwater monitoring sites as it is located near the top of a stormwater drainage system rather than at the bottom near the outfall to the Mississippi River. The MWMO chose to monitor this location to investigate the quantity and quality of stormwater from the southern portion of Saint Anthony Village (602 acres) as it enters Minneapolis. The concrete stormwater pipe is 54 inches in diameter and is accessed in a small green space (Figure 15). The tunnel eventually drains into the Mississippi River several miles away on the east bank at RM 853.2. The monitored pipeshed is shown in Figure 16. Land uses are mainly residential, commercial, and industrial. There is generally continuous baseflow in this stormwater drainage system although the amount is negligible in winter.

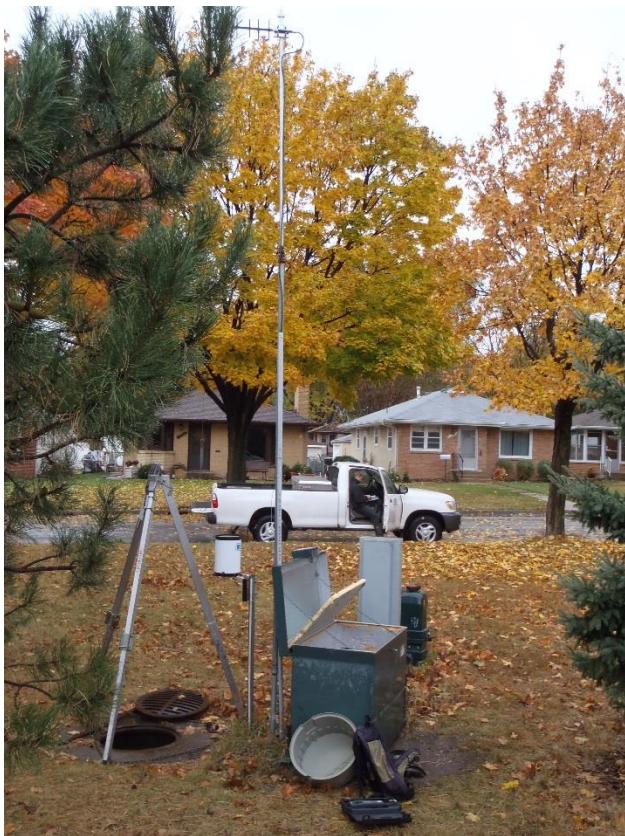


Figure 15. Monitoring equipment and access manhole at the 10SA stormwater site

An equipment problem occurred between late June and early September 2014 at the 10SA site. This led to inaccurate level and discharge data throughout that period. Level and discharge data for the remainder of 2014 are shown in Figure 17. An electronic precipitation gauge is also operated at this site (Figure 17). Since 2011, the MWMO has monitored specific conductivity with continuous monitoring equipment at the 10SA site to provide the MPCA with detailed data for the Twin Cities Metro Area Chloride Project (Figure 18).

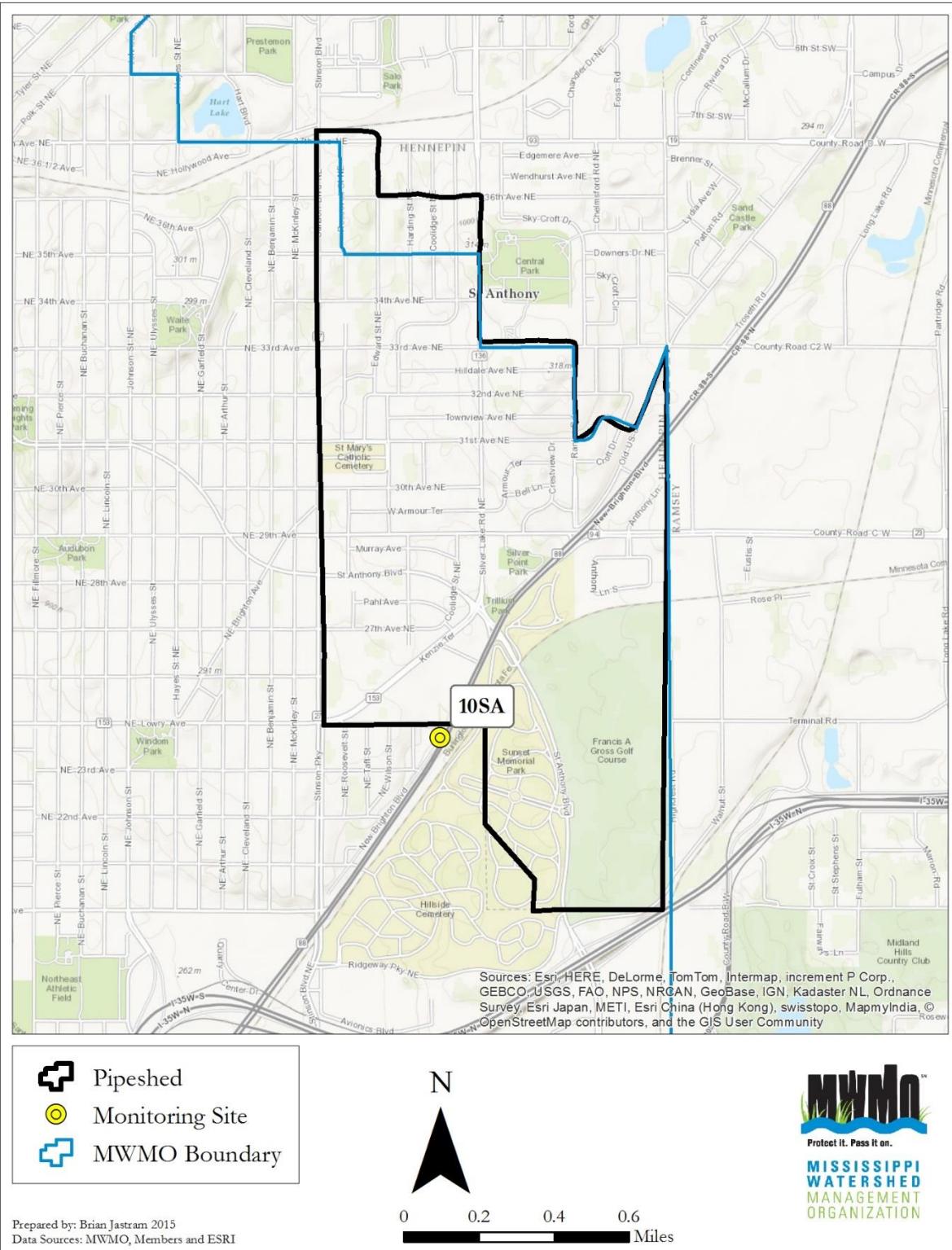


Figure 16. 10SA pipeshed boundary and monitoring site location

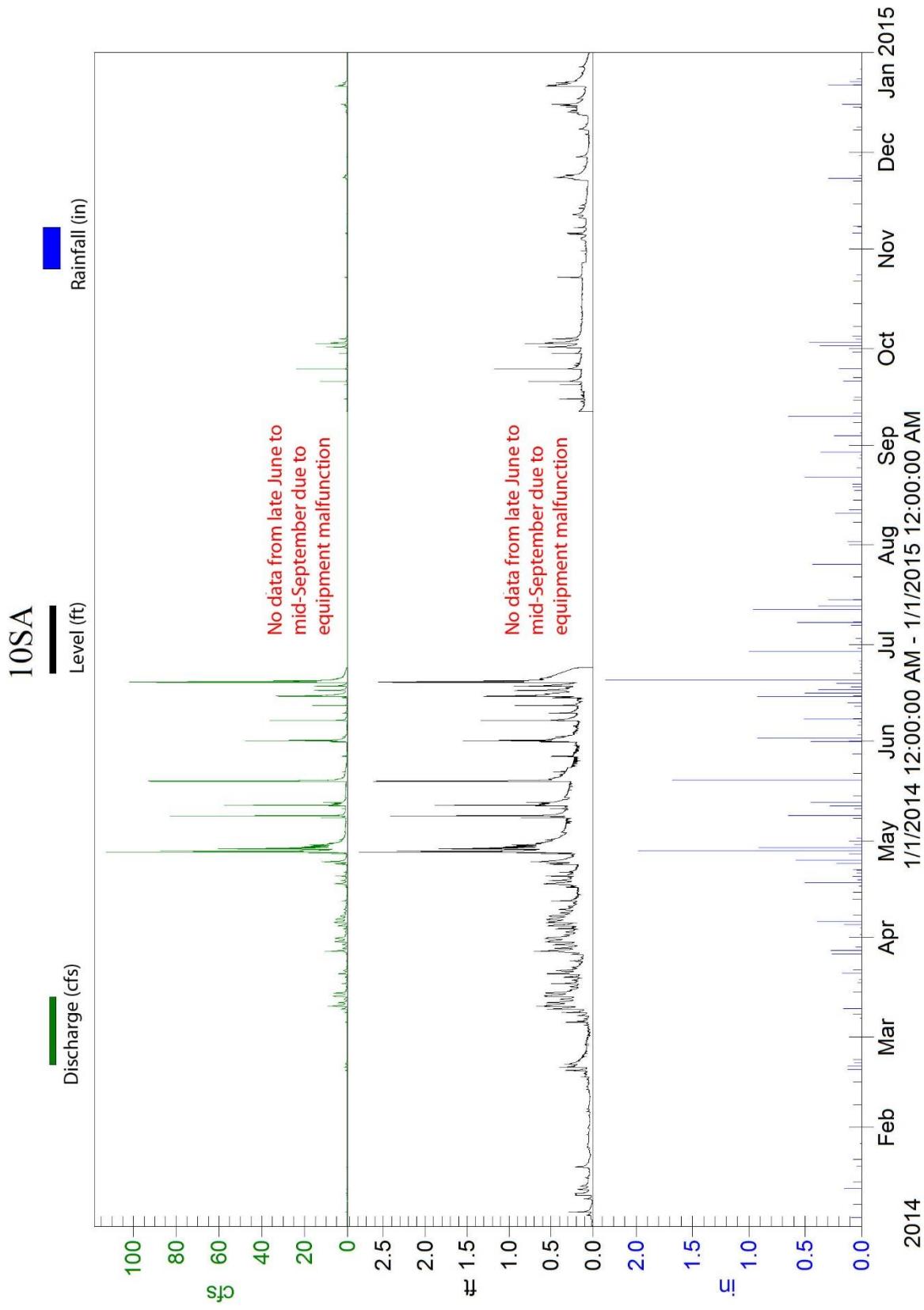


Figure 17. Discharge, level, and precipitation for the 10SA monitoring site

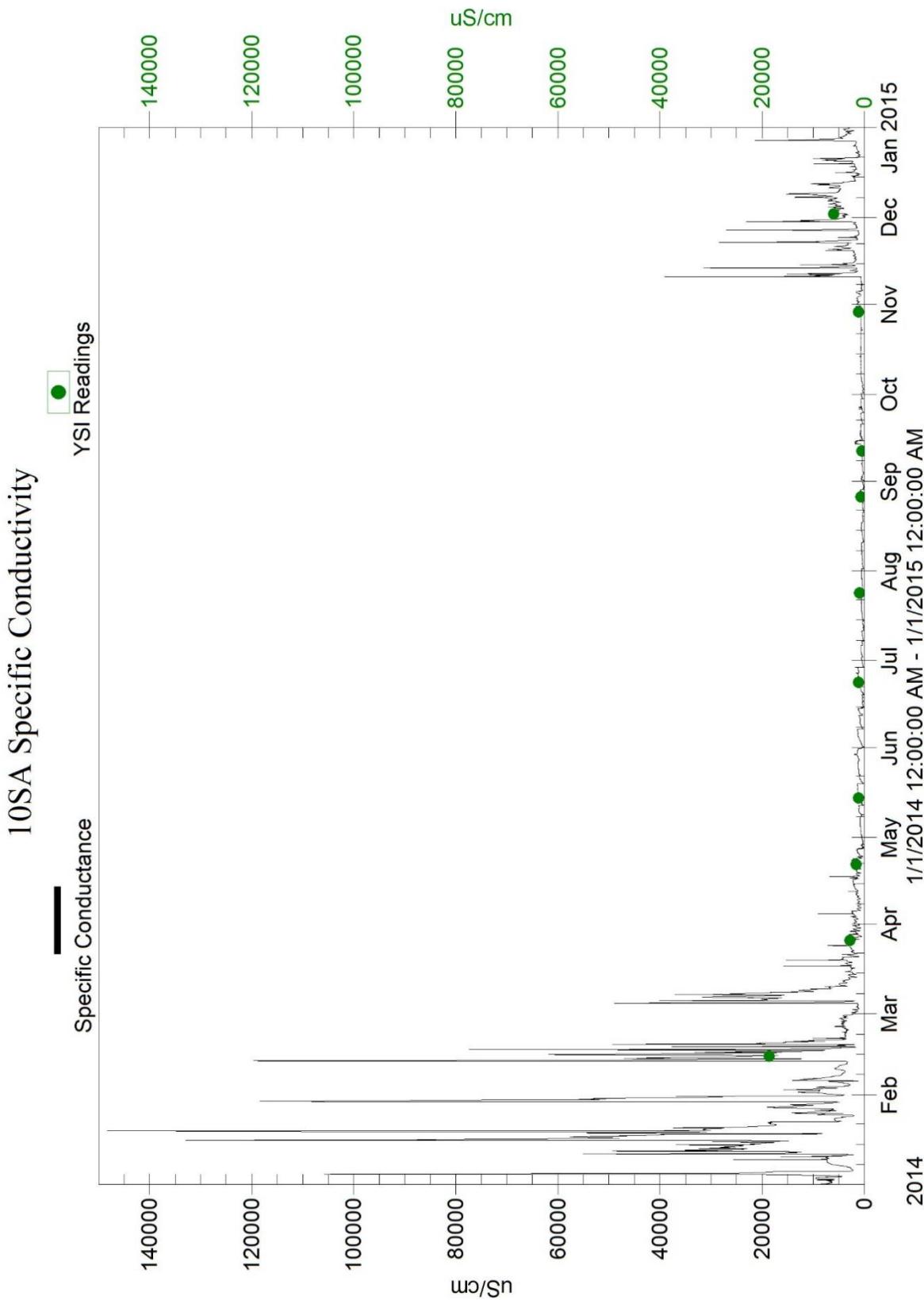


Figure 18. Specific conductivity data for the 10SA monitoring site. The black line shows continuous data collected from a sensor installed in the tunnel. Points represent values obtained using a YSI ProPlus multimeter

4PP (I-35W Bridge)

Established in 2008, this outfall site is located below Lower Saint Anthony Falls Lock and Dam on the west bank of the Mississippi River at RM 853.2. Access to the outfall is gained from the Lower Saint Anthony Falls Lock and Dam service road. The semi-elliptical tunnel is 14 feet high and 14 feet wide (Figure 19). The system drains stormwater from approximately 2780 acres of the Phillips and Powderhorn Neighborhoods and the southern portion of the Central Neighborhood in Minneapolis, as well as water from the I-35W interstate highway (Figure 20). Land use is primarily residential, commercial, and heavy industry. There is continuous baseflow in this stormwater drainage system.



Figure 19. 4PP outfall to the river

Construction within the 4PP tunnel during winter months as well as high river levels affected level and discharge values at the site during 2014. River water was present in the tunnel between April 9 and July 20 of 2014. Level and discharge data are shown in Figure 21.

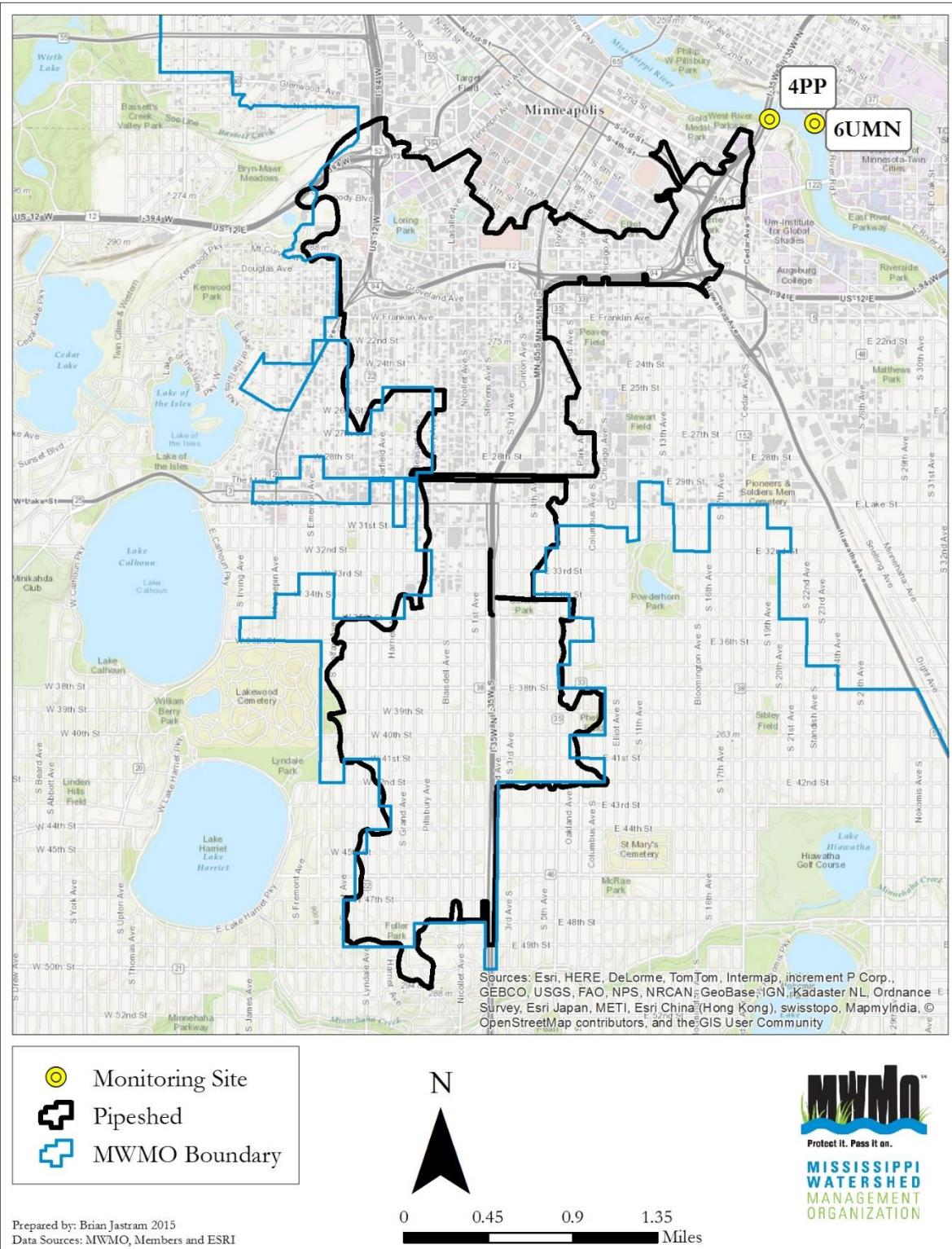


Figure 20. 4PP piped boundary and monitoring site location

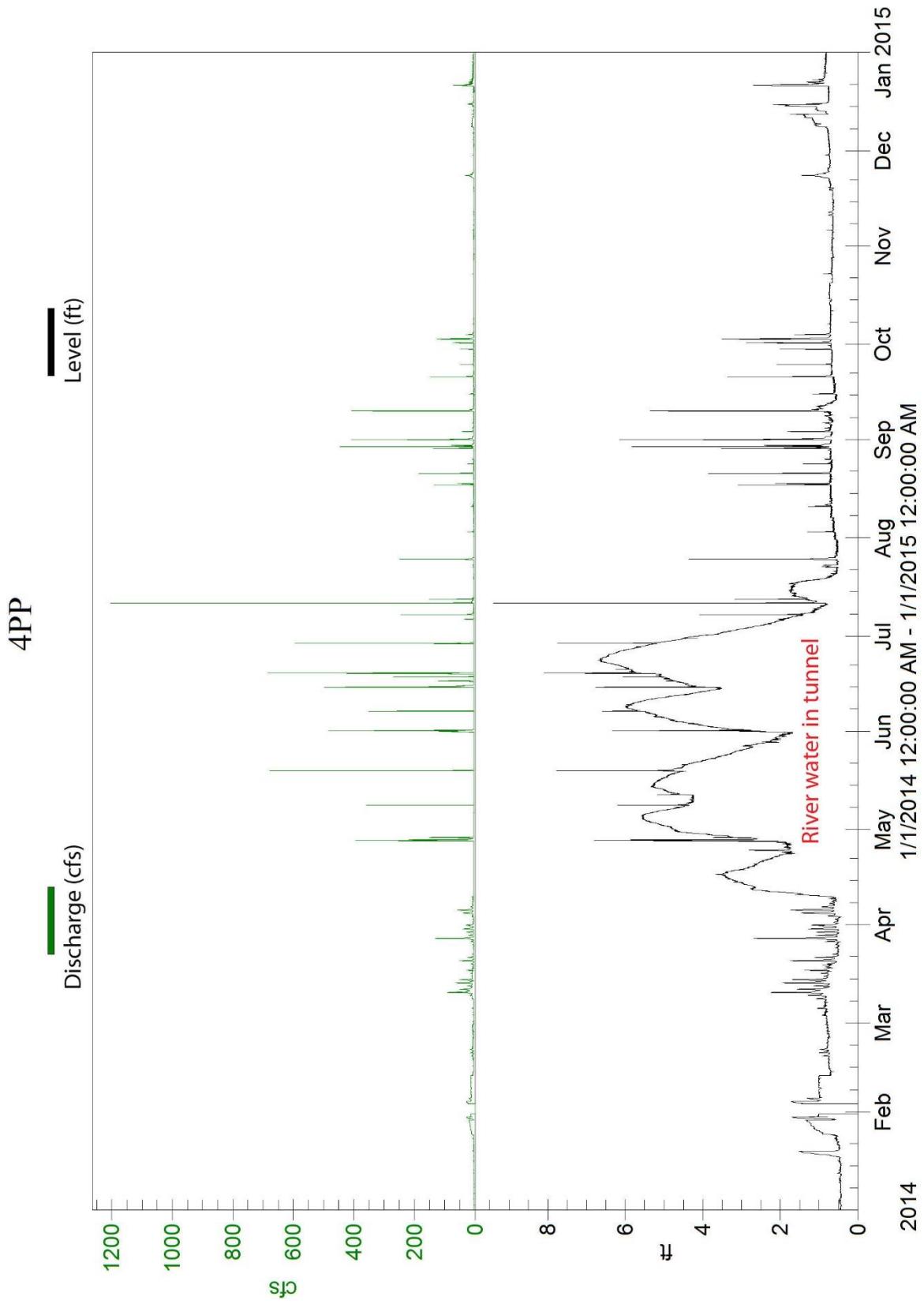


Figure 21. Discharge and level data for the 4PP stormwater monitoring site in 2014

6UMN (University of Minnesota Coal Storage Facility)

The 6UMN outfall site is located on the east bank of the Mississippi River at RM 853.0, downstream from Saint Anthony Falls, behind the University of Minnesota Coal Storage Facility. The monitoring site was established in 2006. This semi-elliptical tunnel is eight feet high and eight feet wide with a rounded top and slightly U-shaped base (Figure 22). The outfall drains water from approximately 765 acres of the City of Minneapolis and the University of Minnesota, Minneapolis Campus (Figure 23). Land use is primarily residential and commercial. There is continuous baseflow in this stormwater drainage system.



Figure 22. 6UMN outfall to the river

Similar to other sites, level and discharge data at 6UMN were affected by high river levels. Tailwater was present in the tunnel between April 9 and July 21 of 2014 (Figure 24).

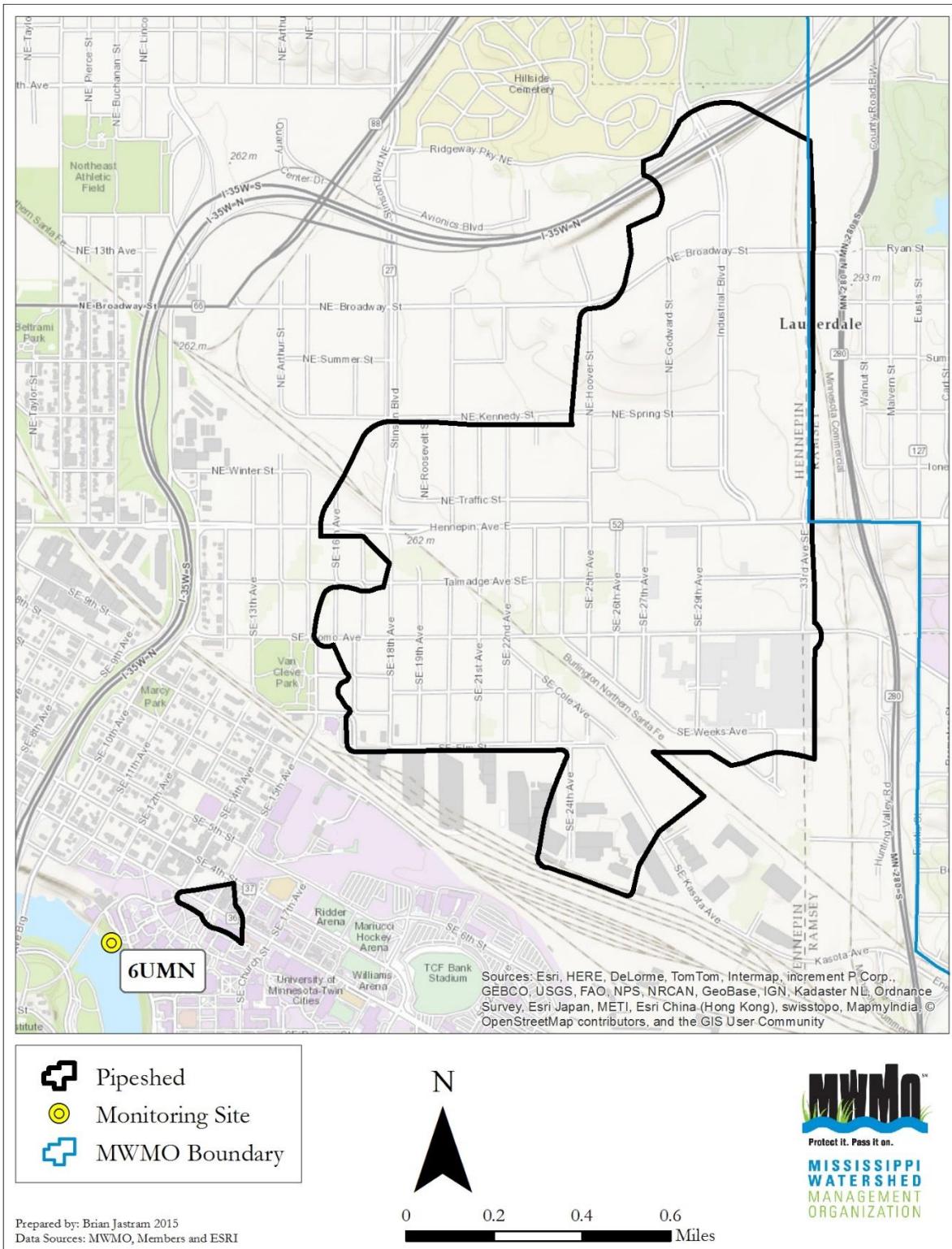


Figure 23. 6UMN pipeshed boundary and monitoring site location

6UMN

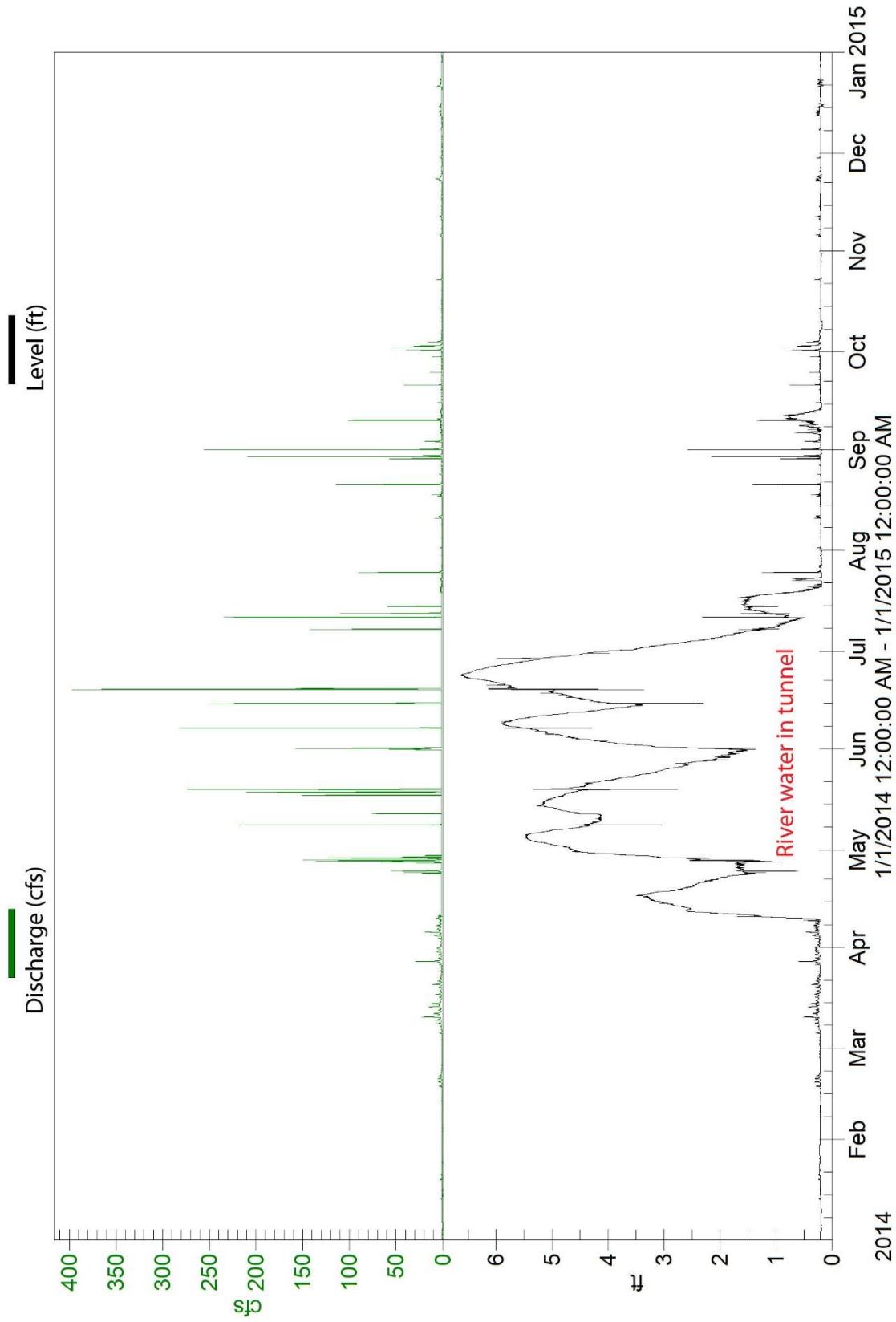


Figure 24. Discharge and level data for the 6UMN monitoring site in 2014

7LSTU (Bridal Veil Tunnel)

7LSTU is the farthest downstream stormwater outfall monitored by the MWMO. The monitoring site was established in 2008 and is located on the east bank of the Mississippi River at RM 851.6, between the I-94 Bridge and Franklin Avenue Bridge. The cathedral-shaped tunnel is 10.37 feet high and 6.67 feet wide (Figure 25). At the mouth of the outfall, five square, concrete pillars baffle (slow) water flow, and an iron stilling basin captures floatable debris. The outfall drains water from approximately 600 acres of the City of Minneapolis and the University of Minnesota, Minneapolis Campus (Figure 26). Land uses within the pipeshed are a mix of residential, commercial, and industrial.



Figure 25. 7LSTU outfall to the river

The 7LSTU monitoring site is equipped with an automated sampler and area/velocity sensor; however, river water is almost constantly present in the tunnel, affecting level and discharge values. Therefore, level and discharge data are not displayed here but were used to determine appropriate times to take grab samples during events.

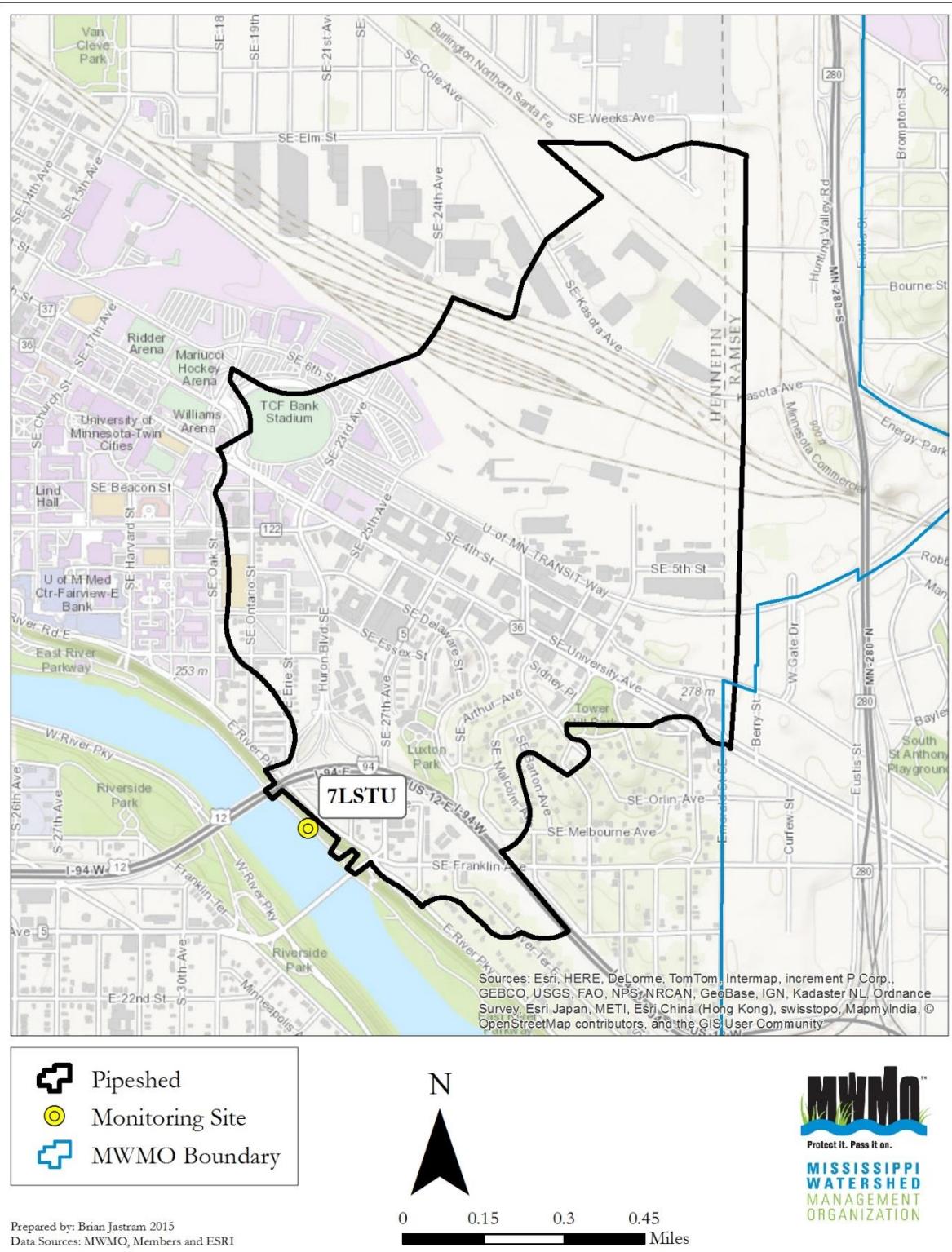


Figure 26. 7LSTU pipeshed boundary and monitoring site location

Lake Monitoring

The MWMO has 3 lakes within its watershed boundary: Loring Pond in the City of Minneapolis, and Sullivan Lake and Highland Lake in the City of Columbia Heights (Figure 27). Since Loring Pond has been monitored by the Minneapolis Park and Recreation Board (MPRB) for several years, the MWMO did not monitor it during 2014. Previously, the MWMO monitored Loring Pond for *E. coli*; however, that monitoring was discontinued because the MPCA does not assess Loring Pond for *E. coli*. Refer to previous MWMO Annual Monitoring Reports at www.mwmo.org for further details about MWMO historical monitoring at Loring Pond. MPRB data can be found in their Water Resources Reports found on their website (MPRB, 2014). Sullivan Lake, located in Columbia Heights, was historically monitored from 1993 to 2005 for water level, transparency, chlorophyll-a, and total phosphorus. The MWMO contracted the Anoka Conservation District (ACD) to conduct water elevation and water quality monitoring during 2013, to gain an understanding of more current lake conditions. Details of the history of Sullivan Lake monitoring, 2013 data, and historical water elevation data can be found in the Sullivan Lake Monitoring Report 2013 (MWMO, 2014). Sullivan Lake was monitored for water elevation only in 2014. Highland Lake was not monitored by the MWMO in 2014.

Sullivan Lake Water Elevation Monitoring

A volunteer, in coordination with ACD, conducted weekly water level monitoring during 2014 between April 16 and November 5. A staff gauge is located on the west side of the lake near the outflow. It is surveyed each year by ACD and the Minnesota Department of Natural Resources (DNR) using datum NGVD 29 in feet. 2014 water elevation data, as well as all additional historic data, are available on the Minnesota DNR website using the “LakeFinder” feature at www.dnr.state.mn.us/lakefind/index.html. The lake ID for Sullivan (Sandy) Lake is 02-0080.

Lake water elevation was measured 30 times during 2014. Sullivan Lake water elevations fluctuate dramatically because it receives a large amount of stormwater relative to its size and its outlet releases water in all but the lowest water conditions. Water elevation data for 2014 are shown in Figure 28. The Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is 880.60 feet for Sullivan Lake. Table 5 shows the average, minimum, and maximum water elevations of the lake for 2008 through 2014.

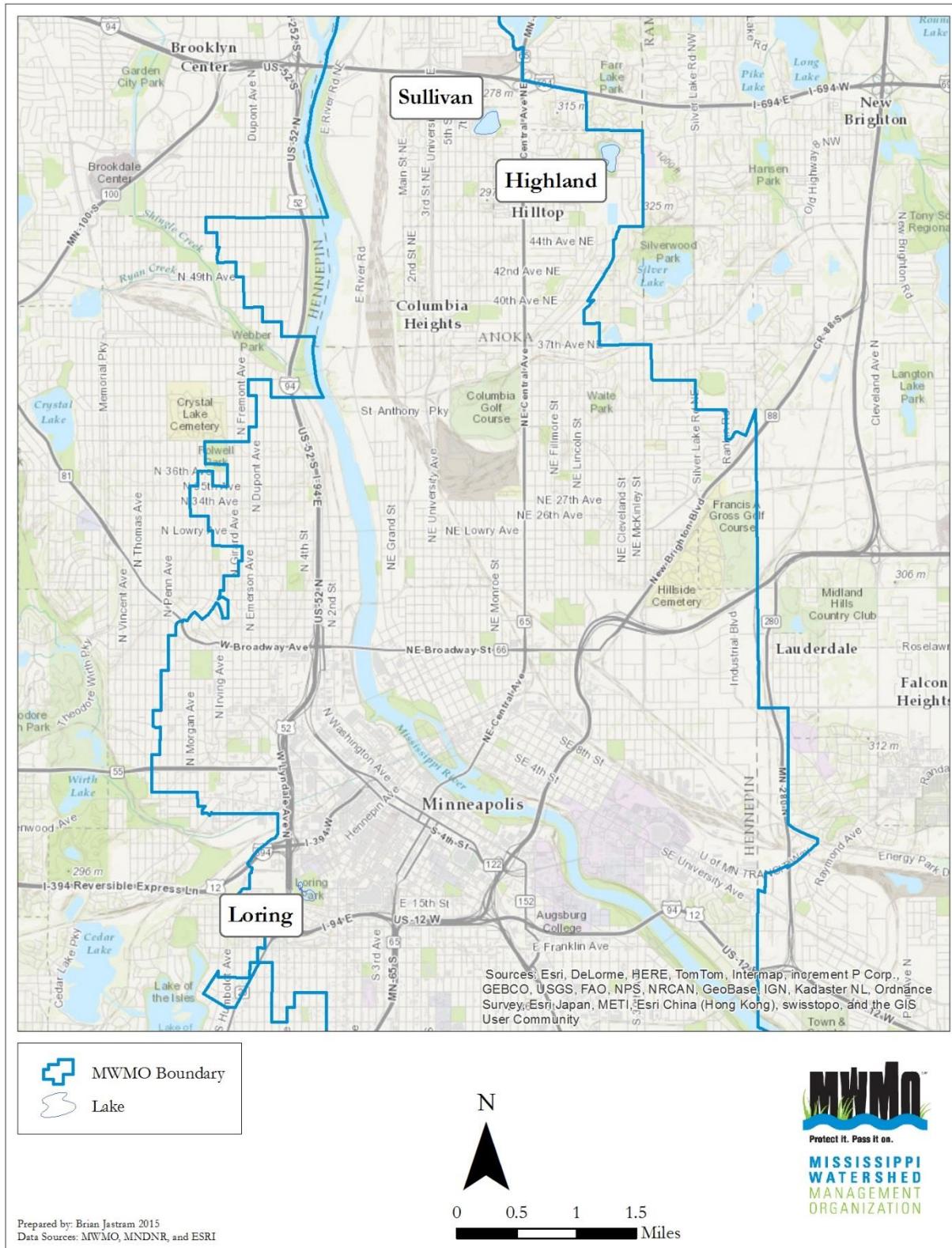


Figure 27. Lakes within the MWMO watershed

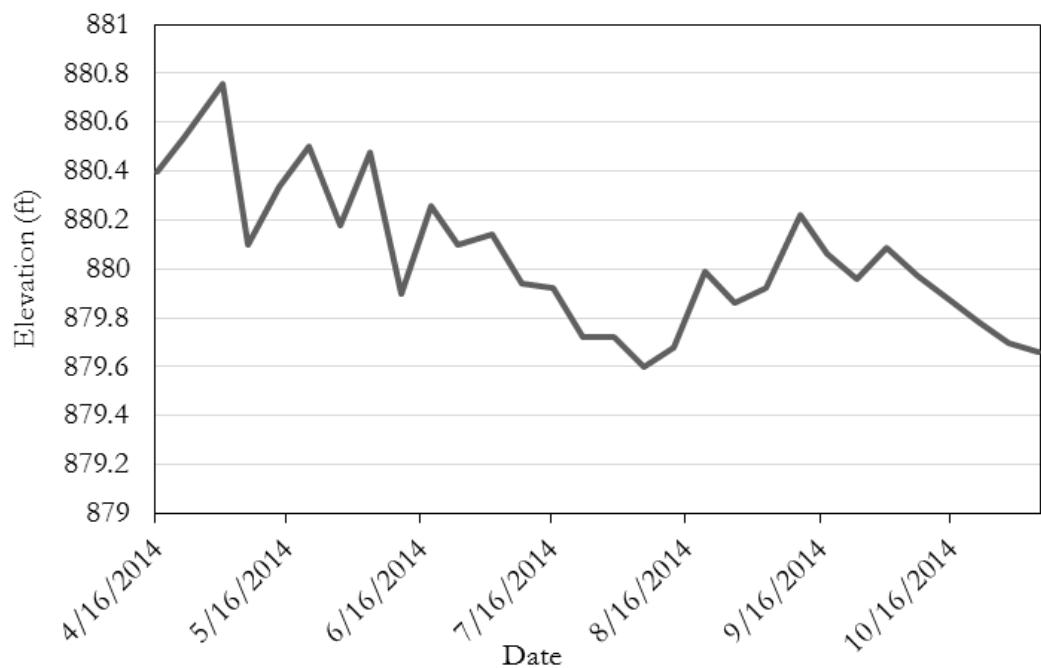


Figure 28. Water elevation at Sullivan Lake in 2014

Table 5. Average, minimum, and maximum water elevations in feet at Sullivan Lake from 2008 to 2014

Year	Average	Minimum	Maximum
2008	880.22	879.42	881.24
2009	879.92	879.36	880.52
2010	880.23	879.62	881.10
2011	880.36	879.29	881.25
2012	879.86	878.91	881.15
2013	880.00	879.23	880.93
2014	880.05	879.6	880.76

Wetland Monitoring (Kasota Ponds)

The MWMO monitored three locations in Kasota Ponds (KP). (See Figure 32 for wetland sampling locations). In previous years, the MWMO monitored seven locations in Kasota Ponds. Statistical comparisons of data from all seven locations indicated that one site in each pond was sufficient to characterize water quality.

Site Descriptions

KPN (Kasota Pond North): KPN is the northernmost pond. It is located west of Highway 280 and south of the intersection of North Hunting Valley Road and West Doswell Avenue. The area surrounding the pond is heavily vegetated with non-native species such as buckthorn and burdock. KPN is dense with cattails and aquatic plants during the summer months (Figure 29). The bottom of the pond contains organic matter, silt, and clay.



Figure 29. Kasota Pond North

KPE (Kasota Pond East): KPE is the largest of the ponds. It is also known as Mallard Marsh. It is located southwest of the intersection of Highway 280 and Kasota Avenue. There is a grassy buffer area surrounding most of the pond. Railroad tracks run alongside the west side of the pond, with approximately six feet of riprap between the tracks and the pond. Turtles and ducks are frequently observed in KPE. This wetland is dense with cattails and aquatic plants during the summer months (Figure 30). The bottom of the pond contains organic matter, silt, and clay.



Figure 30. Kasota Pond East

KPW (Kasota Pond West): KPW is located just west of KPE. KPW receives runoff from a parking lot and the rail yard. Dense algal blooms are observed in KPW during the summer months, while other types of aquatic vegetation are seldom present in this pond (Figure 31). The pond has a sandy bottom.

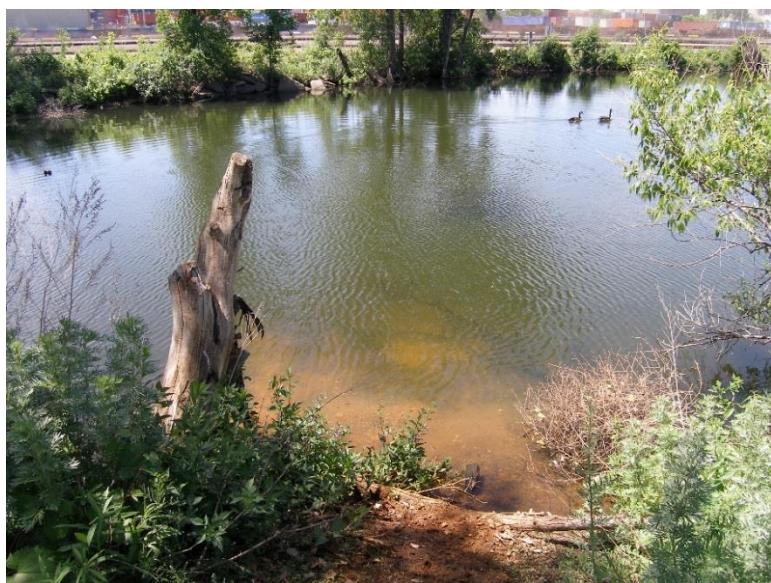


Figure 31. Kasota Pond West

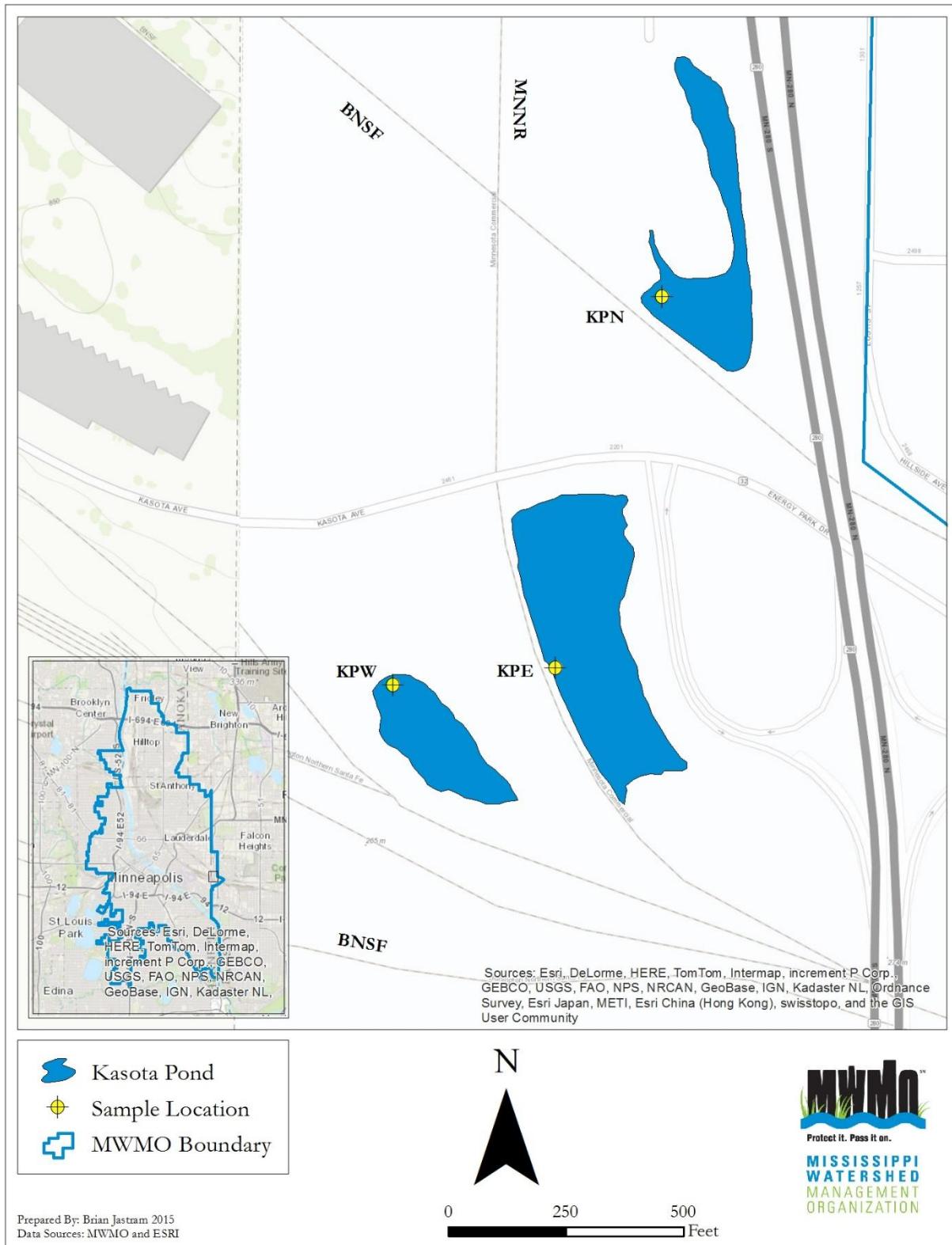


Figure 32. MWMO Kasota Ponds monitoring locations

Methodology

Sample Collection, Handling, and Preservation

Grab samples were collected from three locations in the KP wetlands once a month throughout the year. Collection occurred away from shore, in approximately three feet of water. Samples were collected in laboratory-cleansed (non-sterile) eight-liter plastic bottles. To collect samples, the monitoring specialist plunged an opened, inverted bottle one foot below the water surface, turned it upward to fill, and brought it out of the water. The specialist then poured some of the sample out to provide headspace for the laboratory. Dissolved oxygen, conductivity, salinity, temperature, and pH data were collected concurrently in the wetland using the methods described for the Mississippi River. When ice was present, staff conducted sampling activities by drilling a hole in the ice and using a capped, three-inch diameter PVC tube to collect the sample from the wetland.

Samples were labeled and placed in a cooler for transport to the laboratory by a monitoring specialist. Samples were dropped off at the laboratory after collection of the last sample. Laboratory personnel split the sample and preserved it as needed for various analyses.

Sampling Quality Control

The MWMO staff followed the quality control protocol outlined in the MWMO Ambient Surface Water Monitoring Quality Assurance Project Plan (MPCA, 2010). Blank samples of DI water were submitted to laboratories once a month to verify that sample containers were clean and samples were not contaminated during travel. In addition, ten percent of all samples were collected in duplicate to verify that sampling and laboratory procedures did not jeopardize the data.

Laboratory Analyses

Samples were analyzed at the Metropolitan Council Environmental Services Laboratory. The laboratory followed strict protocols for quality assurance and quality control. Information regarding laboratory protocol is available from MWMO staff. Refer to Table C.1 in Appendix C for a list of sample parameters, the laboratories used for analysis, the analysis methods, and information regarding certification.

Parameter Information

The MWMO has conducted extensive research regarding the parameters of concern. Parameter information includes definitions, sources, impact on various organisms, and water quality standards. Refer to the MWMO 2006 Annual Monitoring Report (2007) for the comprehensive list of parameters.

Water Quality Monitoring Results

The MWMO monitors Kasota Ponds to characterize water quality in its wetlands. Samples are collected for nutrients, sediment, inorganic, and metals analyses. The MPCA water quality criteria indicate that wetland water quality should maintain background conditions. Background water quality has not yet been determined for MWMO wetlands. The data are presented in Tables G.1 – G.3 in Appendix G.

Bacteria Monitoring

Mississippi River Bacteria Monitoring

The MWMO monitors seven locations in the Mississippi River. Six sites are MWMO long-term monitoring sites and are described in the following section. The seventh site—MR853.5E, located between Upper and Lower Saint Anthony Falls—was added in 2010 to provide data for development of the Upper Mississippi River Bacteria TMDL project that is managed by the MPCA. The monitoring sites are identified by the river mile upstream from the confluence of the Mississippi and Ohio Rivers in Cairo, Illinois, and from the nearest riverbank to the sample collection point. The “E” refers to the east bank and “W” refers to the west bank. The highest river mile is the farthest upstream.

Site Descriptions

MR859.1W (Camden): The Camden site is the northernmost bacteria monitoring site in the MWMO’s watershed. It is located in the North Mississippi Regional Park at the intersection of 53rd Avenue and North Lyndale in Minneapolis. The terrain surrounding the site is mostly deciduous forest with a grassland transition zone by the road. Footpaths lead from the paved trail by the road, through the forest to the monitoring site on the river. The footpaths may cause minimal erosion. There is a concrete levy wall and boulders at the sampling site and an outfall just upstream. The river is shallow (three-five feet), rocky, and swift (in places) with sandbars up and downstream (Figure 33). Water levels fluctuate at this site more than at any other in the watershed. Storm events can raise the water level up to three feet. Waterfowl are commonly seen in the river and on shore. Rabbits, bald eagles, a Blanding’s Turtle and a beaver have also been observed.



Figure 33. MWMO bacteria sampling site MR859.1W (Camden) with staff gauge

MR857.6W (MPRB Boat Launch): This site is located adjacent to MPRB land. A paved parking lot leads to the river and boat launch. During the warmer months, a floating dock rests directly upstream from the boat launch. Flat and forested terrain surround the parking lot and boat launch area with some grassy areas and paved and unpaved trails leading up and downstream, respectively. The river bottom near shore is silty mud, gravel, and large stones. The river is deeper here than at MR859.1W and can have a swift current after rainfall. The monitoring site is upstream of the dock foundation. It is located downstream of the mouth of Shingle Creek (Figure 34).



Figure 34. MWMO bacteria sampling site MR 857.6W (MPRB Boat Launch at North Mississippi Regional Park)

MR854.9W (North Loop): The North Loop site is downstream from the Plymouth Avenue Bridge. It is adjacent to a shaded park area with picnic tables, trails, grass, and trees. The riverbank is steep and covered in brush. The shore and shallows at the sampling site are composed of loose rocks and sand. The monitoring site is at the base of a stairway that leads to the river (Figure 35).



Figure 35. MWMO bacteria sampling site MR 854.9W (North Loop) with staff gauge

MR853.5E (Saint Anthony Falls Laboratory): The SAFL site is located between Upper and Lower Saint Anthony Falls. It is located near the bottom of the SAFL's outdoor stream laboratory. The shore is rocky (Figure 36).

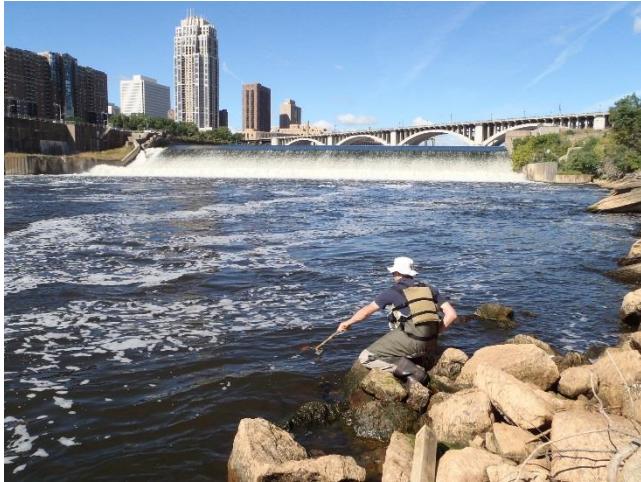


Figure 36. MWMO bacteria sampling site MR853.5 (Near Saint Anthony Falls Laboratory)

MR852.2E (University of Minnesota Boat Launch): The University of Minnesota Boat Launch site is the first river site downstream from Lower Saint Anthony Falls. It is located in the Mississippi River Gorge, behind Coffman Union on the University of Minnesota East Bank Campus. A paved path leading from a parking lot wraps around a grassy area and the University of Minnesota rowing teams' boat house and angles west down to a boat launch. The sampling site is 100 feet upstream of the boat launch and floating dock that is used by the rowing teams. The surrounding terrain consists of deciduous forest along the river and a large grassy area behind the trees. The gently sloping bank leads to a sandy shore that continues into the river (Figure 37). The site is a regular entrance point to the river for approximately 100 geese that graze on the grass in the open area. Goose droppings are common here.



Figure 37. MWMO bacteria sampling site MR852.2E (University of Minnesota Boat Launch)

MR849.9W (Lake Street Bridge): This site is located beneath the Lake Street Bridge over the Mississippi River. There is parking on the street by the bridge and a foot path that leads down into the gorge to the sampling site. The elevation drops more than 70 feet from the street to the river. A small stormwater outfall and the Minneapolis Rowing Club boat facility are located just upstream of the site. There is tall grass along the river and trees on the sides of the gorge (Figure 38). There is a steep, three-foot riverbank leading to a rocky shore. The river bottom is sandy with limestone boulders and gravel (riprap).



Figure 38. MWMO bacteria sampling site MR849.9W (Lake Street Bridge)

MR848.1W (4300 West River Parkway): This monitoring site is the farthest downstream in the MWMO's watershed. There is a parking lot and a paved path from the parking lot into the gorge. There are foot paths leading down the bluffs to the river. The site is surrounded by hardwood forest and is just upstream from a stormwater outfall. The shore and river bottom are made up of sand and large, flat limestone rocks (Figure 39). Lock & Dam No. 1 is less than one mile downstream from the monitoring site.



Figure 39. MWMO bacteria sampling site MR848.1W (4300 West River Parkway) with staff gauge

Methodology

Sample Collection, Handling, and Preservation

In 2014, grab samples were collected from seven locations in the Mississippi River (described above) and seven stormwater locations (see site descriptions in the Stormwater Monitoring section of this report) at least two times per month. Staff followed sampling procedures outlined in the MWMO's Standard Operating Procedure for Surface Water Sampling (2011). Samples were collected in lab-sterilized 125-milliliter (mL) plastic bottles. In the Mississippi River and at stormwater site 2NNBC, collection occurred away from shore, in approximately three feet of water. Samples were taken in positive flow (no back eddies or stagnant water) and upstream of the monitoring specialist to prevent contamination by the disturbed river bottom. To collect samples, the monitoring specialist plunged an opened, inverted bottle one foot below the water surface, turned it upward to fill, and brought it out of the water (Figure 40). The specialist then poured some of the sample out to provide headspace for the laboratory. At the other stormwater monitoring locations, the automated sampler was used to collect a grab sample.

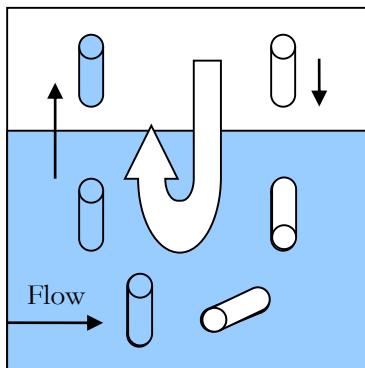


Figure 40. Diagram of sample collection method

Samples were labeled, stored on ice in a cooler, and delivered to the laboratory by the monitoring specialist after the final sample was collected. Analysis conducted on these samples did not require preservation.

Dissolved oxygen, conductivity, salinity, water temperature, and pH data for each site were collected using a YSI ProPlus sonde (YSI Inc., Yellow Springs, OH). The multiparameter probe was placed in the water approximately one foot below the surface. Data were recorded when the values stabilized. Transparency was measured using a Secchi tube.

Sampling Quality Control

The MWMO staff followed the quality control protocol outlined in the MWMO Ambient Surface Water Monitoring Quality Assurance Project Plan (MPCA, 2010). Blank samples of deionized (DI) water were submitted to laboratories once a month to verify that sample containers were clean and samples were not contaminated during travel. In addition, ten percent of all samples were collected in duplicate to verify that sampling and laboratory procedures did not jeopardize the data.

Laboratory Analyses

Bacteria samples were analyzed at the Three Rivers Park District Laboratory. The laboratory followed strict protocols for quality assurance and quality control. Information regarding laboratory protocol is available from MWMO staff.

Refer to Table C.1 in Appendix C for a list of sample parameters, the laboratories used for analysis, the analysis methods, and information regarding certification.

Water Elevation Monitoring

The MWMO has monitored Mississippi River water elevations (commonly referred to as stage) at six of the bacteria sampling site locations since 2005. Mississippi River water elevations rise and fall in response to precipitation events and snow melt, and are also influenced by the dams at Saint Anthony Falls and Lock & Dam No. 1. Since the river pools behind the dams, control activities at the dam cause changes in river elevation, even in the absence of precipitation. The MWMO data are equivalent to data collected by agencies using the North American Vertical Datum, 1988 (NAVD88).

Staff gauges were installed on April 8, 2014. High water in the spring of 2014 submerged and subsequently washed out three staff gauges upstream of Upper Saint Anthony Falls. Therefore, few data points are available and water elevations above Upper Saint Anthony Falls are not shown. Mississippi River water elevation data for the three monitoring locations below the Lower Saint Anthony Falls Lock and Dam are shown in Figure 41. Time periods with missing data were the result of either high river water levels (the staff gauges were submerged underwater) or low river water levels (water was below the lowest elevation of the staff gauge). Other gaps may be due to less frequent site visits to read a gauge compared with other gauge sites. Water elevation data were not recorded at site MR853.5E because of the site's close proximity to Saint Anthony Falls and deep water. The staff gauges were removed on November 14, 2014.

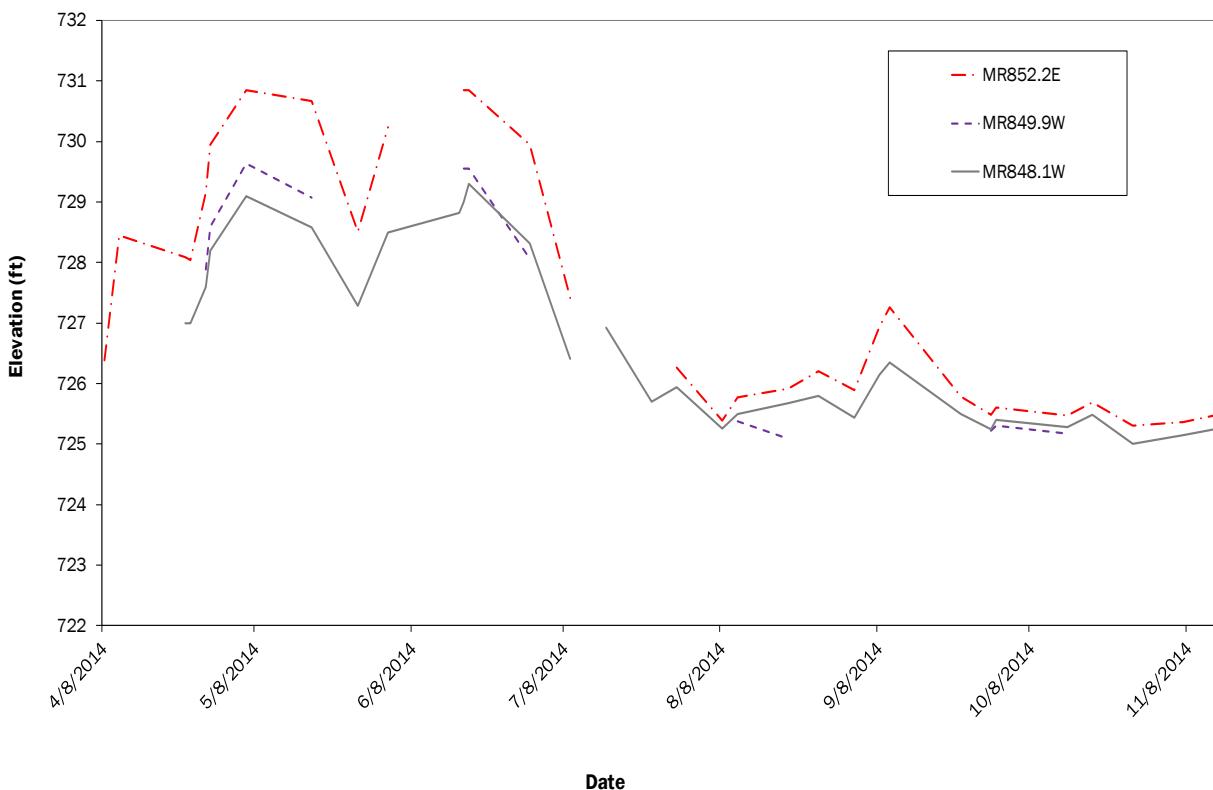


Figure 41. Mississippi River water elevations at three monitoring sites downstream of Saint Anthony Falls

Mississippi River Bacteria Monitoring Results

E. coli

Portions of the MWMO's reach of the Mississippi River are listed on the MPCA's list of impaired waters for fecal coliform pollution. In 2008, the MPCA changed the bacteria water quality standard from fecal coliform to *E. coli* for bacteria monitoring in Minnesota. The standard for *E. coli* in 2B and 2Bd waters is 126 CFU/100 mL for a monthly geometric mean of at least five samples. The MPCA *E. coli* standard also states that *E. coli* cannot exceed 1,260 CFU/100mL in more than 10% of the samples taken in one month. Most sites exceeded this latter standard in one or more months of 2014, as shown in Table 6 and Figure 42. However, the small number of samples collected each month greatly affected these results. The *E. coli* data are presented in more detail in Figures D.1 through D.7 in Appendix D.

Table 6. Sites that exceeded 1,260 MPN/100mL in >10% of samples for the Mississippi River in 2014

Month	Sites that exceed 1,260 MPN/100 mL in > 10% of samples
April	MR857.6W
May	MR857.6W
June	MR857.6W, MR854.9W, MR849.9W
July	None
August	MR859.1W, MR857.6W, MR852.2E
September	MR857.6W, MR849.9W
October	MR859.1W, MR857.6W, MR854.9W, MR849.9W

Prior to 2013, the MWMO collected *E. coli* samples at river sites at least 5 times per month to compute a monthly geomean. During this time, data were being collected to contribute to the MPCA's TMDL assessment of the Upper Mississippi River. In early 2013, the MPCA released its Draft Upper Mississippi River Bacteria TMDL Study and Protection Plan (MPCA, 2013). This document designated the stretch of the Mississippi River within the MWMO as a Protection Reach and deferred it for a TMDL study. Although the reach is now under protection mode, the MWMO continued to sample *E. coli* at the 7 river sites at least twice per month in 2014, with the goal of maintaining a baseline of data. Refer to Table D.1 in Appendix D for the monitoring data.

Precipitation is an important predictor of *E. coli* concentrations. The MWMO targets sampling during baseflow conditions and local rain events to ascertain the impact of precipitation on river bacteria levels. Figure 43 shows boxplots of the 2014 river bacteria data separated out into base and rain values (Refer to Appendix E for an explanation of boxplots). Rain sample *E. coli* concentrations were typically an order of magnitude higher than baseflow values, but there were also instances of high baseflow values. Some potential causes of high baseflow *E. coli* values include water fowl congregating near the sampling site and sanitary overflow into the river. To lower the risk of exposure to high bacteria levels in the river, avoid swimming during rain and for 72 hours after a rain event.

Two additional factors should be considered when evaluating these results. First, these results are based on a maximum of four samples per month. Had more samples been collected, different results may have been observed. Second, two unique features of the MWMO watershed are Upper and Lower Saint Anthony Falls. The Mississippi River water mixes as it flows over the falls, likely affecting water quality.

As these results are highly dependent on precipitation, both in the watershed and upstream, results may differ drastically from year to year. The MWMO does not support interpretation or assumptions based solely on one year of data. The MWMO will continue to collect data on the Mississippi River to provide information for development of TMDLs in the watershed.

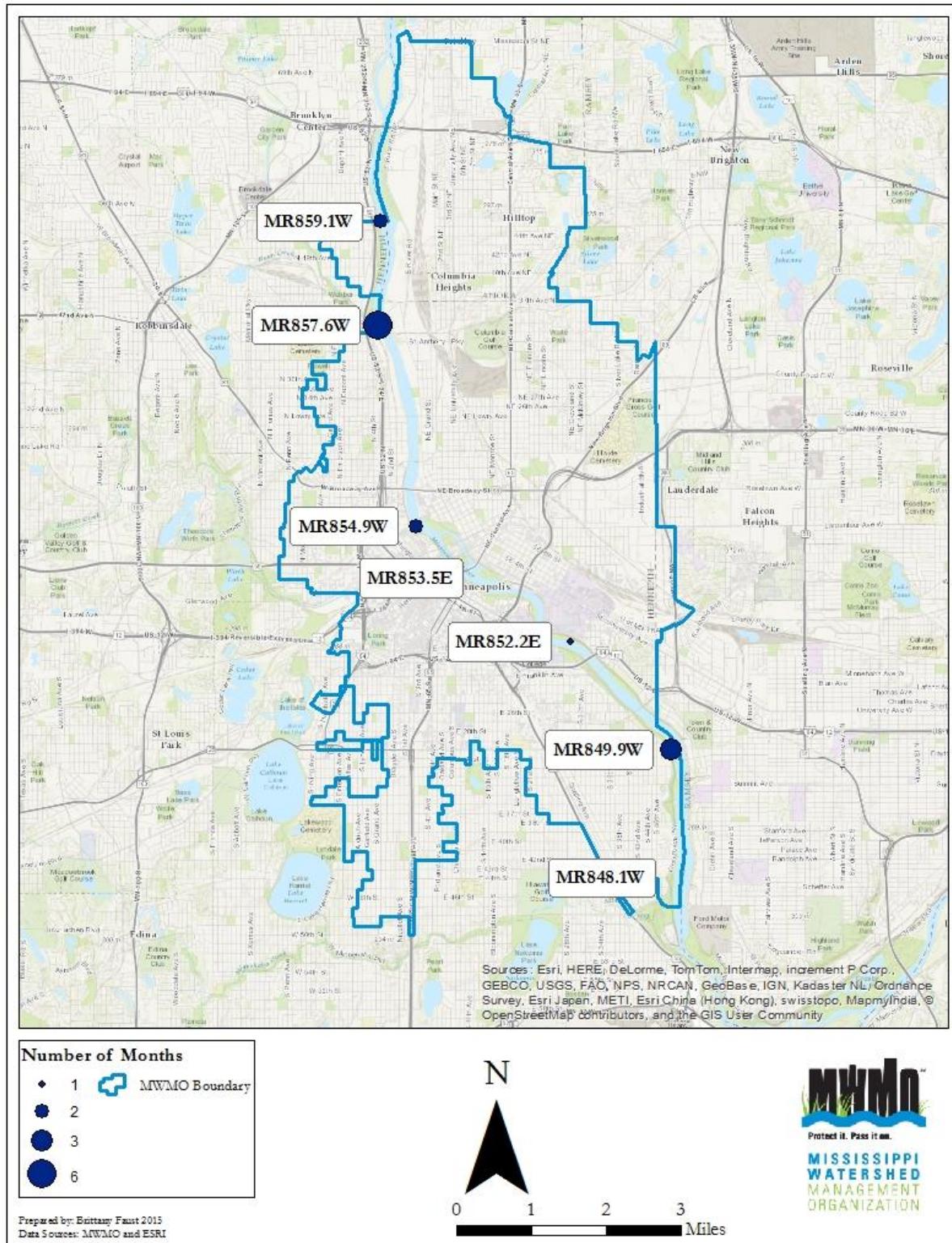


Figure 42. Map of MWMO River bacteria sampling sites. The size of blue circles corresponds to the number of months from April to October in which *E. coli* at individual sites exceeded 1,260 MPN/100mL in >10% of samples in 2014

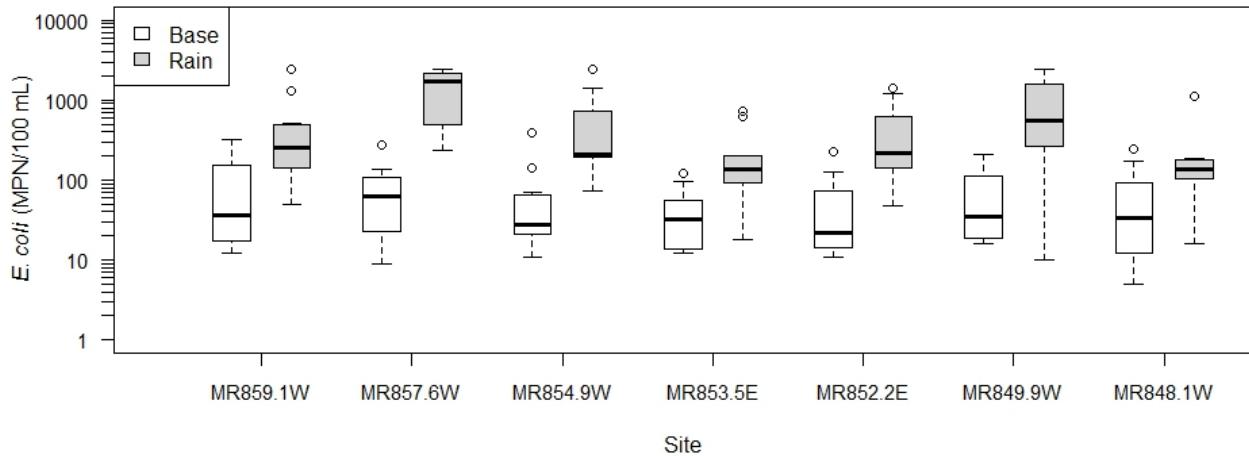


Figure 43. 2014 Mississippi River *E. coli* monitoring results, separated by baseflow and stormflow samples

Water Temperature, Dissolved Oxygen, pH, Transparency, Salinity, and Specific Conductivity

The MWMO monitored dissolved oxygen, pH, water temperature, salinity, specific conductivity, and transparency at least two times per month throughout the 2014 sampling season at the river monitoring sites. These parameters are basic measures that indicate the health of a waterbody, as they contribute to survival of fish and other aquatic organisms and plants. Refer to Figures D.8 through D.14 in Appendix D for the monitoring data.

Stormwater Bacteria Monitoring Results

The MWMO monitors *E. coli* in the stormwater outfalls from April to October. Precipitation is an important predictor of *E. coli* concentrations. Similar to bacteria sampling in the river, the MWMO targets stormwater bacteria sampling during baseflow conditions and local rain events to ascertain the impact of precipitation on stormwater bacteria levels. Stormwater site descriptions can be found in the Stormwater Monitoring section of this report. Sampling methods are detailed in the prior Methodology portion of this section. The 2014 stormwater bacteria data, separated into baseflow and rain event values, are shown in Figure 44. Rain sample *E. coli* concentrations were typically an order of magnitude higher than baseflow values, but there were also instances of high baseflow values. The most likely cause of high baseflow *E. coli* values is sanitary flow into the stormwater pipes. MWMO notifies the applicable member city when there are high baseflow *E. coli* values of concern. All stormwater *E. coli* data are shown in Table D.2 in Appendix D.

Figure 45 shows all of the stormwater and river *E. coli* data plotted together. For the most part, both baseflow and stormflow bacteria concentrations appear to be higher at the stormwater sites than at the river sites. These data suggest that stormwater may be a large contributor of bacteria to the Mississippi River, particularly during storm events.

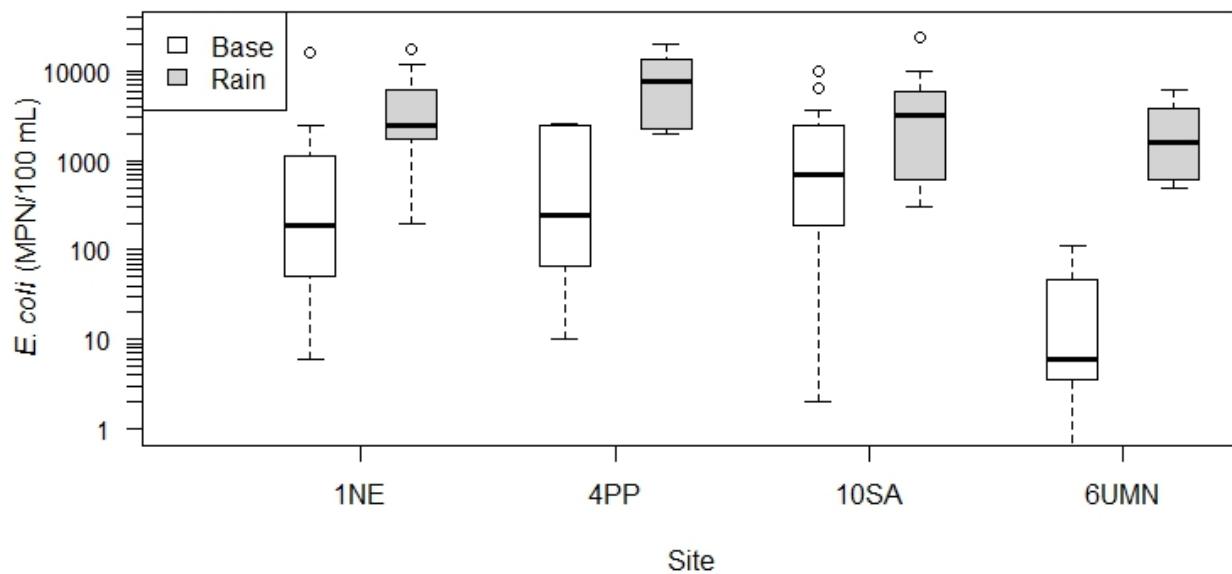


Figure 44. Bacteria data at stormwater sites in 2014, separated by baseflow and rain event samples

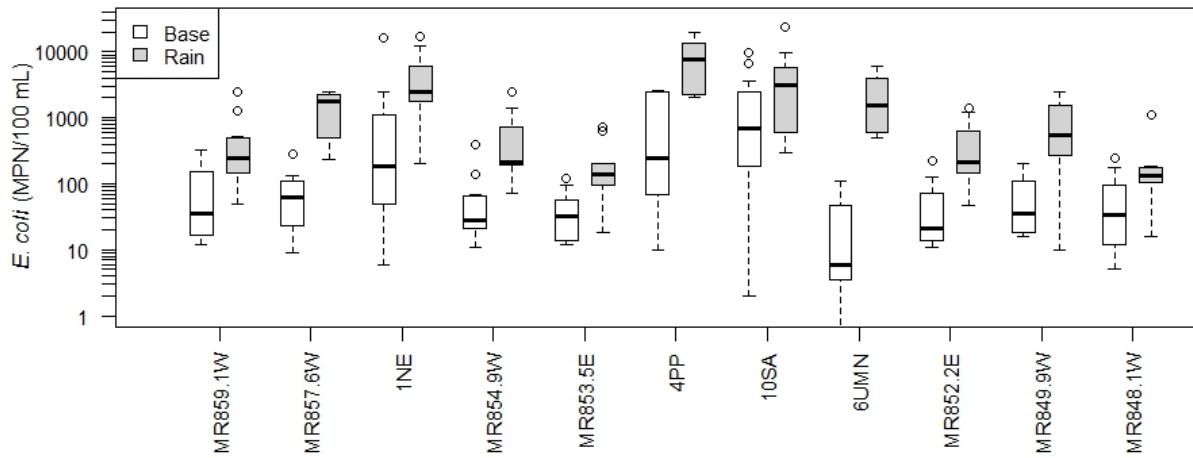


Figure 45. All Mississippi River and stormwater bacteria data from 2014, listed in order from upstream to downstream river location. Data are separated into baseflow and rain event samples

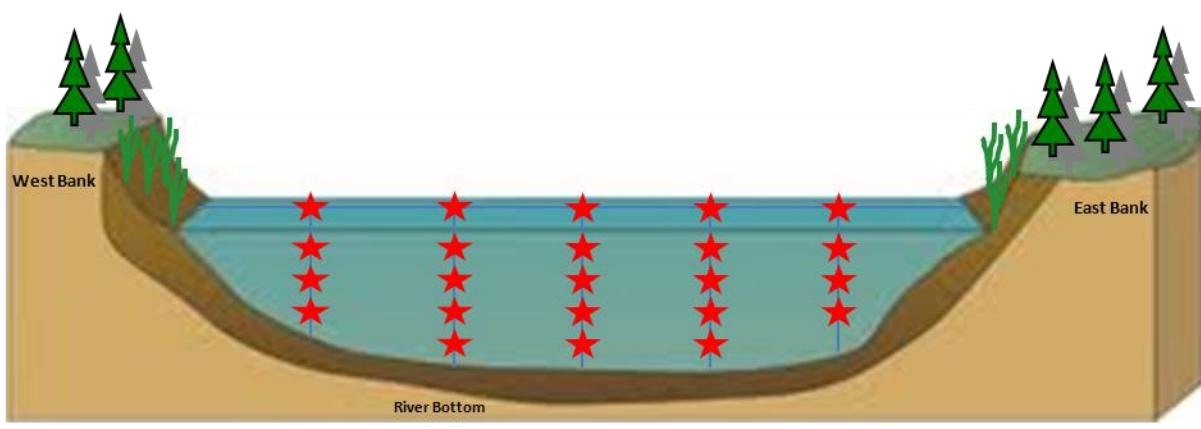
Mississippi River Monitoring For Hydraulic Mixing

In 2006, the MWMO developed plans to better fulfill its responsibility for monitoring water quality in the stormwater drainage systems and the Mississippi River (MWMO, 2006). For an accurate assessment of the water quality within the 14-mile stretch of the Mississippi River, the MWMO needed to know where, how, and when to

sample the reaches of the river in the MWMO, given the patterns of hydraulic mixing as it passes through the watershed. The MWMO contracted Emmons & Olivier Resources, Inc. in 2006, to conduct a literature review to provide necessary information for the development of big river monitoring protocols (MWMO, 2008). The study provided findings and gaps in the hydraulic and pollutant mixing literature related to large river systems. Previously, there were no site specific data or models to address mixing in the MWMO's reaches of the Mississippi River.

In 2012 and 2013, the MWMO monitored the Mississippi River at five locations (cross-sections) in three different reaches to develop methods to fill hydraulic mixing data gaps in the 14-mile stretch of the Mississippi River in the MWMO.

In 2014, the MWMO continued monitoring the Mississippi River at the established five locations. Beginning in April, staff visited each cross-section once or twice a month until November. Each cross-section was divided into five lateral points equally spaced across the width of the river. Measurements were taken at three-foot depth increments starting at the water surface and ending just above the bottom of the river (Figure 46).



★ = Sampling Location

Figure 46. Diagram of a cross-section for river hydraulic mixing sampling. Each star represents a data collection point

Site Selection

Figure 47 shows the monitoring transects for hydraulic mixing. Site selection was based on the hydraulic characteristics of the four reaches in the 14-mile stretch of the Mississippi River in the MWMO (MWMO, 2008). Site MR859.1 (Camden) is just upstream of the beginning of Reach #1 (RM 859.0-RM 857.8). Site MR858.0 (2) is near the end of Reach #1 and just upstream of the Shingle Creek tributary entering the Mississippi River at river mile 857.9. Site MR854.8 (2NNBC) is near the end of Reach #2 (RM 857.8-RM 854.1) and downstream of Boom Island boat launch. Site MR852.6 (Washington Avenue Bridge) is downstream of the beginning of Reach #4 (RM 853.4-RM 847.8) at Lower Saint Anthony Falls. Site MR848.1 (6.1) is near the end of Reach #4. Data were not collected from Reach #3 (RM 854.1 – RM 853.4), located between Upper and Lower Saint Anthony Falls, due to safety concerns.

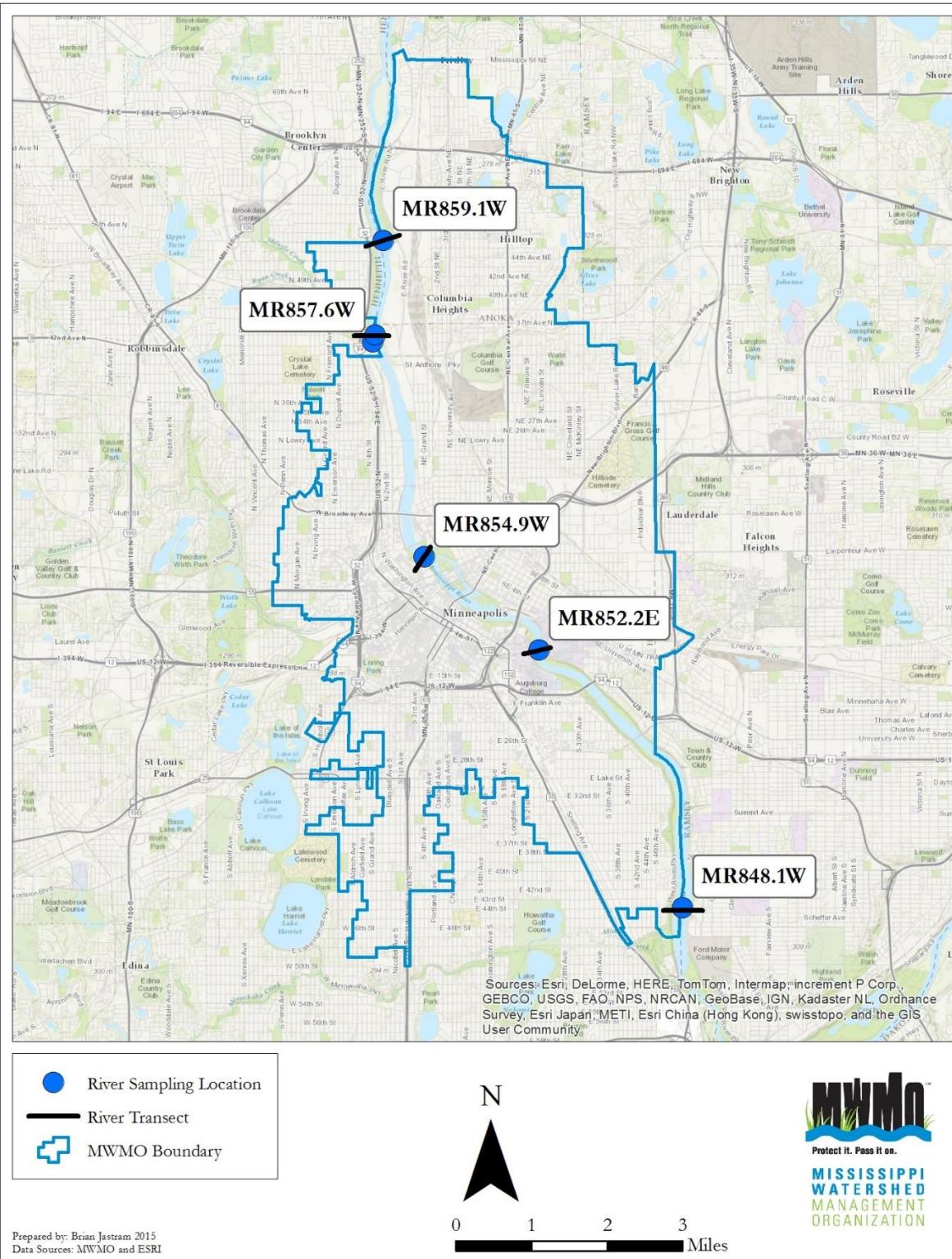


Figure 47. River hydraulic mixing transect sites and river water quality sampling locations. Hydraulic mixing transects are shown with the black lines. Water quality sites are shown with blue circles.

Site (Cross-Section) Descriptions

MR859.1 (Camden): This site is just upstream of the beginning of Reach #1 (RM 859.0-RM 857.8) and is the farthest upstream cross-section in the MWMO's watershed. The cross-section is 840 feet wide. The west end of the cross-section begins at monitoring site MR859.1W, near a concrete levy wall and a stormwater outfall, and terminates at the opposite bank. The river bottom is rocky.

MR857.6 (2): The west end of this cross-section is 200 feet upstream from the outlet of Shingle Creek and is marked by a triple stem *Populus sp.* tree. The east end of the cross-section is a *Populus sp.* tree with no bark on the bottom 10 feet of its trunk. The cross section is 525 feet wide. The river bottom is sandy and rocky.

MR854.9 (2NNBC): The west end of this cross-section is on the shore midway between the two farthest upstream barge tie-up piers. The east end of this cross-section terminates at the concrete steps on Boom Island. The cross-section is 575 feet wide. The river bed is silty and rocky.

MR852.2 (Washington Avenue Bridge): This cross-section is just downstream from the Washington Avenue Bridge. The west end of this cross-section begins near the Bohemian Flats Park, next to the sheet pile wall in line with the park information pavilion. The east end of this transect terminates near a rectangular tunnel structure in the opposite bank. This cross-section is 525 feet wide. The river bottom is composed of sand, silt, and rocks.

MR848.1 (6.1): The west end of this cross-section begins at monitoring site MR848.1W (marked by a staff gauge) and terminates at the opposite bank near two small dead trees that are close together. This cross section is 1060 feet wide. The river bottom is mostly sand.

Methodology

Data Collection

Each cross-section was divided laterally into five equal lengths, and measurements were taken at the mid-point of each (Figure 46) at three-foot depth increments from the water surface to the bottom of the river. Water temperature, pH, D.O., salinity, and specific conductivity data were collected using a multiparameter YSI ProPlus sonde mounted to a telescoping pole. Data were recorded when the values stabilized. The number of measurements made at each lateral position varied with the depth of the river. River sites were accessed with an 18-foot John boat, when conditions allowed. The water depth at site MR859.1 (Camden) is lower than at other sites; therefore, this site was monitored only when accessible by boat. Examples of data collected at a cross-section during a sampling visit are presented in Table 7 and Figure 48.

Data Collection Quality Control

The MWMO staff followed established calibration procedures for YSI data quality control. Dissolved oxygen, pH, and conductivity were calibrated before every use. At the end of the day, the calibration was checked to determine if there was any drift in the YSI data measurements.

Table 7. River monitoring data for cross-section MR854.9W for October 20, 2014. The * refers to data that were collected at a depth of 13 feet rather than 15 feet.

Lateral Position	East Bank		Midpoint		West Bank
	1	2	3	4	5
Depth (ft)	Temperature (C)				
0	11.8	11.8	12.0	11.9	11.9
3	11.7	11.8	12.0	11.9	11.9
6	11.7	11.8	12.0	11.9	11.9
9	11.7	11.8	11.9	11.9	—
12	11.7	11.8	11.9	11.9	—
15	—	11.8	11.9	11.9*	—
18	—	—	11.9	—	—
Dissolved Oxygen (mg/L)					
0	11.51	11.30	11.43	11.45	11.24
3	11.60	11.31	11.40	11.36	11.23
6	11.38	11.30	11.37	11.37	11.16
9	11.28	11.32	11.26	11.33	—
12	11.40	11.35	11.36	11.30	—
15	—	11.35	11.30	11.31*	—
18	—	—	11.31	—	—
pH					
0	7.97	8.01	8.08	8.03	8.05
3	7.96	8.00	8.05	8.03	8.03
6	7.97	7.99	8.05	8.04	8.02
9	7.97	7.99	8.06	8.02	—
12	7.96	8.00	8.06	8.04	—
15	—	7.99	8.03	8.03*	—
18	—	—	8.03	—	—
Specific Conductivity (uS/cm)					
0	384.2	383.6	383.4	387.7	389.4
3	384.0	383.8	384.9	388.2	391.1
6	383.7	383.7	386.0	388.1	391.5
9	383.6	383.6	387.4	388.2	—
12	383.7	383.3	387.6	388.0	—
15	—	383.2	385.1	386.5*	—
18	—	—	387.0	—	—
Salinity (ppt)					
0	0.19	0.19	0.18	0.19	0.19
3	0.19	0.19	0.19	0.19	0.19
6	0.19	0.19	0.19	0.19	0.19
9	0.19	0.19	0.19	0.19	—
12	0.19	0.18	0.19	0.19	—
15	—	0.18	0.19	0.19*	—
18	—	—	0.19	—	—

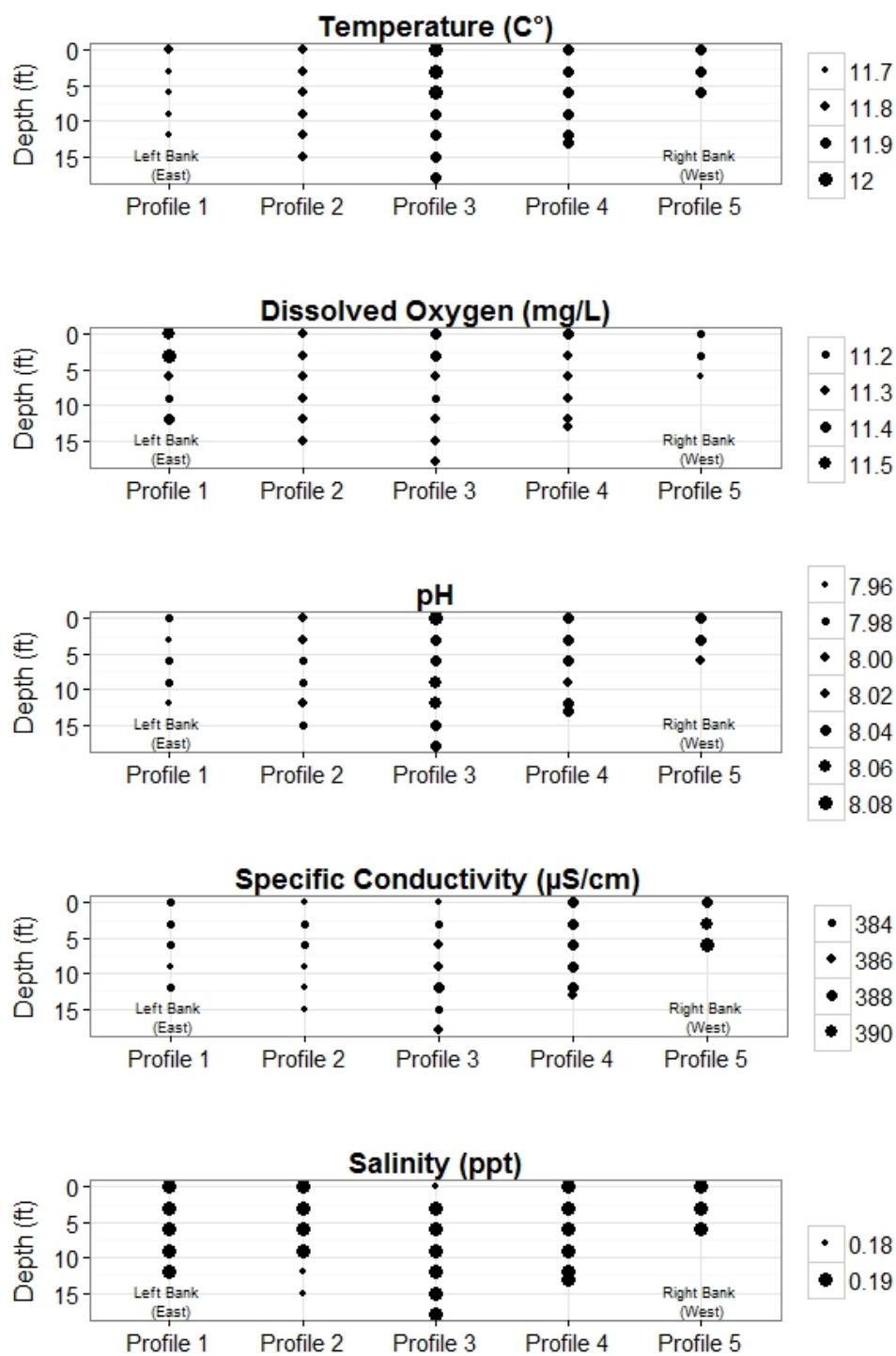


Figure 48. Mississippi River monitoring data for cross-section MR854.9W for October 20, 2014.

Mississippi River Water Quality Monitoring

MWMO staff began collecting water quality samples from the Mississippi River during 2014. The purpose of monitoring the water quality of the Mississippi River is to establish baseline water quality data that can be used for the management of the river. Water quality measurements and samples were collected monthly in November and December of 2014 at six sites (see Figure 47 in previous section). Monitoring sites on the Mississippi River and within the MWMO's boundary were selected to represent three distinct reaches of the river. Each site is located within, at the beginning of, or at the end of a river reach. Samples were collected once a month, from the middle of the river, 3 feet below the surface. Samples were collected progressively from the most downstream site to the most upstream site.

Site Descriptions

River water quality samples were taken at approximately the same locations as the hydraulic mixing monitoring transects. Refer to the site descriptions in the Hydraulic Mixing section of this report for details (Figure 47). At site MR857.6, an additional sample was taken downstream of where Shingle Creek enters the river. During winter months, some of the sampling locations were adjusted based upon access to open river water.

Methodology

Sample Collection, Handling, and Preservation

Samples were collected from the front of the boat in the middle of the river, three feet below the surface, using a Wildco® Beta Plus Horizontal Water Sampler (Wildco, Yulee, FL). The sampler was rinsed once with river water and then was filled two times to collect enough water to fill a laboratory-cleansed (non-sterile) eight-liter plastic bottle. The physical water parameters were collected from the river using a YSI ProPlus sonde (YSI Inc., Yellow Springs, OH) lowered into the water from the boat. The samples were stored in a cooler for transport to the laboratory. When boating to the sample site was not possible, samples were collected by lowering the Wildco® Beta Plus Horizontal Water Sampler from bridges or by filling a laboratory-cleansed (non-sterile) eight-liter plastic bottle from riverbanks.

Sampling Quality Control

The MWMO staff followed the quality control protocol outlined in the MWMO Ambient Surface Water Monitoring Quality Assurance Project Plan (MPCA, 2010). Blank samples of DI water were submitted to laboratories once a month to verify that sample containers were clean and samples were not contaminated during travel. In addition, ten percent of all samples were collected in duplicate to verify that sampling and laboratory procedures did not jeopardize the data.

Laboratory Analyses

All samples were analyzed at the Metropolitan Council Environmental Services (MCES) Laboratory. MCES followed strict protocols for quality assurance and quality control. Information regarding laboratory protocol is available from MWMO staff. Refer to Table C.1 in Appendix C for a list of sample parameters, the laboratories used for analysis, the analysis methods, and information regarding certification.

Mississippi River Water Quality Monitoring Results

Samples were collected for nutrients, sediment, inorganics, organics, and metals analyses. Results are not presented here because there were only two samples collected at each site during 2014. All data will be presented in the 2015 Annual Monitoring Report.

Mississippi River Bathymetry Mapping

The purpose of collecting Mississippi River bathymetric data is to provide baseline data on the Mississippi River. This mapping project recorded the morphology of the river bed. Rock piles, deep holes, navigation channels, dunes, pilings, and other structures were mapped. The mapping produced data that show one-foot contours, hardness, track, and vegetation.

Methodology and Results

Data collection began on September 24th, 2014 and continued through October 31st, 2014. Data were collected on the Mississippi River between Coon Rapids Dam and Lock & Dam No. 1 (Ford Dam). Bathymetric data were collected with a Lowrance HDS-5 Gen2 Fishfinder/Chartplotter (Navico, Inc., Minneapolis, MN) and stored on an SD card. A Lowrance Point-1 GPS/HDG Antenna (Navico, Inc., Minneapolis, MN) was used in combination with the HDS-5 to increase position accuracy. To facilitate efficient coverage of the area to be mapped, a tablet with a tracking application and plotted course was utilized. The boat was navigated along a course of parallel tracks 25 meters apart covering the area between river banks. Data files were recorded for a maximum of one hour before starting a new file. The speed of the boat was kept at or below five mph to ensure data quality. The recorded data files were uploaded to a BioBase (Navico, Inc., Minneapolis, MN) server and merged to form a complete map of the river bottom (Figure 49).



Figure 49. Section of Mississippi River in the MWMO that was mapped as part of the bathymetry project. Inset image shows a section of resulting bathymetric data.

Work Plan

2014 Work Plan

Following is a list of work plan accomplishments for the year 2014:

- Completed the Annual Monitoring Report for 2013 (MWMO, 2014)
- Worked with the Public Works Department staff from the City of Fridley to reassess the location to install monitoring equipment for a new stormwater outfall monitoring site in the 45th Avenue stormwater tunnel
- Worked with Burlington Northern Santa Fe staff and BAE System Inc. staff to access the new location to install monitoring equipment
- Completed installation of a new automated stormwater monitoring site (11CHF) in the City of Fridley 45th Avenue stormwater tunnel and started collecting data in October 2014
- Installed a level troll at the 2NNBC site to continuously monitor the water level from the tunnel to the Mississippi River
- Prepared and signed a professional services agreement with Anoka Conservation District to coordinate water level monitoring for Sullivan Lake
- Signed an agreement with Minneapolis School District, Special School District No.1, to install, operate, and maintain automated rain gauges at Edison High School and Waite Park Community School to collect precipitation data. Expanded the MWMO precipitation monitoring network by installing one heated precipitation gauge at Waite Park Elementary School in Northeast Minneapolis
- Collected precipitation data from five locations using heated precipitation gauges, two locations using non-heated gauges, and an additional non-heated gauge that is operated by a citizen volunteer
- Continued to monitor four stormwater sites using automated samplers. The 2NNBC site was monitored by grab sampling when there was positive flow from the tunnel to the river. The 7LSTU site was monitored by automated and/or grab sampling depending on the presence of tailwater in the outfall tunnel
- Continued monthly monitoring of the Kasota Ponds wetlands in St. Paul
- Continued biweekly monitoring of seven sites on the Mississippi River and seven stormwater outfall sites for *E. coli* and submitted the data to the MPCA's EQuIS database
- Continued working on developing monitoring protocols for the Mississippi River through monitoring for hydraulic mixing and physical parameters (pH, temperature, dissolved oxygen, and conductivity) at five cross-sections on the river from April 2014 to November 2014
- Worked with Metropolitan Council Environmental Services department staff and National Park Service staff to identify the Mississippi River water quality monitoring sites within the MWMO jurisdiction
- Started collecting water quality samples at six locations between the upper and lower boundaries of the Mississippi River in the MWMO watershed
- Calculated preliminary estimates of total suspended solids and total phosphorus loadings from 2007 to 2013 for the 1NE stormwater site
- Calculated preliminary estimates of total suspended solids and total phosphorus loadings from 2011 to 2012 for the 10SA stormwater site
- Collected bathymetry data for the Mississippi River between the Coon Rapids Dam and Lock & Dam No. 1
- Assisted the City of Minneapolis with their illicit discharge monitoring program

- Worked with the MPCA on the Upper Mississippi River Bacteria TMDL Project and the Twin Cities Metro Area Chloride Project
- Worked with the City of Minneapolis Health Department staff to write a contract between the MWMO and the City of Minneapolis to hire two interns to enhance their erosion and sediment control inspections program
- Developed partnerships with Capital Region Watershed District water quality monitoring staff to collaborate on monitoring work and confined space entry training
- Shared MWMO data through the MPCA's EQuIS database, the MWMO's annual monitoring report, and data requests

2015 Work Plan

The 2015 work plan for the MWMO's monitoring program includes:

- Complete the Annual Monitoring Report for the 2014 monitoring season
- Work with St. Anthony Falls Laboratory to test the accuracy of water level and velocity sensors under laboratory conditions
- Continue to work with the MWMO member cities to assess their monitoring needs and assist in developing additional monitoring plans for stormwater monitoring and lake monitoring
- Continue to look for opportunities to expand the precipitation monitoring network using heated precipitation gauges and citizen precipitation recorders
- Continue to monitor five stormwater sites using automated samplers. The 2NNBC site will be monitored by grab sampling when there is positive flow from the tunnel to the river. The 7LSTU site will be monitored by automated or grab sampling depending on the presence of tailwater in the outfall
- Continue monthly monitoring of the Kasota Ponds wetlands in St. Paul
- Continue biweekly monitoring of seven sites on the Mississippi River and seven stormwater sites for *E. coli* and submit the data to the MPCA
- Continue development of monitoring protocols for the Mississippi River through monitoring for hydraulic mixing and collection of data at five river cross-sections
- Continue to sample the Mississippi River at six locations for water quality analysis
- Finalize the bathymetry data for the Mississippi River that was collected in fall 2014 and collect additional bathymetry data in fall 2015
- Continue working on pollutant loading calculations for the stormwater outfall sites
- Develop a new contract with the City of Minneapolis to continue assisting with their illicit discharge monitoring program and enhance their spill response activities
- Continue to work with the MPCA on the Upper Mississippi River Bacteria TMDL Project and the Twin Cities Metro Area Chloride Project
- Continue to work with the City of Minneapolis Health Department staff to enhance their erosion and sediment control inspections program
- Share MWMO data through the MPCA's EQuIS database, the MWMO's annual monitoring report, and data requests

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Appendix A – Watershed Maps

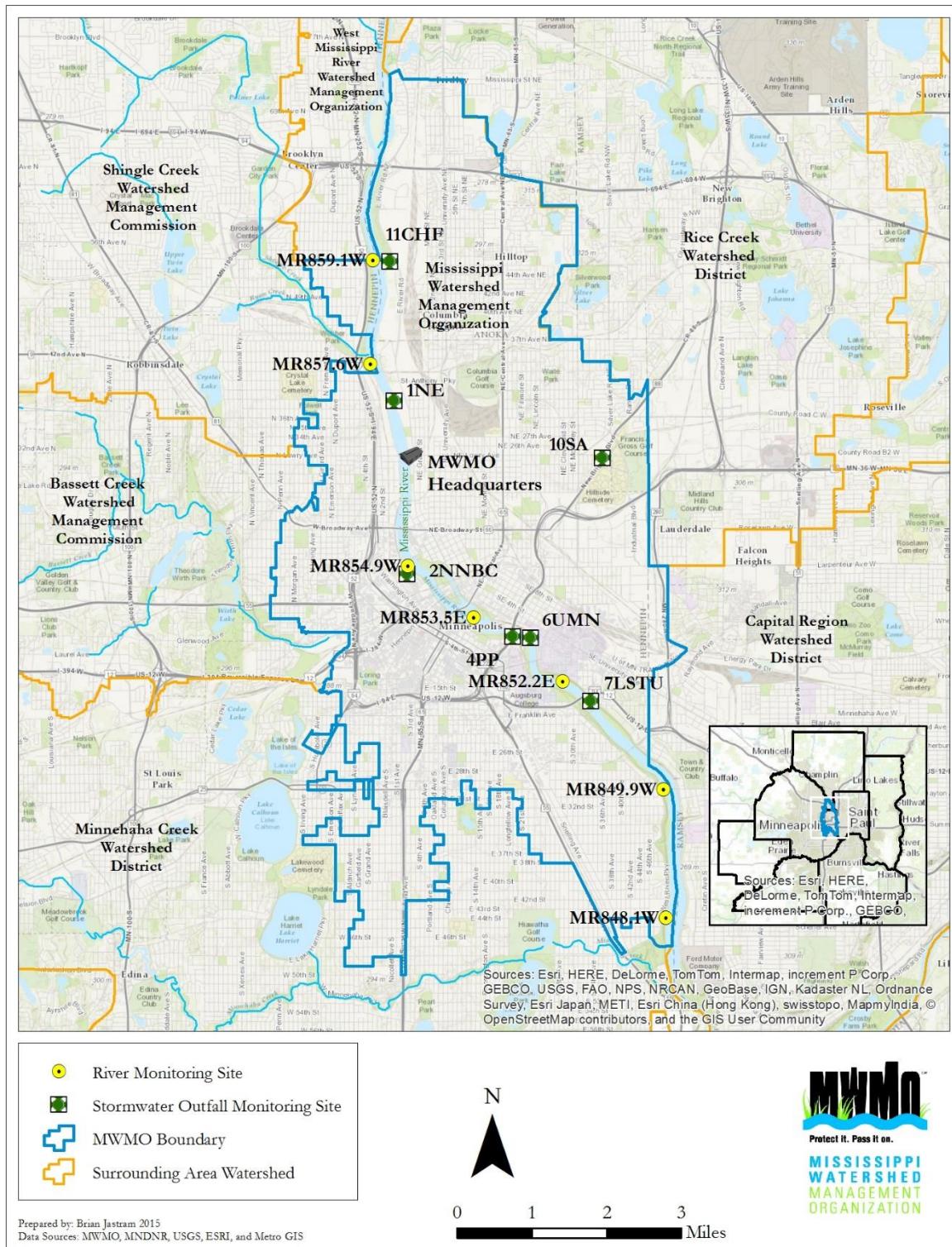


Figure A.1. MWMO watershed boundary, river monitoring sites for bacteria, and stormwater monitoring sites

Appendix B – Precipitation Event Sampling Data

Table B.1. Precipitation event data and samples collected. A precipitation event is defined as being greater than 0.01 inches and separated by 8 hours. The rain gauge is located at Saint Anthony Falls Laboratory.

Event #	Start Date/Time	End Date/Time	Precip. Type	Precip. (inches)	Duration (hours)	Intensity (in/hr)	Sample Type	Site 11CHF	Site 1NE	Site 2NNBC	Site 10SA	Site 4PP	Site 6UMN	Site 7LSTU
†1	1/3/2014 22:00	1/3/2014 23:30	Snow	0.05	1.50	0.033	—	—	—	—	—	—	—	—
‡2	1/14/2014 2:30	1/14/2014 6:45	Snow	0.13	4.25	0.031	—	—	—	—	—	—	—	—
‡3	1/18/2014 3:00	1/19/2014 7:30	Snow	0.13	28.50	0.005	—	—	—	—	—	—	—	—
‡4	1/24/2014 10:30	1/24/2014 18:30	Snow	0.03	8.00	0.004	—	—	—	—	—	—	—	—
‡5	1/25/2014 23:15	1/26/2014 3:15	Snow	0.05	4.00	0.013	—	—	—	—	—	—	—	—
‡6	1/30/2014 4:45	1/30/2014 12:15	Snow	0.11	7.50	0.015	—	—	—	—	—	—	—	—
‡7	2/1/2014 9:15	2/1/2014 11:15	Snow	0.03	2.00	0.015	—	—	—	—	—	—	—	—
‡8	2/17/2014 5:30	2/17/2014 10:15	Snow	0.16	4.75	0.034	—	—	—	—	—	—	—	—
9	2/18/2014 11:30	2/19/2014 10:00	None	n/a	n/a	n/a	Composite	—	—	—	X(l)	—	—	—
10	2/19/2014 10:45	2/20/2014 0:15	None	n/a	n/a	n/a	Composite	—	X	—	X	—	—	—
†11	2/20/2014 12:15	2/20/2014 21:15	Snow	0.61	9.00	0.068	Composite	—	—	—	—	—	—	—
12	3/8/2014 12:45	3/10/2014 9:00	None	n/a	n/a	n/a	Composite	—	X	—	X	X(cc)	—	—
13	3/10/2014 10:00	3/11/2014 6:00	None	n/a	n/a	n/a	Cmp. & Grab	—	X	X	X	X	X	X
14	3/11/2014 11:00	3/12/2014 6:00	None	n/a	n/a	n/a	Composite	—	X	—	X	—	—	—
15	3/12/2014 13:30	3/13/2014 5:30	None	n/a	n/a	n/a	Composite	—	X	—	X	—	—	—
16	3/13/2014 12:30	3/14/2014 9:45	None	n/a	n/a	n/a	Cmp. & Grab	—	X	X	X	X	X	X
17	3/14/2014 12:30	3/16/2014 19:00	None	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	—	—	—
†18	3/17/2014 8:00	3/19/2014 1:30	Snow	0.20	29.50	0.007	Composite	—	X, X(l)	—	X	—	—	—
19	3/19/2014 13:45	3/19/2014 22:45	None	n/a	n/a	n/a	Composite	—	X(l)	—	—	—	—	—
20	3/20/2014 12:45	3/21/2014 6:15	None	n/a	n/a	n/a	Composite	—	X	—	X	X	X	—
†21	3/27/2014 6:00	3/27/2014 17:15	Rain/Snow	0.36	17.25	0.021	Composite	—	X	—	X	X	X	—
22	3/28/2014 11:15	3/31/2014 7:30	None	n/a	n/a	n/a	Composite	—	X	—	X	X	—	—
23	3/31/2014 9:00	3/31/2014 19:30	Rain	0.05	10.50	0.005	Composite	—	X	—	X	X	—	—
†24	4/3/2014 15:45	4/4/2014 6:00	Snow	0.73	14.25	0.051	—	—	—	—	—	—	—	—
25	4/4/2014 14:45	4/4/2014 14:45	None	n/a	n/a	n/a	Grab	—	—	—	—	—	—	X
26	4/4/2014 11:45	4/7/2014 3:30	None	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	X(l)	—	—
27	4/12/2014 5:00	4/12/2014 6:00	Rain	0.06	1.00	0.060	—	—	—	—	—	—	—	—
†28	4/16/2014 9:00	4/16/2014 23:45	Snow	0.87	14.75	0.059	—	—	—	—	—	—	—	—
29	4/19/2014 21:00	4/20/2014 0:30	Rain	0.08	3.50	0.023	—	—	—	—	—	—	—	—
30	4/21/2014 2:15	4/21/2014 7:00	Rain	0.04	4.75	0.008	—	—	—	—	—	—	—	—
31	4/23/2014 12:30	4/24/2014 12:15	Rain	0.78	23.75	0.033	Composite	—	X(ec)	X(ec)	X(ec)	—	X(ec)	X(ec)
32	4/26/2014 19:30	5/1/2014 4:30	Rain	3.76	105.00	0.036	Cmp. & Grab	—	2X(l), X(ec)(ec)	X(ec)	2X(l), X(ec)(ec)	X(ec)(ec)	X(ec), X(ec)	X(ec), X(ec)
33	5/7/2014 23:45	5/8/2014 18:45	Rain	0.64	19.00	0.034	Composite	—	—	X	—	—	—	—
34	5/10/2014 19:15	5/12/2014 20:30	Rain	0.88	49.25	0.018	Composite	—	—	X	—	—	—	—
35	5/19/2014 9:15	5/19/2014 19:45	Rain	1.46	10.50	0.139	Grab	—	—	X(ec)	X(l)(ec)	X(ec)	X(ec)	X(l)(ec)
36	5/27/2014 0:45	5/27/2014 12:15	Rain	0.21	11.50	0.018	—	—	—	—	—	—	—	—
37	5/31/2014 15:15	6/2/2014 6:15	Rain	1.72	39.00	0.044	Composite	—	X(l)	—	X(l)	—	—	—
38	6/6/2014 19:30	6/7/2014 12:15	Rain	0.41	16.75	0.024	Composite	—	—	—	X(l)	—	—	—
39	6/9/2014 5:45	6/9/2014 7:00	Rain	0.03	1.25	0.024	—	—	—	—	—	—	—	—
40	6/11/2014 22:00	6/11/2014 23:30	Rain	0.18	1.50	0.120	—	—	—	—	—	—	—	—
41	6/14/2014 8:45	6/15/2014 9:30	Rain	1.41	24.75	0.057	Composite	—	—	—	X(l)	—	—	—
42	6/16/2014 15:45	6/16/2014 19:30	Rain	0.35	3.75	0.093	Composite	—	—	—	X(l)	—	—	—

† snowmelt event

n/a = not applicable

X = full suite of analytes

X(ec) = event sampled with *E. coli*

(ec) = event sampled with *E. coli* only

X(l) = event sampled with limited parameters generally due to holding times

Table B.1 continued. Precipitation event data and samples collected. A precipitation event is defined as being greater than 0.01 inches and separated by 8 hours. The rain gauge is located at Saint Anthony Falls Laboratory.

Event #	Start Date/Time	End Date/Time	Precip. Type	Precip. (inches)	Duration (hours)	Intensity (in/hr)	Sample Type	Site 11CHF	Site 1NE	Site 2NNBC	Site 10SA	Site 4PP	Site 6UMN	Site 7LSTU
43	6/17/2014 22:00	6/19/2014 19:15	Rain	2.95	45.25	0.065	Cmp. & Grab	—	X(ec)	X(ec)	X(ec)	X(ec)	X(ec)	X(ec)
44	6/22/2014 13:15	6/22/2014 14:00	Rain	0.02	0.75	0.027	—	—	—	—	—	—	—	—
45	6/24/2014 21:00	6/24/2014 21:30	Rain	0.06	0.50	0.120	—	—	—	—	—	—	—	—
46	6/26/2014 9:30	6/26/2014 10:00	Rain	0.02	0.50	0.040	—	—	—	—	—	—	—	—
47	6/28/2014 14:30	6/29/2014 0:15	Rain	1.50	11.75	0.128	Composite	—	—	—	X	—	—	—
48	7/6/2014 4:30	7/6/2014 6:45	Rain	0.14	2.25	0.062	—	—	—	—	—	—	—	—
49	7/7/2014 13:15	7/7/2014 17:45	Rain	0.62	4.50	0.138	Composite	—	—	X	—	—	—	—
50	7/11/2014 0:45	7/12/2014 14:00	Rain	1.33	27.25	0.049	Cmp. & Grab	X(l)	X	X(l)	X	X	X	X
51	7/14/2014 15:30	7/14/2014 19:00	Rain	0.17	3.50	0.049	Composite	X(l)	—	X	—	—	—	—
52	7/25/2014 4:00	7/25/2014 8:00	Rain	0.40	4.00	0.100	Composite	X(l)	—	X	X	X(l)	—	—
53	8/10/2014 18:30	8/11/2014 9:00	Rain	0.21	14.50	0.014	Composite	—	X(ec)	—	X(l)(ec)	(ec)	(ec)	—
54	8/17/2014 13:00	8/17/2014 23:45	Rain	0.23	10.75	0.021	Composite	—	X(l), X(l)	—	X	—	X(l)	—
55	8/21/2014 3:00	8/21/2014 6:30	Rain	0.69	3.50	0.197	Composite	X(l), X(l)(ec)	—	X(l), X(l)(ec)	X(l)(ec)	X(l)(ec)	(ec)	—
56	8/24/2014 4:30	8/24/2014 16:15	Rain	0.19	11.75	0.016	Composite	X(l)	—	X(l)	X(l)	—	—	—
57	8/26/2014 23:30	8/26/2014 23:45	Rain	0.02	0.25	0.080	—	—	—	—	—	—	—	—
58	8/28/2014 13:30	8/30/2014 1:15	Rain	1.41	35.75	0.039	Composite	X(l), X(l)	—	X(l)	X(l)	X(l), X(l)	—	—
59	8/31/2014 20:30	8/31/2014 23:45	Rain	0.33	3.25	0.102	Composite	X(l)	—	X(l)	—	X(l)	—	—
60	9/3/2014 7:45	9/3/2014 20:30	Rain	0.21	12.75	0.016	Composite	X(l)(ec)	—	X(l)(ec)	(ec)	X(l)(ec)	—	—
61	9/9/2014 20:15	9/10/2014 8:00	Rain	0.92	11.75	0.078	Cmp. & Grab	X, X(l)(ec)	—	X, X(l)(ec)	—	—	—	—
62	9/15/2014 5:15	9/15/2014 7:00	Rain	0.07	1.75	0.040	—	—	—	—	—	—	—	—
63	9/20/2014 16:30	9/20/2014 17:15	Rain	0.13	0.75	0.173	Composite	X(l)	—	X(l)	—	—	—	—
64	9/24/2014 13:30	9/24/2014 13:45	Rain	0.06	0.25	0.240	Composite	X(l)	—	X(l)	X(l)	—	—	—
65	9/29/2014 8:45	9/29/2014 9:15	Rain	0.09	0.75	0.120	—	—	—	—	—	—	—	—
66	10/1/2014 6:30	10/4/2014 6:00	Rain	0.94	65.50	0.014	Cmp. & Grab	X(ec)	2X(l), X(ec)	X(ec)	2X, X(l)(ec)	2X, X(l)(ec)	2X(l), X(ec)	X(ec)
67	10/23/2014 1:45	10/23/2014 5:00	Rain	0.04	3.25	0.012	—	—	—	—	—	—	—	—
68	11/5/2014 8:45	11/5/2014 19:45	Rain	0.08	11.00	0.007	—	—	—	—	—	—	—	—
69	11/7/2014 12:30	11/7/2014 12:45	Rain	0.02	0.25	0.080	—	—	—	—	—	—	—	—
†70	11/10/2014 3:45	11/11/2014 6:45	Snow	0.62	27.00	0.023	—	—	—	—	—	—	—	—
71	11/22/2014 12:30	11/24/2014 0:00	None	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	X(l)	X(l)	—
72	11/24/2014 23:00	11/25/2014 15:00	None	n/a	n/a	n/a	Composite	—	—	—	—	X(l)	—	—
†73	11/26/2014 9:15	11/26/2014 10:30	Snow	0.03	1.25	0.024	—	—	—	—	—	—	—	—
†74	11/28/2014 1:30	11/28/2014 14:15	Snow	0.03	10.75	0.003	—	—	—	—	—	—	—	—
75	11/29/2014 14:00	11/29/2014 14:30	None	n/a	n/a	n/a	Composite	—	—	—	X(l)	X(l)	—	—
76	12/13/2014 12:00	12/16/2014 0:30	Rain	0.18	60.50	0.003	Composite	—	X	—	X(l)	X	—	—
†77	12/21/2014 9:00	12/23/2014 9:15	Rain/Snow	0.18	48.25	0.004	Composite	X(l)	X(l)	—	X	X	—	—
†78	12/26/2014 20:00	12/27/2014 4:45	Snow	0.14	7.75	0.018	—	—	—	—	—	—	—	—

† snowmelt event

n/a = not applicable

X = full suite of analytes

X(ec) = event sampled with *E. coli*

(ec) = event sampled with *E. coli* only

X(l) = event sampled with limited parameters generally due to holding times

Appendix C – Laboratory Methods and Certification

Table C.1. Laboratory methods and certification for each analyte

Analyte	Lab	Method	Certified
Total Metals (Copper, Nickel, Lead, Zinc, Cadmium, Chromium, Mercury)	Metropolitan Council	EPA 200.8 with ATP, Rev. 5.4 (Mercury) EPA 245.7	Yes
Total Soluble Metals	Metropolitan Council	EPA 200.8 with ATP, Rev. 5.4 (Mercury) EPA 245.7	Yes
Total Chemical Oxygen Demand	Metropolitan Council	EPA 410.4 Rev 2.0	Yes
Carbonaceous Biological Oxygen Demand (CBOD) 5-Day	Metropolitan Council	SM 5210 B-2001, Hach 10360 Rev. 1.1	Yes
Total 5-day BOD	Metropolitan Council	SM 5210 B-2001, Hach 10360 Rev. 1.1	No*
Total Organic Carbon	Metropolitan Council	SM 5310 A & C	n/a
Total & Volatile Suspended Solids	Metropolitan Council	SM 2540 D and E - 1997	Yes
Total Dissolved Solids	Metropolitan Council	SM 2540 C	No
Total Alkalinity	Metropolitan Council	EPA 310.2, Rev. 1974	Yes
Total Hardness	Metropolitan Council	SM 2340 C-97	Yes
Total Chlorides	Metropolitan Council	SM 4500-CI E-97	Yes
Total Sulfates	Metropolitan Council	EPA 300.0 Rev 2.1	Yes

*No = Indicates that the lab follows standard certification test methods but has not sought certification from the Minnesota Department of Health.

Table C.1 continued. Laboratory methods and certification for each analyte

Analyte	Lab	Method	Certified
Fluoride	Pace Analytical Services, Inc.	SM 4500-F SPADNS Method, Ref SM 20 th ed. P 4-82 and EPA 300.1, Rev. 2.1	Yes
Total Phosphorus plus Total Kjeldahl Nitrogen	Metropolitan Council	EPA 365.4 & EPA 351.2 Rev 2.0	Yes
Dissolved Phosphorus	Metropolitan Council	EPA 365.4	Yes
Orthophosphorus	Metropolitan Council	SM 4500-P E	Yes
Total Ammonia Nitrogen	Metropolitan Council	EPA 350.1 Rev 2.0	Yes
Nitrate & Nitrite Nitrogen	Metropolitan Council	4500 NO3 H-00	Yes
Total Volatile Organic Compounds	Metropolitan Council	EPA 624/625	Yes
Oil and Grease	Metropolitan Council	SM 5520 D	n/a
<i>E. coli</i>	Three Rivers Park District Water Resources Laboratory and Metropolitan Council	SM 9223 B and Colilert 18 with Quanti Tray/ 2000, IDEXX Laboratories, Inc.	Yes

Appendix D –Bacteria Monitoring Data

Table D.1. Physical parameters and bacteria monitoring data for Mississippi River sites

River Mile	Sample Date	Sample Type	Air	Water	Dissolved	Conductivity	Specific	pH	Transparency	Salinity	E. coli
			Temp (F)	Temp (F)	Oxygen (mg/L)	(µS/cm)	Conductivity (µS/cm)		(cm)	(ppt)	(MPN/ 100 mL)
MR859.1W	4/8/2014 12:42	Base Grab	48	41.2	14.65	272.9	440.6	8.01	60	0.21	13
MR859.1W	4/24/2014 13:03	Rain Grab	42	47.5	12.64	202.0	294.2	7.97	42	0.14	54
MR859.1W	4/28/2014 13:35	Rain Grab	43	44.8	12.42	174.2	264.9	7.86	36	0.13	161
MR859.1W	4/29/2014 13:11	Rain Grab	36	43.7	13.32	203.7	315.0	7.83	30	0.15	150
MR859.1W	5/6/2014 11:30	Base Grab	60	51.4	11.96	243.9	334.7	7.83	51	0.16	12
MR859.1W	5/19/2014 14:10	Rain Grab	55	55.2	10.80	227.6	296.0	7.75	57	0.14	158
MR859.1W	6/3/2014 12:26	Base Grab	73	71.2	8.64	332.6	353.9	7.86	28	0.17	260
MR859.1W	6/18/2014 12:15	Base Grab	78	68.7	5.2	324.1	355.0	7.67	45	0.17	276
MR859.1W	6/19/2014 13:11	Rain Grab	69	69.3	6.37	306.5	334.0	7.70	39	0.16	435
MR859.1W	7/1/2014 11:35	Base Grab	72	72.9	4.67	400.5	418.9	7.69	52	0.20	34
MR859.1W	7/16/2014 11:55	Base Grab	72	70.5	8.74	366.6	394.0	7.90	44	0.19	114
MR859.1W	7/30/2014 13:10	Base Grab	80	76.6	9.37	434.8	436.4	8.28	80	0.21	82
MR859.1W	8/11/2014 13:40	Rain Grab	69	73.9	6.10	477.4	493.6	7.74	81	0.24	326
MR859.1W	8/21/2014 13:28	Rain Grab	82	76.5	8.42	409.2	411.3	8.07	75	0.20	1,300
MR859.1W	9/3/2014 13:29	Rain Grab	66	71.4	8.15	361.6	384.7	7.66	84	0.18	441
MR859.1W	9/10/2014 11:00	Rain Grab	52	66.6	8.94	288.4	324.1	7.77	54	0.15	488
MR859.1W	9/30/2014 13:05	Base Grab	56	63.7	10.52	352.5	410.5	7.82	> 100	0.20	24
MR859.1W	10/1/2014 11:33	Rain Grab	50	58.5	9.28	318.0	388.1	7.91	65	0.19	> 2,420
MR859.1W	10/15/2014 12:25	Base Grab	65	53.4	12.70	306.2	408.1	8.05	> 100	0.20	15
MR859.1W	10/28/2014 13:13	Base Grab	46	51.8	12.33	297.8	407.0	8.24	> 100	0.20	37
MR859.1W	11/13/2014 13:59	Base Grab	22	34.9	15.82	234.0	423.1	8.29	> 100	0.20	19
MR857.6W	4/8/2014 12:27	Base Grab	47	41.7	14.08	347.5	556.0	7.97	65	0.27	13
MR857.6W	4/24/2014 12:47	Rain Grab	42	47.1	12.79	259.4	379.4	7.90	38	0.18	276
MR857.6W	4/28/2014 13:24	Rain Grab	43	44.1	12.68	202.2	310.9	7.81	28	0.15	1,733
MR857.6W	4/29/2014 12:50	Rain Grab	36	42.8	13.32	235.0	369.0	7.69	38	0.18	435
MR857.6W	5/6/2014 11:17	Base Grab	59	51.6	11.72	297.4	407.3	7.78	51	0.20	25
MR857.6W	5/19/2014 13:54	Rain Grab	55	54.9	10.66	224.6	293.5	7.70	22	0.14	1,414
MR857.6W	6/3/2014 12:10	Base Grab	72	70.7	8.56	362.7	388.6	7.84	27	0.19	276
MR857.6W	6/18/2014 12:01	Base Grab	78	69.1	3.84	346.7	378.3	7.64	43	0.18	122
MR857.6W	6/19/2014 12:52	Rain Grab	69	68.7	6.27	274.0	300.1	7.66	44	0.14	> 2,420
MR857.6W	7/1/2014 11:20	Base Grab	72	72.7	5.82	416.5	436.2	7.69	50	0.21	75
MR857.6W	7/16/2014 11:36	Base Grab	72	69.6	8.52	400.6	434.5	7.87	49	0.21	82
MR857.6W	7/30/2014 12:52	Base Grab	80	75.6	9.37	457.9	464.7	8.25	80	0.22	50
MR857.6W	8/11/2014 13:25	Rain Grab	68	74.3	6.23	444.2	457.2	7.72	> 100	0.22	238
MR857.6W	8/21/2014 13:15	Rain Grab	82	75.9	8.37	422.5	427.4	8.01	85	0.20	1,986
MR857.6W	9/3/2014 13:12	Rain Grab	65	70.7	8.04	413.4	443.1	7.58	85	0.21	548
MR857.6W	9/10/2014 10:45	Rain Grab	52	66.2	8.32	329.3	371.6	7.64	49	0.18	1,986
MR857.6W	9/30/2014 12:30	Base Grab	56	63.3	10.29	370.8	433.8	7.82	> 100	0.21	48
MR857.6W	10/1/2014 11:20	Rain Grab	50	59.0	9.45	350.2	433.2	7.91	94	0.21	> 2,420
MR857.6W	10/15/2014 12:05	Base Grab	65	52.7	12.37	321.4	433.2	7.99	> 100	0.21	21
MR857.6W	10/28/2014 12:57	Base Grab	46	51.4	12.50	315.0	432.2	8.19	> 100	0.21	9
MR857.6W	11/13/2014 13:44	Base Grab	22	34.9	16.60	246.3	445.9	8.61	> 100	0.21	108

Table D.1 continued. Physical parameters and bacteria monitoring data for Mississippi River sites

River Mile	Sample Date	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	E. coli (MPN/100 mL)
	Sample Time										
MR854.9W	4/8/2014 11:50	Base Grab	45	40.6	14.10	258.7	421.4	8.04	66	0.20	23
MR854.9W	4/24/2014 12:00	Rain Grab	41	47.8	12.46	196.3	284.3	7.91	36	0.14	72
MR854.9W	4/28/2014 13:08	Rain Grab	43	45.5	12.21	192.0	288.6	7.81	41	0.14	210
MR854.9W	4/29/2014 12:16	Rain Grab	36	43.9	14.00	193.4	297.9	7.70	19	0.14	194
MR854.9W	5/6/2014 11:00	Base Grab	59	51.3	12.25	229.0	315.0	7.83	51	0.15	13
MR854.9W	5/19/2014 13:29	Rain Grab	55	55.4	10.78	230.6	299.4	7.73	34	0.14	146
MR854.9W	6/3/2014 11:30	Base Grab	72	71.4	8.45	313.4	333.0	7.82	30	0.16	387
MR854.9W	6/18/2014 11:37	Base Grab	77	68.7	4.32	310.9	340.6	7.67	41	0.16	142
MR854.9W	6/19/2014 11:24	Rain Grab	65	68.7	4.32	310.9	340.6	7.67	40	0.16	1,414
MR854.9W	7/1/2014 11:00	Base Grab	72	73.2	6.27	376.8	392.9	7.75	53	0.19	69
MR854.9W	7/16/2014 10:59	Base Grab	71	70.3	8.46	349.5	376.1	7.87	49	0.18	62
MR854.9W	7/30/2014 12:15	Base Grab	78	75.4	8.70	401.7	409.1	8.27	72	0.20	28
MR854.9W	8/11/2014 12:34	Rain Grab	66	75.4	6.08	400.4	407.4	7.77	> 100	0.19	461
MR854.9W	8/21/2014 12:50	Rain Grab	82	76.8	8.07	379.5	380.3	8.01	84	0.18	727
MR854.9W	9/3/2014 12:50	Rain Grab	66	72.1	8.06	349.2	368.0	7.64	81	0.18	214
MR854.9W	9/10/2014 10:53	Rain Grab	52	66.7	8.52	280.5	315.0	7.26	65	0.15	206
MR854.9W	9/30/2014 11:24	Base Grab	54	63.5	9.16	348.3	406.5	7.72	—	0.20	46
MR854.9W	10/1/2014 10:56	Rain Grab	50	59.7	9.25	323.3	395.5	7.20	> 100	0.19	> 2,420
MR854.9W	10/15/2014 10:50	Base Grab	48	52.5	11.29	293.9	396.8	7.63	> 100	0.19	11
MR854.9W	10/28/2014 12:33	Base Grab	46	51.8	11.39	296.0	404.4	8.10	> 100	0.20	19
MR854.9W	11/13/2014 12:27	Base Grab	20	34.5	16.01	224.2	408.1	8.10	> 100	0.19	23
MR853.5E	4/8/2014 11:20	Base Grab	43	39.4	14.04	242.9	404.1	8.03	36	0.19	16
MR853.5E	4/24/2014 11:29	Rain Grab	41	47.8	12.60	177.5	257.3	7.87	—	0.12	18
MR853.5E	4/28/2014 12:49	Rain Grab	43	45.7	12.42	181.1	271.5	7.73	40	0.13	93
MR853.5E	4/29/2014 12:15	Rain Grab	36	43.9	13.46	149.4	230.1	7.75	—	0.11	115
MR853.5E	5/6/2014 10:40	Base Grab	58	51.1	12.10	194.2	268.2	7.87	—	0.13	13
MR853.5E	5/19/2014 12:59	Rain Grab	55	55.6	10.96	213.9	276.8	7.66	—	0.13	201
MR853.5E	6/3/2014 11:15	Base Grab	71	71.1	9.20	283.0	302.0	8.01	—	0.14	122
MR853.5E	6/18/2014 11:18	Base Grab	75	—	—	—	—	—	—	—	96
MR853.5E	6/19/2014 10:59	Rain Grab	65	69.1	8.61	273.7	298.9	7.56	33	0.14	613
MR853.5E	7/1/2014 10:40	Base Grab	72	72.9	6.57	341.5	357.4	7.86	—	0.17	39
MR853.5E	7/16/2014 10:40	Base Grab	71	70.0	8.85	324.6	350.4	7.99	35	0.17	61
MR853.5E	7/30/2014 11:55	Base Grab	77	74.8	8.65	388.6	397.3	8.26	56	0.19	14
MR853.5E	8/11/2014 12:00	Rain Grab	65	75.2	7.12	385.3	392.7	7.56	77	0.19	166
MR853.5E	8/21/2014 12:20	Rain Grab	80	76.3	8.33	366.4	369.2	8.00	82	0.18	727
MR853.5E	9/3/2014 11:20	Rain Grab	66	72.0	8.35	335.4	354.6	7.34	69	0.17	93
MR853.5E	9/10/2014 10:41	Rain Grab	52	66.6	9.15	252.2	283.5	7.20	55	0.14	162
MR853.5E	9/30/2014 10:50	Base Grab	52	63.9	9.34	328.6	381.9	7.66	> 100	0.18	50
MR853.5E	10/1/2014 10:57	Rain Grab	50	60.1	9.60	318.6	388.7	7.98	> 100	0.19	44
MR853.5E	10/15/2014 11:20	Base Grab	65	52.5	11.39	284.7	384.2	7.92	> 100	0.19	12
MR853.5E	10/28/2014 11:15	Base Grab	46	51.8	11.28	281.2	384.0	8.01	> 100	0.19	13
MR853.5E	11/13/2014 10:16	Base Grab	20	34.3	14.87	207.5	379.6	7.72	> 100	0.18	30

Table D.1 continued. Physical parameters and bacteria monitoring data for Mississippi River sites

River Mile	Sample Date	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	E. coli (MPN/100 mL)
	Sample Time										
MR852.2E	4/8/2014 9:30	Base Grab	39	39.6	15.33	253.1	419.5	7.69	47.0	0.20	17
MR852.2E	4/24/2014 10:15	Rain Grab	41	47.8	12.81	179.0	259.5	7.90	41.0	0.12	48
MR852.2E	4/28/2014 11:20	Rain Grab	43	45.9	12.55	179.6	268.1	7.75	31.0	0.13	155
MR852.2E	4/29/2014 10:52	Rain Grab	36	44.2	13.99	184.0	282.2	7.77	35.0	0.13	131
MR852.2E	5/6/2014 9:55	Base Grab	54	50.9	13.23	201.6	278.5	7.63	42.0	0.13	13
MR852.2E	5/19/2014 11:45	Rain Grab	55	55.8	11.69	227.9	294.6	7.63	68.0	0.14	74
MR852.2E	6/3/2014 10:20	Base Grab	68	71.2	10.04	296.4	315.7	7.65	25.0	0.15	225
MR852.2E	6/18/2014 10:30	Base Grab	73	68.7	9.63	295.9	324.5	7.70	41.0	0.15	127
MR852.2E	6/19/2014 9:45	Rain Grab	65	68.9	9.59	263.0	287.6	7.68	27.0	0.14	1,203
MR852.2E	7/1/2014 9:52	Base Grab	70	72.9	7.47	350.0	365.8	7.75	46.0	0.17	42
MR852.2E	7/16/2014 9:53	Base Grab	67	69.8	9.16	327.8	354.6	7.79	39.0	0.17	39
MR852.2E	7/30/2014 10:15	Base Grab	72	73.9	9.19	418.9	432.8	7.98	56.0	0.21	22
MR852.2E	8/11/2014 11:20	Rain Grab	63	74.5	6.61	394.0	404.6	7.55	73.0	0.19	437
MR852.2E	8/21/2014 11:30	Rain Grab	78	75.6	8.83	394.3	400.1	7.95	76.0	0.19	1,414
MR852.2E	9/3/2014 10:25	Rain Grab	64	71.2	8.84	387.1	412.7	7.74	66.0	0.20	236
MR852.2E	9/10/2014 10:30	Rain Grab	52	66.6	9.60	258.3	240.6	7.06	54.0	0.15	182
MR852.2E	9/30/2014 9:56	Base Grab	50	63.7	9.46	337.2	393.1	7.16	> 100.0	0.19	83
MR852.2E	10/1/2014 10:20	Rain Grab	50	59.9	9.61	329.3	401.9	7.88	95.0	0.19	687
MR852.2E	10/15/2014 10:35	Base Grab	63	52.9	11.60	341.1	457.9	7.72	> 100.0	0.22	17
MR852.2E	10/28/2014 9:59	Base Grab	43	51.3	11.33	313.8	432.1	7.74	> 100.0	0.21	13
MR852.2E	11/13/2014 10:01	Base Grab	20	34.3	15.44	228.8	417.8	7.66	> 100.0	0.20	11
MR849.9W	4/8/2014 9:10	Base Grab	38	39.6	14.96	255.9	424.8	7.41	47.0	0.20	20
MR849.9W	4/24/2014 9:23	Rain Grab	40	47.7	13.02	181.4	263.7	7.89	36.0	0.13	96
MR849.9W	4/28/2014 10:21	Rain Grab	41	45.9	12.96	195.3	291.2	7.43	29.5	0.14	291
MR849.9W	4/29/2014 10:10	Rain Grab	36	44.2	14.40	193.1	295.8	7.73	35.0	0.14	240
MR849.9W	5/6/2014 9:40	Base Grab	54	51.3	13.19	214.3	295.1	7.52	32.0	0.14	17
MR849.9W	5/19/2014 10:50	Rain Grab	55	55.8	11.42	238.1	307.6	7.39	59.0	0.15	10
MR849.9W	6/3/2014 9:52	Base Grab	67	71.6	9.61	307.7	326.5	7.39	34.0	0.16	206
MR849.9W	6/18/2014 10:15	Base Grab	73	68.7	9.06	302.1	330.9	7.64	44.0	0.16	166
MR849.9W	6/19/2014 9:25	Rain Grab	65	68.9	9.24	264.3	288.9	7.62	30.0	0.14	1,553
MR849.9W	7/1/2014 9:30	Base Grab	69	73.0	8.43	361.9	377.7	7.72	48.0	0.18	51
MR849.9W	7/16/2014 9:30	Base Grab	66	69.8	9.31	341.0	368.9	7.79	40.0	0.18	47
MR849.9W	7/30/2014 9:55	Base Grab	71	73.6	8.65	392.3	407.3	7.95	59.0	0.19	24
MR849.9W	8/11/2014 10:30	Rain Grab	64	74.7	6.79	394.4	404.5	7.26	87.0	0.19	548
MR849.9W	8/21/2014 10:45	Rain Grab	78	75.6	8.49	376.0	381.8	7.96	87.0	0.18	1,120
MR849.9W	9/3/2014 10:16	Rain Grab	66	71.8	8.51	343.6	364.0	7.58	81.0	0.17	2,420
MR849.9W	9/10/2014 10:16	Rain Grab	52	66.7	9.35	268.4	301.5	7.07	59.0	0.15	361
MR849.9W	9/30/2014 9:40	Base Grab	49	63.9	9.31	337.1	391.5	7.14	> 100.0	0.19	162
MR849.9W	10/1/2014 9:34	Rain Grab	53	73.0	8.43	361.9	377.7	7.72	85.0	0.18	> 2,420
MR849.9W	10/15/2014 10:10	Base Grab	62	51.8	11.35	297.6	406.7	7.71	> 100.0	0.20	17
MR849.9W	10/28/2014 9:43	Base Grab	43	51.8	11.41	289.1	395.0	7.79	> 100.0	0.19	16
MR849.9W	11/13/2014 9:41	Base Grab	20	33.6	15.76	216.9	401.4	7.70	> 100.0	0.19	34

Table D.1 continued. Physical parameters and bacteria monitoring data for Mississippi River sites

River Mile	Sample Date	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)	Specific Conductivity ($\mu\text{S}/\text{cm}$)	pH	Transparency (cm)	Salinity (ppt)	<i>E. coli</i> (MPN/100 mL)
	Sample Time										
MR848.1W	4/8/2014 8:50	Base Grab	36	39.2	15.24	254.8	425.0	7.26	68.0	0.20	12
MR848.1W	4/24/2014 9:00	Rain Grab	40	47.8	13.10	190.8	276.2	7.92	51.0	0.13	133
MR848.1W	4/28/2014 10:00	Rain Grab	41	46.2	14.06	194.8	289.6	7.69	39.0	0.14	66
MR848.1W	4/29/2014 9:50	Rain Grab	36	44.4	14.62	193.4	295.8	7.80	39.0	0.14	178
MR848.1W	5/6/2014 9:15	Base Grab	53	51.4	12.38	223.6	307.0	7.25	32.0	0.15	9
MR848.1W	5/19/2014 10:35	Rain Grab	55	55.8	11.61	242.4	312.8	7.66	72.0	0.15	16
MR848.1W	6/3/2014 9:25	Base Grab	66	72.0	9.26	319.0	337.3	7.28	21.5	0.16	241
MR848.1W	6/18/2014 9:45	Base Grab	73	68.9	9.10	301.0	329.6	7.77	40.0	0.16	172
MR848.1W	6/19/2014 9:07	Rain Grab	65	69.3	8.83	279.3	304.4	7.66	41.5	0.15	1,120
MR848.1W	7/1/2014 9:10	Base Grab	68	73.0	8.34	360.2	375.7	7.77	50.0	0.18	25
MR848.1W	7/16/2014 9:12	Base Grab	64	69.8	9.68	340.5	368.5	7.85	36.0	0.18	54
MR848.1W	7/30/2014 9:30	Base Grab	70	73.4	8.73	391.7	407.3	7.93	60.0	0.19	19
MR848.1W	8/11/2014 10:10	Rain Grab	63	75.4	6.88	397.4	404.6	7.55	95.0	0.19	127
MR848.1W	8/21/2014 10:25	Rain Grab	77	76.1	8.15	390.8	394.5	7.90	81.0	0.19	148
MR848.1W	9/3/2014 9:55	Rain Grab	64	71.6	8.62	340.9	361.3	7.80	71.0	0.17	105
MR848.1W	9/10/2014 9:59	Rain Grab	52	66.7	9.40	267.3	300.0	7.26	65.0	0.15	186
MR848.1W	9/30/2014 9:25	Base Grab	49	64.9	9.18	337.8	387.6	7.28	> 100.0	0.19	104
MR848.1W	10/1/2014 9:20	Rain Grab	53	73.0	8.34	360.2	375.7	7.77	> 100.0	0.18	135
MR848.1W	10/15/2014 9:42	Base Grab	62	52.7	11.45	291.5	392.9	7.87	> 100.0	0.19	5
MR848.1W	10/28/2014 9:14	Base Grab	43	52.7	11.69	288.4	388.5	7.98	> 100.0	0.19	37
MR848.1W	11/13/2014 9:10	Base Grab	20	34.0	16.34	215.6	396.7	8.20	> 100.0	0.19	34

Table D.2. Physical parameters and bacteria monitoring data for stormwater sites

Site	Sample Date	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)	Specific Conductivity ($\mu\text{S}/\text{cm}$)	pH	Transparency (cm)	Salinity (ppt)	E. coli (MPN/100 mL)	Fluoride (mg/L)
	Sample Time											
11CHF	9/30/2014 12:45	Base Grab	57	60.1	8.72	424.9	517.3	7.59	> 100	0.25	1,350	< 1.00
11CHF	10/1/2014 11:41	Rain Grab	50	57.4	9.03	124.9	157.7	7.36	15	0.07	10,460	
11CHF	10/15/2014 12:00	Base Grab	53	55.9	9.87	308.3	396.6	8.21	84	0.19	387	< 1.00
11CHF	10/28/2014 11:45	Base Grab	46	53.1	9.31	380.4	510.5	7.68	57	0.25	80	—
11CHF	11/13/2014 12:29	Base Grab	20	45.0	9.81	911.0	1,379.0	6.55	> 100	0.69	10	< 1.00
11CHF	12/2/2014 9:15	Base Grab	19	43.7	11.10	907.0	1,404.0	7.32	> 100	0.70	6	~ 0.03
11CHF	12/19/2014 9:36	Base Grab	20	48.0	11.38	713.0	1,029.0	8.27	> 100	0.51	29	
1NE	1/13/2014 9:16	Base Grab	28	40.3	11.68	2,022.0	3,309.0	7.79	> 100	1.72	42	
1NE	2/13/2014 9:10	Base Grab	26	39.2	14.06	951.0	1,587.0	7.84	> 100	0.80	7	0.21
1NE	3/5/2014 9:15	Base Grab	17	42.4	13.20	964.0	1,522.0	7.83	> 100	0.77	50	—
1NE	3/20/2014 9:35	Base Grab	30	40.1	12.47	2,495.0	4,106.0	7.32	15	2.17	71	—
1NE	4/8/2014 12:05	Base Grab	46	43.5	12.22	579.0	898.0	7.83	55	0.44	6	—
1NE	4/24/2014 12:31	Rain Grab	42	45.3	12.16	151.5	228.1	7.84	10	0.11	1,733	—
1NE	4/28/2014 10:15	Rain Grab	43	49.6	10.69	127.1	179.3	7.63	—	0.09	2,300	—
1NE	4/29/2014 9:35	Rain Grab	36	42.1	13.57	182.8	290.6	7.51	—	0.14	200	—
1NE	6/19/2014 12:16	Rain Grab	67	69.1	7.26	269.3	293.8	7.63	40	0.14	500	—
1NE	7/16/2014 11:22	Base Grab	71	58.8	9.55	1,118.0	1,387.0	7.65	> 100	0.70	276	< 1.00
1NE	7/30/2014 12:35	Base Grab	79	62.6	9.30	1,265.0	1,492.0	7.80	> 100	0.75	1,203	< 1.00
1NE	8/11/2014 12:57	Rain Grab	66	66.4	6.73	396.5	446.4	7.66	18	0.22	> 2,420	—
1NE	8/21/2014 9:35	Rain Grab	73	70.7	8.56	163.5	175.2	7.77	24	0.08	12,030	—
1NE	9/3/2014 13:05	Rain Grab	64	68.4	8.34	189.4	208.5	7.46	39	0.10	6,130	—
1NE	9/10/2014 9:43	Rain Grab	52	60.6	9.10	179.7	217.9	7.89	23	0.10	6,130	—
1NE	9/30/2014 12:20	Base Grab	56	57.4	9.35	1,064.0	1,345.0	7.50	> 100	0.68	1,110	< 1.00
1NE	10/1/2014 11:20	Rain Grab	50	58.3	8.75	142.6	177.9	7.34	23	0.08	17,330	—
1NE	10/15/2014 11:30	Base Grab	50	56.1	9.31	1,188.0	1,524.0	7.73	> 100	0.77	186	< 1.00
1NE	10/28/2014 11:24	Base Grab	46	53.6	11.12	1,157.0	1,539.0	7.91	> 100	0.78	100	< 1.00
1NE	11/13/2014 11:56	Base Grab	20	45.3	11.98	1,275.0	1,922.0	6.62	> 100	0.98	580	< 1.00
1NE	12/2/2014 9:45	Base Grab	19	43.5	11.16	1,021.0	1,583.0	7.40	> 100	0.80	> 2,420	< 0.02
1NE	12/19/2014 10:01	Base Grab	20	46.2	11.65	1,041.0	1,543.0	7.91	> 100	0.78	16,000	
2NNBC	4/24/2014 12:10	Rain Grab	41	43.7	12.22	171.3	264.8	8.00	6	0.13	2,420	—
2NNBC	4/28/2014 12:20	Rain Grab	38	43.0	13.32	108.0	169.1	7.91	12	0.08	3,000	—
2NNBC	5/19/2014 13:24	Rain Grab	55	54.5	10.47	90.4	118.7	8.00	6	0.06	2,360	—
2NNBC	6/19/2014 11:21	Rain Grab	65	66.7	8.53	81.8	91.9	7.57	19	0.04	8,660	—
2NNBC	10/1/2014 10:49	Rain Grab	50	58.1	8.81	247.2	308.9	7.08	16	0.15	8,660	—

Table D.2 continued. Physical parameters and bacteria monitoring data for stormwater sites

Site	Sample Date Sample Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	E. coli (MPN/ 100 mL)	Fluoride (mg/L)
4PP	1/13/2014 11:25	Base Grab	28	46.2	9.89	1,582.0	2,348.0	8.02	9	1.21	> 2,420	—
4PP	2/13/2014 11:40	Base Grab	22	42.1	5.12	1,983.0	3,149.0	8.02	—	1.64	143,900	0.18
4PP	3/5/2014 11:45	Base Grab	22	46.4	10.03	1,439.0	2,132.0	8.18	> 100	1.09	> 2,420	—
4PP	3/10/2014 8:52	Base Grab	48	—	—	—	—	—	—	—	> 2,420	—
4PP	3/20/2014 11:05	Base Grab	30	44.4	10.69	1,312.0	2,002.0	7.88	88	1.02	10	—
4PP	4/8/2014 10:55	Base Grab	42	46.6	10.94	1,158.0	1,711.0	7.90	62	0.87	21	< 1.00
4PP	4/28/2014 12:18	Rain Grab	43	48.4	10.52	461.8	663.4	7.63	16	0.32	2,000	—
4PP	4/29/2014 11:50	Rain Grab	36	43.7	12.19	225.5	348.4	7.63	4	0.17	3,800	—
4PP	5/19/2014 12:34	Rain Grab	55	55.2	10.50	108.2	140.6	7.72	6	0.07	2,060	—
4PP	6/19/2014 10:16	Rain Grab	65	66.4	8.73	41.6	46.9	7.59	13	0.02	11,200	—
4PP	7/30/2014 11:35	Base Grab	76	55.9	9.81	977.0	1,259.0	7.88	> 100	0.63	308	< 1.00
4PP	8/11/2014 10:15	Rain Grab	63	61.2	8.63	908.0	1,091.0	7.61	29	0.54	> 2,420	—
4PP	8/21/2014 12:40	Rain Grab	81	68.2	8.15	703.0	776.0	7.71	43	0.38	19,860	—
4PP	9/3/2014 11:20	Rain Grab	64	65.1	8.75	284.9	326.2	7.55	—	0.16	15,530	—
4PP	9/30/2014 11:05	Base Grab	54	55.0	9.24	1,124.0	1,467.0	7.43	78	0.74	2,610	< 1.00
4PP	10/1/2014 10:07	Rain Grab	50	56.7	9.59	151.7	193.4	7.17	19	0.07	11,200	—
4PP	10/15/2014 10:30	Base Grab	45	54.0	9.77	1,320.0	1,748.0	7.22	55	0.89	101	< 1.00
4PP	10/28/2014 11:33	Base Grab	46	52.9	10.09	1,204.0	1,620.0	7.62	42	0.82	120	< 1.00
4PP	11/13/2014 11:38	Base Grab	20	41.4	11.39	1,108.0	1,781.0	7.65	> 100	0.90	240	< 1.00
4PP	12/2/2014 12:04	Base Grab	19	44.6	10.51	1,120.0	1,706.0	7.77	96	0.86	34	< 0.02
4PP	12/5/2014 10:25	Illicit Discharge Grab	30	51.1	10.19	1,116.0	1,540.0	8.21	—	0.78	—	—
4PP	12/19/2014 12:09	Base Grab	20	51.1	10.80	1,087.0	1,498.0	8.12	> 10	0.76	16	—
6UMN	1/13/2014 11:00	Base Grab	29	47.1	11.30	1,549.0	2,267.0	8.37	> 100	1.17	6	—
6UMN	2/13/2014 10:55	Base Grab	24	44.6	11.18	1,800.0	2,743.0	8.21	—	1.42	< 1	0.18
6UMN	3/5/2014 10:45	Base Grab	22	42.3	11.97	1,007.0	1,594.0	8.11	> 100	0.80	4	—
6UMN	3/20/2014 10:40	Base Grab	30	46.0	11.38	988.0	1,472.0	8.03	100	0.74	3	—
6UMN	4/24/2014 10:35	Rain Grab	40	43.7	13.01	161.0	248.7	7.73	8	0.12	548	—
6UMN	4/28/2014 11:41	Rain Grab	43	43.9	12.31	74.9	115.6	7.77	15	0.05	600	—
6UMN	4/29/2014 11:25	Rain Grab	36	42.1	12.85	153.1	243.2	7.60	11	0.12	500	—
6UMN	5/19/2014 12:05	Rain Grab	55	54.5	8.64	217.7	286.2	7.41	12	0.07	650	—
6UMN	6/19/2014 10:15	Rain Grab	65	65.8	8.81	74.5	84.4	7.20	9	0.04	6,130	—
6UMN	7/30/2014 10:37	Base Grab	74	58.6	10.16	1,017.0	1,264.0	7.83	> 100	0.63	64	< 1.00
6UMN	8/11/2014 11:40	Rain Grab	64	64.0	8.01	387.7	449.5	7.37	18	0.22	> 2,420	—
6UMN	8/21/2014 12:04	Rain Grab	79	66.9	8.93	477.0	533.6	7.79	62	0.26	1,560	—
6UMN	9/3/2014 10:51	Rain Grab	67	64.2	8.52	172.2	199.3	7.12	18	0.09	4,880	—
6UMN	9/30/2014 10:18	Base Grab	45	54.3	10.01	994.0	1,308.0	7.25	> 100	0.66	110	< 1.00
6UMN	10/1/2014 9:36	Rain Grab	53	56.3	9.81	159.7	204.4	7.21	15	0.10	3,870	—
6UMN	10/15/2014 10:05	Base Grab	45	52.5	10.18	967.0	1,308.0	7.12	> 100	0.66	10	< 1.00
6UMN	10/28/2014 10:28	Base Grab	46	52.2	10.52	967.0	1,314.0	7.66	> 100	0.66	< 10	< 1.00
6UMN	12/2/2014 11:15	Base Grab	19	45.1	11.45	948.0	1,420.0	8.25	> 100	0.72	56	< 0.02
6UMN	12/19/2014 11:14	Base Grab	20	47.3	11.28	1,126.0	1,642.0	8.26	> 100	0.83	39	—

Table D.2 continued. Physical parameters and bacteria monitoring data for stormwater sites

Site	Sample Date Sample Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	E. coli (MPN/ 100 mL)	Fluoride (mg/L)
7LSTU	4/24/2014 9:45	Rain Grab	40	43.2	13.22	275.0	429.4	7.84	8	0.21	488	—
7LSTU	4/28/2014 10:37	Rain Grab	43	42.6	12.94	158.2	249.1	7.64	4	0.12	800	—
7LSTU	4/29/2014 10:25	Rain Grab	36	41.7	13.72	330.7	529.0	7.62	—	0.26	300	—
7LSTU	5/19/2014 11:15	Rain Grab	55	54.5	11.22	331.9	436.4	7.56	8	0.21	740	—
7LSTU	6/19/2014 9:35	Rain Grab	65	66.6	8.70	90.0	101.2	7.89	6	0.05	5,480	—
7LSTU	8/11/2014 10:55	Rain Grab	64	65.7	8.29	669.0	760.0	7.29	15	0.37	> 2,420	—
7LSTU	8/21/2014 11:10	Rain Grab	78	69.4	8.99	434.5	471.9	7.74	21	0.23	7,395	—
7LSTU	10/1/2014 10:04	Rain Grab	50	56.3	9.90	280.5	359.3	7.76	5	0.17	2,490	—
10SA	1/13/2014 9:57	Base Grab	28	39.7	11.68	14,715.0	24,375.0	7.72	25	14.56	1,573	—
10SA	2/14/2014 12:00	Base Grab	7	39.2	11.12	11,157.0	18,605.0	7.54	< 20	10.86	> 2,420	—
10SA	3/20/2014 10:05	Base Grab	30	38.1	12.81	2,287.0	3,897.0	7.59	25	2.04	150	—
10SA	4/8/2014 10:21	Base Grab	40	41.0	12.81	754.0	1,219.0	7.68	43	0.61	78	< 1.00
10SA	4/24/2014 11:07	Rain Grab	41	43.0	12.87	213.8	334.6	7.71	9	0.16	548	—
10SA	4/28/2014 11:45	Rain Grab	43	42.1	13.14	189.5	300.7	7.58	—	0.14	300	—
10SA	4/29/2014 11:05	Rain Grab	36	—	—	—	—	—	—	—	600	—
10SA	5/6/2014 10:19	Base Grab	57	50.0	11.58	935.0	1,310.0	7.53	> 100	0.66	2	—
10SA	5/19/2014 13:00	Rain Grab	55	54.3	10.59	70.6	92.9	8.42	17	0.04	1,470	—
10SA	6/3/2014 10:50	Base Grab	69	62.4	9.97	764.0	903.0	7.71	> 100	0.45	461	—
10SA	6/18/2014 10:55	Base Grab	74	68.5	7.64	386.5	425.1	8.31	13	0.20	866	—
10SA	6/19/2014 11:45	Rain Grab	65	66.6	8.35	128.1	144.2	7.41	21	0.07	5,790	—
10SA	7/1/2014 10:20	Base Grab	71	64.6	7.58	810.0	933.0	7.69	89	0.46	260	< 1.00
10SA	7/16/2014 10:20	Base Grab	69	66.0	8.69	758.0	859.0	7.85	> 100	0.42	687	< 1.00
10SA	7/30/2014 11:05	Base Grab	75	66.4	8.68	839.0	946.0	8.01	> 100	0.47	219	< 1.00
10SA	8/11/2014 11:20	Rain Grab	63	68.4	8.63	232.0	255.2	7.90	28	0.12	> 2,420	—
10SA	8/21/2014 9:55	Rain Grab	75	71.6	7.81	210.0	223.0	7.56	34	0.11	4,110	—
10SA	9/3/2014 10:55	Rain Grab	64	66.2	8.49	146.4	165.3	7.74	31	0.08	3,870	—
10SA	9/10/2014 10:15	Rain Grab	52	63.0	8.30	227.2	267.2	7.56	43	0.13	9,800	—
10SA	9/30/2014 11:52	Base Grab	56	59.4	9.05	425.6	524.2	7.74	78	0.25	3,650	< 1.00
10SA	10/1/2014 10:24	Rain Grab	50	57.4	9.45	84.2	106.5	7.16	23	0.05	> 24,200	—
10SA	10/15/2014 9:25	Base Grab	43	55.0	10.02	506.0	659.0	7.02	> 100	0.32	17	< 1.00
10SA	10/28/2014 12:08	Base Grab	46	54.3	9.65	790.0	1,041.0	7.93	> 100	0.52	6,490	< 1.00
10SA	11/13/2014 13:05	Base Grab	20	42.8	19.74	4,457.0	6,987.0	7.73	26	3.82	9,800	< 1.00
10SA	12/2/2014 10:25	Base Grab	19	46.0	10.84	3,968.0	5,911.0	7.32	40	3.21	> 2,420	0.70

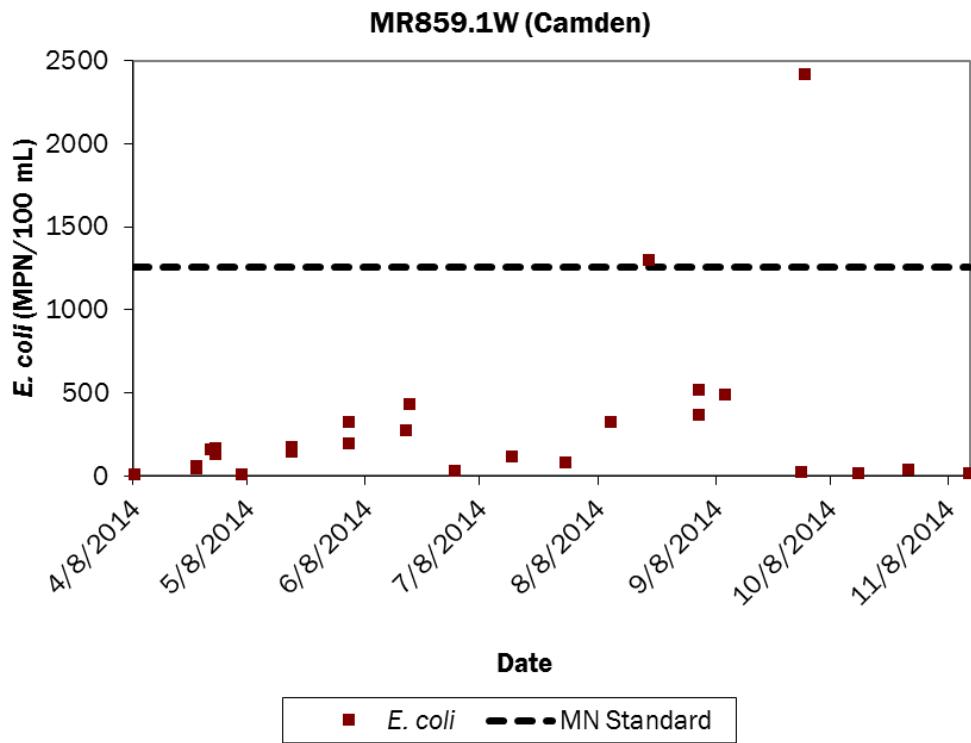


Figure D.1. E.coli data for MR859.1W

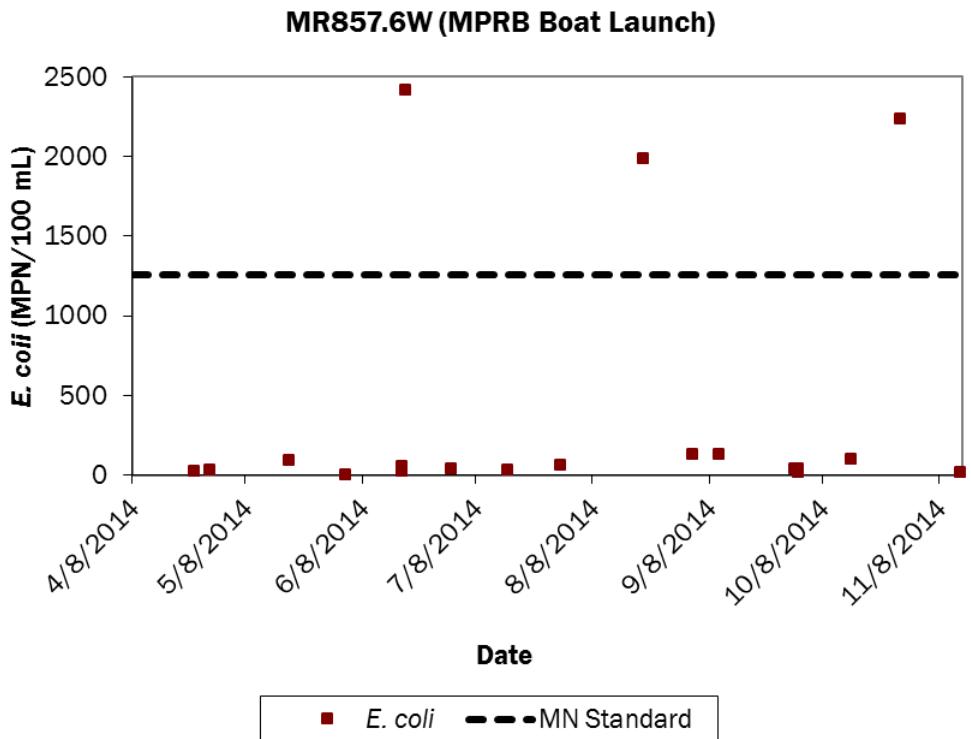


Figure D.2. E.coli data for MR857.6W

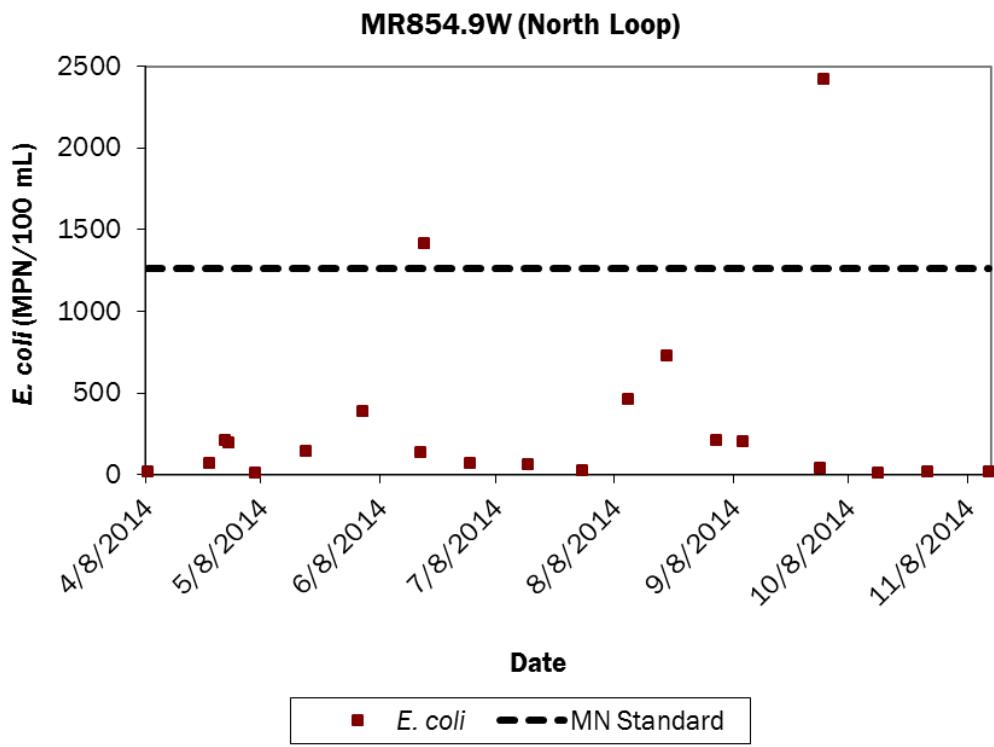


Figure D.3. E.coli data for MR854.9W

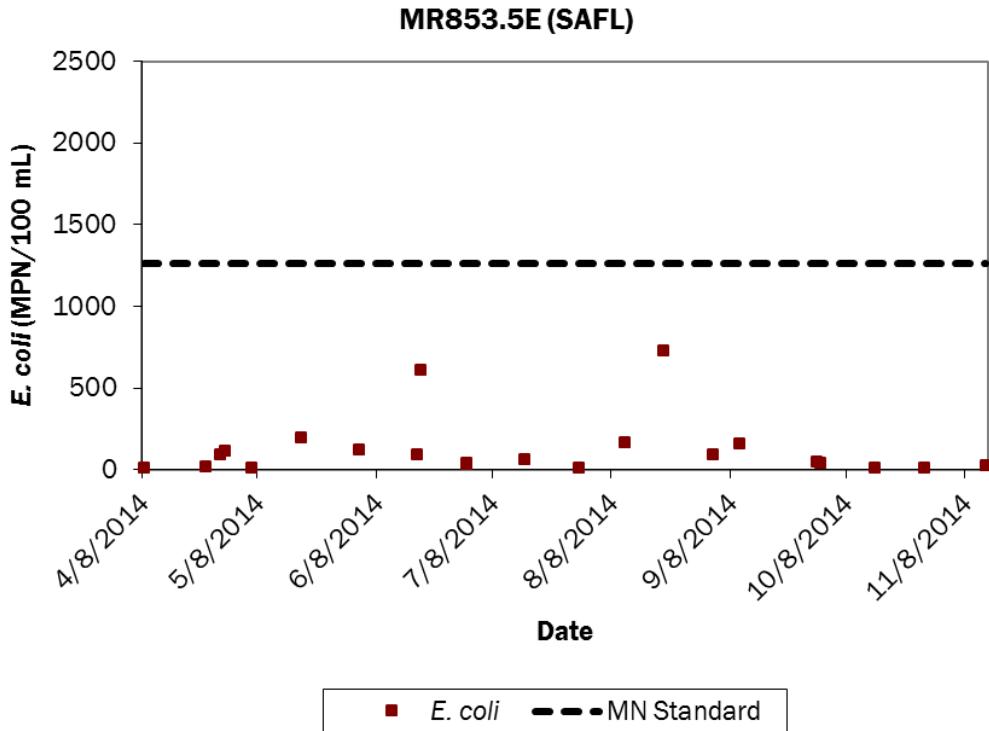


Figure D.4. E. coli data for MR853.5E

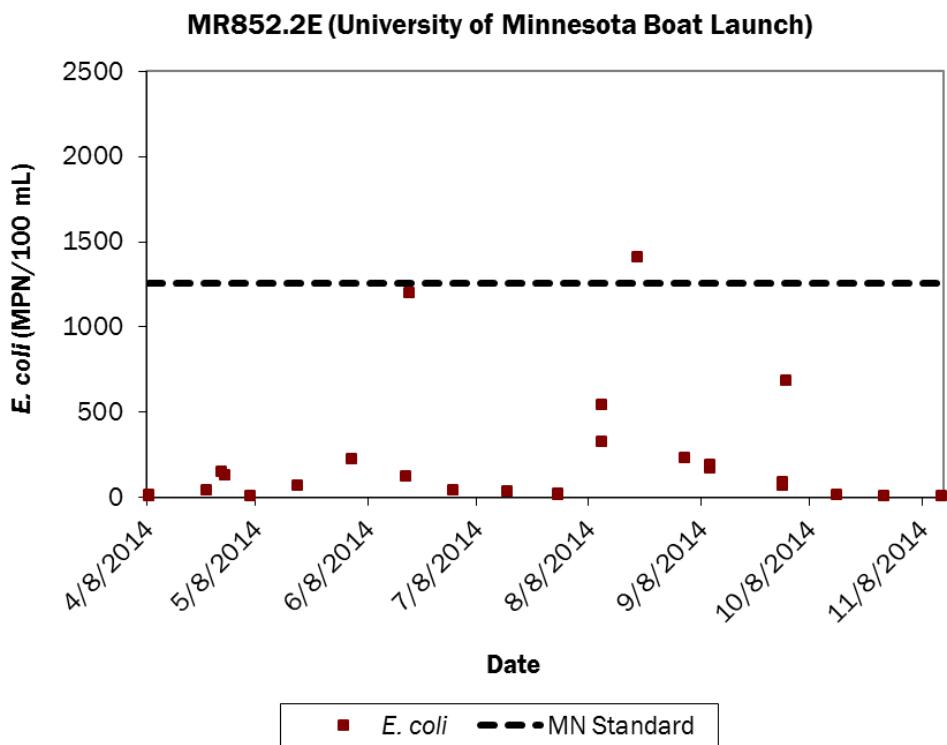


Figure D.5. E. coli data for MR852.2E

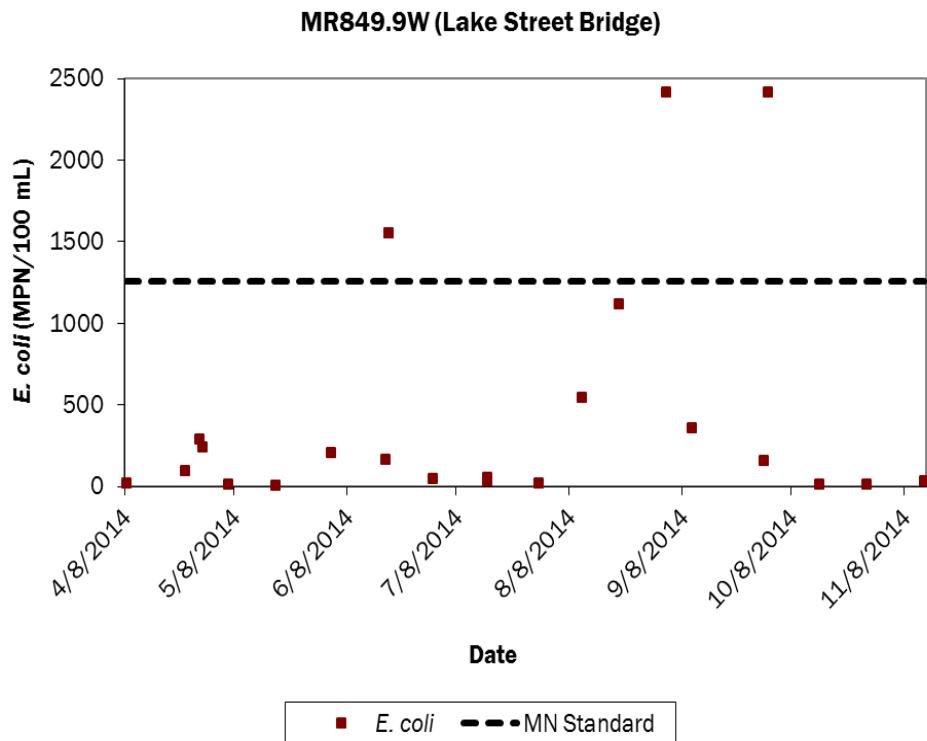


Figure D.6. E. coli data for MR849.9W

MR848.1W (4300 West River Parkway)

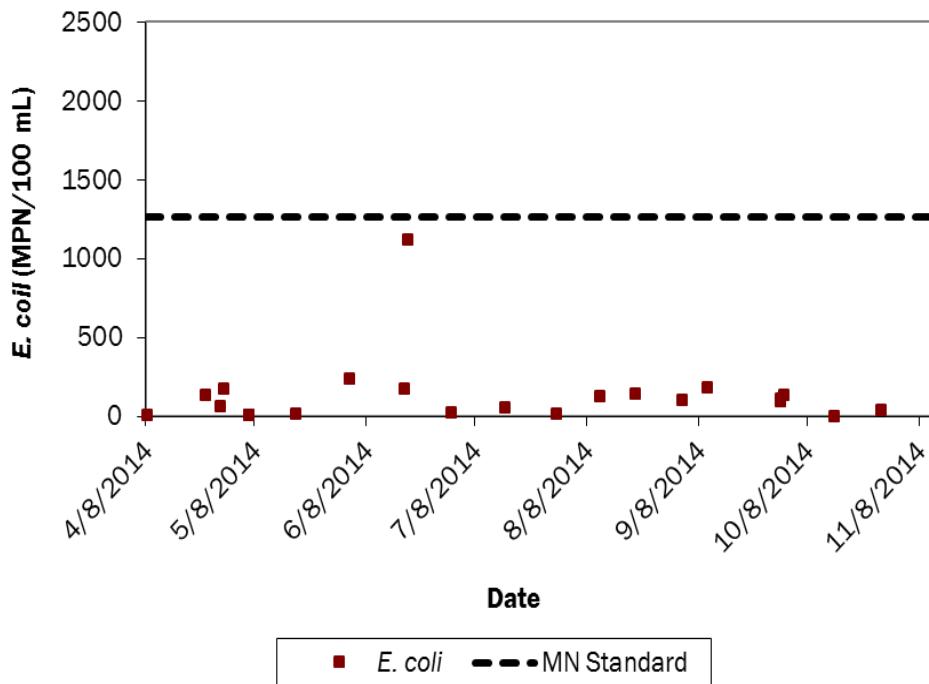


Figure D.7. *E.coli* data for MR848.1W

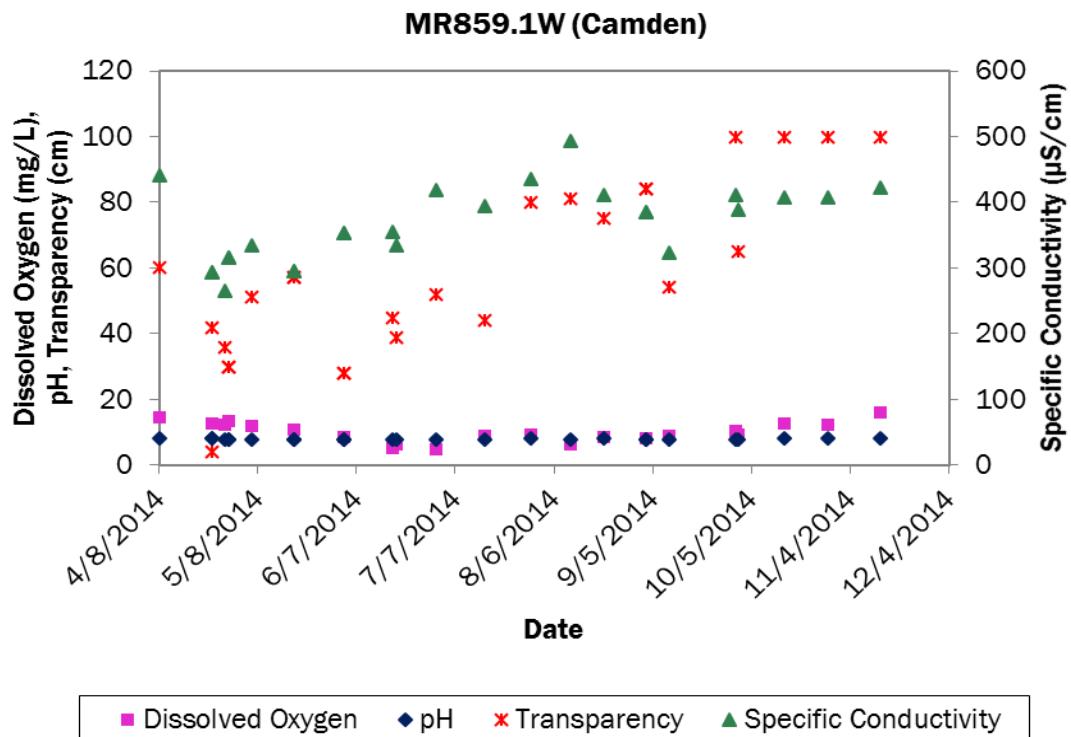


Figure D.8. Dissolved oxygen, pH, transparency, and specific conductivity for MR859.1W

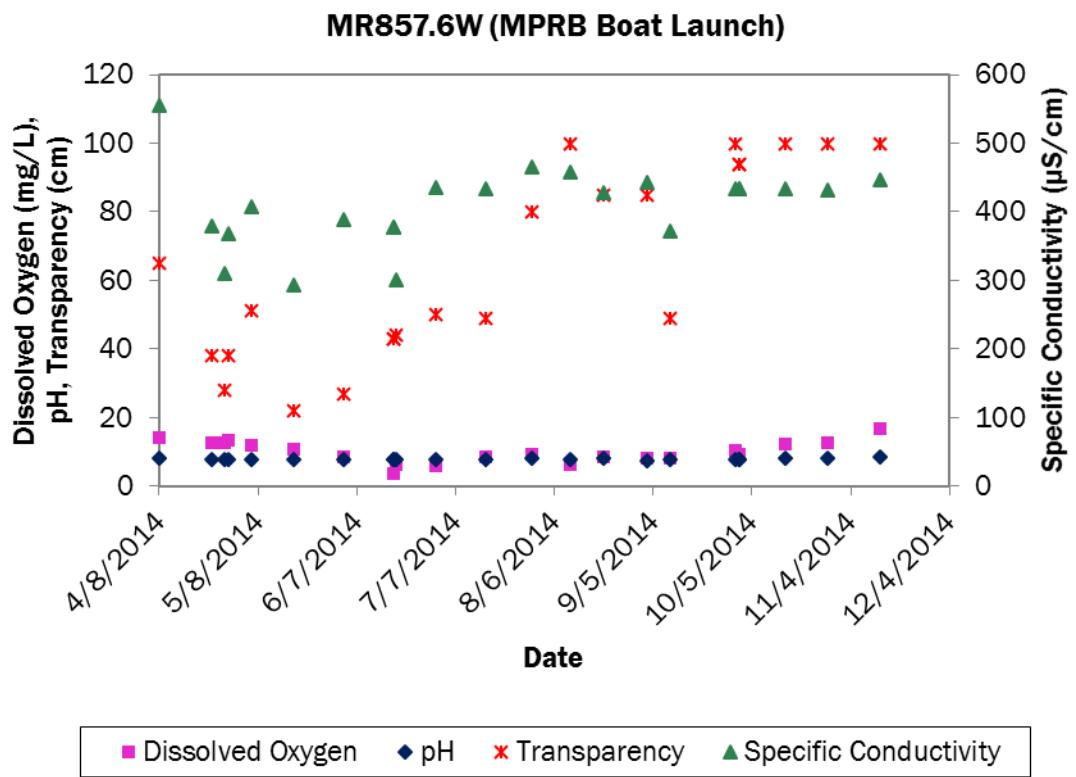


Figure D.9. Dissolved oxygen, pH, transparency, and specific conductivity for MR857.6W

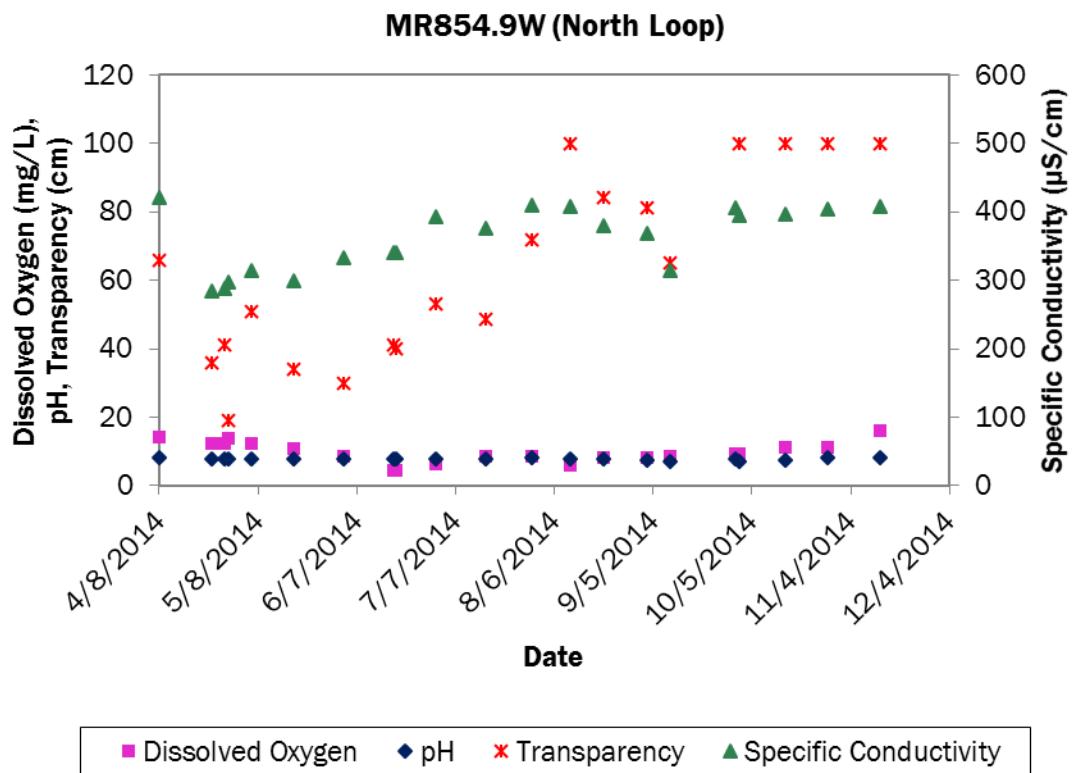


Figure D.10. Dissolved oxygen, pH, transparency, and specific conductivity for MR854.9W

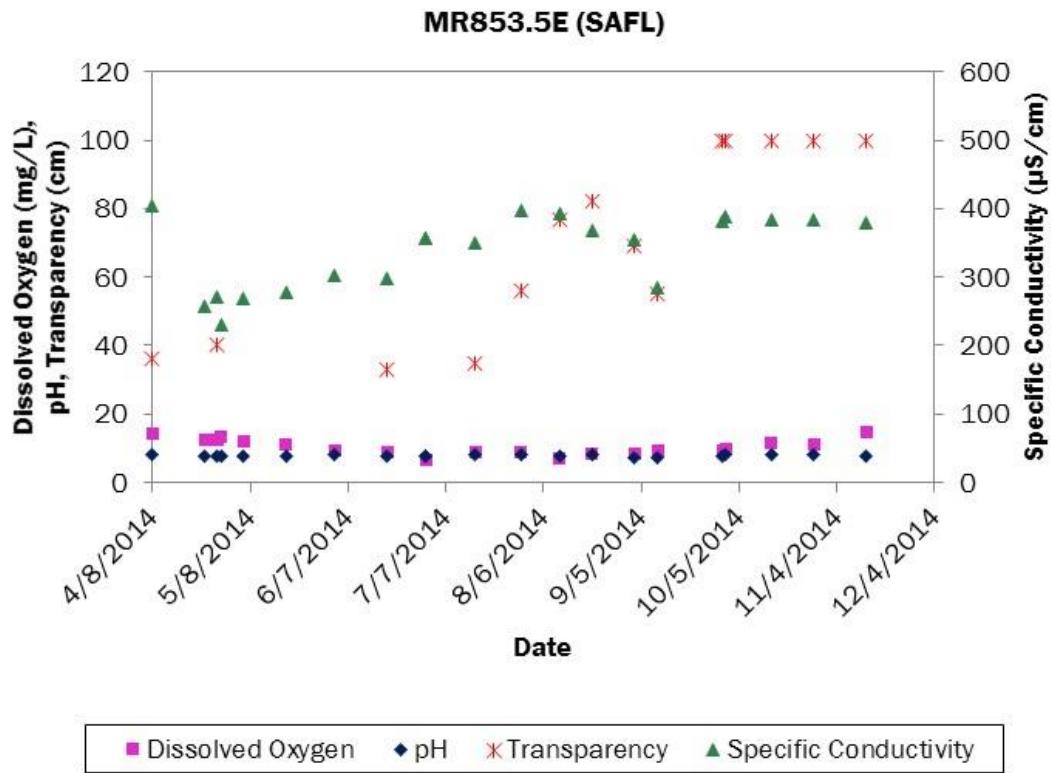


Figure D.11. Dissolved oxygen, pH, transparency, and specific conductivity for MR853.5E

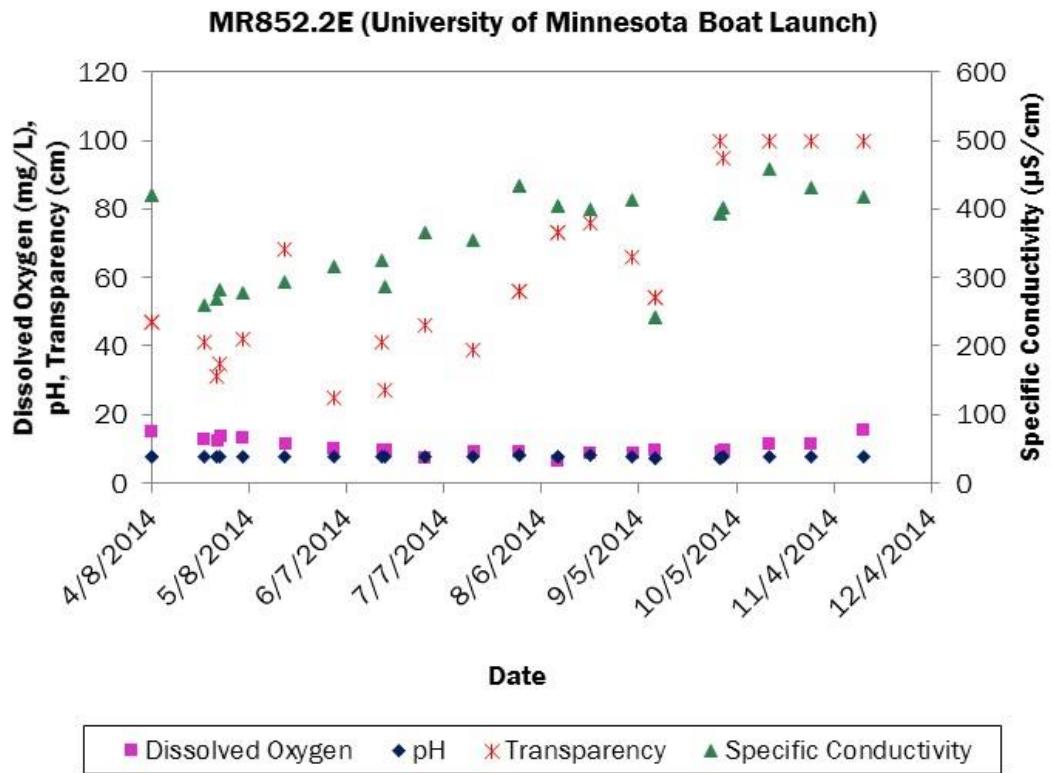


Figure D.12. Dissolved oxygen, pH, transparency, and specific conductivity for MR852.2E

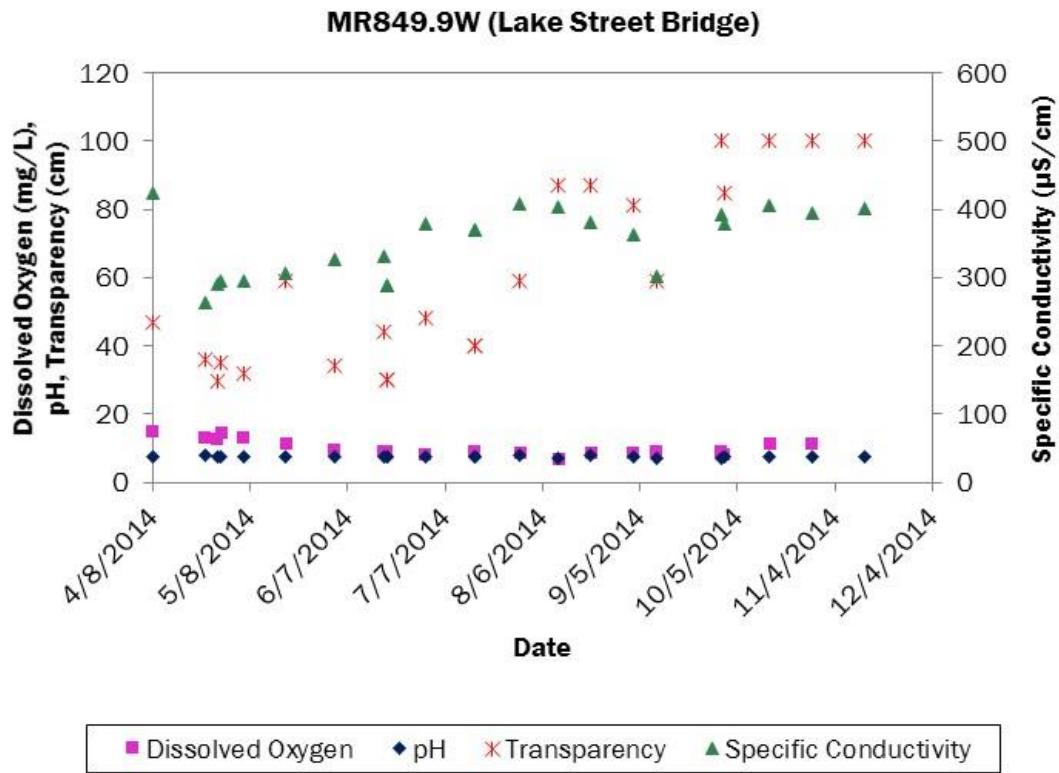


Figure D.13. Dissolved oxygen, pH, transparency, and specific conductivity for MR849.9W

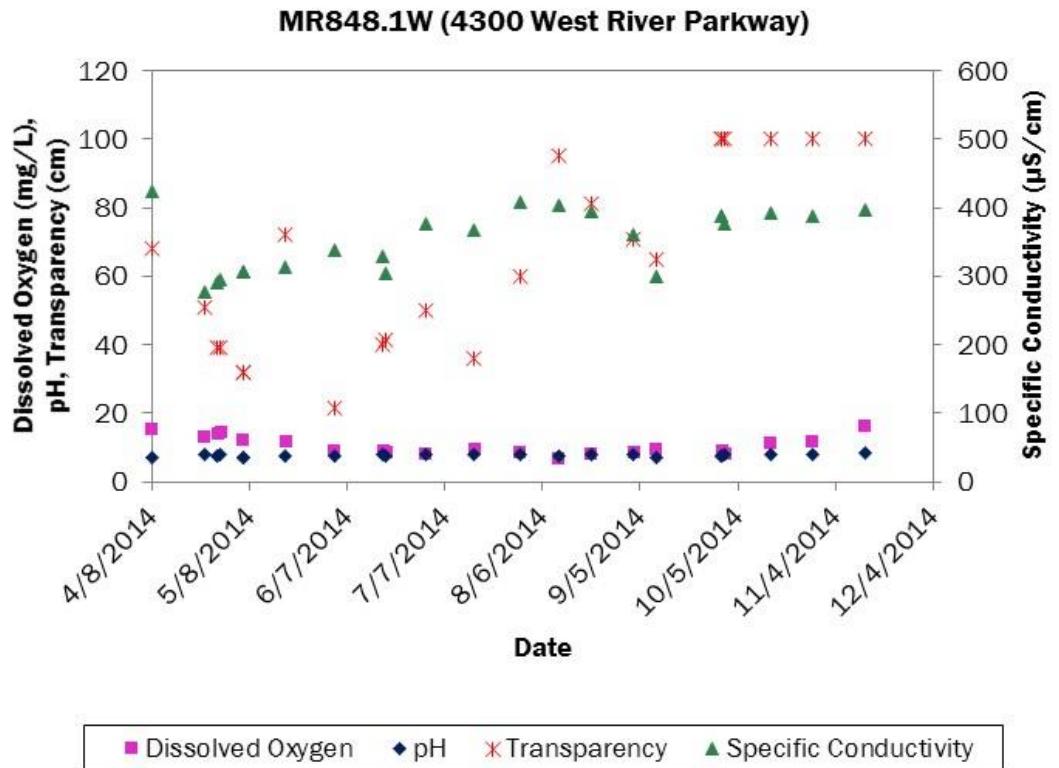


Figure D.14. Dissolved oxygen, pH, transparency, and specific conductivity for MR 848.1W

Appendix E – Boxplot Explanation

Some of the bacteria data in this report are displayed using box and whisker plots (boxplots). Boxplots are a valuable way to determine trends and show variability within a year. The MWMO used boxplots in this report to show the difference in bacteria concentrations during base and rain conditions.

A boxplot uses all of the data points to compute basic summary statistics. Figure E.1 shows an example boxplot. For each plot, the box represents the middle 50 percent of the data from the 25th to the 75th percentile. The vertical lines extending off of the boxes (the ‘whiskers’) represent the 5th to the 25th percentile (for the lower whisker) and 75th to 95th percentile (for the upper whisker). The horizontal line that cuts across the box represents the median value, or 50th percentile. Any data point falling outside of the 5th to 95th percentile is marked by an open circle and is considered an outlier.

Generally, more compact boxes with short ‘whiskers’ and few outliers indicate low variability in bacteria concentrations. To better visualize the data, boxplots have been plotted on a logarithmic scale. A log scale reduces wide range data to a more manageable size in a graph.

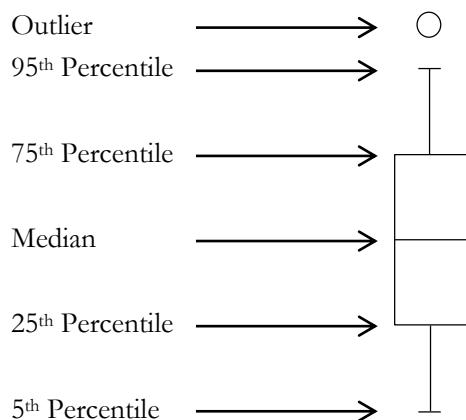


Figure E.1. An example boxplot. Each plot contains all available bacteria data for the site

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Appendix F – Stormwater Monitoring Data

Table F.1. Monitoring data for 11CHF outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)	Specific Conductivity ($\mu\text{S}/\text{cm}$)	pH	Transparency (cm)	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
9/30/2014 9:00	9/30/2014 9:01	Base Grab	42	56.1	9.39	417.8	537.0	7.23	> 100	0.26	~ 1	~ 2	288	27.2	0.079	0.128	0.025	0.63	< 0.02	< 0.03	1.02
10/2/2014 13:55	10/2/2014 13:56	Rain Grab	53	60.8	9.40	55.4	66.9	7.25	13	0.03	44	18	38	2.1	0.132	0.265	0.139	1.25	0.14	0.03	0.20
10/7/2014 9:40	10/7/2014 9:41	Base Grab	55	55.2	9.43	425.4	553.5	7.26	> 100	0.27	~ 1	~ 1	302	31.4	0.063	0.083	0.061	0.47	< 0.02	< 0.03	1.40
10/21/2014 9:05	10/21/2014 9:06	Base Grab	46	54.0	10.26	539.0	714.0	6.97	> 100	0.35	< 1	~ 1	429	46.5	0.053	0.079	0.212	0.49	< 0.02	< 0.03	2.00
11/6/2014 9:25	11/6/2014 9:26	Base Grab	36	48.7	10.38	467.9	668.3	7.38	58	0.33	3	~ 2	382	53.5	0.236	0.241	0.225	0.76	~ 0.02	< 0.03	2.09
12/2/2014 9:15	12/2/2014 9:16	Base Grab	19	43.7	11.10	907.0	1,404.0	7.32	> 100	0.70	~ 2	~ 2	799	52.5	~ 0.049	0.096	0.055	0.71	0.08	0.03	2.09
12/19/2014 9:36	12/19/2014 9:37	Base Grab	20	48.0	11.38	713.0	1,029.0	8.27	> 100	0.51	< 1	~ 1	582	91.4	~ 0.022	~ 0.034	0.026	0.39	~ 0.02	0.03	1.32
12/21/2014 12:45	12/22/2014 5:30	Rain/Melt Composite	35	36.0	13.82	755.0	1,336.0	7.54	10	0.66	68	35	655	11.6	0.095	0.258	—	2.60	0.76	0.08	0.82

Table F.1 continued. Monitoring data for 11CHF outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO ₃)	Chloride Ion (mg/L)	Hardness (mg/L CaCO ₃)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
9/30/2014 9:00	9/30/2014 9:01	Base Grab	145	51.0	188	21	7.1	1.8	2.3	0.0018	0.0019	0.0012	0.0013	< 0.0001	~ 0.0001	0.0067	0.0088	< 0.0002	< 0.0002	0.0003	0.0003	—
10/2/2014 13:55	10/2/2014 13:56	Rain Grab	15	4.1	25	67	12.8	> 7.9	> 7.9	0.0041	0.0091	0.0010	0.0034	~ 0.0003	0.0056	0.0123	0.0551	< 0.0002	< 0.0002	0.0016	0.0038	—
10/7/2014 9:40	10/7/2014 9:41	Base Grab	152	57.6	202	15	5.9	1.1	1.1	0.0015	0.0014	0.0011	0.0011	< 0.0001	~ 0.0003	0.0052	0.0056	< 0.0002	< 0.0002	0.0003	0.0003	—
10/21/2014 9:05	10/21/2014 9:06	Base Grab	210	71.3	134	~ 13	4.7	< 1.0	< 1.0	0.0015	0.0017	0.0011	0.0013	< 0.0001	~ 0.0001	0.0042	0.0072	< 0.0002	< 0.0002	0.0002	0.0003	—
11/6/2014 9:25	11/6/2014 9:26	Base Grab	216	39.5	298	39	15.6	7.6	10.0	0.0068	0.0061	0.0044	0.0049	~ 0.0004	0.0056	0.0235	0.0273	< 0.0002	< 0.0002	0.0008	0.0006	—
12/2/2014 9:15	12/2/2014 9:16	Base Grab	240	294.8	328	20	6.1	1.1	< 1.0	0.0021	0.0020	0.0017	0.0025	< 0.0001	~ 0.0002	0.0160	0.0112	< 0.0002	< 0.0002	0.0008	0.0004	—
12/19/2014 9:36	12/19/2014 9:37	Base Grab	275	105.3	432	~ 9	3.1	< 1.0	< 1.0	0.0007	0.0008	0.0009	0.0011	~ 0.0001	~ 0.0002	0.0226	0.0050	< 0.0002	< 0.0002	0.0002	0.0003	8
12/21/2014 12:45	12/22/2014 5:30	Rain/Melt Composite	34	336.1	76	112	10.8	—	—	0.0080	0.0175	0.0020	0.0061	0.0008	0.0085	0.0217	0.1140	< 0.0002	< 0.0002	0.0023	0.0069	—

Table F.2. Monitoring data for 1NE outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
1/13/2014 9:16	1/13/2014 9:17	Base Grab	28	40.3	11.68	2,022.0	3,309.0	7.79	> 100	1.72	~ 1	~ 1	1,740	—	—	< 0.020	—	0.84	—	—	—
2/13/2014 9:10	2/13/2014 9:11	Base Grab	26	39.2	14.06	951.0	1,587.0	7.84	> 100	0.80	< 1	~ 1	941	—	—	< 0.020	—	0.45	—	—	—
2/19/2014 14:31	2/19/2014 22:14	Melt Composite	35	48.9	11.65	7,039.0	10,015.0	7.35	5	5.65	212	~ 100	5,170	60.0	0.140	0.495	0.088	5.10	0.81	0.15	1.08
3/5/2014 9:15	3/5/2014 9:16	Base Grab	17	42.4	13.20	964.0	1,522.0	7.83	> 100	0.77	~ 1	~ 1	896	163.0	< 0.020	< 0.020	< 0.005	0.76	0.10	< 0.03	0.95
3/8/2014 14:22	3/10/2014 4:43	Melt Composite	45	44.8	11.91	4,373.0	6,639.0	7.47	5	3.62	138	~ 50	3,380	38.5	0.149	1.070	—	7.50	1.16	0.16	0.46
3/10/2014 9:58	3/10/2014 16:21	Melt Composite	30	49.6	10.27	3,100.0	4,372.0	7.51	5	2.34	264	86	2,320	11.1	0.246	0.807	0.219	7.30	1.34	0.15	0.48
3/11/2014 13:07	3/11/2014 21:45	Melt Composite	20	41.9	12.47	2,179.0	3,475.0	7.46	9	1.82	84	~ 36	1,820	20.4	0.472	0.675	0.446	6.40	1.26	0.18	0.55
3/12/2014 13:26	3/12/2014 23:57	Melt Composite	25	42.4	12.71	1,922.0	3,038.0	7.37	—	1.58	65	~ 26	2,420	29.3	—	0.652	—	6.10	1.45	0.13	0.66
3/13/2014 12:28	3/14/2014 1:55	Melt Composite	36	47.1	12.82	1,499.0	2,196.0	7.40	5	1.13	114	~ 40	1,070	15.2	0.385	0.645	0.359	4.40	1.17	0.09	0.43
3/14/2014 13:30	3/14/2014 21:00	Melt Composite	25	48.0	9.81	1,253.0	1,808.0	7.12	10	0.92	82	~ 28	936	12.3	0.413	0.642	—	4.40	0.92	0.08	0.42
3/17/2014 13:16	3/17/2014 21:20	Melt Composite	30	47.3	11.32	2,437.0	3,654.0	6.81	—	1.87	102	~ 50	1,870	35.8	0.239	0.435	0.220	5.00	0.61	0.11	0.52
3/18/2014 14:03	3/18/2014 19:35	Melt Composite	30	43.3	11.13	1880.0	2,929.0	7.37	—	1.52	25	~ 10	1,690	34.3	0.212	0.324	—	3.30	0.53	0.04	0.64
3/19/2014 13:49	3/19/2014 22:38	Melt Composite	30	43.5	11.77	2,965.0	4,603.0	7.26	—	2.46	65	~ 25	2,340	39.0	0.158	0.326	—	4.00	0.54	0.06	0.72
3/20/2014 9:35	3/20/2014 9:36	Base Grab	30	40.1	12.47	2,495.0	4,106.0	7.32	15	2.17	22	10	2,100	32.2	0.109	0.182	0.072	3.10	0.43	0.08	0.67
3/20/2014 12:41	3/20/2014 19:02	Melt Composite	35	48.0	10.87	1,124.0	1,621.0	7.59	6	0.82	132	~ 44	964	16.2	0.266	0.584	0.228	3.00	0.47	0.08	0.51
3/27/2014 13:53	3/27/2014 18:34	Rain/Melt Composite	38	49.8	11.10	336.5	473.3	7.53	4	0.23	252	80	281	7.7	0.373	0.956	0.337	4.55	0.96	0.07	0.57
3/28/2014 12:43	3/30/2014 13:25	Melt Composite	46	47.3	10.38	607.0	886.0	7.19	15	0.44	40	~ 14	448	19.8	0.422	0.571	—	3.00	0.59	0.06	0.51
3/31/2014 13:44	3/31/2014 23:12	Melt Composite	20	41.5	12.59	306.0	490.7	7.07	12	0.24	37	12	261	14.0	0.474	0.424	0.260	1.90	0.45	0.04	0.55
4/5/2014 13:50	4/7/2014 3:29	Melt Composite	50	59.7	9.56	416.7	510.0	7.35	22	0.25	45	~ 17	281	20.4	0.126	0.230	—	1.20	0.14	0.04	0.70
4/10/2014 8:10	4/10/2014 8:11	Base Grab	45	45.1	11.73	511.0	771.0	7.40	41	0.38	9	~ 4	423	52.9	0.153	0.265	0.125	2.30	0.50	0.11	1.76
4/23/2014 9:40	4/23/2014 9:41	Base Grab	47	46.2	11.70	720.0	1,068.0	7.70	88	0.53	4	~ 2	623	88.6	~ 0.041	0.103	0.046	1.20	0.10	0.05	1.70
4/27/2014 4:44	4/27/2014 12:12	Rain Composite	38	49.6	10.69	127.1	179.3	7.83	7	0.09	203	57	101	6.9	~ 0.041	0.375	—	2.20	0.21	< 0.03	0.33
4/28/2014 10:30	4/28/2014 19:00	Rain/Snow Composite	36	44.1	12.10	120.1	184.8	7.48	10	0.09	84	23	114	—	0.067	0.233	0.062	1.20	0.11	< 0.03	0.54
4/29/2014 9:45	4/29/2014 22:19	Rain Composite	38	46.0	12.15	203.4	303.1	7.46	15	0.15	32	7	207	19.1	~ 0.028	0.140	—	1.00	~ 0.05	< 0.03	1.06
5/30/2014 9:40	5/30/2014 9:41	Base Grab	77	61.5	9.74	1,051.0	1,258.0	7.45	> 100	0.63	~ 1	~ 1	836	258.0	0.178	0.182	0.085	3.70	0.35	0.31	1.93
5/31/2014 17:30	5/31/2014 22:00	Rain Composite	67	69.8	3.56	335.8	363.2	7.19	~ 10	0.17	802	412	—	15.9	0.167	1.390	0.099	6.20	~ 0.02	< 0.03	< 0.05
6/19/2014 12:16	6/19/2014 12:17	Rain Grab	65	69.1	7.26	269.3	293.8	7.63	40	0.14	26	7	195	18.6	0.082	0.132	0.064	0.99	< 0.02	< 0.03	0.66
7/11/2014 8:07	7/11/2014 12:01	Rain Composite	62	68.4	6.49	99.5	109.5	2.34	28	0.05	78	22	56	4.3	0.056	0.191	—	0.96	0.09	0.04	0.22
7/14/2014 18:14	7/15/2014 2:00	Rain Composite	65	65.1	8.73	373.3	427.4	7.17	—	0.21	53	~ 24	257	32.8	~ 0.048	0.203	0.021	0.98	< 0.02	< 0.03	0.92
7/17/2014 9:00	7/17/2014 9:01	Base Grab	65	59.2	10.28	1,208.0	1,490.0	7.16	> 100	0.75	< 1	~ 1	918	166.5	~ 0.033	0.060	0.029	0.85	~ 0.03	0.04	3.04
7/25/2014 5:36	7/25/2014 7:17	Rain Composite	67	68.7	8.1	250.4	274.5	7.12	—	0.13	141	51	171	24.6	0.213	0.679	0.182	2.70	0.27	0.12	0.82
7/28/2014 10:30	7/28/2014 10:31	Base Grab	69	63.0	9.41	1,289.0	1,515.0	7.35	> 100	0											

Table F.2 continued. Monitoring data for 1NE outfall

Start Date Start Time	End Date End Time	Sample Type	Air	Water	Dissolved	Conductivity	Specific	pH	Transparency	Salinity	Total	Volatile	Total	Sulfate	Dissolved	Total	Ortho	Total	Ammonia	Nitrite N	Nitrate N
			Temp (F)	Temp (F)	Oxygen (mg/L)	(μS/cm)	Conductivity (μS/cm)	(cm)	(ppt)	Suspended Solids (mg/L)	Suspended Solids (mg/L)	Dissolved Solids (mg/L)	(mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Phosphate (mg/L)	Kjeldahl Nitrogen (mg/L)	Nitrogen (mg/L)	(mg/L)	(mg/L)	
8/1/2014 18:45	8/1/2014 22:00	Rain Composite	76	78.3	5.72	814.0	803.0	7.28	—	0.39	117	53	—	121.0	0.076	1.150	—	2.30	~ 0.02	0.53	0.96
8/10/2014 21:55	8/11/2014 11:00	Rain Composite	64	71.4	6.34	282.4	299.9	7.50	—	0.14	176	51	189	20.0	0.089	0.445	0.068	2.10	~ 0.04	0.09	0.48
8/18/2014 1:03	8/18/2014 3:40	Rain Composite	71	80.4	6.20	298.9	288.7	7.19	—	0.14	298	80	—	—	0.066	0.561	—	2.20	< 0.02	0.06	0.66
8/18/2014 18:14	8/18/2014 20:37	Rain Composite	69	73.6	7.31	567.0	588.0	7.36	—	0.28	97	36	—	18.7	0.091	0.272	0.064	1.50	0.08	0.04	1.51
8/19/2014 18:29	8/19/2014 18:30	Rain Composite	80	81.1	2.36	225.9	216.4	7.49	—	0.10	~ 5	< 3	542	—	—	0.102	—	0.81	~ 0.04	< 0.03	2.18
8/21/2014 6:06	8/21/2014 9:07	Rain Composite	71	76.5	5.58	200.8	202.0	7.22	14	0.09	173	41	105	5.5	0.083	0.350	—	1.70	~ 0.05	< 0.03	0.59
8/24/2014 5:51	8/25/2014 1:05	Rain Composite	77	74.8	7.50	1,009.0	1,034.0	7.55	—	0.51	8	~ 4	669	164.0	0.112	0.208	—	1.40	0.10	0.09	1.22
8/28/2014 10:50	8/28/2014 10:51	Base Grab	76	65.1	7.97	1,098.0	1,256.0	7.14	82	0.63	5	~ 2	812	202.0	~ 0.043	0.129	0.021	2.00	0.69	0.22	1.32
8/29/2014 3:42	8/29/2014 4:10	Rain Composite	72	69.8	7.87	244.4	264.5	7.45	—	0.13	366	120	—	34.4	0.087	0.629	0.079	2.50	0.08	0.05	0.73
8/29/2014 12:30	8/30/2014 7:00	Rain Composite	70	72.9	7.49	136.0	142.8	7.16	21	0.07	103	30	93	9.4	0.057	0.247	—	1.10	0.05	0.08	0.44
8/31/2014 22:22	9/1/2014 6:23	Rain Composite	70	72.5	7.40	189.7	198.3	7.15	—	0.09	28	9	111	16.9	0.060	0.192	—	1.00	0.07	0.04	0.39
9/3/2014 10:32	9/3/2014 10:33	Rain Grab	77	72.9	5.80	207.4	217.2	7.26	—	0.10	—	—	—	10.6	0.169	0.360	—	1.50	0.26	0.22	0.50
9/9/2014 21:42	9/10/2014 0:12	Rain Composite	50	50.4	7.03	110.0	154.0	7.63	—	0.07	101	26	—	12.1	0.239	0.480	—	1.80	0.06	0.06	0.48
9/11/2014 9:30	9/11/2014 9:31	Base Grab	50	55.4	9.43	963.0	1,248.0	7.48	> 100	0.63	~ 2	~ 1	792	159.0	0.104	0.096	0.039	1.00	0.15	0.05	1.59
9/20/2014 18:34	9/20/2014 18:35	Rain Grab	63	59.4	7.10	262.9	323.5	6.71	—	0.16	—	—	—	16.6	0.053	0.932	—	3.40	< 0.02	0.21	0.29
9/24/2014 15:48	9/24/2014 15:53	Rain Composite	63	65.1	6.86	485.2	555.3	7.06	—	0.27	92	40	334	38.4	0.083	0.744	0.025	2.40	< 0.02	0.09	1.23
9/30/2014 9:25	9/30/2014 9:26	Base Grab	45	55.4	9.74	1,002.0	1,300.0	7.29	> 100	0.65	~ 1	~ 2	785	147.0	~ 0.038	0.057	0.031	0.80	~ 0.05	< 0.03	1.05
10/1/2014 9:34	10/1/2014 13:22	Rain Composite	58	59.7	6.90	138.7	169.7	6.96	—	0.08	48	19	102	7.8	0.180	0.404	0.150	1.50	< 0.02	< 0.03	< 0.05
10/2/2014 13:11	10/2/2014 20:43	Rain Composite	45	54.9	8.86	151.5	198.0	7.28	13	0.09	52	16	119	11.0	0.085	0.228	0.081	0.89	< 0.02	< 0.03	0.30
10/4/2014 0:17	10/4/2014 7:42	Rain Composite	34	46.0	10.86	489.5	729.3	7.44	—	0.36	8	~ 5	432	107.0	0.057	0.152	—	0.91	~ 0.02	0.03	0.69
10/7/2014 10:25	10/7/2014 10:26	Base Grab	55	62.6	9.08	1,323.0	1,562.0	7.68	> 100	0.79	~ 1	~ 1	908	194.0	~ 0.021	~ 0.024	0.023	0.89	0.10	0.03	1.60
10/21/2014 9:35	10/21/2014 9:36	Base Grab	46	52.2	9.89	1,119.0	1,518.0	6.88	> 100	0.77	~ 2	< 1	966	181.0	~ 0.027	< 0.020	0.119	0.69	~ 0.05	< 0.03	1.03
11/6/2014 10:02	11/6/2014 10:03	Base Grab	36	49.8	9.62	1,010.0	1,421.0	7.32	65	0.72	5	3	859	160.0	0.098	0.134	0.101	1.40	0.38	0.05	0.91
11/22/2014 22:55	11/24/2014 4:24	Melt Composite	23	48.6	7.99	2,751.0	3,945.0	7.37	—	2.10	53	~ 29	2,070	15.8	0.129	0.426	—	2.30	0.06	0.10	0.16
12/2/2014 9:45	12/2/2014 9:46	Base Grab	19	43.5	11.16	1,021.0	1,583.0	7.40	> 100	0.80	< 1	~ 1	956	187.5	< 0.020	< 0.020	0.021	0.65	0.19	< 0.03	1.08
12/13/2014 12:32	12/15/2014 20:27	Melt Composite	23	37.8	10.54	1,204.0	2,063.0	7.58	3	1.04	192	75	1,120	35.9	0.134	0.566	0.129	3.20	0.26	0.10	0.51
12/19/2014 10:01	12/19/2014 10:02	Base Grab	20	46.2	11.65	1,041.0	1,543.0	7.91	> 100	0.78	~ 1	~ 1	930	179.0	~ 0.050	0.068	0.050	1.10	0.48	< 0.03	1.06
12/21/2014 12:37	12/22/2014 19:54	Rain/Melt Grab	35	56.1	8.23	1,412.0	1,816.0	7.62	7	0.93	66	26	953	38.0	0.067	0.267	—	2.00	0.26	0.08	0.84

Table F.2 continued. Monitoring data for 1NE outfall

Table F.2 continued. Monitoring data for 1NE outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)	
8/1/2014 18:45	8/1/2014 22:00	Rain Composite	149	82.0	268	64	12.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
8/10/2014 21:55	8/11/2014 11:00	Rain Composite	68	32.9	100	86	17.6	—	16.0	0.0102	—	0.0015	—	~ 0.0004	—	0.0397	—	< 0.0002	—	0.0008	—	—	
8/18/2014 1:03	8/18/2014 3:40	Rain Composite	59	34.8	92	119	10.7	—	—	—	0.0321	—	0.0081	—	0.0263	—	0.3440	—	~ 0.0004	—	0.0082	—	—
8/18/2014 18:14	8/18/2014 20:37	Rain Composite	137	67.2	204	57	9.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/19/2014 18:29	8/19/2014 18:30	Rain Composite	204	98.0	—	20	—	—	—	—	0.0104	—	0.0022	—	0.0007	—	0.0088	—	0.0017	—	0.0006	—	—
8/21/2014 6:06	8/21/2014 9:07	Rain Composite	41	17.5	80	80	7.2	—	—	0.0066	0.0296	0.0006	0.0054	~ 0.0002	0.0194	0.0049	0.1060	< 0.0002	~ 0.0003	0.0009	0.0072	—	—
8/24/2014 5:51	8/25/2014 1:05	Rain Composite	222	90.8	424	41	11.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/28/2014 10:50	8/28/2014 10:51	Base Grab	247	131.8	532	27	8.7	1.0	2.2	0.0026	0.0031	0.0026	0.0029	< 0.0001	0.0006	0.0212	0.0389	< 0.0002	~ 0.0003	0.0003	0.0013	—	—
8/29/2014 3:42	8/29/2014 4:10	Rain Composite	47	24.0	112	106	8.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/29/2014 12:30	8/30/2014 7:00	Rain Composite	38	10.4	56	45	4.1	—	—	0.0055	0.0175	< 0.0010	0.0042	~ 0.0002	0.0140	0.0058	0.0643	< 0.0002	~ 0.0002	0.0017	0.0047	—	—
8/31/2014 22:22	9/1/2014 6:23	Rain Composite	46	16.9	80	37	5.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/3/2014 10:32	9/3/2014 10:33	Rain Grab	43	19.6	80	40	10.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/9/2014 21:42	9/10/2014 0:12	Rain Composite	28	10.9	56	59	7.0	—	—	0.0077	0.0229	0.0008	0.0046	~ 0.0003	0.0154	0.0166	0.1050	< 0.0002	~ 0.0003	0.0007	0.0041	—	—
9/11/2014 9:30	9/11/2014 9:31	Base Grab	288	129.9	460	21	7.2	< 1.0	< 1.0	0.0018	0.0021	0.0028	0.0031	< 0.0001	~ 0.0003	0.0106	0.0213	< 0.0002	< 0.0002	0.0002	0.0003	—	—
9/20/2014 18:34	9/20/2014 18:35	Rain Grab	60	44.1	104	191	24.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/24/2014 15:48	9/24/2014 15:53	Rain Composite	81	92.0	156	109	17.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/30/2014 9:25	9/30/2014 9:26	Base Grab	313	148.6	468	~ 10	5.9	1.4	1.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/1/2014 9:34	10/1/2014 13:22	Rain Composite	40	12.7	76	72	21.0	—	—	0.0103	0.0169	0.0012	0.0031	0.0006	0.0068	0.0205	0.0656	< 0.0002	< 0.0002	0.0018	0.0036	—	—
10/2/2014 13:11	10/2/2014 20:43	Rain Composite	43	16.6	108	47	9.4	7.2	> 7.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/4/2014 0:17	10/4/2014 7:42	Rain Composite	154	67.4	268	29	9.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/7/2014 10:25	10/7/2014 10:26	Base Grab	338	158.8	556	~ 12	5.6	< 1.0	< 1.0	0.0015	0.0020	0.0036	0.0039	< 0.0001	< 0.0001	0.0041	0.0052	< 0.0002	< 0.0002	0.0002	0.0002	—	—
10/21/2014 9:35	10/21/2014 9:36	Base Grab	390	150.4	520	~ 10	3.8	< 1.0	1.1	0.0015	0.0016	0.0035	0.0038	< 0.0001	< 0.0001	0.0029	0.0028	< 0.0002	< 0.0002	~ 0.0001	~ 0.0002	—	—
11/6/2014 10:02	11/6/2014 10:03	Base Grab	357	172.0	544	23	10.4	6.0	7.2	0.0024	0.0036	0.0042	0.0046	~ 0.0002	0.0006	0.0124	0.0204	< 0.0002	< 0.0002	0.0005	0.0006	—	—
11/22/2014 22:55	11/24/2014 4:24	Melt Composite	87	1,045.3	156	115	19.4	—	37.0	0.0110	0.0179	0.0018	0.0038	0.0009	0.0053	0.0350	0.0759	< 0.0002	< 0.0002	0.0040	0.0065	—	—
12/2/2014 9:45	12/2/2014 9:46	Base Grab	387	178.5	564	~ 10	4.6	1.2	< 1.0	0.0015	0.0015	0.0041	0.0044	< 0.0001	< 0.0001	0.0062	0.0044	< 0.0002	< 0.0002	~ 0.0002	~ 0.0002	—	—
12/13/2014 12:32	12/15/2014 20:27	Melt Composite	104	468.0	152	218	15.9	11.0	17.0	0.0143	0.0425	0.0024	0.0122	0.0014	0.0302	0.0171	0.3130	< 0.0002	~ 0.0004	0.0050	0.0180	—	—
12/19/2014 10:01	12/19/2014 10:02	Base Grab	391	181.4	534	~ 14	4.1	< 1.0	1.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12/21/2014 12:37	12/22/2014 19:54	Rain/Melt Grab	111	454.2	148	88	8.7	5.9	8.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table F.3. Monitoring data for 2NNBC outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
3/10/2014 13:15	3/10/2014 13:16	Melt Grab	48	39.0	13.15	2,947.0	4,942.0	7.70	5.0	2.63	97	44	2,540	14.5	0.178	0.485	0.155	6.70	1.20	0.15	0.84
3/13/2014 15:21	3/13/2014 15:22	Melt Grab	48	40.3	12.28	1,757.0	2,885.0	7.75	4.0	1.49	108	~ 38	1,450	10.4	0.214	0.487	0.198	3.90	0.87	0.08	0.53
4/28/2014 12:20	4/28/2014 12:21	Rain Grab	38	43.0	13.32	108.0	169.1	7.91	12.0	0.08	78	23	96	9.7	0.057	0.190	0.059	1.00	0.21	< 0.03	0.32
5/19/2014 14:10	5/19/2014 14:11	Rain Grab	51	54.5	10.47	90.4	118.7	8.00	17.5	0.06	123	38	79	4.4	0.111	0.249	0.099	1.40	0.28	< 0.03	0.21
6/19/2014 11:21	6/19/2014 11:22	Rain Grab	65	66.7	8.53	81.8	91.9	7.57	19.0	0.04	56	15	73	2.2	~ 0.049	0.147	0.052	0.65	~ 0.04	< 0.03	< 0.05
7/11/2014 9:48	7/11/2014 9:49	Rain Grab	67	68.5	8.31	141.3	155.1	7.73	26.0	0.07	48	14	85	4.1	0.059	0.148	0.053	0.88	0.11	< 0.03	0.15
10/2/2014 14:03	10/2/2014 14:04	Rain Grab	60	59.9	9.46	251.9	308.0	7.40	3.0	0.15	295	36	166	22.1	0.061	0.366	0.032	1.70	0.27	0.07	0.57
10/2/2014 14:05	10/2/2014 14:06	Rain Grab	60	59.9	9.46	251.9	308.0	7.40	3.0	0.15	309	36	166	21.4	~ 0.035	0.387	0.029	1.70	0.28	0.07	0.56

Table F.3 continued. Monitoring data for 2NNBC outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO ₃)	Chloride Ion (mg/L)	Hardness (mg/L CaCO ₃)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
3/10/2014 13:15	3/10/2014 13:16	Melt Grab	55	1,459.9	168	153	10.6	17.0	23.0	0.0091	0.0302	0.0019	0.0061	0.0008	0.0185	0.0818	0.2180	< 0.0002	~ 0.0003	0.0022	0.0114	—
3/13/2014 15:21	3/13/2014 15:22	Melt Grab	71	840.3	140	103	11.0	9.0	13.0	0.0085	0.0251	0.0015	0.0060	~ 0.0007	0.0276	0.0143	0.1260	< 0.0004	< 0.0004	0.0021	0.0083	28
4/28/2014 12:20	4/28/2014 12:21	Rain Grab	21	25.7	64	83	5.1	3.2	4.4	0.0027	0.0128	~ 0.0005	0.0036	0.0008	0.0195	0.0071	0.0720	< 0.0002	~ 0.0002	0.0015	0.0049	—
5/19/2014 14:10	5/19/2014 14:11	Rain Grab	19	16.6	40	50	6.3	5.4	7.3	0.0023	0.0123	~ 0.0005	0.0035	~ 0.0005	0.0160	0.0115	0.0733	< 0.0002	< 0.0002	0.0013	0.0050	—
6/19/2014 11:21	6/19/2014 11:22	Rain Grab	21	8.9	48	30	4.0	3.8	4.7	0.0015	0.0067	~ 0.0004	0.0024	0.0005	0.0127	0.0060	0.0410	< 0.0002	< 0.0002	0.0010	0.0029	< 6
7/11/2014 9:48	7/11/2014 9:49	Rain Grab	28	22.6	48	31	5.7	4.2	5.8	0.0017	0.0078	~ 0.0005	0.0022	0.0005	0.0076	0.0084	0.0437	< 0.0002	< 0.0002	0.0011	0.0027	—
10/2/2014 14:03	10/2/2014 14:04	Rain Grab	55	38.5	136	94	10.2	> 7.8	> 7.8	0.0030	0.0249	0.0016	0.0167	~ 0.0002	0.0481	< 0.0050	0.1120	< 0.0002	0.0005	0.0014	0.0099	—
10/2/2014 14:05	10/2/2014 14:06	Rain Grab	52	37.6	152	94	9.4	> 7.7	> 7.7	0.0030	0.0258	0.0017	0.0175	~ 0.0002	0.0520	< 0.0050	0.1140	< 0.0002	0.0006	0.0015	0.0105	—

Table F.4. Monitoring data for 4PP outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N	Nitrate N
1/13/2014 11:25	1/13/2014 11:26	Base Grab	29	46.2	9.89	1,582.0	2,348.0	8.02	9	1.21	27	6	1,100	—	—	0.379	—	3.70	—	—	—
2/13/2014 11:40	2/13/2014 11:41	Base Grab	22	42.1	5.12	1,983.0	3,149.0	8.02	—	1.64	20	8	1,700	—	—	0.268	—	3.40	—	—	—
3/5/2014 11:45	3/5/2014 11:46	Base Grab	22	46.4	10.03	1,439.0	2,132.0	8.18	> 100	1.09	105	14	1,170	116.5	0.138	0.403	0.132	3.45	1.44	0.04	1.21
3/10/2014 13:40	3/10/2014 13:41	Melt Grab	48	40.1	14.08	3,434.0	5,639.0	7.71	3	3.03	588	160	2,920	36.5	0.167	1.280	0.140	8.00	1.64	0.19	0.58
3/13/2014 15:00	3/13/2014 15:03	Melt Grab	47	44.4	11.89	1,665.0	2,547.0	7.57	4	1.32	222	68	1,180	28.5	0.249	0.646	0.221	5.60	1.07	0.10	0.52
3/20/2014 11:05	3/20/2014 11:06	Base Grab	30	44.4	10.69	1,312.0	2,002.0	7.88	88	1.02	~ 2	~ 1	1,070	110.0	0.023	~ 0.039	0.013	0.85	~ 0.05	< 0.03	1.17
3/20/2014 15:11	3/21/2014 6:13	Melt Composite	37	43.3	10.90	982.0	1,528.0	7.61	8	0.77	124	~ 44	796	42.9	0.176	0.444	0.158	3.10	0.47	0.08	0.71
3/27/2014 13:29	3/27/2014 21:27	Rain/Melt Composite	25	48.4	10.52	461.8	663.4	7.63	5	0.32	284	~ 84	372	19.9	0.264	0.929	0.243	4.50	0.86	0.09	0.58
3/28/2014 13:02	3/31/2014 7:30	Melt Composite	46	64.9	6.77	954.0	1,094.0	7.65	24	0.55	68	16	524	55.0	0.205	0.429	—	2.60	0.42	0.05	0.65
3/31/2014 11:35	4/1/2014 0:03	Melt Composite	20	55.8	8.47	852.0	1,101.0	7.43	—	0.55	116	~ 38	590	51.1	0.178	0.431	0.167	2.40	0.30	0.06	0.61
4/4/2014 11:40	4/5/2014 15:15	Melt Composite	45	70.7	5.87	2,813.0	3,014.0	7.57	10	1.57	180	60	1,580	50.1	< 0.020	0.247	—	2.60	< 0.02	0.06	0.58
4/28/2014 12:45	4/28/2014 12:46	Rain Grab	38	43.7	13.28	88.7	137.3	7.61	16	0.06	576	31	84	10.8	~ 0.031	0.145	0.031	0.99	0.17	< 0.03	0.24
5/19/2014 12:40	5/19/2014 12:41	Rain Grab	50	55.2	10.50	108.2	140.6	7.72	11	0.07	472	86	91	5.6	0.138	0.560	0.119	2.80	0.54	0.03	0.36
6/19/2014 10:21	6/19/2014 10:22	Rain Grab	65	66.4	8.73	41.6	46.9	7.59	13	0.02	100	25	29	1.6	~ 0.036	0.199	0.036	1.00	0.07	< 0.03	0.08
7/11/2014 10:20	7/11/2014 10:21	Rain Grab	67	68.2	8.84	52.7	58.1	7.27	—	0.03	52	14	44	2.6	0.069	0.144	0.063	0.71	0.10	< 0.03	0.14
7/25/2014 5:16	7/25/2014 9:52	Rain Composite	71	71.4	6.35	275.4	292.6	7.29	—	0.14	1,310	133	186	16.1	0.119	0.502	0.120	2.80	0.25	0.04	0.73
7/28/2014 12:10	7/28/2014 12:11	Base Grab	73	55.9	10.25	966.0	1,243.0	7.63	> 100	0.62	4	~ 2	722	72.1	~ 0.028	0.099	0.029	0.74	0.14	0.05	1.37
8/2/2014 19:55	8/3/2014 0:05	Rain Composite	75	77.9	4.76	1,062.0	1,053.0	7.19	—	0.52	112	33	—	60.5	~ 0.047	0.201	—	1.80	0.26	0.33	0.97
8/10/2014 21:50	8/10/2014 21:51	Rain Composite	64	68.7	3.84	1,039.0	1,138.0	7.32	—	0.57	—	—	—	74.6	0.534	5.570	—	4.60	~ 0.02	< 0.03	1.17
8/21/2014 5:45	8/21/2014 14:45	Rain Composite	71	75.9	5.29	645.0	652.0	7.29	—	0.32	78	30	363	37.4	0.082	0.315	—	1.30	0.07	0.08	0.85
8/24/2014 6:05	8/24/2014 6:06	Rain Grab	77	78.6	6.82	1,486.0	1,460.0	7.74	—	0.73	—	—	—	91.7	~ 0.045	0.253	—	1.60	< 0.02	0.05	1.20
8/28/2014 12:08	8/28/2014 12:09	Base Grab	74	63.0	9.42	1,327.0	1,558.0	7.77	> 100	0.79	~ 2	~ 1	906	93.4	~ 0.033	~ 0.033	0.023	0.62	0.07	0.03	1.34
8/29/2014 3:30	8/29/2014 3:31	Rain Grab	75	70.5	7.88	496.4	534.0	7.48	—	0.26	—	—	—	30.3	< 0.020	0.642	0.016	3.00	< 0.02	0.05	0.84
8/29/2014 17:05	8/29/2014 17:22	Rain Composite	76	72.7	6.00	237.5	249.0	7.22	—	0.12	685	64	147	12.6	~ 0.036	0.189	—	1.10	0.11	0.05	0.42
9/24/2014 14:45	9/24/2014 17:23	Rain Composite	63	65.5	7.84	926.0	1,054.0	6.96	—	0.52	—	—	—	64.2	< 0.020	0.171	~ 0.009	1.40	< 0.02	0.04	1.40
9/30/2014 11:07	9/30/2014 11:10	Base Grab	54	55.0	9.24	1,124.0	1,467.0	7.43	78	0.74	3	~ 2	678	90.5	< 0.020	0.063	0.016	0.70	~ 0.04	< 0.03	1.09
10/1/2014 9:02	10/2/2014 0:49	Rain Composite	60	58.8	8.31	381.3	479.9	7.12	25	0.23	40	16	254	26.7	~ 0.038	0.181	0.032	1.00	< 0.02	< 0.03	0.46
10/2/2014 12:55	10/2/2014 22:53	Rain Composite	40	54.3	9.53	220.5	290.7	7.19	26	0.14	39	15	152	15.2	~ 0.036	0.134	0.033	1.00	~ 0.04	0.03	0.45
10/4/2014 0:10	10/4/2014 8:12	Rain Composite	34	48.6	10.08	601.0	861.0	7.39	—	0.43	25	9	449	50.2	~ 0.045	0.075	—	0.69	< 0.02	< 0.03	0.79
10/7/2014 12:40	10/7/2014 12:41	Base Grab	61	55.8	9.85	1,191.0	1,538.0	7.61	88	0.78	3	~ 1	809	88.3	0.491	~ 0.036	0.020	0.60	~ 0.04	< 0.03	1.36
10/21/2014 11:07	10/21/20																				

Table F.4 continued. Monitoring data for 4PP outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO ₃)	Chloride Ion (mg/L)	Hardness (mg/L CaCO ₃)	Chemical Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Soluble Oil and Grease (mg/L)
1/13/2014 11:25	1/13/2014 11:26	Base Grab	—	466.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/13/2014 11:40	2/13/2014 11:41	Base Grab	—	805.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3/5/2014 11:45	3/5/2014 11:46	Base Grab	299	436.9	586	46	3.6	5.5	7.9	—	—	—	—	—	—	—	—	—	—	—	—	—
3/10/2014 13:40	3/10/2014 13:41	Melt Grab	67	1,718.3	200	445	17.4	38.0	50.0	0.0127	0.1000	0.0030	0.0214	~ 0.0004	0.0602	0.0506	0.7060	< 0.0002	0.0014	0.0051	0.0454	38
3/13/2014 15:00	3/13/2014 15:03	Melt Grab	78	645.8	132	191	14.6	18.0	27.0	0.0109	0.0427	0.0025	0.0096	~ 0.0007	0.0265	0.0143	0.2350	< 0.0004	< 0.0004	0.0023	0.0155	23
3/20/2014 11:05	3/20/2014 11:06	Base Grab	270	383.3	556	~ 14	5.1	7.5	> 7.7	—	—	—	—	—	—	—	—	—	—	—	—	—
3/20/2014 15:11	3/21/2014 6:13	Melt Composite	110	352.5	208	114	11.6	12.0	17.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/27/2014 13:29	3/27/2014 21:27	Rain/Melt Composite	63	152.1	76	196	17.4	15.0	21.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/28/2014 13:02	3/31/2014 7:30	Melt Composite	149	213.5	160	50	8.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3/31/2014 11:35	4/1/2014 0:03	Melt Composite	124	256.8	264	110	10.1	6.2	7.5	0.0103	0.0296	0.0029	0.0095	0.0010	0.0175	0.0383	0.1660	< 0.0002	~ 0.0003	0.0014	0.0094	—
4/4/2014 11:40	4/5/2014 15:15	Melt Composite	137	824.1	232	126	7.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 8
4/28/2014 12:45	4/28/2014 12:46	Rain Grab	22	13.1	48	43	3.9	3.4	4.9	0.0030	0.0149	0.0009	0.0035	~ 0.0005	0.0106	0.0093	0.0791	< 0.0002	< 0.0002	0.0021	0.0059	—
5/19/2014 12:40	5/19/2014 12:41	Rain Grab	25	12.0	84	141	11.5	13.0	18.0	0.0055	0.0541	0.0008	0.0122	~ 0.0004	0.0527	0.0090	0.3690	< 0.0002	~ 0.0004	0.0039	0.0194	—
6/19/2014 10:21	6/19/2014 10:22	Rain Grab	13	3.0	40	39	2.9	2.6	3.6	0.0014	0.0106	< 0.0003	0.0031	~ 0.0004	0.0183	0.0024	0.0589	< 0.0002	< 0.0002	0.0025	0.0063	—
7/11/2014 10:20	7/11/2014 10:21	Rain Grab	10	4.4	48	29	4.5	3.7	4.8	0.0031	0.0091	~ 0.0003	0.0021	~ 0.0003	0.0107	0.0105	0.0440	< 0.0002	< 0.0002	0.0024	0.0044	—
7/25/2014 5:16	7/25/2014 9:52	Rain Composite	55	39.3	84	120	19.3	21.0	> 24.0	—	—	—	—	—	—	—	—	—	—	—	—	—
7/28/2014 12:10	7/28/2014 12:11	Base Grab	274	188.9	432	~ 11	1.6	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
8/2/2014 19:55	8/3/2014 0:05	Rain Composite	218	160.2	336	39	10.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/10/2014 21:50	8/10/2014 21:51	Rain Composite	234	193.5	440	241	36.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/21/2014 5:45	8/21/2014 14:45	Rain Composite	96	97.7	208	50	9.0	—	—	0.0080	0.0266	0.0015	0.0044	~ 0.0002	0.0216	0.0207	0.1110	< 0.0002	~ 0.0002	0.0018	0.0054	24
8/24/2014 6:05	8/24/2014 6:06	Rain Grab	230	258.6	432	53	6.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/28/2014 12:08	8/28/2014 12:09	Base Grab	296	274.6	492	~ 10	2.7	< 1.0	< 1.0	~ 0.0006	0.0010	0.0021	0.0025	< 0.0001	~ 0.0003	0.0039	0.0094	< 0.0002	< 0.0002	~ 0.0001	0.0003	—
8/29/2014 3:30	8/29/2014 3:31	Rain Grab	97	80.5	184	164	7.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/29/2014 17:05	8/29/2014 17:22	Rain Composite	52	32.1	88	54	4.1	—	—	0.0066	0.0273	< 0.0010	0.0038	< 0.0001	0.0202	0.0077	0.0881	< 0.0002	~ 0.0002	0.0031	0.0070	—
9/24/2014 14:45	9/24/2014 17:23	Rain Composite	201	172.2	344	53	9.0	—	—	0.0067	0.0184	0.0022	0.0044	< 0.0001	0.0094	0.0093	0.0642	∼ 0.0003	0.0007	0.0010	0.0038	—
9/30/2014 11:07	9/30/2014 11:10	Base Grab	281	255.1	500	~ 7	3.2	< 1.0	1.1	0.0009	0.0015	0.0030	0.0036	< 0.0001	~ 0.0004	0.0119	0.0089	< 0.0002	< 0.0002	~ 0.0001	0.0003	—
10/1/2014 9:02	10/2/2014 0:49	Rain Composite	89	72.9	172	51	9.6	11.0	14.0	0.0085	0.0200	0.0015	0.0029	~ 0.0003	0.0067	0.0155	0.0620	< 0.0002	< 0.0002	0.0019	0.0036	—
10/2/2014 12:55	10/2/2014 22:53	Rain Composite	50	37.6	96	33	7.8	6.4	> 7.9	—	—	—	—	—	—	—	—	—	—	—	—	—
10/4/2014 0:10	10/4/2014 8:12	Rain Composite	154	137.9	280	22	6.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/7/2014 12:40	10/7/2014 12:41	Base Grab	297	252.3	460	~ 7	3.1	< 1.0	< 1.0	~ 0.0037	0.0008	0.0028	0.0032	< 0.0001	~ 0.0003	0.0036	0.0062	< 0.0002	< 0.0002	~ 0.0002	0.0003	—
10/21/2014 11:05	10/21/2014 11:06	Base Grab	303	325.6	522	~ 6	2.4	< 1.0	< 1.0	~ 0.0006	0.0010	0.0029	0.0034	< 0.0001	~ 0.0004	0.0038	0.00					

Table F.5. Monitoring data for 6UMN outfall

Start Date Start Time	End Date End Time	Sample Type	Air	Water	Dissolved	Conductivity	Specific	pH	Transparency	Salinity	Total	Volatile	Total	Sulfate	Dissolved	Total	Ortho	Total	Ammonia	Nitrite N	Nitrate N
			Temp (F)	Temp (F)	Oxygen (mg/L)	(µS/cm)	Conductivity (µS/cm)	(cm)	(ppt)		Suspended Solids (mg/L)	Suspended Solids (mg/L)	Dissolved Solids (mg/L)	(mg/L)	Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Kjeldahl Nitrogen (mg/L)	Nitrogen (mg/L)		
1/13/2014 11:00	1/13/2014 11:01	Base Grab	29	47.1	11.30	1,549.0	2,267.0	8.37	> 100	1.17	~ 1	~ 1	1,180	—	—	~ 0.049	—	0.53	—	—	—
2/13/2014 10:55	2/13/2014 10:56	Base Grab	24	44.6	11.18	1,800.0	2,743.0	8.21	—	1.42	~ 2	~ 1	1,475	—	—	~ 0.020	—	0.38	—	—	—
3/5/2014 10:45	3/5/2014 10:46	Base Grab	22	42.3	11.97	1,007.0	1,594.0	8.11	> 100	0.80	~ 1	~ 1	892	69.7	< 0.020	< 0.020	~ 0.007	0.62	~ 0.05	< 0.03	1.11
3/10/2014 14:13	3/10/2014 14:14	Melt Grab	48	40.3	14.51	2,020.0	3,308.0	7.93	4	1.72	252	78	1,730	22.1	0.289	0.712	0.196	5.60	0.93	0.15	0.48
3/13/2014 14:55	3/13/2014 14:56	Melt Grab	40	42.6	12.01	1,002.0	1,579.0	7.80	6	0.80	178	~ 58	828	16.5	0.185	0.537	0.176	4.20	0.69	0.08	0.34
3/20/2014 10:40	3/20/2014 10:41	Base Grab	30	46.0	11.38	988.0	1,472.0	8.03	> 100	0.74	~ 2	~ 1	820	63.9	~ 0.023	0.050	0.023	0.99	~ 0.06	< 0.03	1.07
3/20/2014 14:20	3/20/2014 14:21	Melt Grab	42	43.9	12.69	866.0	1,337.0	8.52	5	0.67	134	~ 46	754	15.0	0.113	0.545	0.096	3.10	0.42	0.10	0.71
3/27/2014 14:15	3/27/2014 14:16	Rain/Melt Grab	38	38.5	13.99	516.0	872.0	7.60	3	0.43	444	138	534	22.4	0.246	1.310	0.182	6.90	0.76	0.11	0.57
4/28/2014 13:15	4/28/2014 13:16	Rain Grab	38	43.3	13.12	62.6	97.4	7.61	10	0.05	91	24	69	5.4	~ 0.043	0.164	0.044	0.85	0.12	< 0.03	0.22
4/29/2014 12:48	4/29/2014 12:49	Rain Grab	37	43.3	12.39	216.0	335.7	7.17	17	0.16	29	8	190	15.6	0.065	0.153	0.066	0.74	0.10	0.04	0.31
5/19/2014 12:05	5/19/2014 12:06	Rain Grab	50	54.5	8.64	217.7	286.2	7.41	12	0.14	46	~ 14	96	7.4	0.267	0.346	0.243	1.80	0.73	< 0.03	0.26
6/19/2014 10:15	6/19/2014 10:16	Rain Grab	65	65.8	8.81	74.5	84.4	7.20	9	0.04	60	15	43	2.4	~ 0.039	0.171	0.043	0.63	< 0.02	< 0.03	< 0.05
7/11/2014 11:00	7/11/2014 11:01	Rain Grab	69	66.7	8.63	105.5	118.3	7.46	20	0.08	25	6	70	4.9	0.051	0.119	0.052	0.54	0.10	< 0.03	0.25
7/25/2014 5:31	7/25/2014 7:58	Rain Composite	69	67.1	8.61	178.4	199.3	7.22	—	0.19	117	42	128	10.7	0.088	0.298	0.090	2.00	0.21	< 0.03	0.55
7/28/2014 11:17	7/28/2014 11:18	Base Grab	71	59.9	10.58	1,088.0	1,328.0	7.46	> 100	0.67	< 1	~ 1	819	84.8	< 0.020	~ 0.038	0.015	0.35	~ 0.03	< 0.03	1.46
8/18/2014 1:26	8/18/2014 5:31	Rain Composite	72	73.4	7.93	489.5	509.1	7.88	—	0.25	—	—	—	—	0.080	0.879	—	2.30	< 0.02	0.04	0.60
8/21/2014 6:26	8/21/2014 16:47	Rain Composite	71	73.6	6.56	293.3	304.2	7.30	—	0.14	249	85	170	15.9	0.063	0.332	—	1.60	< 0.02	< 0.03	0.39
8/28/2014 11:00	8/28/2014 11:01	Base Grab	70	60.6	10.13	1,075.0	1,302.0	7.61	> 100	0.65	~ 1	~ 1	771	77.3	~ 0.023	~ 0.028	~ 0.008	0.56	< 0.02	< 0.03	0.90
8/29/2014 3:48	8/29/2014 5:07	Rain Composite	71	67.8	8.34	182.7	202.5	7.40	—	0.10	308	111	—	11.1	0.064	0.415	0.052	2.10	< 0.02	< 0.03	0.43
8/29/2014 17:06	8/30/2014 14:36	Rain Composite	73	70.5	8.79	153.6	164.8	7.46	40	0.08	52	18	98	7.3	~ 0.030	0.147	—	0.90	0.11	< 0.03	0.36
8/31/2014 21:48	8/31/2014 22:07	Rain Composite	73	72.5	7.99	134.5	141.2	7.37	—	0.07	94	25	72	6.4	< 0.020	0.213	—	1.30	0.06	< 0.03	0.26
9/3/2014 10:22	9/3/2014 22:38	Rain Composite	77	74.1	7.88	288.3	297.2	7.39	—	0.14	36	15	—	16.6	0.084	0.156	—	1.10	< 0.02	0.03	0.42
9/30/2014 10:30	9/30/2014 10:31	Base Grab	45	54.3	10.01	994.0	1,308.0	7.25	> 100	0.66	~ 1	~ 1	758	78.2	< 0.020	0.062	0.011	0.64	< 0.02	< 0.03	0.92
10/1/2014 11:42	10/1/2014 20:00	Rain Composite	60	57.9	10.28	196.7	246.5	7.12	—	0.12	36	13	124	0.7	0.091	0.126	—	0.99	< 0.02	< 0.03	0.40
10/2/2014 13:08	10/2/2014 19:57	Rain Composite	43	51.8	10.33	126.7	172.8	7.28	20	0.08	40	14	94	8.4	0.050	0.117	0.032	0.79	~ 0.04	< 0.03	0.32
10/4/2014 0:32	10/4/2014 7:14	Rain Composite	34	44.8	11.71	332.9	505.7	7.43	—	0.25	12	7	273	26.3	~ 0.030	0.055	—	0.62	< 0.02	< 0.03	0.31
10/7/2014 11:58	10/7/2014 11:59	Base Grab	60	55.4	10.76	921.0	1,195.0	7.71	> 100	0.60	~ 2	~ 1	633	68.1	< 0.020	< 0.020	0.018	0.54	~ 0.02	< 0.03	0.93
10/21/2014 10:45	10/21/2014 10:46	Base Grab	50	52.3	10.14	973.0	1,320.0	7.33	> 100	0.66	5	~ 2	750	75.9	< 0.020	< 0.020	0.137	0.82	< 0.02	< 0.03	0.85
11/6/2014 11:20	11/6/2014 11:21	Base Grab	36	49.8	11.58	929.0	1,306.0	7.79	> 100	0.66	~ 1	~ 1	711	78.0	~ 0.022	~ 0.028	0.019	0.41	< 0.02	< 0.03	0.75
11/23/2014 5:22	11/24/2014 5:05	Melt Composite	23	35.4	13.62	972.0	1,742.0	7.79	—	0.87	26	~ 12	896	29.5	~ 0.040	0.145	—	1.40	0.30	0.07	0.42
12/2/2014 11:15	12/2/2014 11:16	Base Grab																			

Table F.5 continued. Monitoring data for 6UMN outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
1/13/2014 11:00	1/13/2014 11:01	Base Grab	—	463.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/13/2014 10:55	2/13/2014 10:56	Base Grab	—	629.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3/5/2014 10:45	3/5/2014 10:46	Base Grab	351	272.2	440	16	2.1	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/10/2014 14:13	3/10/2014 14:14	Melt Grab	32	958.7	136	243	13.8	22.0	32.0	0.0097	0.0377	0.0022	0.0102	0.0008	0.0287	0.0268	0.2470	~ 0.0003	0.0007	0.0037	0.0176	17.0
3/13/2014 14:55	3/13/2014 14:56	Melt Grab	53	433.4	116	160	12.5	12.0	19.0	0.0102	0.0358	0.0017	0.0101	~ 0.0007	0.0332	0.0176	0.2080	< 0.0004	~ 0.0004	0.0021	0.0143	22.0
3/20/2014 10:40	3/20/2014 10:41	Base Grab	307	233.8	448	~ 7	2.9	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/20/2014 14:20	3/20/2014 14:21	Melt Grab	57	372.0	100	169	11.2	9.4	15.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/27/2014 14:15	3/27/2014 14:16	Rain/Melt Grab	69	237.2	96	442	—	17.0	24.0	—	—	—	—	—	—	—	—	—	—	—	—	—
4/28/2014 13:15	4/28/2014 13:16	Rain Grab	22	11.4	32	45	3.6	3.0	3.8	0.0020	0.0104	0.0007	0.0037	~ 0.0005	0.0101	0.0067	0.0651	< 0.0002	< 0.0002	0.0022	0.0076	—
4/29/2014 12:48	4/29/2014 12:49	Rain Grab	56	42.0	112	33	5.0	2.3	3.1	—	—	—	—	—	—	—	—	—	—	—	—	—
5/19/2014 12:05	5/19/2014 12:06	Rain Grab	24	18.8	52	50	10.1	8.2	10.0	0.0041	0.0116	0.0016	0.0043	~ 0.0004	0.0087	0.0158	0.0756	< 0.0002	< 0.0002	0.0033	0.0061	—
6/19/2014 10:15	6/19/2014 10:16	Rain Grab	23	6.0	36	34	4.3	2.6	3.4	0.0019	0.0086	0.0007	0.0036	~ 0.0004	0.0114	0.0038	0.0408	< 0.0002	< 0.0002	0.0019	0.0042	—
7/11/2014 11:00	7/11/2014 11:01	Rain Grab	28	11.5	64	28	4.5	2.8	3.4	0.0025	0.0065	0.0009	0.0025	~ 0.0003	0.0053	0.0050	0.0307	< 0.0002	< 0.0002	0.0017	0.0030	—
7/25/2014 5:31	7/25/2014 7:58	Rain Composite	40	25.7	76	94	17.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7/28/2014 11:15	7/28/2014 11:16	Base Grab	308	203.5	450	~ 8	1.5	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
8/18/2014 1:26	8/18/2014 5:31	Rain Composite	128	62.8	—	111	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/21/2014 6:26	8/21/2014 16:47	Rain Composite	62	34.4	112	116	7.2	—	—	0.0072	0.0343	0.0022	0.0090	~ 0.0001	0.0217	0.0087	0.1930	< 0.0002	~ 0.0004	0.0014	0.0083	—
8/28/2014 11:00	8/28/2014 11:01	Base Grab	307	183.5	252	~ 10	3.3	< 1.0	1.2	0.0010	0.0012	0.0043	0.0047	< 0.0001	< 0.0001	0.0041	0.0041	< 0.0002	< 0.0002	~ 0.0001	0.0002	—
8/29/2014 3:48	8/29/2014 5:07	Rain Composite	46	22.5	100	124	8.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/29/2014 17:06	8/30/2014 14:36	Rain Composite	48	14.8	64	42	4.3	—	—	0.0053	0.0148	0.0011	0.0035	~ 0.0001	0.0090	0.0100	0.0665	< 0.0002	~ 0.0002	0.0023	0.0045	—
8/31/2014 21:48	8/31/2014 22:07	Rain Composite	50	14.4	76	62	4.2	—	—	0.0051	0.0247	< 0.0010	0.0062	~ 0.0001	0.0221	0.0065	0.1210	< 0.0002	~ 0.0005	0.0018	0.0057	—
9/3/2014 10:22	9/3/2014 22:38	Rain Composite	68	32.9	—	56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/30/2014 10:30	9/30/2014 10:31	Base Grab	302	195.8	476	~ 6	3.0	< 1.0	< 1.0	0.0012	0.0012	0.0044	0.0046	< 0.0001	< 0.0001	0.0047	0.0046	< 0.0002	< 0.0002	0.0002	0.0002	—
10/1/2014 11:42	10/1/2014 20:00	Rain Composite	55	24.1	108	35	7.5	—	—	0.0053	0.0116	0.0020	0.0039	~ 0.0001	0.0052	0.0088	0.0497	< 0.0002	< 0.0002	0.0021	0.0036	—
10/2/2014 13:08	10/2/2014 19:57	Rain Composite	38	15.1	92	33	7.1	5.1	6.7	—	—	—	—	—	—	—	—	—	—	—	—	—
10/4/2014 0:32	10/4/2014 7:14	Rain Composite	122	65.5	192	24	6.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/7/2014 11:58	10/7/2014 11:59	Base Grab	287	137.5	424	~ 9	3.7	1.4	1.6	0.0009	0.0018	0.0044	0.0052	< 0.0001	~ 0.0004	0.0035	0.0341	< 0.0002	< 0.0002	0.0002	0.0004	—
10/21/2014 10:45	10/21/2014 10:46	Base Grab	331	176.9	448	~ 5	1.8	< 1.0	< 1.0	0.0008	0.0009	0.0046	0.0048	< 0.0001	< 0.0001	0.0063	0.0025	< 0.0002	< 0.0002	0.0002	~ 0.0001	—
11/6/2014 11:20	11/6/2014 11:21	Base Grab	336	185.9	92	< 5	3.9	1.2	1.2	0.0012	0.0012	0.0050	0.0053	< 0.0001	~ 0.0001	0.0083	0.0043	< 0.0002	< 0.0002	0.0004	0.0002	—
11/23/2014 5:22	11/24/2014 5:05	Melt Composite	123	415.0	208	63	11.6	—	13.0	0.0078	0.0126	0.0042	0.0065	~ 0.0004	0.0037	0.0186	0.0495	< 0.0002	< 0.0002	0.0029	0.0048	—
12/2/2014 11:15	12/2/2014 11:16	Base Grab	325	235.9	480	~ 8	2.7	1.1	< 1.0	0.0011												

Table F.6. Monitoring data for 7LSTU outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
3/10/2014 14:59	3/10/2014 15:00	Melt Grab	48	42.6	14.64	2,533.0	3,985.0	7.93	3.0	2.11	472	136	2,220	30.1	0.568	1.960	0.448	7.20	1.05	0.17	0.43
3/13/2014 15:55	3/13/2014 15:56	Melt Grab	50	45.5	12.27	1,166.0	1,753.0	8.13	2.0	0.89	1,220	268	1,000	25.7	0.418	2.850	0.334	13.00	0.71	0.11	0.34
4/4/2014 14:49	4/4/2014 14:50	Melt Grab	35	49.1	10.87	2,546.0	3,618.0	8.02	—	1.91	513	147	2,030	32.5	0.409	1.910	—	12.00	0.56	0.15	0.48
4/28/2014 10:43	4/28/2014 10:44	Rain Grab	38	42.6	12.94	158.2	249.1	7.64	—	0.12	401	99	170	10.7	0.159	1.120	0.148	4.60	0.25	0.08	0.24
4/29/2014 13:37	4/29/2014 13:38	Rain Grab	37	42.6	13.26	351.3	553.3	7.73	6.0	0.27	97	29	312	16.3	0.097	0.382	0.056	2.30	0.10	< 0.03	0.37
5/19/2014 11:15	5/19/2014 11:16	Rain Grab	60	55.6	9.33	264.8	342.4	7.57	8.0	0.16	146	35	197	11.3	~ 0.048	0.496	—	2.90	0.50	0.04	0.51
6/19/2014 9:35	6/19/2014 9:36	Rain Grab	65	66.6	8.70	90.0	101.2	7.89	6.0	0.05	350	60	71	3.7	0.090	0.917	0.096	2.40	0.14	< 0.03	0.11
7/11/2014 10:14	7/11/2014 10:15	Rain Grab	72	68.0	8.70	156.4	173.1	7.29	6.0	0.08	176	29	121	7.4	0.094	0.363	0.091	1.60	0.12	0.03	0.26
10/2/2014 14:42	10/2/2014 14:43	Rain Grab	60	59.5	9.90	161.8	198.5	7.56	3.0	0.09	257	65	124	9.8	0.111	0.672	0.101	2.70	0.19	0.08	0.35

Table F.6 continued. Monitoring data for 7LSTU outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO ₃)	Chloride Ion (mg/L)	Hardness CaCO ₃)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
3/10/2014 14:59	3/10/2014 15:00	Melt Grab	50	1,248.9	200	437	19.2	37.0	48.0	0.0124	0.0653	0.0024	0.0211	0.0010	0.1170	0.0116	0.4950	< 0.0002	0.0012	0.0023	0.0330	33
3/13/2014 15:55	3/13/2014 15:56	Melt Grab	91	467.5	232	606	15.9	25.0	38.0	0.0093	0.1060	0.0016	0.0387	0.0011	0.2170	0.0070	0.8850	< 0.0004	0.0026	0.0014	0.0462	35
4/4/2014 14:49	4/4/2014 14:50	Melt Grab	72	1,082.5	276	367	16.7	—	—	0.0106	0.0685	0.0021	0.0233	~ 0.0003	0.1300	0.0083	0.5870	< 0.0002	0.0015	0.0128	0.0391	—
4/28/2014 10:43	4/28/2014 10:44	Rain Grab	37	36.2	92	197	6.3	6.9	—	0.0029	0.0335	~ 0.0006	0.0116	0.0008	0.0768	0.0080	0.3550	< 0.0002	0.0010	0.0019	0.0138	—
4/29/2014 13:37	4/29/2014 13:38	Rain Grab	75	91.0	152	84	10.0	7.0	11.4	—	—	—	—	—	—	—	—	—	—	—	—	—
5/19/2014 11:15	5/19/2014 11:16	Rain Grab	55	60.0	112	124	9.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/19/2014 9:35	6/19/2014 9:36	Rain Grab	23	9.2	56	132	5.1	4.8	5.6	0.0018	0.0269	~ 0.0004	0.0101	~ 0.0005	0.0580	0.0023	0.1960	< 0.0002	0.0010	0.0012	0.0109	16
7/11/2014 10:14	7/11/2014 10:15	Rain Grab	43	24.5	88	80	6.4	5.2	6.2	0.0037	0.0162	0.0007	0.0056	~ 0.0003	0.0229	0.0033	0.0964	< 0.0002	~ 0.0004	0.0014	0.0068	—
10/2/2014 14:42	10/2/2014 14:43	Rain Grab	50	21.1	112	176	9.9	> 7.7	> 7.7	0.0040	0.0274	0.0009	0.0116	~ 0.0001	0.0344	< 0.0050	0.1850	< 0.0002	~ 0.0004	0.0025	0.0144	—

Table F.7. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Air	Water	Dissolved	Conductivity	Specific	pH	Transparency	Salinity	Total	Volatile	Total	Sulfate	Dissolved	Total	Ortho	Total	Ammonia	Nitrite N	Nitrate N
			Temp (F)	Temp (F)	Oxygen (mg/L)	(μS/cm)	Conductivity (μS/cm)		(cm)	(ppt)	Suspended Solids (mg/L)	Suspended Solids (mg/L)	Dissolved Solids (mg/L)	(mg/L)	Phosphorus (mg/L)	Phosphorus (mg/L)	Phosphate (mg/L)	Kjeldahl Nitrogen (mg/L)	Nitrogen (mg/L)	(mg/L)	
1/13/2014 9:57	1/13/2014 9:58	Base Grab	28	39.7	11.68	14,715.0	24,375.0	7.72	25	14.56	14	6	12,500	—	—	0.186	—	3.10	—	—	—
2/14/2014 12:00	2/14/2014 12:01	Base Grab	7	39.2	11.12	11,157.0	18,605.0	7.54	< 2	10.86	1,520	~ 680	10,700	—	—	4.970	—	30.00	—	—	—
2/18/2014 11:58	2/18/2014 21:23	Melt Composite	25	44.4	11.15	15,500.0	23,657.0	7.79	3	14.22	269	117	13,600	—	—	0.521	—	5.40	—	—	—
2/19/2014 10:43	2/20/2014 0:16	Melt Composite	35	45.3	11.39	7,514.0	11,311.0	7.78	4	6.42	168	~ 92	5,870	39.8	0.163	0.471	0.125	6.70	1.63	0.16	0.59
3/8/2014 12:52	3/9/2014 17:10	Melt Composite	50	36.7	12.50	4,820.0	8,437.0	7.67	5	4.62	140	~ 56	4,220	33.3	0.092	0.553	—	6.50	1.07	0.14	0.43
3/10/2014 10:03	3/11/2014 5:53	Melt Composite	30	37.9	12.93	2,467.0	4,209.0	7.65	8	2.21	81	30	2,160	19.4	0.252	0.464	0.232	5.60	1.28	0.11	0.58
3/11/2014 10:56	3/12/2014 6:07	Melt Composite	22	32.2	13.90	1,890.0	3,598.0	7.60	8	1.85	35	~ 16	1,720	18.2	0.330	0.483	0.331	3.90	1.17	0.11	0.64
3/12/2014 13:51	3/13/2014 5:34	Melt Composite	25	32.0	14.37	1,597.0	3,059.0	7.51	—	1.56	27	~ 11	1,480	17.6	0.235	0.391	0.218	2.60	1.13	0.08	0.58
3/13/2014 12:31	3/14/2014 9:39	Melt Composite	36	37.2	13.54	1,150.0	1,992.0	7.51	12	1.01	44	~ 16	964	12.8	0.319	0.432	0.301	3.30	0.85	0.06	0.53
3/14/2014 12:30	3/16/2014 19:00	Melt Composite	26	57.6	10.53	1,558.0	1,964.0	7.34	16	1.01	27	~ 11	1,010	13.3	0.305	0.425	—	3.30	0.62	0.06	0.58
3/17/2014 12:54	3/18/2014 6:12	Melt Composite	30	45.0	11.27	3,530.0	5,342.0	7.31	—	2.88	220	~ 72	2,880	28.3	0.163	0.469	0.139	5.00	0.52	0.11	0.51
3/20/2014 10:05	3/20/2014 10:06	Base Grab	30	38.1	12.81	2,287.0	3,897.0	7.59	25	2.04	9	~ 4	2,130	26.0	0.112	0.196	0.081	3.00	0.42	0.03	0.81
3/20/2014 13:04	3/21/2014 3:44	Melt Composite	35	46.8	10.83	1,231.0	1,815.0	7.46	11	0.92	52	~ 18	864	13.6	0.225	0.393	0.190	2.40	0.37	0.07	0.70
3/27/2014 10:37	3/28/2014 3:23	Rain/Melt Composite	22	44.8	12.10	488.3	741.3	7.56	6	0.36	92	~ 40	406	11.9	0.264	0.479	0.213	2.80	0.62	0.06	0.66
3/28/2014 11:14	3/30/2014 19:16	Melt Composite	46	54.7	9.52	857.0	1,123.0	7.44	24	0.56	25	~ 10	585	14.4	0.280	0.398	—	2.60	0.42	0.06	0.72
3/31/2014 10:43	4/1/2014 3:42	Melt Composite	20	44.2	11.59	775.0	1,187.0	7.23	21	0.59	22	~ 8	632	15.9	0.208	0.286	0.204	1.90	0.27	0.04	1.26
4/4/2014 13:22	4/6/2014 13:58	Melt Composite	50	49.3	10.94	938.0	1,331.0	7.53	16	0.67	66	~ 17	706	16.5	0.104	0.246	—	2.20	0.13	0.05	1.11
4/10/2014 8:45	4/10/2014 8:46	Base Grab	45	43.9	12.12	865.0	1,344.0	7.72	72	0.67	8	3	726	35.4	0.069	0.142	0.062	1.19	0.06	0.04	1.88
4/23/2014 10:15	4/23/2014 10:16	Base Grab	47	43.9	12.50	1,321.0	2,038.0	7.93	100	1.04	2	~ 2	948	58.7	0.054	0.073	0.041	1.40	0.09	0.05	1.80
4/23/2014 15:14	4/25/2014 5:20	Rain Composite	47	44.4	11.95	424.5	648.0	7.43	21	0.32	61	16	347	16.1	~ 0.046	0.205	—	2.20	0.38	0.04	0.82
4/26/2014 22:51	4/27/2014 12:14	Rain Composite	38	42.1	13.14	189.5	306.7	7.58	8	0.14	148	34	179	7.1	~ 0.042	0.309	—	1.90	0.26	< 0.03	0.40
4/28/2014 11:55	4/28/2014 18:40	Rain Composite	36	43.0	12.90	176.4	275.9	7.44	23	0.1	42	11	149	9.5	0.083	0.157	0.080	0.92	0.11	< 0.03	1.04
4/29/2014 12:41	5/1/2014 0:40	Rain Composite	40	56.1	10.89	428.7	550.0	7.59	50	0.27	7	3	329	22.9	0.066	0.143	—	0.82	~ 0.04	< 0.03	2.27
5/5/2014 12:22	5/5/2014 12:23	Base Grab	57	52.3	12.00	948.0	1,284.0	7.74	> 100	0.65	~ 1	~ 1	746	64.5	~ 0.027	0.054	0.038	0.66	~ 0.03	< 0.03	3.00
5/8/2014 16:02	5/9/2014 2:50	Rain Composite	48	55.6	9.09	304.1	393.8	7.04	12	0.19	182	44	213	18.1	0.068	0.290	0.042	2.20	0.72	0.05	1.03
5/11/2014 22:06	5/12/2014 3:17	Rain Composite	55	59.7	9.25	188.4	230.8	7.08	18	0.11	69	17	127	7.1	0.064	0.198	0.062	1.20	0.21	< 0.03	0.43
5/19/2014 10:31	5/19/2014 14:40	Rain Composite	57	54.9	9.60	133.9	175.0	7.36	16	0.08	80	19	102	5.4	0.082	0.206	—	1.40	0.22	< 0.03	0.34
5/30/2014 10:23	5/30/2014 10:24	Base Grab	79	59.2	10.73	1,165.0	1,436.0	7.71	> 100	0.73	< 1	~ 1	849	65.6	0.082	0.109	0.074	0.95	~ 0.05	0.06	2.76
5/31/2014 16:40	6/1/2014 23:00	Rain Composite	68	71.2	6.87	295.9	315.1	7.41	30	0.15	61	20	171	9.5	0.078	0.191	0.059	1.40	0.15	0.04	0.37
6/7/2014 6:31	6/7/2014 21:47	Rain Composite	65	66.0	6.74	333.2	377.1	7.62	36	0.18	54	19	215	12.3	0.109	0.270	—	1.50	0.10	0.06	0.51
6/13/2014 9:00	6/13/2014 9:01	Base Grab	63	61.0	10.28	787.0	949.0	7.33	> 100	0.47	~ 2	~ 2	540	37.6</							

Table F.7 continued. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Air Temp	Water Temp	Dissolved Oxygen	Conductivity ($\mu\text{S}/\text{cm}$)	Specific Conductivity ($\mu\text{S}/\text{cm}$)	pH	Transparency (cm)	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
			(F)	(F)	(mg/L)																
7/7/2014 14:55	7/8/2014 8:28	Rain Composite	67	73.6	7.07	179.2	185.9	7.57	26	0.09	78	21	112	5.9	0.064	0.250	0.048	1.60	0.13	0.04	0.28
7/11/2014 8:38	7/12/2014 21:21	Rain Composite	61	70.7	7.40	163.7	175.3	7.20	37	0.08	28	8	88	4.8	0.089	0.183	—	0.99	0.13	0.04	0.26
7/14/2014 17:47	7/15/2014 9:27	Rain Composite	66	65.5	8.40	306.5	348.8	7.10	—	0.17	148	47	198	12.4	0.064	0.196	0.052	0.98	< 0.02	< 0.03	0.37
7/17/2014 9:35	7/17/2014 9:36	Base Grab	68	66.2	9.01	649.0	733.0	7.55	> 100	0.38	~ 2	~ 2	415	26.6	0.101	0.161	0.096	0.65	< 0.02	0.04	1.12
7/25/2014 5:41	7/25/2014 12:23	Rain Composite	74	73.8	6.78	322.2	333.9	7.45	29	0.16	31	13	228	11.9	0.073	0.257	0.076	1.50	0.09	0.03	0.57
7/25/2014 16:15	7/26/2014 19:30	Rain Composite	75	44.1	9.20	348.1	535.1	7.17	—	0.26	8	7	321	15.7	0.118	0.216	—	1.40	0.30	0.04	0.41
7/28/2014 13:15	7/28/2014 13:16	Base Grab	75	67.5	8.82	709.0	788.0	7.89	98	0.39	3	3	458	28.7	0.154	0.229	0.140	0.92	~ 0.02	< 0.03	1.18
8/1/2014 18:12	8/2/2014 11:57	Rain Composite	76	81.0	3.17	358.8	344.1	7.66	—	0.16	1,370	232	—	15.3	0.098	0.734	—	3.60	0.35	0.16	< 0.05
8/10/2014 19:27	8/11/2014 7:53	Rain Composite	64	70.9	6.41	212.7	227.6	7.31	—	0.11	70	24	140	7.9	~ 0.027	0.223	0.017	1.70	~ 0.05	0.12	0.29
8/17/2014 14:32	8/18/2014 10:06	Rain Composite	79	75.2	6.23	361.4	368.2	7.39	—	0.18	143	49	225	10.7	0.096	0.301	0.057	2.00	~ 0.05	0.08	0.24
8/19/2014 17:12	8/19/2014 17:13	Rain Composite	80	79.0	7.04	912.0	893.0	7.46	—	0.44	225	54	165	—	—	0.277	—	1.80	< 0.02	0.16	0.44
8/21/2014 7:17	8/21/2014 13:02	Rain Composite	71	75.4	6.16	173.4	176.6	7.02	—	0.08	43	14	99	5.0	0.062	0.181	—	1.10	~ 0.05	< 0.03	0.24
8/24/2014 5:52	8/25/2014 1:08	Rain Composite	77	76.3	6.12	422.0	425.4	7.64	—	0.20	106	35	—	16.5	0.114	0.297	—	1.10	~ 0.03	0.03	0.46
8/28/2014 11:20	8/28/2014 11:21	Base Grab	76	65.7	8.31	589.0	670.0	7.64	> 100	0.33	~ 1	~ 1	391	25.8	0.238	0.228	0.216	0.22	< 0.02	< 0.03	0.23
8/29/2014 3:36	8/30/2014 9:31	Rain Composite	72	72.5	6.92	142.2	149.3	7.11	32	0.07	62	18	90	4.3	~ 0.047	0.167	—	1.10	0.18	0.06	0.31
8/31/2014 21:49	9/2/2014 1:54	Rain Composite	72	72.1	7.87	167.0	176.0	7.19	43	0.08	41	9	84	4.5	~ 0.046	0.136	—	0.78	0.07	< 0.03	0.21
9/3/2014 10:16	9/4/2014 6:08	Rain Composite	77	71.4	7.45	251.4	267.1	7.36	—	0.13	14	6	143	7.3	~ 0.047	0.123	0.050	0.80	< 0.02	< 0.03	0.28
9/9/2014 22:48	9/10/2014 10:11	Rain Composite	55	58.8	8.47	143.2	177.4	7.81	—	0.08	18	6	102	5.7	0.082	0.142	—	0.86	0.06	< 0.03	0.26
9/11/2014 9:08	9/11/2014 9:09	Base Grab	55	55.9	9.81	327.7	421.8	7.86	60	0.20	9	7	232	15.3	0.121	0.207	0.082	0.91	< 0.02	< 0.03	0.19
9/20/2014 18:30	9/21/2014 3:35	Rain Composite	63	57.0	7.25	203.1	257.4	7.21	—	0.12	37	16	151	8.9	0.054	0.217	—	1.30	< 0.02	< 0.03	0.30
9/24/2014 14:47	9/24/2014 15:25	Rain Composite	63	64.4	7.16	153.9	117.6	7.10	—	0.08	606	136	—	7.1	0.060	0.556	0.042	2.30	< 0.02	< 0.03	0.32
9/30/2014 9:55	9/30/2014 9:56	Base Grab	45	58.8	9.47	414.5	513.4	7.77	62	0.25	7	6	292	18.0	0.156	0.268	0.149	0.84	< 0.02	< 0.03	0.07
10/1/2014 8:02	10/2/2014 6:10	Rain Composite	58	58.6	8.32	160.6	199.3	7.09	—	0.09	30	17	104	6.3	0.063	0.200	0.055	1.10	< 0.02	< 0.03	0.09
10/2/2014 12:55	10/3/2014 2:32	Rain Composite	45	54.9	9.35	116.2	151.9	7.15	32	0.07	19	~ 9	89	4.2	0.051	0.156	0.048	0.88	< 0.02	< 0.03	0.05
10/3/2014 23:53	10/4/2014 8:53	Rain Composite	34	44.4	10.35	172.4	263.6	7.44	—	0.13	10	7	144	8.0	0.068	0.168	—	0.82	< 0.02	< 0.03	0.15
10/7/2014 11:10	10/7/2014 11:11	Base Grab	55	57.6	9.81	478.4	602.9	7.84	> 100	0.29	~ 1	~ 1	340	22.3	0.201	0.227	0.199	0.26	< 0.02	< 0.03	0.27
10/21/2014 10:15	10/21/2014 10:16	Base Grab	47	55.0	9.92	502.0	654.0	7.35	> 100	0.32	~ 1	~ 1	386	25.5	0.231	0.210	0.452	0.17	< 0.02	< 0.03	0.12
11/6/2014 10:32	11/6/2014 10:33	Base Grab	36	53.2	8.93	408.0	545.3	7.55	30	0.27	7	5	322	29.5	0.279	0.669	0.540	1.40	~ 0.02	0.03	0.16
11/22/2014 13:39	11/24/2014 0:43	Melt Composite	23	52.2	8.84	4,120.0	5,591.0	7.38	—	3.02	62	33	2,920	17.8	0.054	0.240	—	2.10	0.45	0.12	0.44
11/29/2014 13:56	11/29/2014 13:57	Melt Grab	19	30.7	11.83	10,667.0	20,928.0	7.11	—	12.03	—	—	—	23.2	~ 0.042	0.293	—	3.20	0.60	0.21	0.51
12/2/2014 10:15	12/2/2014 10:16	Base Grab	19	46.0	10.84	3,968.0	5,911.0	7.32	> 100	3.21	12	7	3,090	37.8	0.05						

Table F.7 continued. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO ₃)	Chloride Ion (mg/L)	Hardness (mg/L CaCO ₃)	Chemical Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Soluble Oil and Grease (mg/L)
1/13/2014 9:57	1/13/2014 9:58	Base Grab	—	7,554.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/14/2014 12:00	2/14/2014 12:01	Base Grab	—	6,242.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/18/2014 11:58	2/18/2014 21:23	Melt Composite	—	8,379.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/19/2014 10:43	2/20/2014 0:16	Melt Composite	70	3,490.9	188	267	19.6	28.0	34.0	0.0131	0.0412	0.0030	0.0103	~ 0.0002	0.0128	0.0345	0.2290	< 0.0002	~ 0.0003	0.0101	0.0267	—
3/8/2014 12:52	3/9/2014 17:10	Melt Composite	41	2,623.4	160	225	14.7	—	—	0.0130	0.0409	0.0026	0.0104	< 0.0001	0.0116	0.0215	0.2190	< 0.0002	~ 0.0003	0.0066	0.0244	—
3/10/2014 10:03	3/11/2014 5:53	Melt Composite	35	1,253.5	100	129	14.2	12.0	17.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/11/2014 10:56	3/12/2014 6:07	Melt Composite	44	918.4	136	82	13.9	12.0	15.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/12/2014 13:51	3/13/2014 5:34	Melt Composite	53	836.4	140	66	12.2	8.4	11.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/13/2014 12:31	3/14/2014 9:39	Melt Composite	47	542.5	100	74	13.2	8.8	11.0	0.0090	0.0143	0.0018	0.0036	~ 0.0004	0.0037	0.0124	0.0591	< 0.0004	< 0.0004	0.0017	0.0049	< 8
3/14/2014 12:30	3/16/2014 19:00	Melt Composite	58	530.4	116	64	11.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3/17/2014 12:54	3/18/2014 6:12	Melt Composite	78	1,594.4	188	243	17.9	17.0	23.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/20/2014 10:05	3/20/2014 10:06	Base Grab	104	1,130.0	232	48	10.1	3.6	5.1	—	—	—	—	—	—	—	—	—	—	—	—	—
3/20/2014 13:04	3/21/2014 3:44	Melt Composite	53	439.0	116	81	10.1	6.2	9.3	—	—	—	—	—	—	—	—	—	—	—	—	—
3/27/2014 10:37	3/28/2014 3:23	Rain/Melt Composite	52	182.8	76	106	16.1	8.3	12.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/28/2014 11:14	3/30/2014 19:16	Melt Composite	62	280.5	128	46	11.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3/31/2014 10:43	4/1/2014 3:42	Melt Composite	67	299.2	148	39	10.9	3.6	4.9	0.0063	0.0075	0.0015	0.0023	~ 0.0003	0.0022	0.0135	0.0273	< 0.0002	< 0.0002	0.0017	0.0029	—
4/4/2014 13:22	4/6/2014 13:58	Melt Composite	74	352.2	136	53	9.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4/10/2014 8:45	4/10/2014 8:46	Base Grab	146	312.8	240	18	6.8	2.0	2.5	0.0026	0.0032	0.0014	0.0018	< 0.0001	0.0005	0.0072	0.0105	< 0.0002	< 0.0002	0.0007	0.0012	—
4/23/2014 10:15	4/23/2014 10:16	Base Grab	241	460.2	432	30	7.1	1.1	1.2	0.0045	0.0046	0.0021	0.0023	~ 0.0001	~ 0.0002	0.0145	0.0165	< 0.0002	< 0.0002	0.0007	0.0008	—
4/23/2014 15:14	4/25/2014 5:20	Rain Composite	64	134.5	108	61	8.2	—	—	0.0048	0.0115	0.0015	0.0037	~ 0.0002	0.0041	0.0117	0.0536	< 0.0002	< 0.0002	0.0021	0.0066	—
4/26/2014 22:51	4/27/2014 12:14	Rain Composite	27	64.3	72	102	6.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4/28/2014 11:55	4/28/2014 18:40	Rain Composite	51	29.4	42	35	6.5	2.2	3.2	—	—	—	—	—	—	—	—	—	—	—	—	—
4/29/2014 12:41	5/1/2014 0:40	Rain Composite	69	77.1	120	28	6.1	—	—	0.0039	0.0050	0.0012	0.0017	~ 0.0002	0.0009	0.0154	0.0177	< 0.0002	< 0.0002	0.0012	0.0018	—
5/5/2014 12:22	5/5/2014 12:23	Base Grab	339	162.2	480	20	4.5	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
5/8/2014 16:02	5/9/2014 2:50	Rain Composite	75	58.7	128	83	7.6	5.4	7.0	0.0044	0.0162	0.0012	0.0062	~ 0.0001	0.0083	0.0070	0.0785	< 0.0002	< 0.0002	0.0026	0.0093	—
5/11/2014 22:06	5/12/2014 3:17	Rain Composite	38	32.0	64	44	6.9	5.3	7.5	—	—	—	—	—	—	—	—	—	—	—	—	—
5/19/2014 10:31	5/19/2014 14:40	Rain Composite	33	24.2	64	53	5.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5/30/2014 10:23	5/30/2014 10:24	Base Grab	330	233.5	454	26	7.8	1.3	1.4	—	—	—	—	—	—	—	—	—	—	—	—	—
5/31/2014 16:40	6/1/2014 23:00	Rain Composite	60	45.6	88	52	8.1	—	—	0.0059	0.0098	0.0012	0.0023	~ 0.0002	0.0026	0.0057	0.0263	< 0.0002	< 0.0002	0.0008	0.0025	—
6/7/2014 6:31	6/7/2014 21:47	Rain Composite	78	54.8	112	47	12.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/13/2014 9:00	6/13/2014 9:01	Base Grab	224	128.7	308	26	7.8	1.8	2.2	0.0125	0.0156	0.0014	0.0018	< 0.0001	~ 0.0001	0.0069	0.0042	< 0.0002	< 0.0002	0.0004	0.0004	—
6/14/2014 10:45	6/15/2014 5:38	Rain Composite	36	24.2	64	35	5.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/16/2014 17:32	6/16/2014 20:40	Rain Composite	63	33.2	82	46	9.9	—	—	—												

Table F.7 continued. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO ₃)	Chloride Ion (mg/L)	Hardness (mg/L CaCO ₃)	Chemical Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
7/7/2014 14:55	7/8/2014 8:28	Rain Composite	43	19.2	60	57	8.1	5.4	9.8	—	—	—	—	—	—	—	—	—	—	—	—	< 8
7/11/2014 8:38	7/12/2014 21:21	Rain Composite	48	16.5	80	33	5.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7/14/2014 17:47	7/15/2014 9:27	Rain Composite	95	39.0	132	47	7.6	5.2	7.6	0.0035	0.0085	0.0011	0.0032	< 0.0001	0.0033	0.0037	0.0345	< 0.0002	< 0.0002	0.0013	0.0035	—
7/17/2014 9:35	7/17/2014 9:36	Base Grab	197	90.0	232	22	6.2	2.1	3.0	0.0024	0.0028	0.0010	0.0012	< 0.0001	< 0.0001	0.0051	0.0026	< 0.0002	< 0.0002	0.0003	0.0003	—
7/25/2014 5:41	7/25/2014 12:23	Rain Composite	91	51.6	528	48	12.3	> 7.8	> 7.8	—	—	—	—	—	—	—	—	—	—	—	—	—
7/25/2014 16:15	7/26/2014 19:30	Rain Composite	132	67.9	176	31	5.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7/28/2014 13:15	7/28/2014 13:16	Base Grab	221	98.3	280	25	4.1	2.2	3.0	—	—	—	—	—	—	—	—	—	—	—	—	—
8/1/2014 18:12	8/2/2014 11:57	Rain Composite	81	40.2	128	224	24.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/10/2014 19:27	8/11/2014 7:53	Rain Composite	55	22.7	88	97	19.3	12.0	15.0	0.0115	0.0229	0.0017	0.0044	~ 0.0002	0.0042	0.0095	0.0667	< 0.0002	< 0.0002	0.0015	0.0040	—
8/17/2014 14:32	8/18/2014 10:06	Rain Composite	98	43.4	136	81	14.3	7.2	12.0	0.0111	—	0.0015	—	~ 0.0002	—	< 0.0050	—	< 0.0002	—	0.0011	—	—
8/19/2014 17:12	8/19/2014 17:13	Rain Composite	64	19.7	84	149	—	—	—	—	0.0426	—	0.0104	—	0.0118	—	0.1650	—	0.0009	—	0.0144	—
8/21/2014 7:17	8/21/2014 13:02	Rain Composite	46	16.0	72	37	9.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/24/2014 5:52	8/25/2014 1:08	Rain Composite	129	38.8	146	61	9.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8/28/2014 11:20	8/28/2014 11:21	Base Grab	272	42.8	312	13	3.2	< 1.0	< 2.0	0.0076	0.0083	< 0.0010	0.0007	< 0.0001	< 0.0001	0.0057	0.0029	< 0.0002	~ 0.0002	0.0002	0.0002	—
8/29/2014 3:36	8/30/2014 9:31	Rain Composite	50	11.0	64	42	5.1	—	—	0.0056	0.0145	< 0.0010	0.0029	< 0.0001	0.0039	0.0058	0.0458	< 0.0002	< 0.0002	0.0016	0.0038	—
8/31/2014 21:49	9/2/2014 1:54	Rain Composite	50	16.3	68	33	4.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/3/2014 10:16	9/4/2014 6:08	Rain Composite	80	23.6	116	27	7.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/9/2014 22:48	9/10/2014 10:11	Rain Composite	47	13.7	< 5	27	6.4	—	—	0.0110	0.0156	0.0009	0.0017	< 0.0001	0.0012	0.0042	0.0138	< 0.0002	< 0.0002	0.0009	0.0014	—
9/11/2014 9:08	9/11/2014 9:09	Base Grab	146	27.5	220	29	5.3	5.3	5.1	0.0070	0.0099	~ 0.0006	0.0009	< 0.0001	~ 0.0002	~ 0.0015	0.0040	< 0.0002	< 0.0002	0.0004	0.0003	—
9/20/2014 18:30	9/21/2014 3:35	Rain Composite	77	20.8	104	54	8.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/24/2014 14:47	9/24/2014 15:25	Rain Composite	46	16.3	80	151	13.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/30/2014 9:55	9/30/2014 9:56	Base Grab	206	28.4	248	19	4.9	4.1	5.2	—	—	—	—	—	—	—	—	—	—	—	—	—
10/1/2014 8:02	10/2/2014 6:10	Rain Composite	62	13.8	84	44	14.6	11.0	13.0	0.0085	0.0141	0.0008	0.0018	< 0.0001	0.0015	0.0055	0.0280	< 0.0002	< 0.0002	0.00180	0.00250	11
10/2/2014 12:55	10/3/2014 2:32	Rain Composite	39	10.9	108	33	8.0	6.2	6.9	—	—	—	—	—	—	—	—	—	—	—	—	—
10/3/2014 23:53	10/4/2014 8:53	Rain Composite	75	24.2	100	28	7.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/7/2014 11:10	10/7/2014 11:11	Base Grab	222	37.3	292	~ 8	3.7	1.0	1.1	0.0022	0.0048	~ 0.0005	0.0009	< 0.0001	< 0.0001	0.0025	0.0050	< 0.0002	< 0.0002	0.00021	0.00020	—
10/21/2014 10:15	10/21/2014 10:16	Base Grab	281	31.9	324	< 5	1.9	< 1.0	< 1.0	0.0012	0.0013	~ 0.0005	0.0006	< 0.0001	< 0.0001	0.0029	< 0.0050	< 0.0002	< 0.0002	~ 0.00014	~ 0.00011	—
11/6/2014 10:32	11/6/2014 10:33	Base Grab	109	74.1	148	105	38.3	28.0	32.0	0.0127	0.0136	0.0037	0.0043	0.0006	0.0010	0.0318	0.0380	< 0.0002	< 0.0002	0.00150	0.00120	—
11/22/2014 13:39	11/24/2014 0:43	Melt Composite	48	1,539.8	144	122	14.7	—	17.0	0.0125	0.0227	0.0017	0.0046	~ 0.0003	0.0052	0.0303	0.1000	< 0.0002	~ 0.0003	0.00230	0.00630	—
11/29/2014 13:56	11/29/2014 13:57	Melt Grab	152	6,609.4	280	300	16.5	—	~ 0.0187	0.0521	< 0.0120	~ 0.0140	< 0.0040	~ 0.0140	< 0.0320	0.3080	< 0.0080	< 0.0080	0.00880	0.02230	—	
12/2/2014 10:15	12/2/2014 10:16	Base Grab	230	1,673.9	404	49	9.2	2.0	2.2	0.0052	0.0073	0.0021	0.0028	< 0.0001	0.0009	0.0053	0.0155	< 0.0002	< 0.0			

Appendix G – Kasota Ponds Monitoring Data

Table G.1. Monitoring data for Kasota Pond North

Date	Sample	Air Temp	Water Temp	Dissolved Oxygen	Conductivity ($\mu\text{S}/\text{cm}$)	Specific Conductivity ($\mu\text{S}/\text{cm}$)	pH	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Chloride Ion (mg/L)	Hardness (mg/L CaCO ₃)	Soluble Copper (mg/L)	Total Nickel (mg/L)	Soluble Nickel (mg/L)	Total Lead (mg/L)	Soluble Lead (mg/L)	Total Zinc (mg/L)	Soluble Zinc (mg/L)	Total Cadmium (mg/L)	Soluble Cadmium (mg/L)	Total Chromium (mg/L)	Soluble Chromium (mg/L)		
		(F)	(F)	(mg/L)																												
1/24/2014		9:20	22	34.0	1.08	1,743.0	3,208.0	6.80	1.65	38	< 10	1,660	0.361	~ 0.007	3.10	1.17	< 0.03	< 0.05	786.6	820	~ 0.0003	~ 0.0003	0.0015	0.0016	< 0.0001	0.0005	0.0091	0.0162	< 0.0002	< 0.0002	0.00042	0.00032
4/23/2014		10:05	43	51.3	7.53	1,320.0	1,817.0	7.12	0.93	17	9	1,035	0.087	< 0.005	1.55	< 0.02	< 0.03	< 0.05	450.5	386	0.0007	0.0020	0.0008	0.0013	< 0.0001	0.0019	< 0.0050	0.0124	< 0.0002	< 0.0002	0.00017	0.00046
5/14/2014		9:30	49	54.1	7.64	1,012.0	1,336.0	7.07	0.67	11	5	729	~ 0.044	< 0.005	1.50	< 0.02	< 0.03	< 0.05	248.0	280	0.0013	0.0022	0.0013	0.0015	~ 0.0001	0.0015	0.0055	0.0083	< 0.0002	< 0.0002	0.00032	0.00053
6/10/2014		9:20	67	64.6	2.34	1,065.0	1,226.0	7.04	0.61	13	12	650	0.092	0.019	1.10	< 0.02	< 0.03	< 0.05	265.9	252	< 0.0010	< 0.0010	0.0011	< 0.0001	0.0010	< 0.0008	~ 0.0013	< 0.0002	< 0.0002	0.00021	0.00024	
7/8/2014		9:15	69	72.0	1.51	1,090.0	1,153.0	6.99	0.57	16	12	620	0.100	< 0.005	1.30	< 0.02	< 0.03	< 0.05	216.0	276	< 0.0003	~ 0.0004	0.0008	0.0011	< 0.0001	~ 0.0002	0.0025	0.0058	< 0.0002	< 0.0002	0.00022	0.00021
8/5/2014		9:20	68	73.4	0.40	1,489.0	1,547.0	7.33	0.78	85	46	714	0.171	< 0.007	2.10	< 0.02	< 0.03	< 0.05	272.9	280	< 0.0003	0.0023	0.0006	0.0017	< 0.0001	0.0034	0.0026	0.0150	< 0.0002	< 0.0002	~ 0.00013	0.00088
9/9/2014		11:06	67	65.7	2.28	1,354.0	1,541.0	6.73	0.78	10	6	836	0.119	< 0.007	1.20	< 0.02	< 0.03	< 0.05	344.0	340	< 0.0003	< 0.0003	< 0.0010	< 0.0010	< 0.0001	~ 0.0004	0.0466	0.0054	< 0.0002	< 0.0002	~ 0.00010	0.00020
10/7/2014		10:16	52	50.9	4.66	1,170.0	1,619.0	7.09	0.82	6	3	838	~ 0.021	0.92	< 0.02	< 0.03	< 0.05	341.8	348	< 0.0003	~ 0.0006	0.0017	0.0009	< 0.0001	~ 0.0002	0.0101	0.0026	< 0.0002	< 0.0002	0.00023	0.00021	
11/5/2014		9:40	43	42.8	7.74	1,169.0	1,838.0	7.42	0.93	3	3	868	~ 0.023	0.74	< 0.02	< 0.03	< 0.05	418.1	404	< 0.0003	< 0.0003	0.0007	0.0009	< 0.0001	~ 0.0002	0.0050	~ 0.0011	< 0.0002	< 0.0002	0.00023	~ 0.00009	
12/10/2014		9:20	23	32.5	8.77	1,266.0	2,394.0	7.09	1.21	5	4	1,250	~ 0.023	< 0.005	0.96	< 0.02	< 0.03	< 0.05	547.8	444	0.0008	0.0013	0.0012	0.0017	< 0.0001	~ 0.0004	0.0069	0.0099	< 0.0002	< 0.0002	0.00021	0.00030

Table G.2. Monitoring data for Kasota Pond West

Date	Sample	Air Temp	Water Temp	Dissolved Oxygen	Conductivity ($\mu\text{S}/\text{cm}$)	Specific Conductivity ($\mu\text{S}/\text{cm}$)	pH	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Chloride Ion (mg/L)	Hardness (mg/L CaCO ₃)	Soluble Copper (mg/L)	Total Nickel (mg/L)	Soluble Nickel (mg/L)	Total Lead (mg/L)	Soluble Lead (mg/L)	Total Zinc (mg/L)	Soluble Zinc (mg/L)	Total Cadmium (mg/L)	Soluble Cadmium (mg/L)	Total Chromium (mg/L)	Soluble Chromium (mg/L)		
		(F)	(F)	(mg/L)																												
1/24/2014		10:00	24	33.1	0.77	1,018.0	1,903.0	7.40	0.95	12	9	945	0.153	< 0.005	2.70	0.35	< 0.03	< 0.05	446.5	308	< 0.0003	0.0006	0.0010	0.0015	< 0.0001	~ 0.0001	0.0096	0.0059	< 0.0002	< 0.0002	0.00024	0.00026
3/4/2014		13:12	20	34.3	0.86	1,089.0	1,991.0	7.32	1.00	16	8	1,090	0.192	< 0.005	3.50	0.81	< 0.03	< 0.05	508.8	372	< 0.0003	~ 0.0006	0.0011	0.0012	< 0.0001	< 0.0001	< 0.0050	< 0.0002	< 0.0002	0.00016	~ 0.00013	
4/23/2014		10:42	46	52.0	11.32	1,366.0	1,860.0	7.64	0.95	5	3	1,070	~ 0.042	< 0.005	1.50	< 0.02	< 0.03	< 0.05	490.7	312	0.0009	0.0011	0.0010	0.0013	< 0.0001	0.0006	< 0.0050	0.0116	< 0.0002	< 0.0002	0.00018	0.00020
5/14/2014		9:55	51	54.5	12.18	1,204.0	1,579.0	7.47	0.80	8	5	861	0.051	< 0.005	1.10	< 0.02	< 0.03	< 0.05	395.8	316	< 0.0010	< 0.0010	0.0011	0.0012	< 0.0001	~ 0.0004	0.0182	0.0029	< 0.0002	< 0.0002	0.00024	0.00021
6/10/2014		9:40	68	67.1	10.15	1,348.0	1,507.0	7.30	0.76	11	9	822	0.092	< 0.007	1.20	< 0.02	< 0.03	< 0.05	365.8	248	< 0.0010	< 0.0010	0.0013	< 0.0001	~ 0.0003	~ 0.0010</td						