Memorandum

Date:	December 15, 2023
To:	Brant Fleming – Illinois Environmental Protection Agency
Copied to:	Corey Branson – Illinois Environmental Protection Agency, Michael Rousey and Anne George – City of Woodstock, Pat Kelsey and Leonard Dane – Fehr Graham Engineering & Environmental
From:	Karoline Qasem and Mark Halm – Fehr Graham Engineering & Environmental
Subject:	Nutrient Assessment Reduction Plan (NARP) for Woodstock North Wastewater Treatment Plant

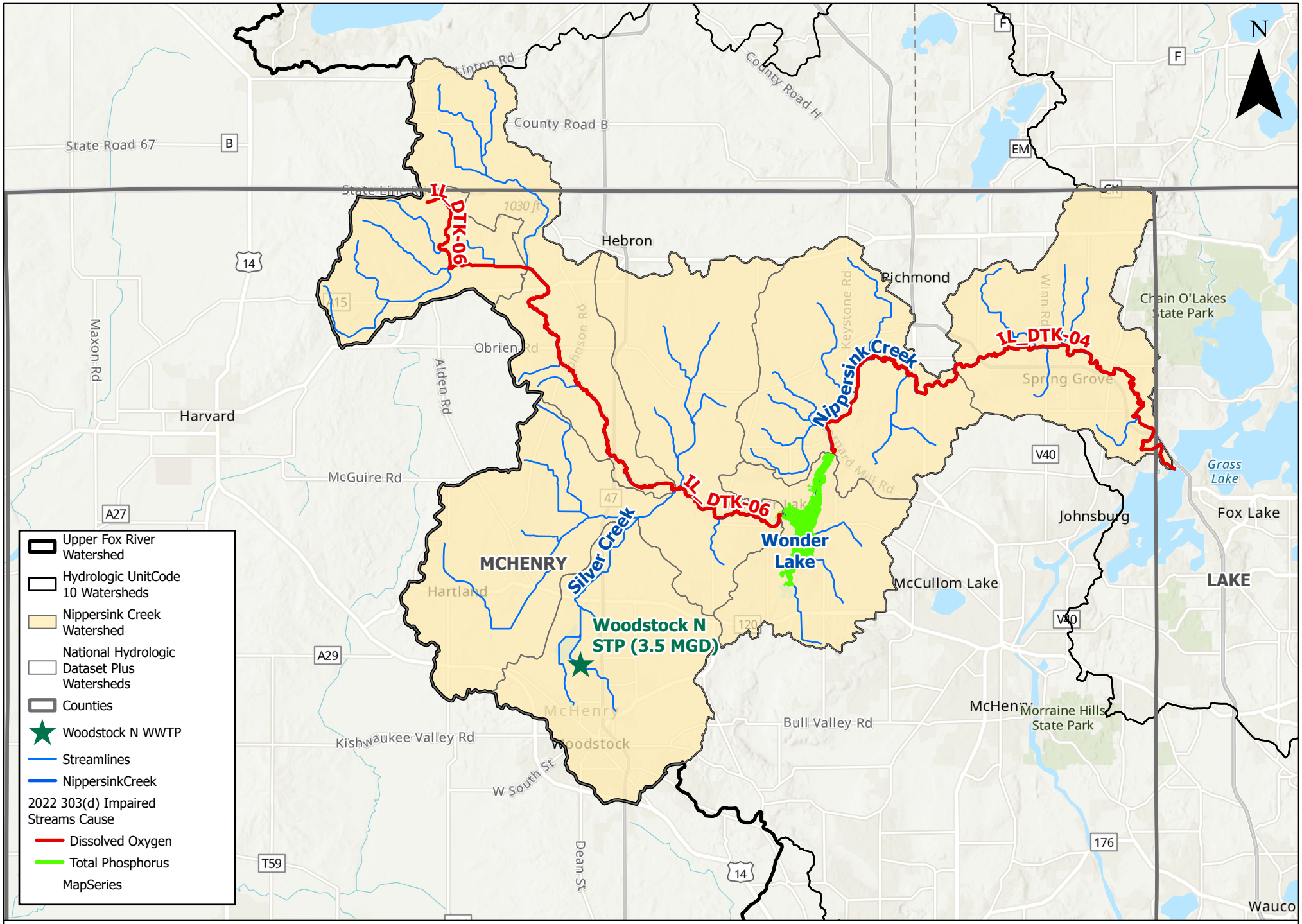
---

This memorandum outlines the Nutrient Assessment Reduction Plan (NARP) mandated by Special Condition #20 for the City of Woodstock North Wastewater Treatment Plant National Pollutant Discharge Elimination System (NPDES) permit IL0031861. The plan was discussed during the conversation I had with you via Microsoft Teams on November 30, 2023 (*Attachment 1: 2023 Data Monitoring Results PowerPoint Presentation*). The following sections provide an overview of the NARP approach and highlight key findings.

INTRODUCTION

The Woodstock North Wastewater Treatment Plant (WWTP), owned and operated by the City of Woodstock (City), treats a design average flow of 3.5 million gallons per day (MGD). Its main outfall (001) discharges into Silver Creek tributary segment IL_DTK-06 with a 7Q10[1] flow of 0.16 cubic feet per second (cfs). This segment has not been assessed and is not listed in the 2020/2022 Illinois Integrated Water Quality Report and Section 303(d) List. Silver Creek joins Nippersink Creek segment IL_DTK-06, which is listed in the draft 2020/2022 303(d) List as impaired for aquatic life due to dissolved oxygen (DO) (**Figure 1**) (Illinois EPA, 2022). Consequently, The WWTP's NPDES permit Special Condition #20 requires developing a NARP study to identify phosphorus input reductions from point and nonpoint sources and other measures to eliminate the phosphorus-related impairments. These impairments include low DO and nuisance algae.

[1] The lowest seven-day average flow that occurs once every ten years.



FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

Figure 1: Nippersink Creek Watershed
2022 303(d) Impaired Streams

According to Special Condition #20 in the NPDES permit, NARP outcomes may conclude that phosphorus reductions are unnecessary if data assessment reveals no phosphorus-related impairment. Alternatively, outcomes may recommend phosphorus reductions from point sources, nonpoint sources, or both. The NARP might also identify other measures to eliminate the phosphorus-related impairment in the watershed (**Figure 2**). If phosphorus reductions are deemed necessary, the NARP must incorporate a schedule and implementation for these reductions.

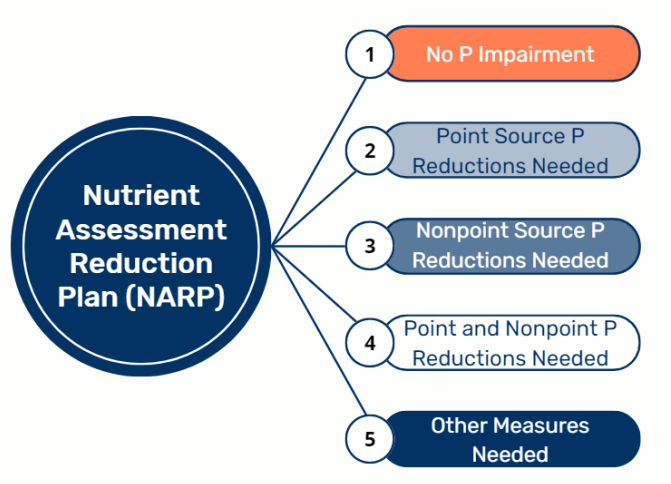


Figure 2: Nutrient Reduction Assessment Plan Potential Outcomes

WOODSTOCK NORTH NARP

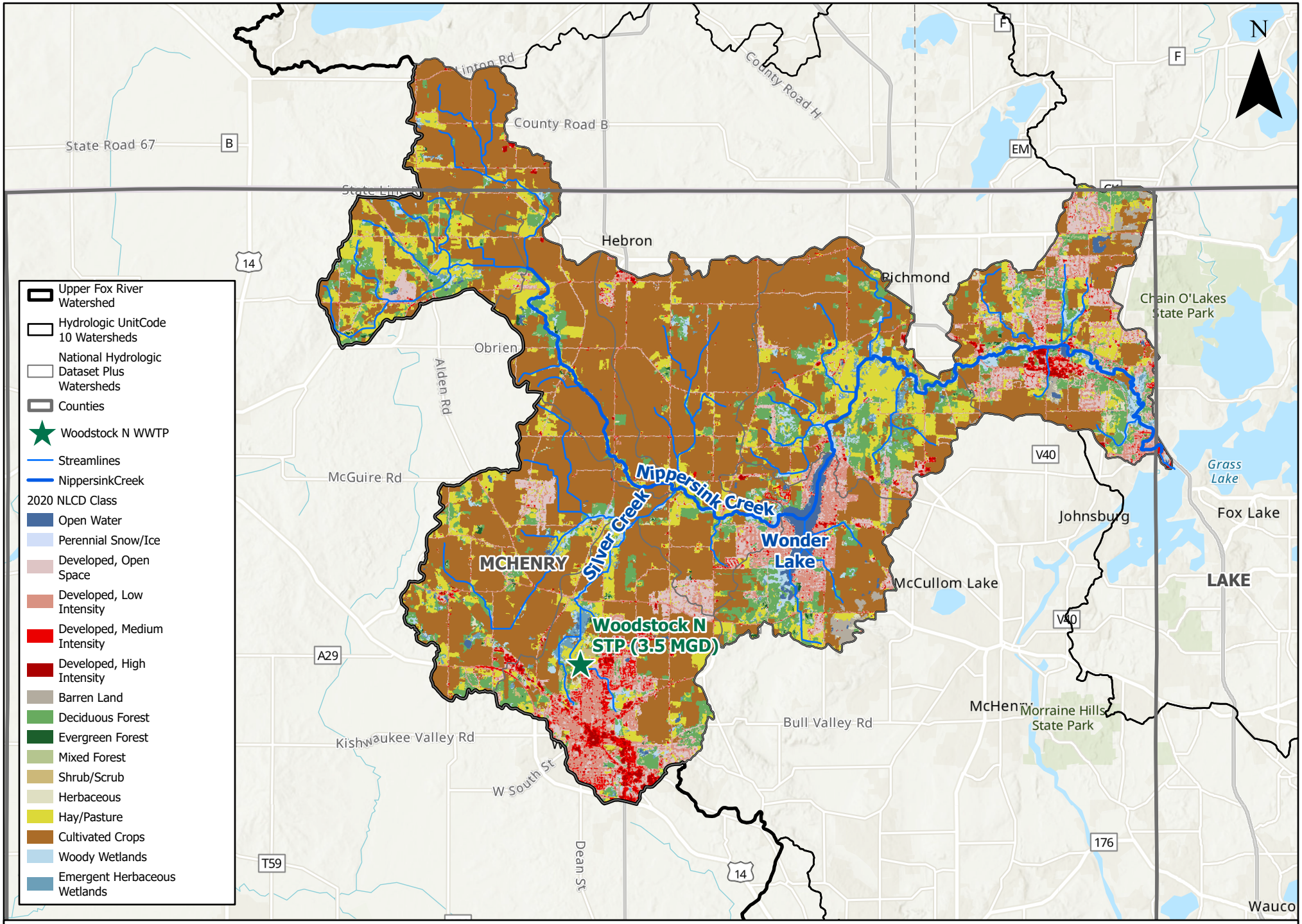
The NARP development involved a systematic approach to identifying phosphorus sources and validating phosphorus-related impairments. The process involved various steps: land cover review, water quality data monitoring and analysis, and an examination of the SPAtially Referenced Regression on Watershed Attributes (SPARROW) model by Schwarz et al. (2006). The following sections summarize the methods and results of each step.

Nippersink Creek Watershed 2020 Land cover

Nippersink Creek Watershed, Hydrologic Code Unit 10 #0712000609, spans an area of 186 square miles. Based on the 2020 National Land Cover Dataset (NLCD), the primary land cover in the watershed is cultivated crops, covering 53.3% of the area, followed by pasture and hay with 12.7% of the total area. Developed areas comprise about 14.9% of the watershed area, and other land cover categories cover the remainder (**Figure 3**).

Table 1: Nippersink Creek 2020 National Land Cover Categories Areas

Land Cover Category	Area (%)
Cultivated Crops	53.3
Pasture/Hay	12.7
Developed	14.9
Other	19.1



FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

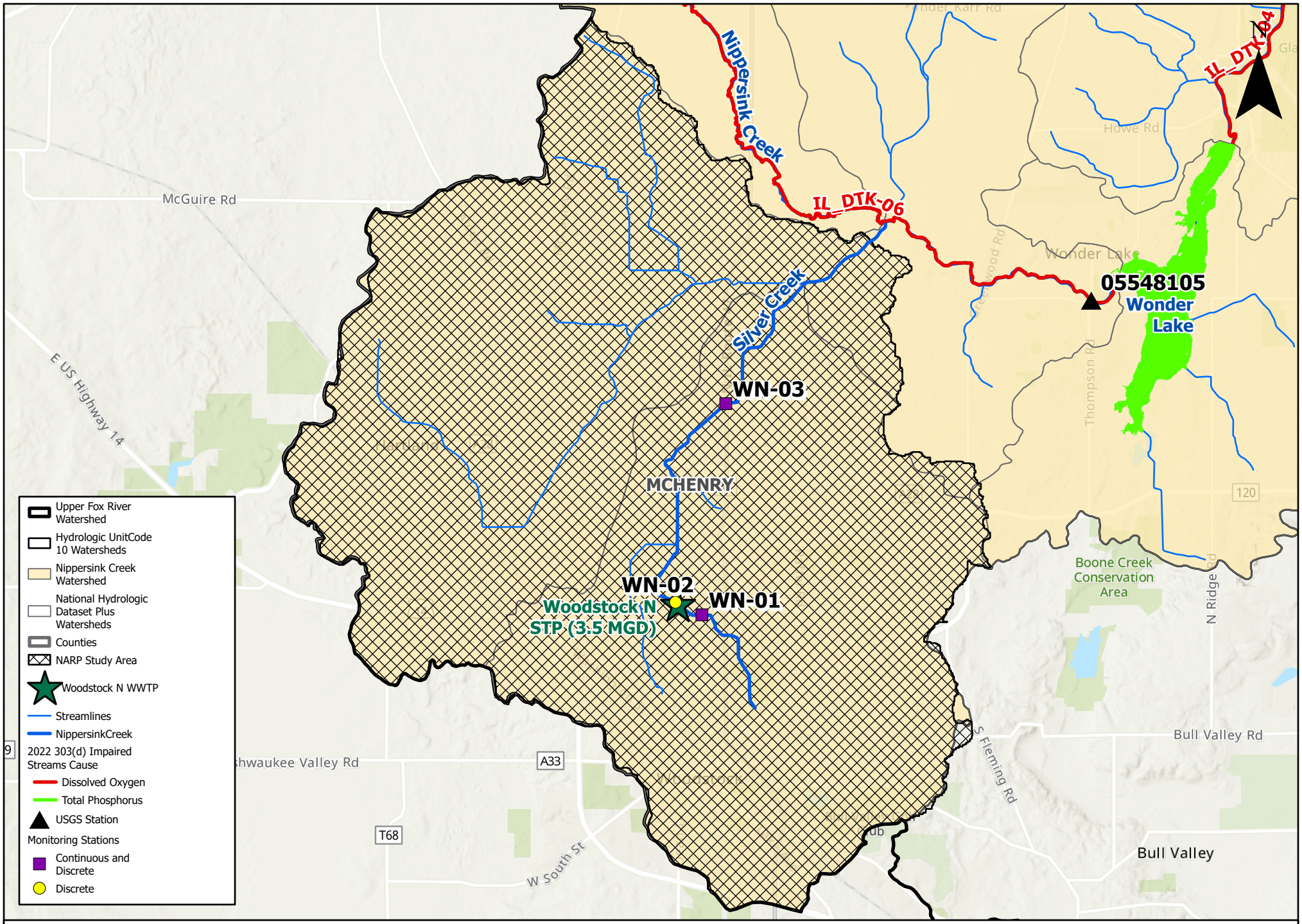
Figure 3: Nippersink Creek Watershed
2020 National Land Cover Dataset (NLCD)

2023 Water Quality Data Monitoring

The City's WWTP's effluent travels 10.7 miles along Silver Creek before reaching Nippersink Creek, allowing sufficient distance to detect potential adverse impacts on water quality. Due to the lack of water quality data on Silver Creek, which was not previously assessed, additional data monitoring was necessary. A Quality Assurance Project Plan (QAPP) was developed to guide this effort, outlining the scope and approach for data collection, validation, and documentation (*Attachment 2: QAPP for the City of Woodstock North Wastewater Treatment Plant Water Quality Monitoring Project*). The QAPP was submitted to the Illinois Environmental Protection Agency (Illinois EPA) on April 18, 2023.

Continuous water quality monitoring was conducted at stations WN-01 and WN-03 between May 1 and October 31. Continuous parameters included DO, temperature, pH, and conductivity. Discrete water quality samples were collected at three stations – WN-01, WN-02, and WN-03 – eight times during the same period: once in May, June, September, and October and twice in July and August. Discrete parameters included total phosphorus, ammonia, nitrite, nitrate, total Kjeldahl nitrogen, carbonaceous biochemical oxygen demand, sestonic chlorophyll-a, and benthic chlorophyll-a (**Figure 4**).

Water quality monitoring revealed a dynamic DO pattern. At station WN-01, upstream of the City's WWTP, DO levels are consistently lower than the standard, as shown by the yellow line in **Figure 5**. This low dissolved oxygen is potentially due to the stagnant water condition and the lack of reaeration (Michaud, 1991).However, DO levels improved at station WN-03, further downstream of the WWTP, as illustrated by the green line in **Figure 5**. While some DO saturation measurements at WN-03 exceeded 100%, the corresponding pH remained lower than 8.35, indicating no risk of eutrophication (Illinois Nutrient Loss Reduction Strategy, 2023). Sestonic chlorophyll-a was generally low throughout the system, indicating no evidence of nuisance algae. Additionally, some total phosphorus peaks were observed upstream of the WWTP. However, these peaks were reduced after the WWTP to approximately 0.2 mg/L by the time water reached WN-03, potentially due to dilution. These results align with Outcome #1 of **Figure 2**, indicating no evidence of phosphorus-related impairment in Silver Creek as it flows into Nippersink Creek.



FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

Figure 4: Woodstock North Wastewater Treatment Plant
Nutrient Assessment Reduction Plan (NARP) Study Area and Monitoring Stations

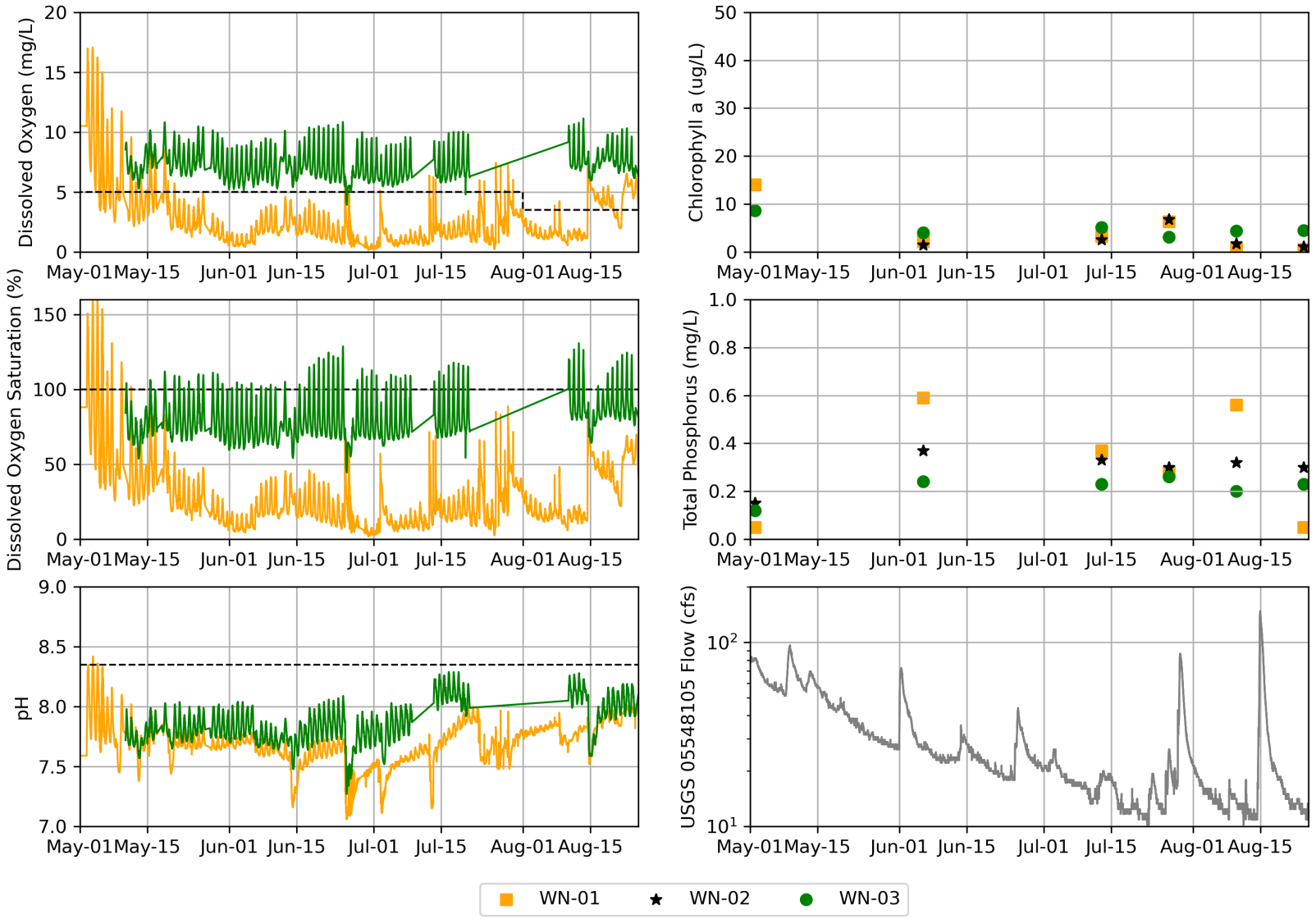


Figure 5: 2023 Water Quality Monitoring Results

SPARROW Model Investigation

In addition to the land cover review and the 2023 data monitoring, the SPARROW model results were reviewed to estimate the WWTP's effluent contribution to the phosphorus loads at the confluence of Silver Creek and Nippersink Creek (watershed ID # 14770826 in **Figure 6**). The total delivered phosphorus load from the different sources was derived from the SPARROW model online mapper.

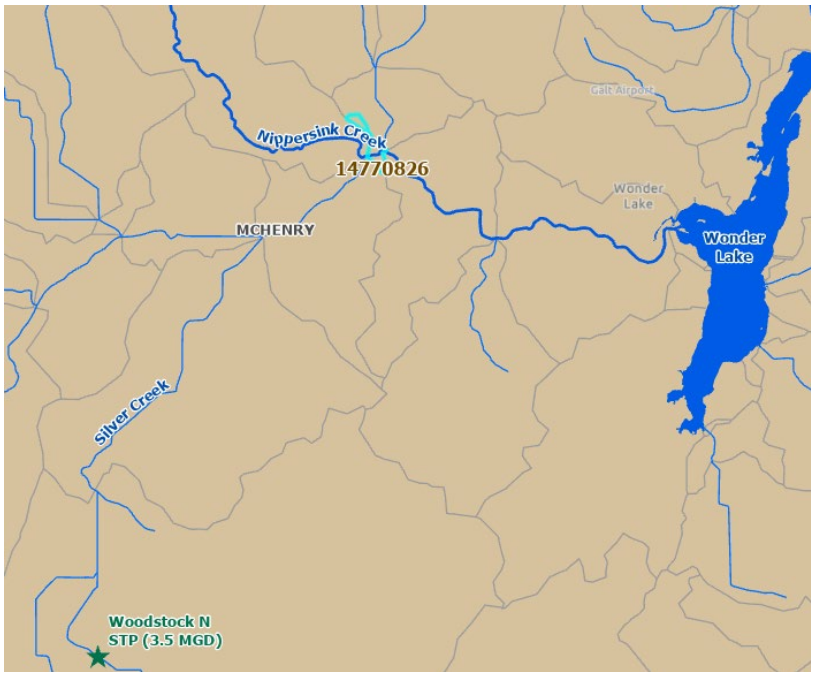


Figure 6: SPARROW Model Watersheds (Not to Scale)

The results revealed that the City's WWTP effluent is not the primary phosphorus contributor at the confluence of Silver Creek and Nippersink Creek. It only accounts for less than 10% of the total phosphorus (**Figure 7**).

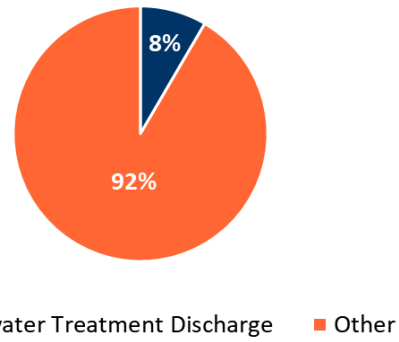


Figure 7: SPARROW Model Total Delivered Phosphorus Load Percentage for the WWTP and the Other Sources at Watershed ID # 14770826

DISCUSSION AND RECOMMENDATIONS

The results of the land cover review, 2023 data monitoring and analysis, and SPARROW model investigations present a comprehensive approach for understanding the phosphorus dynamics downstream of the City of Woodstock North WWTP. These results showed that phosphorus-related impairments do not exist in Silver Creek, and therefore, phosphorus reductions from various sources within the Silver Creek watershed are unnecessary. Considering the relatively large phosphorus contribution from nonpoint sources in the Nippersink Creek watershed, forthcoming initiatives should prioritize addressing and mitigating these sources to eliminate the phosphorus-related impairment in Nippersink Creek that potentially extend to Wonder Lake.

REFERENCES

Illinois EPA. (2022). Illinois Integrated Water Quality Report and Section 303(d) List, 2020/2022. Clean Water Act Sections 303(d), 305(b), and 314 Water Resource Assessment Information and List of Impaired Waters. Illinois Environmental Protection Agency, June 2022.

Illinois Nutrient Loss Reduction Strategy. (2023). Biennial Report 2023. Retrieved from https://epa.illinois.gov/content/dam/soi/en/web/

/topics/water-quality/watershed-management/excess-nutrients/documents/2023-biennial-report/Illinois%20NLRS%202023%20Biennial%20Report.pdf

Michaud, J. P. (1991). A Citizen's Guide: To Understanding and Monitoring Lake and Streams, Washington State Department of Ecology, pp.11.

Schwarz, G.E., Hoos, A.B., Alexander, R.B., and Smith, R.A. (2006). Section 3. The SPARROW Surface Water-Quality Model—Theory, application and user documentation. U.S. Geological Survey Techniques and Methods, 6–B3. Retrieved from https://pubs.er.usgs.gov/publication/tm6B3.

ATTACHMENTS

1- 2023 Data Monitoring Results PowerPoint Presentation (November 30, 2023)
2- QAPP for the City of Woodstock North Wastewater Treatment Plant Water Quality Monitoring Project

FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

Woodstock North Sewer Treatment Plant NARP

2023 Field Data Review

November 30, 2023

CITY OF WOODSTOCK ILLINOIS

Agenda

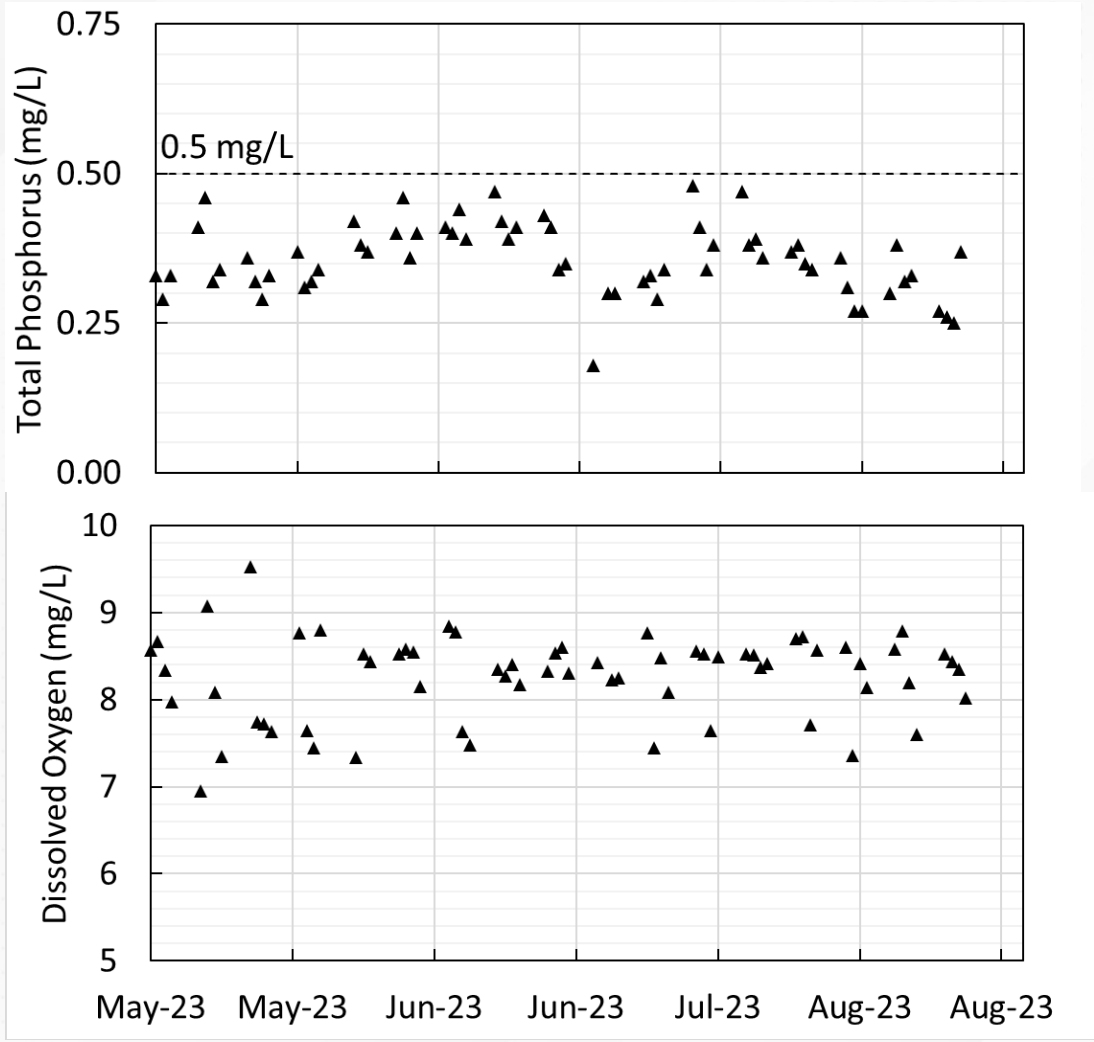
- Woodstock North STP NARP Requirement
  - Current effluent total phosphorus
  - Watershed land cover
  - Permit language
- 2023 Monitoring Data Review
  - Sites overview
  - Collected data
  - Data analysis
- Additional Analysis
- Summary and Next Steps

FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

Woodstock North STP NARP

Woodstock North Effluent Total Phosphorus

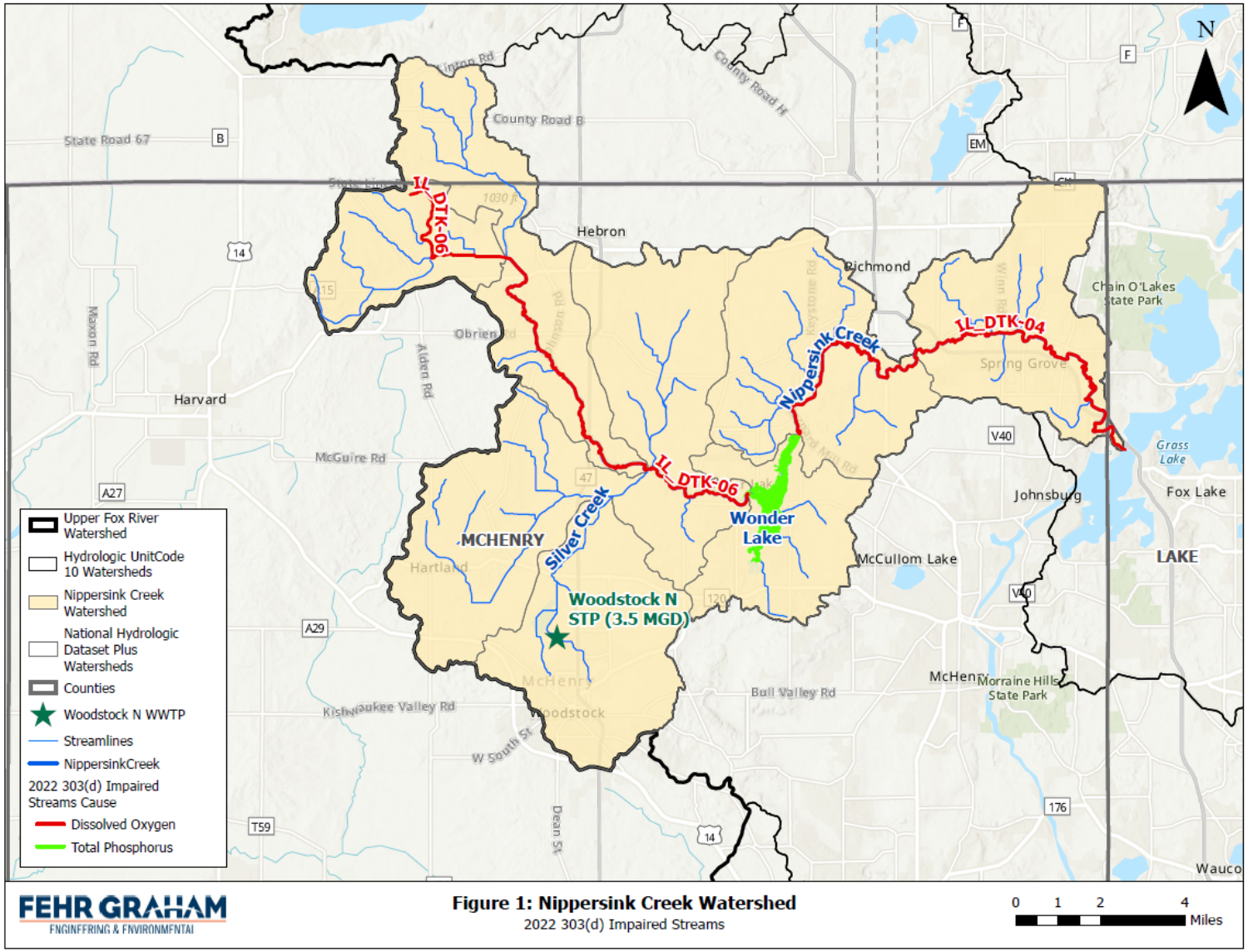
- Effluent total phosphorus is below 0.5 mg/L
- Effluent is well aerated
  - Average Dissolved oxygen = 8.3 mg/L



Woodstock North STP NARP

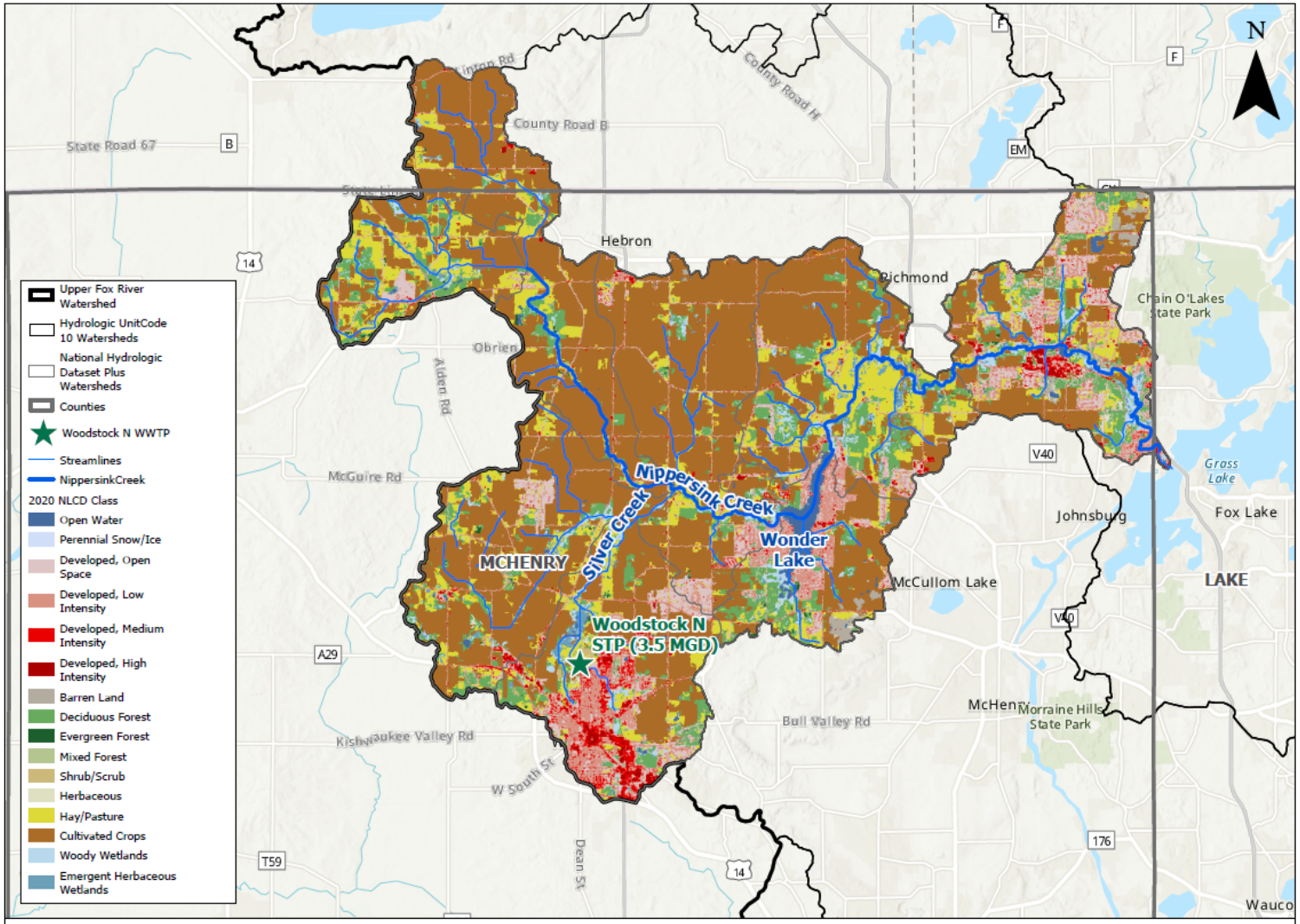
- Woodstock North STP discharges to Silver Creek, a tributary to Nippersink Creek
  - 7Q10* = 0.16 cfs
- NARP due to impairment on stream segment IL_DTK_06
- NARP is due by December 31, 2023

**The seven day once in ten-year low flow*



Woodstock North STP NARP

- Nippersink Creek Watershed Land Cover
  - Primarily agricultural land
  - Urban areas at the upstream and around Wonder Lake



FEHR GRAHAM ENGINEERING & ENVIRONMENTAL

Figure 2: Nippersink Creek Watershed
2020 National Land Cover Dataset (NLCD)

Woodstock North STP – 2019 Public Notice

- Silver Creek was not assessed
- Nippersink Creek is impaired for Dissolved Oxygen

A phosphorus related impairment means that the downstream waterbody or segment is listed by the Agency as impaired due to dissolved oxygen and/or offensive condition (algae and/or aquatic plant growth) impairments that is related to excessive phosphorus levels. The Agency has determined that the Permittee's treatment plant effluent is located upstream of a waterbody or stream segment that has been determined to have a phosphorus related impairment. This determination was made upon reviewing available information concerning the characteristics of the relevant waterbody/segment and the relevant facility (such as quantity of discharge flow and nutrient load relative to the stream flow).

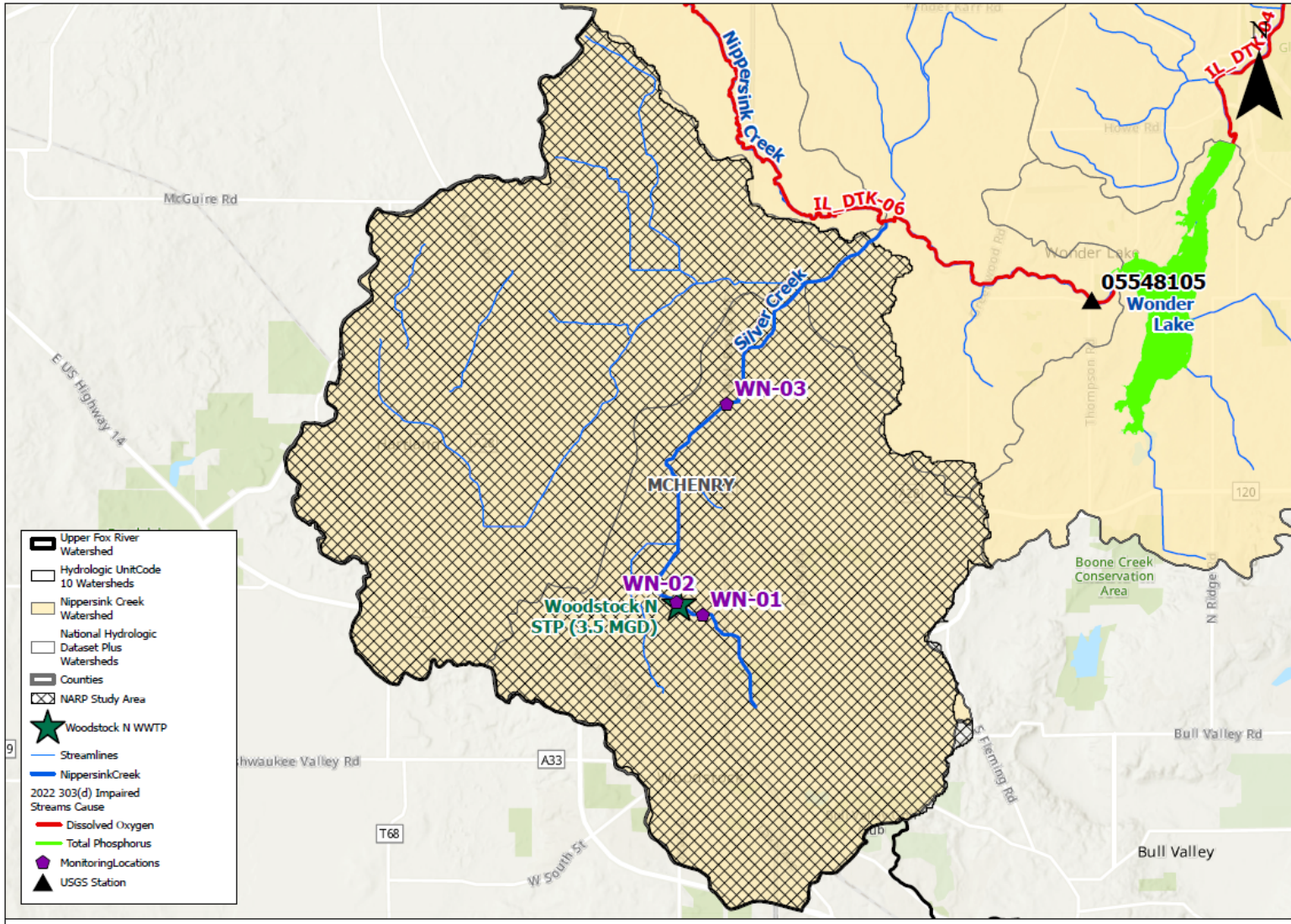
The Woodstock – North STP discharges to Silver Creek (tributary to IL_DTK-06). Silver Creek, tributary to Waterbody Segment, IL_DTK-06, is not listed on the draft 2016 Illinois Integrated Water Quality Report and Section 303(d) List since it has not been assessed. From the treatment plant to segment IL_DTK-06 is a distance of 10.7 stream miles.

Silver Creek flows into Nippersink Creek (Segment IL_DTK-06). The draft 2016 303(d) List indicates that aquatic life use is impaired with potential causes given as aldrin, aquatic plants (Macrophytes) (non-pollutant), cause unknown, and nickel; fish consumption use is impaired with potential causes given as mercury and polychlorinated biphenyls; and primary contact recreation use is impaired with potential cause given as fecal coliform. Aesthetic quality use is fully supported. From Silver Creek to Wonder Lake is 5.3 stream miles in length.

NARP Study Area

» NARP Study Area

- Silver Creek watershed till the confluence with Queen Anne Road
- Stream length: 5.38 miles
- Watershed area: 38.6 square miles

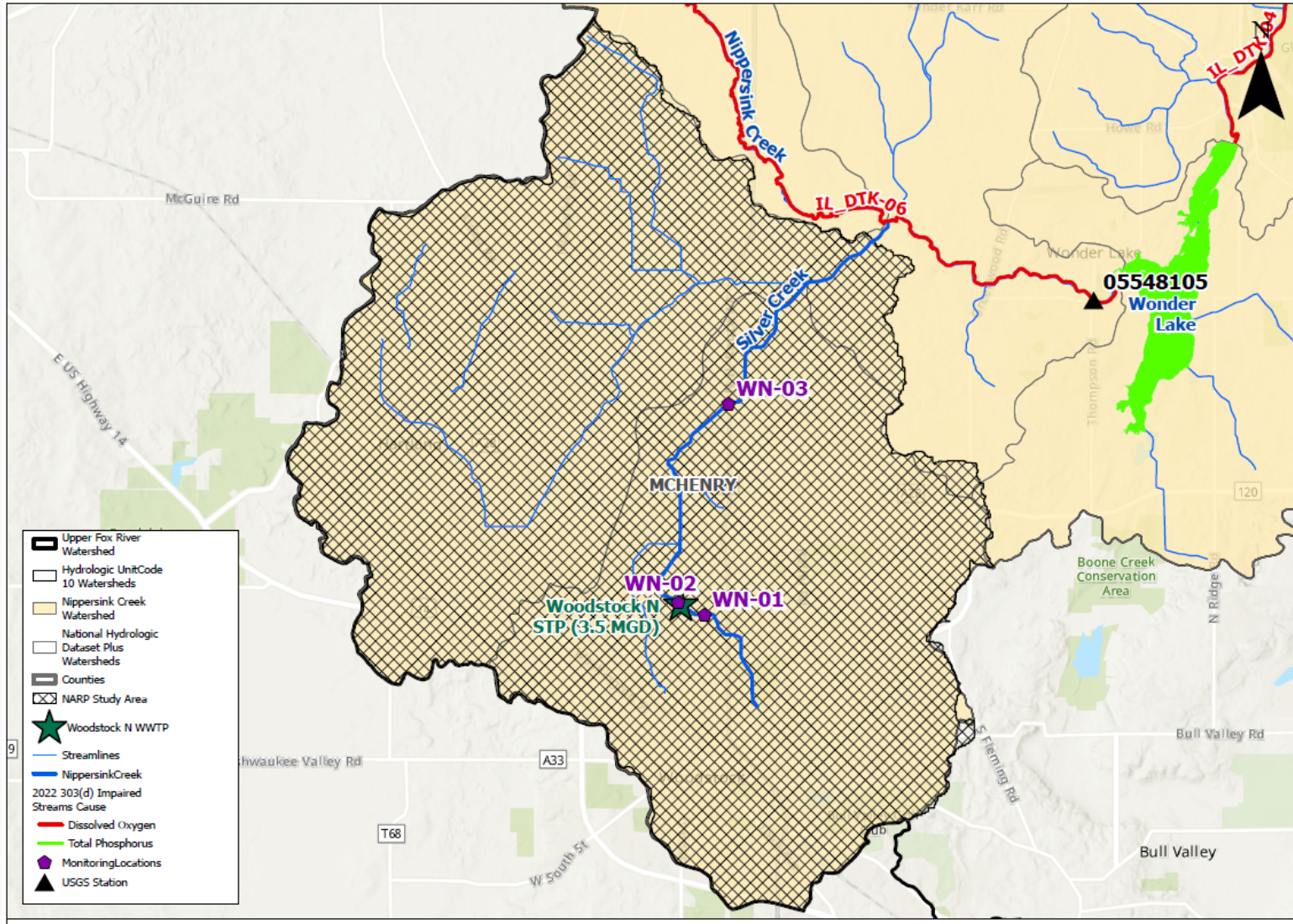


FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

2023 Monitoring Data Review

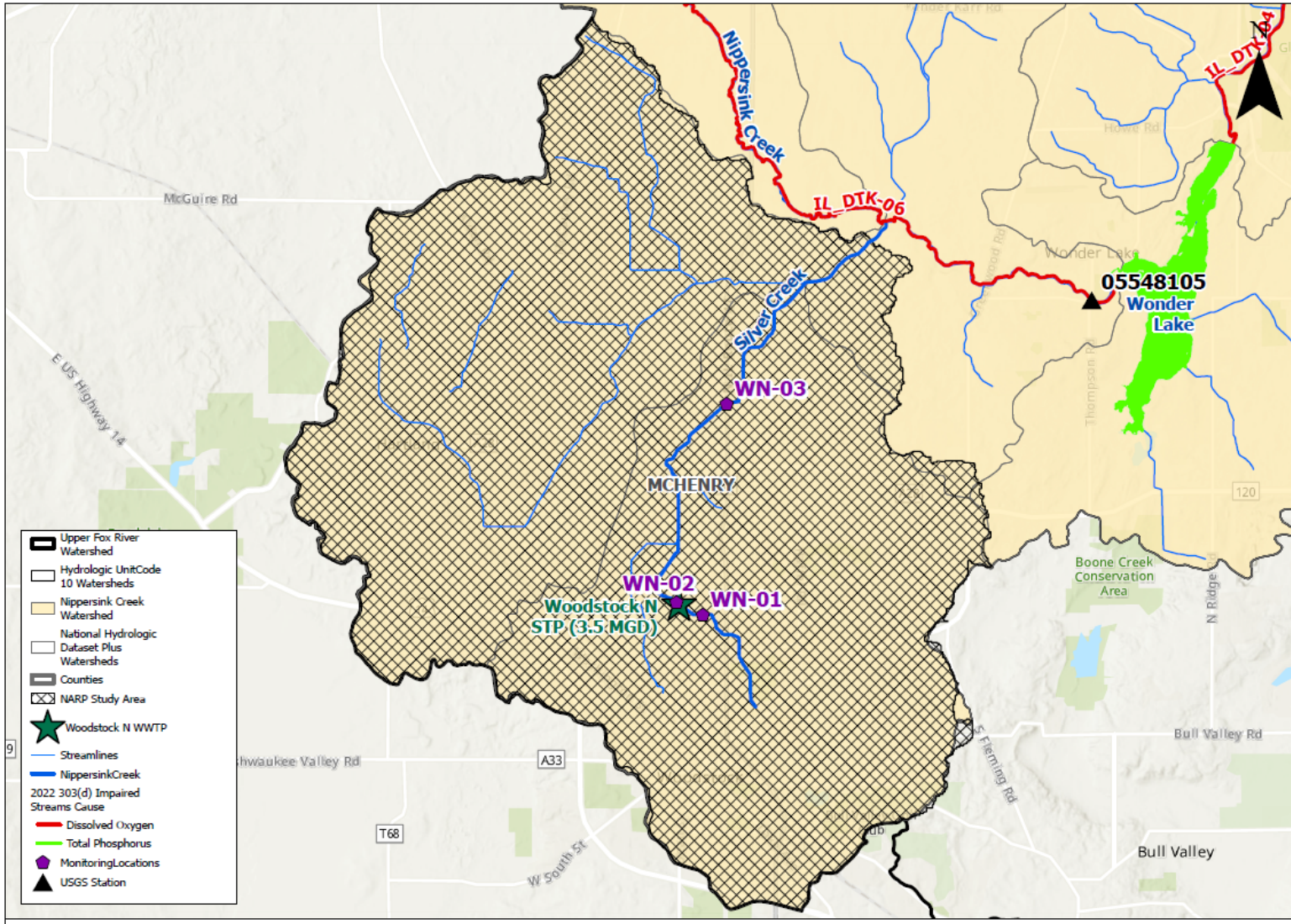
2023 Monitoring Sites

- Three discrete monitors
  - WN-01
  - WN-02
  - WN-03
- Two continuous monitors and flow meters
  - WN-01
  - WN-03
- June to September 2023



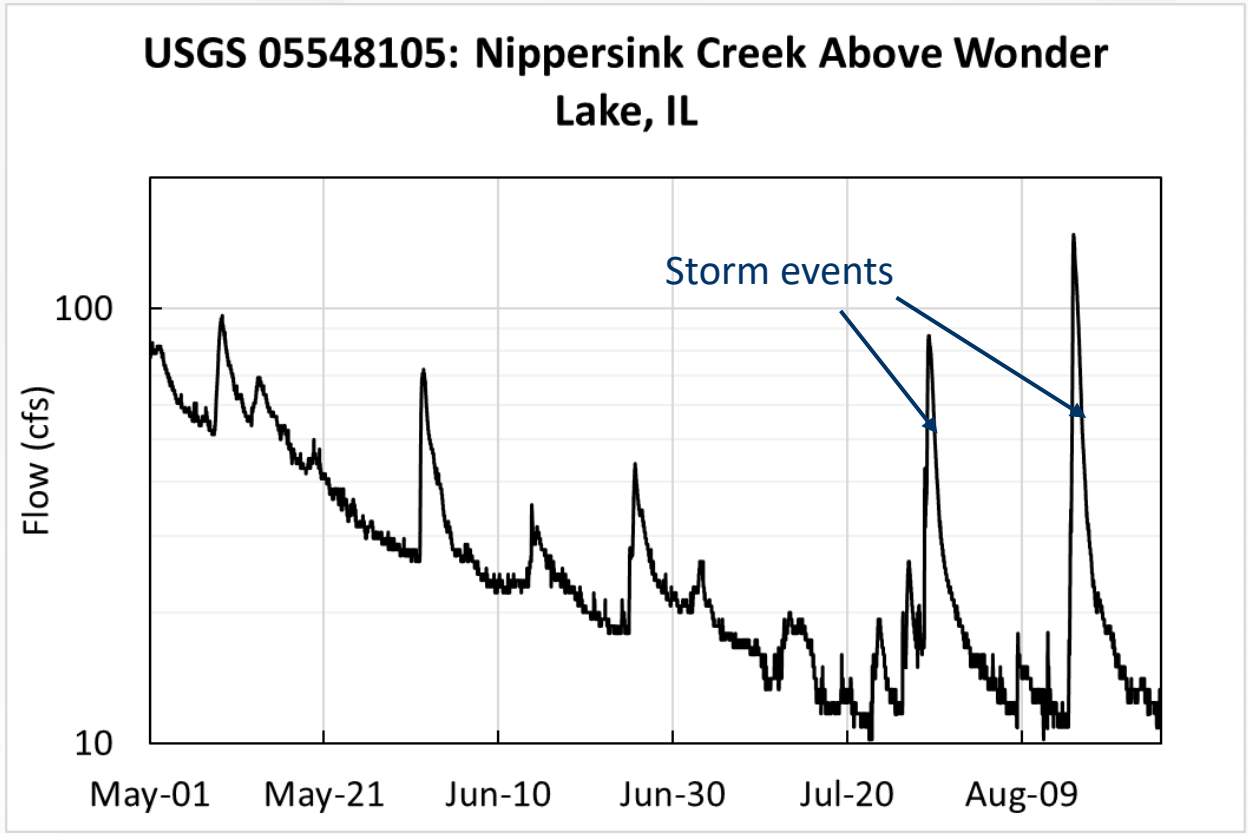
2023 Monitoring Parameters

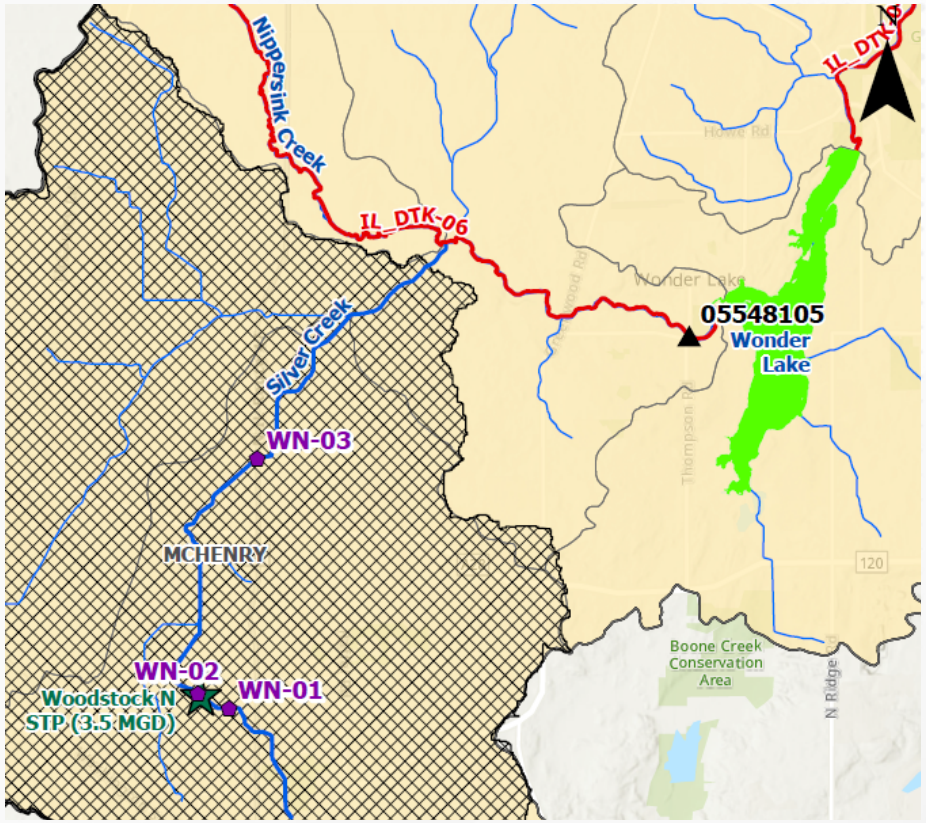
- Discrete
  - Ammonia
  - Nitrate-Nitrite
  - Total Kjeldahl Nitrogen
  - Total Phosphorus
  - Carbonaceous Biological Oxygen Demand
  - Algae (benthic and sestonic)
- Continuous
  - Temperature
  - Dissolved Oxygen
  - pH
  - Conductivity



2023 Sampling Flows

» Revisit the flows collected at WN-01 and WN-03



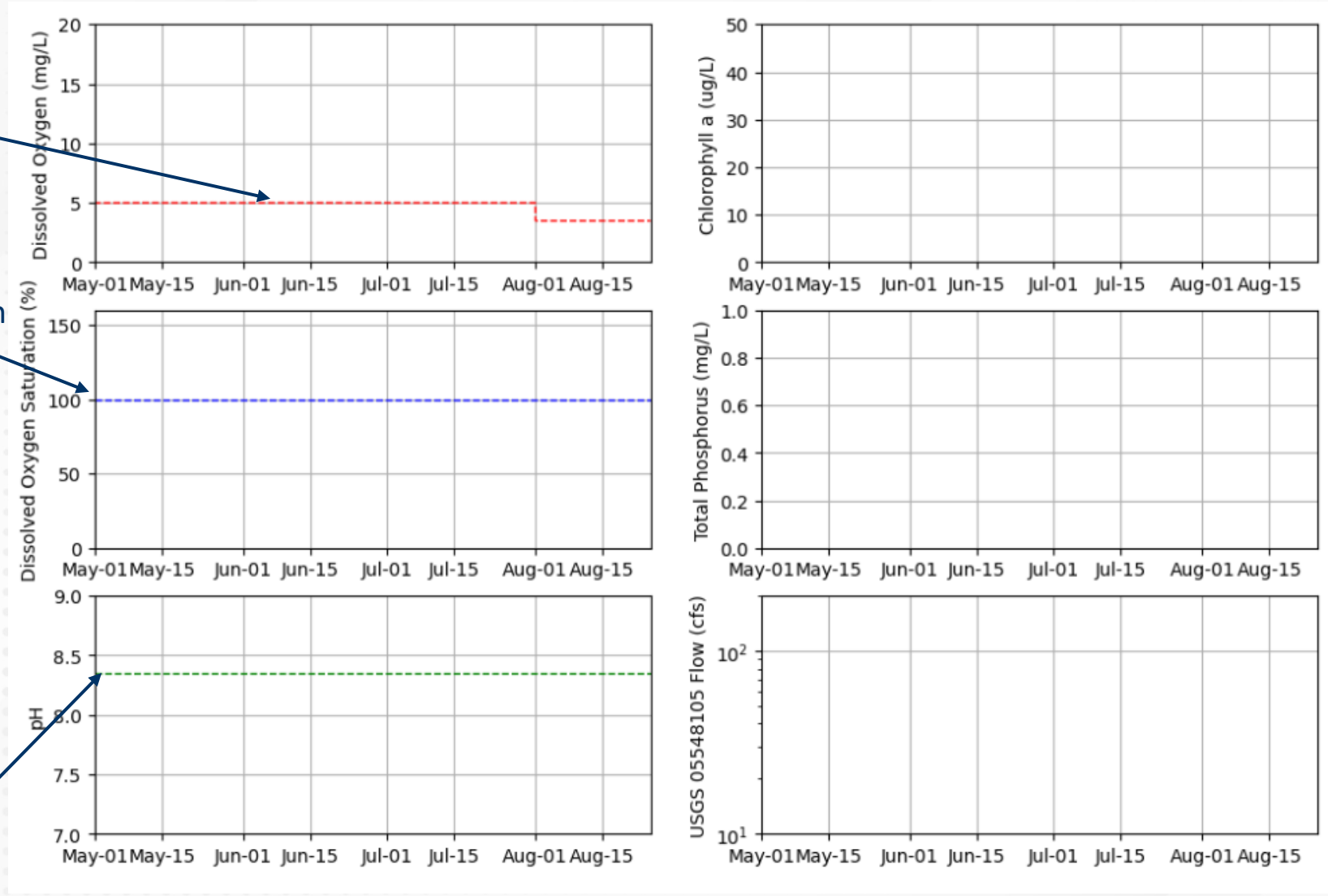


Station Name (~distance from the plant)

Dissolved oxygen standard

Oversaturation

9 and 8.35 Risk of Eutrophication trigger

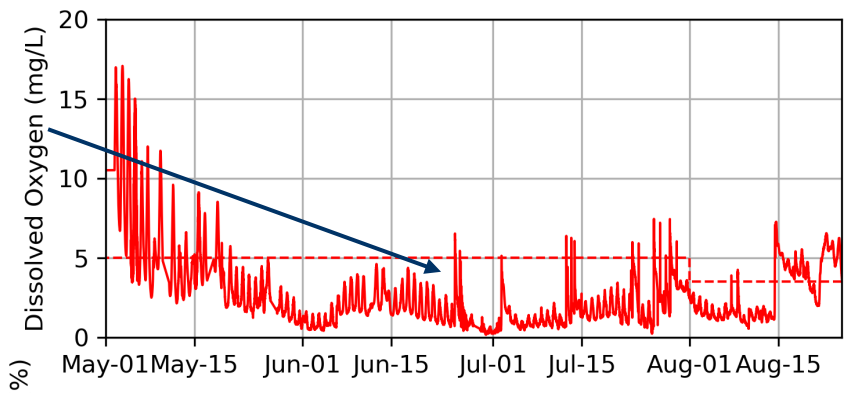


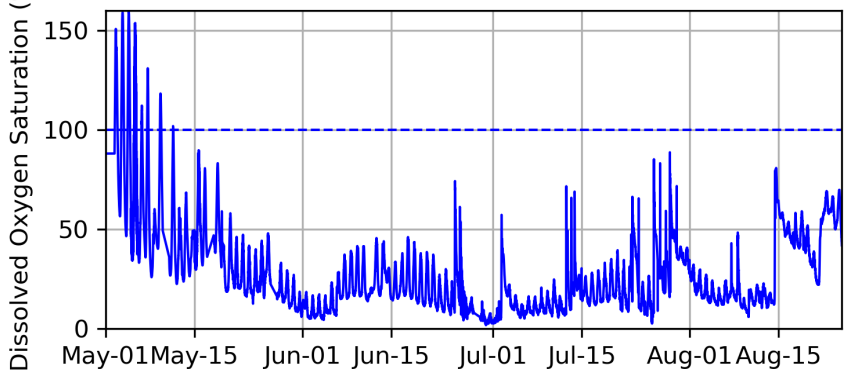
Station on the map

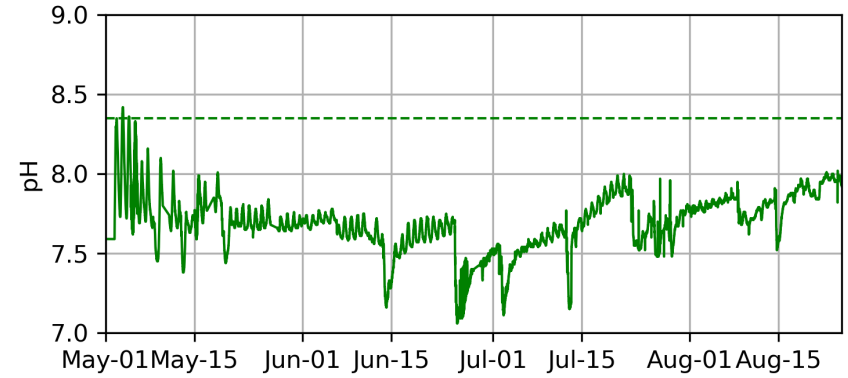
Site photo

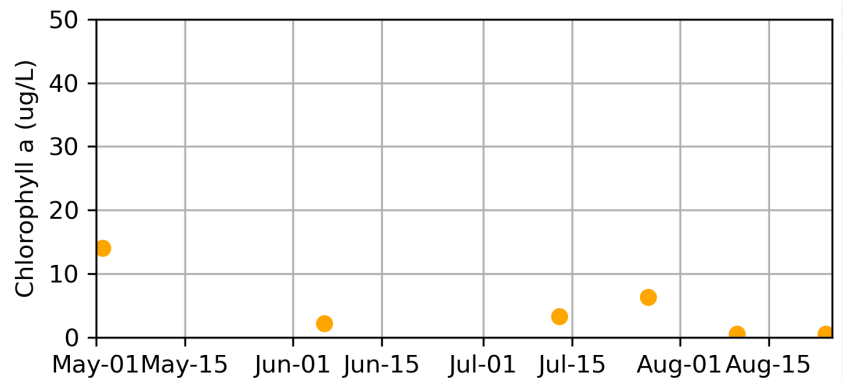
WN-01 (~0.28 miles upstream of the plant)

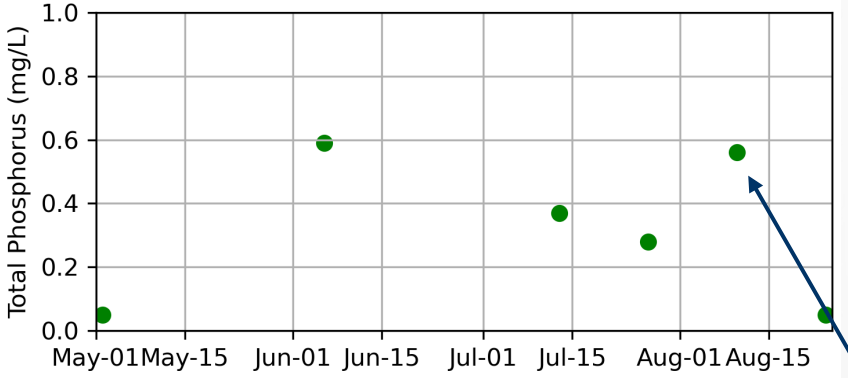
Dissolved Oxygen below the standard most of the time

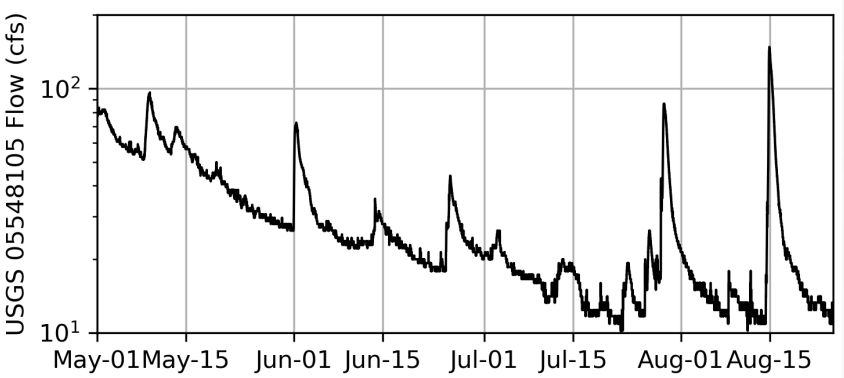


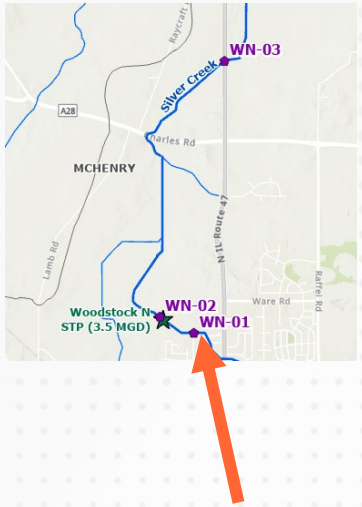








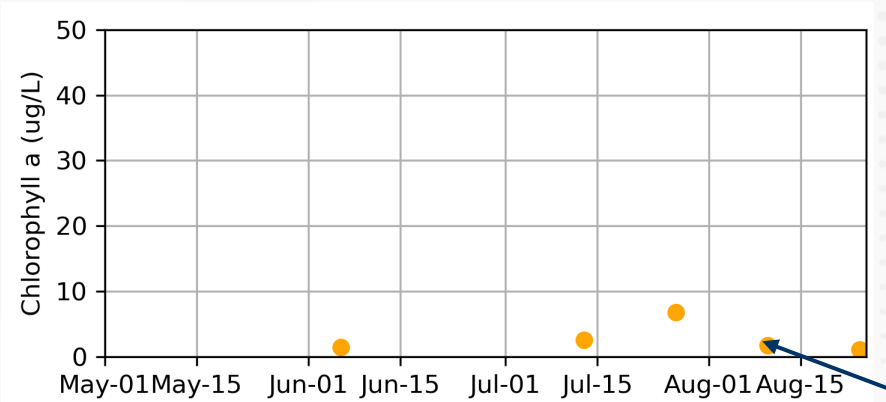


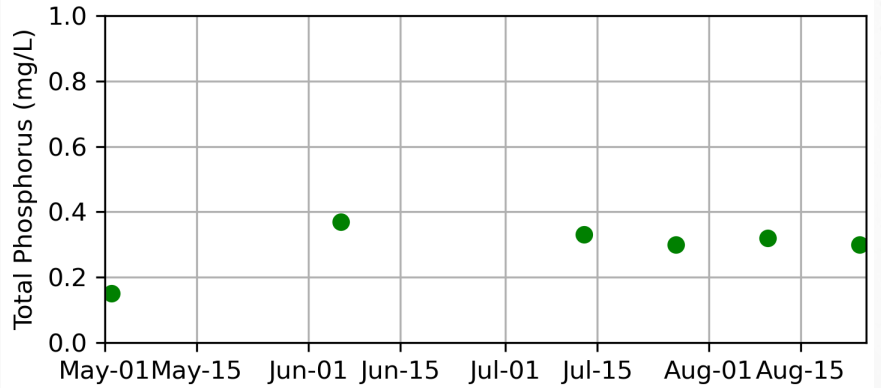


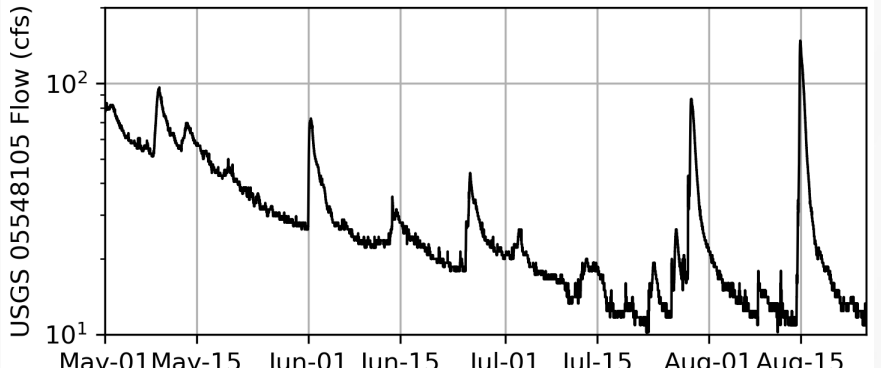
Phosphorus input to the system

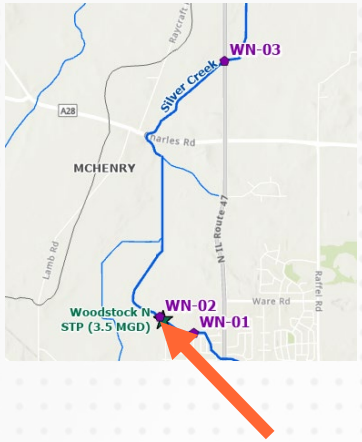
WN-02 (~263 ft downstream of the plant)

» Discrete station





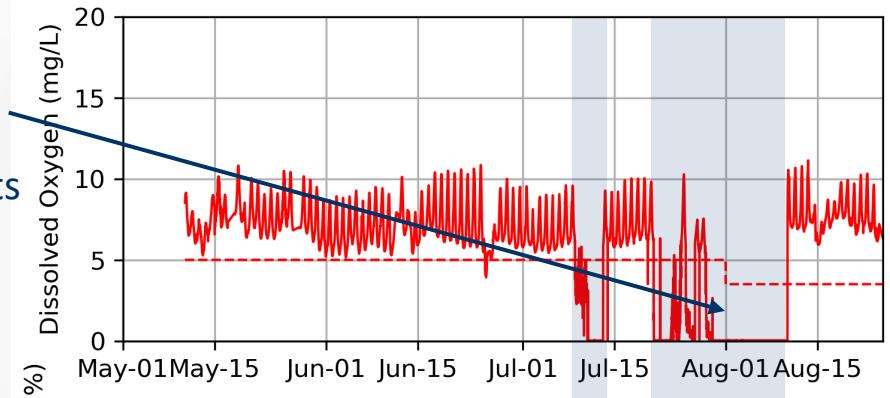


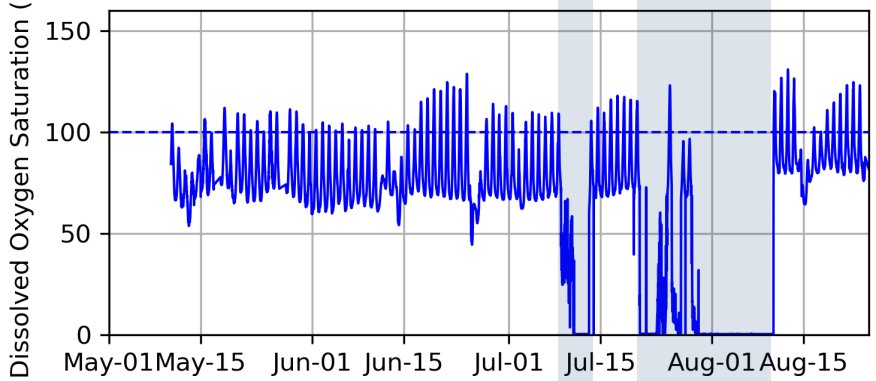


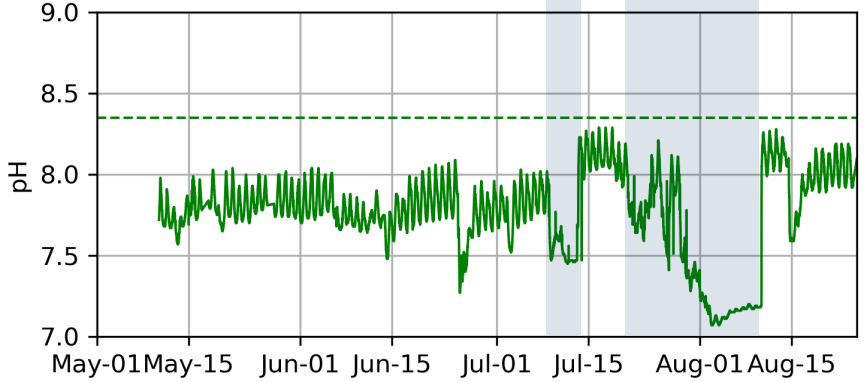
Low chlorophyll-a most of the time

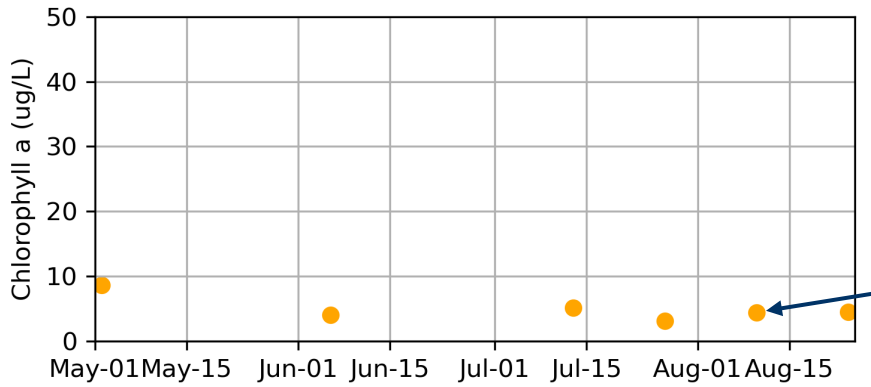
WN-03 (~2.67 miles downstream of the plant)

Sondes issues and potential impact of storm events

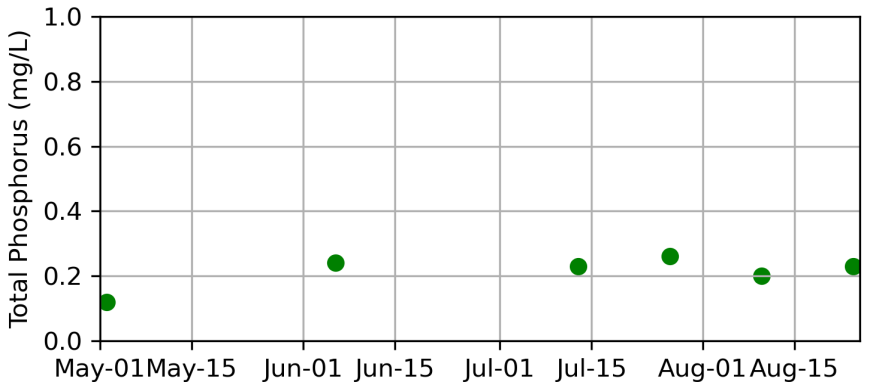


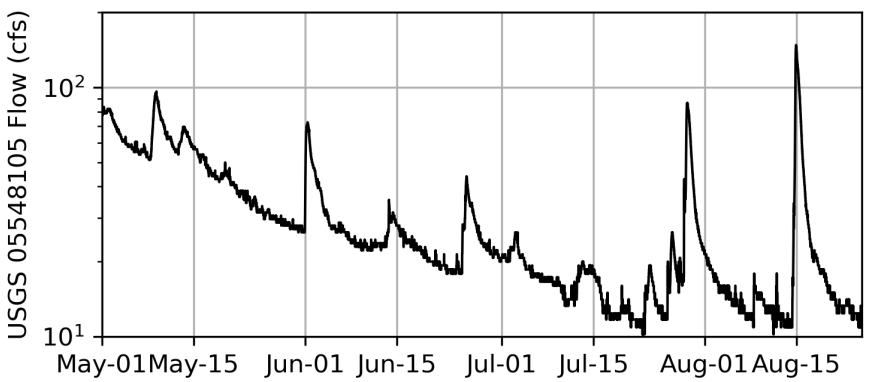


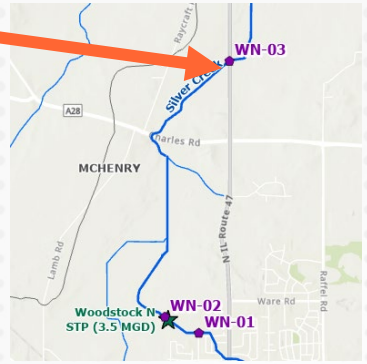




Overall low chlorophyll-a







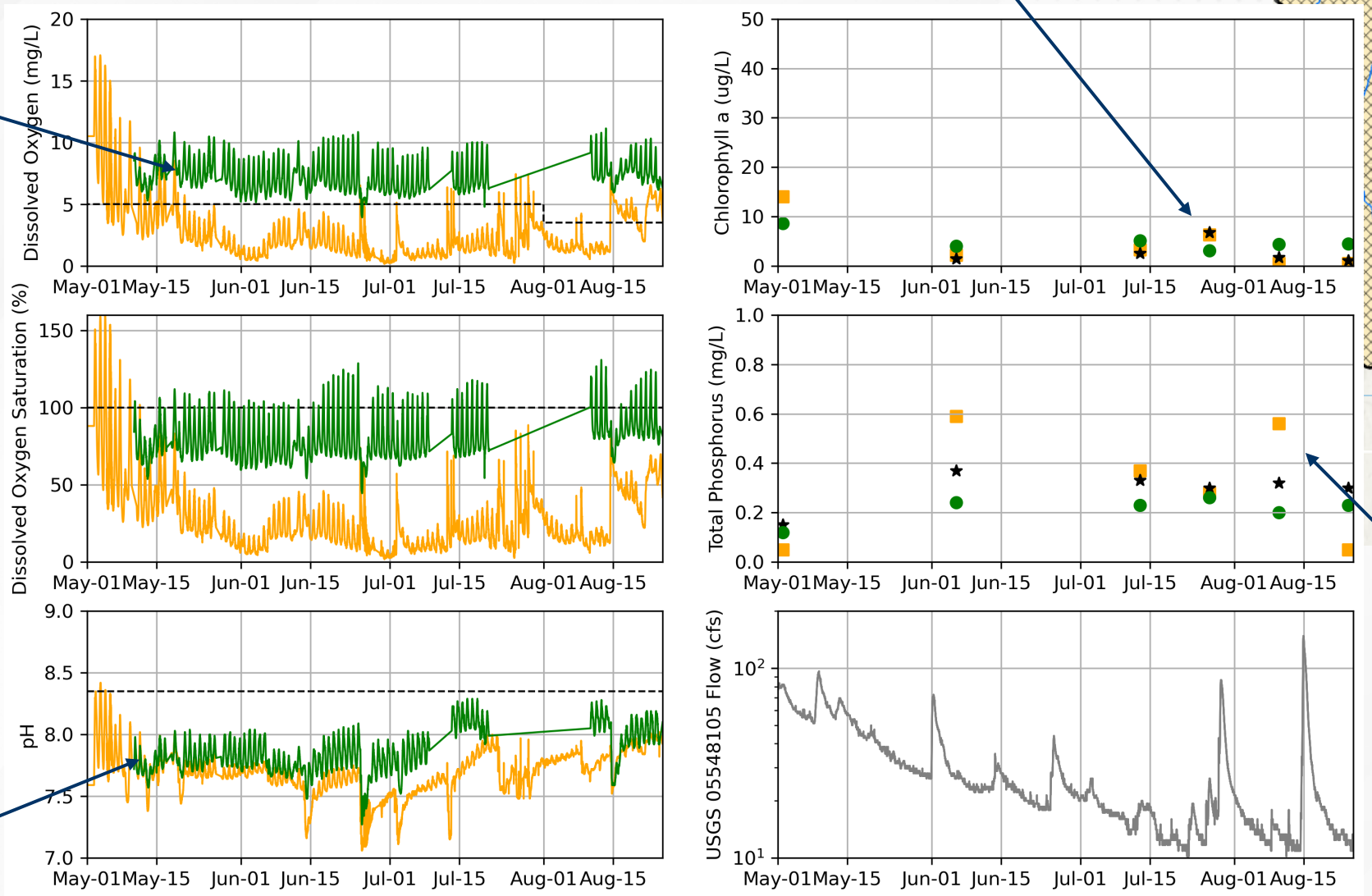
All Stations

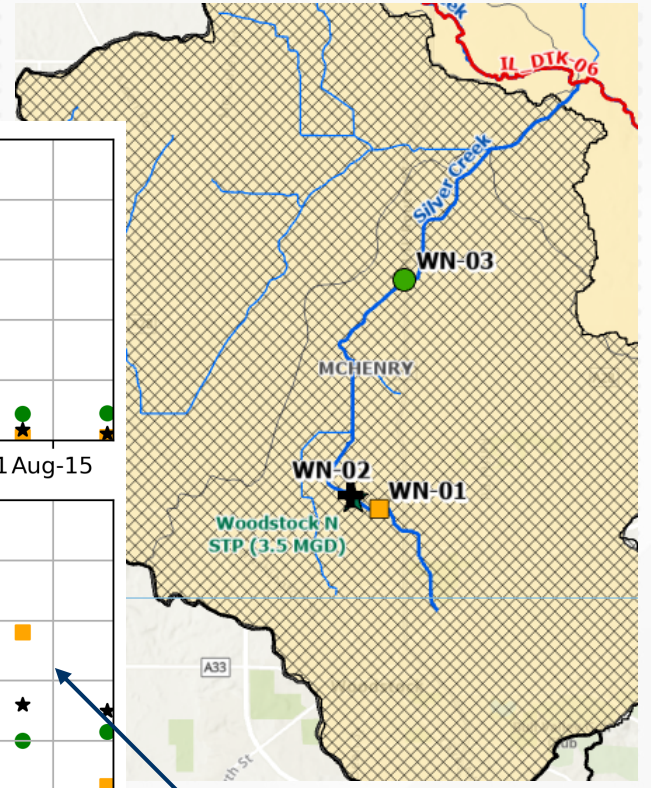
Improvement in dissolved oxygen after the plant input

WN-03 pH is never >8.35

Overall low chlorophyll-a throughout the system

Some reductions in total phosphorus



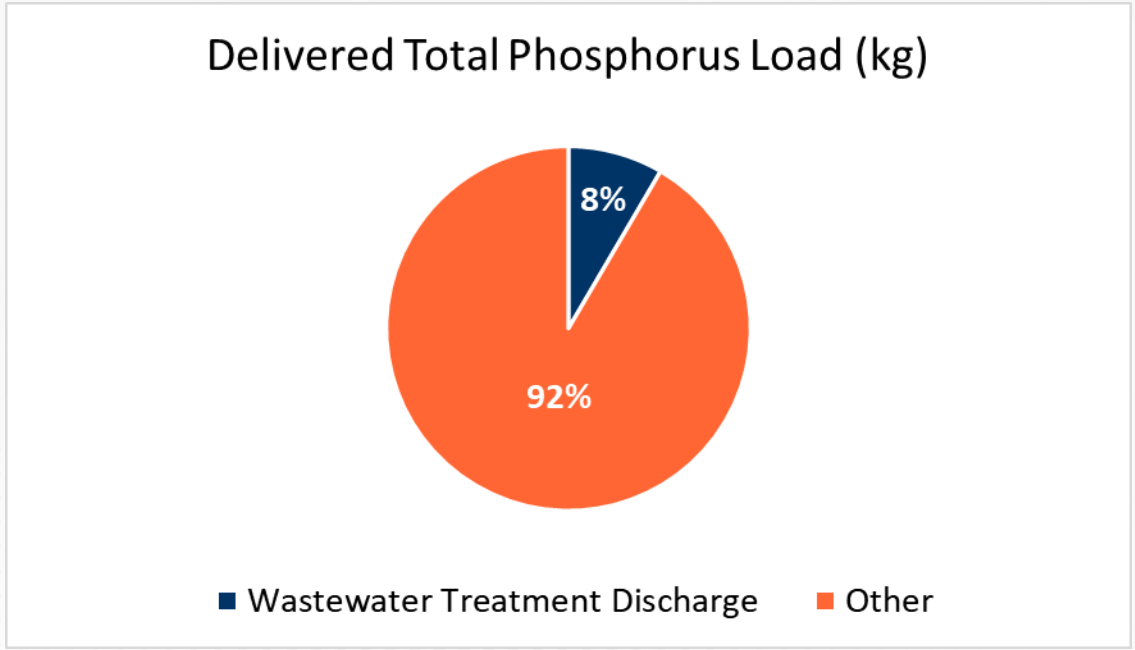


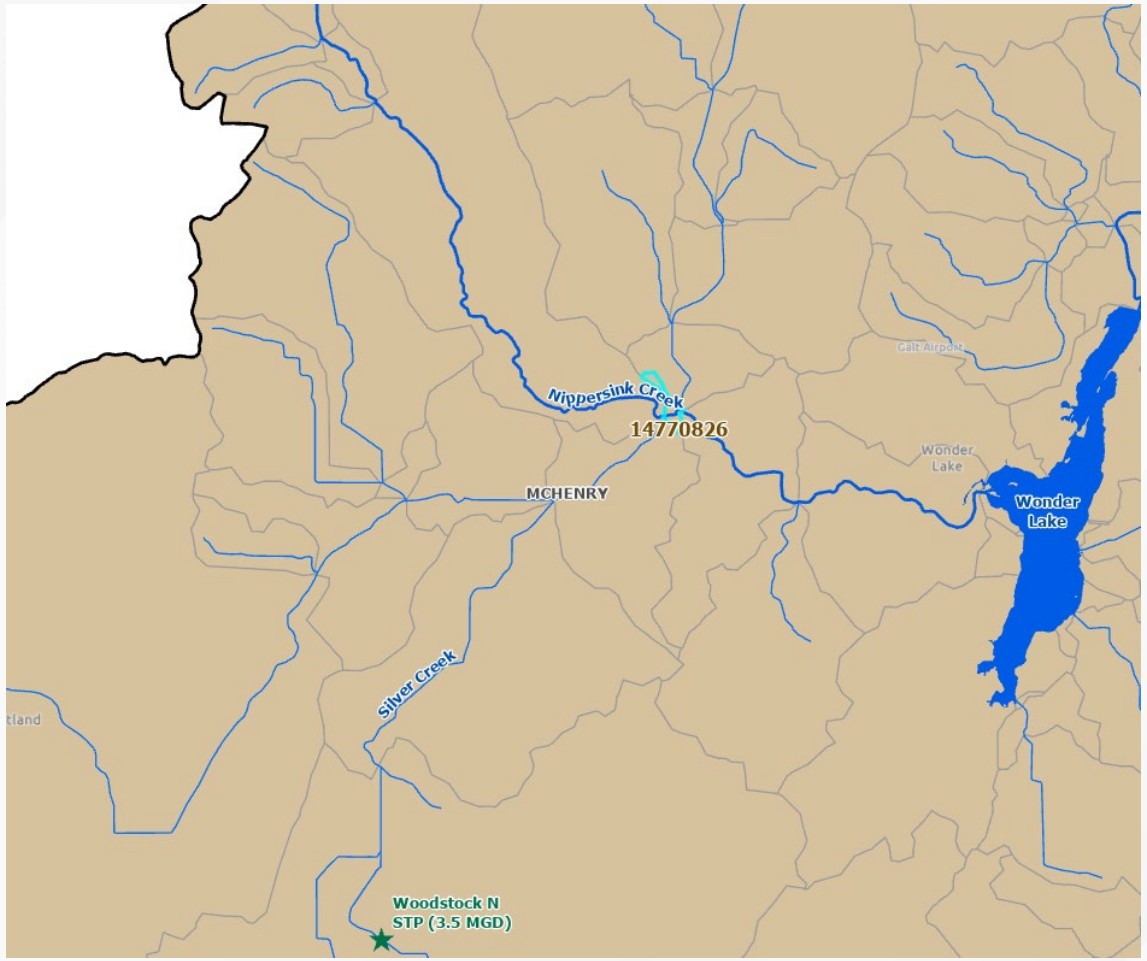
FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

Additional Analysis

USGS SPAtially Referenced Regression On Watershed (SPARROW) Model

» Nippersink Creek confluence (ID:14770826)





Saad, D.A., and Robertson, D.M., 2020, SPARROW model inputs and simulated streamflow, nutrient and suspended-sediment loads in streams of the Midwestern United States, 2012 Base Year: U.S. Geological Survey data release, https://doi.org/10.5066/P93QMXC9.

FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

Summary and Next Steps

Summary

- By the time Silver Creek enters Nippersink Creek
  - No dissolved oxygen excursion
  - Low chlorophyll-a
  - Low phosphorus
  - No risk of eutrophication

- Recommendation
  - Submit a memo summarizing the analysis and results to Brant Fleming to fulfill the NARP requirement.

FEHR GRAHAM
ENGINEERING & ENVIRONMENTAL

Questions?

Quality Assurance Project Plan (QAPP)
for Village of Woodstock Northside Wastewater Treatment Plant Water Quality Monitoring Project

Version 1.0

Prepared by

Fehr Graham Engineering & Environmental
230 Woodlawn Avenue
Aurora, IL 60506

For the
Village of Woodstock

The following have approved this document for use with the Village of Woodstock Northside Wastewater Treatment Plant Water Quality Monitoring on Silver Creek in Northern Illinois.

Signature_____ Date_____
Leonard Dane
Fehr Graham Engineering & Environmental

Signature _____ Date_____
Anne George
Village of Woodstock

Signature _____ Date_____
Michelle Rousey
Illinois Environmental Protection Agency

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

TABLE OF CONTENTS

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

TABLES

FIGURES

APPENDICES

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

1.0 Project Management

1.1 Distribution

Data collection and management for the Village of Woodstock Northside Wastewater Treatment Plant (WWTP) Water Quality Monitoring will be the responsibility of Fehr Graham Engineering & Environmental (Fehr Graham). Pace Analytical (Pace) will perform laboratory analyses. All the following individuals listed in Table 1-1, regardless of project responsibilities, will receive a copy electronically in "*.pdf*" format of the Quality Assurance Project Plan (QAPP) prior to the initiation of the field sampling activities. In the case of a revision, each of the participants will receive the revised version electronically in "*.pdf*" format. Prior to work commencing, copies of the QAPP will also be provided to all Fehr Graham personnel that assist with data collection or data entry on this project.

Table 1-1. Distribution List for the Village of Woodstock Northside WWTP Water Quality Monitoring Project

Individual	*Organization*
Leonard Dane	Fehr Graham
Matt Drabik	Fehr Graham
Carrie Carter	Fehr Graham
Pat Kelsey	Fehr Graham
Andrew Barbeau	Fehr Graham
Margaret Trowbridge	Fehr Graham
Diane Billings	Pace
Anne George	Village of Woodstock
Michael Rousey	Village of Woodstock

1.2 Project/Task Organization

Figure 1-1 is an organizational chart describing the lines of communication for the Village of Woodstock North WWTP Water Quality Monitoring. Table 1-2 lists the individuals that will participate in at least part of the water quality monitoring and the role that each of the participants will have in the program.

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

Figure 1-1. Organizational chart of the Village of Woodstock North WWTP Water Quality Monitoring.

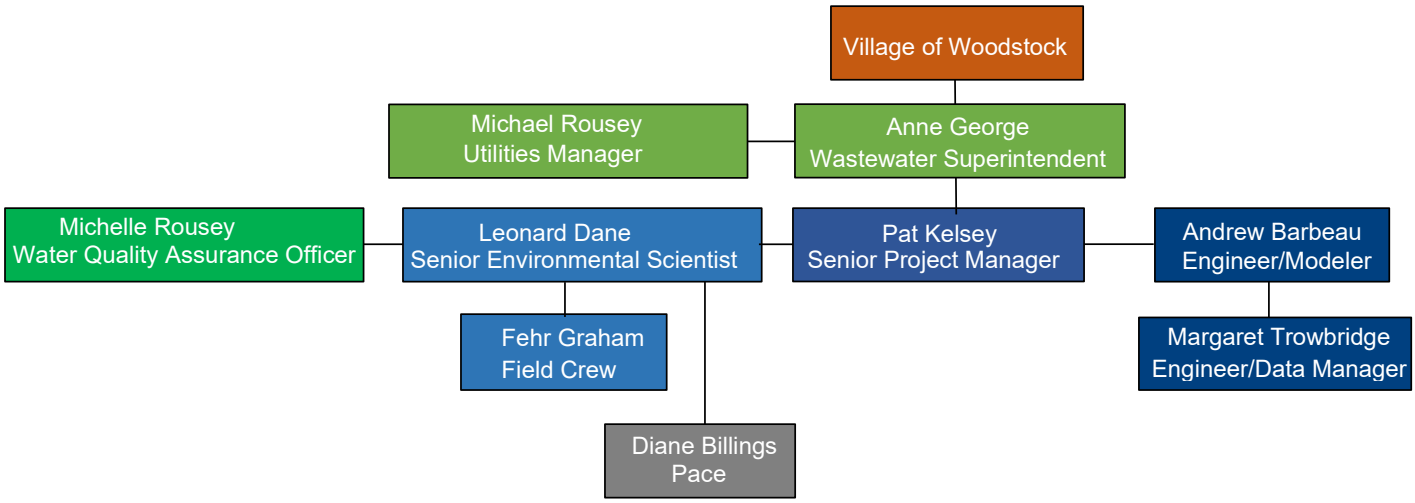


Table 1-2. Roles and Responsibilities of Individuals with the Village of Woodstock Northside WWTP Water Quality Monitoring

Name	*Organization*	*Responsibility*
Anne George	Village of Woodstock	• Wastewater Superintendent
Pat Kelsey	Fehr Graham	• Overall project oversight • Producing and implementing the plan of study • Management of personnel and resources
Leonard Dane	Fehr Graham	• General oversight of continuous monitoring, and discrete sampling • Conduct fieldwork
Matt Drabik	Fehr Graham	• General oversight of benthic algae sampling • Conduct fieldwork
Andrew Barbeau	Fehr Graham	• Oversight of data management • Analysis and interpretation of data
Diane Billings	Pace	• Coordination of analytical services • Director of laboratory quality assurance

Name	*Organization*	*Responsibility*
Michelle Rousey	Illinois EPA	• The Illinois EPA Bureau of Water Quality Assurance Officer (QAO) will review and approve this QAPP as meeting the QAPP requirements in USEPA's publication QA/R-5. The QAO will conduct audits if deemed necessary

1.3 Definition/Background

The Village of Woodstock has contracted Fehr Graham to address the Nutrient Assessment and Reduction Plan (NARP) special condition included in their National Pollutant Discharge Elimination System (NPDES) discharge permit IL0031861.

The purpose of a NARP is to identify nutrient reduction strategies which address phosphorus-related impairments and the risk of eutrophication through point source controls, nonpoint source controls, and/or other measures (such as dam removals, riparian shading, etc.). This approach to addressing nutrient reduction is in lieu of creating total maximum daily loads (TMDLs) for impaired rivers and streams in Illinois. The NARP process is also an integral part of the Illinois Nutrient Loss Reduction Strategy.

The Village of Woodstock Northside Wastewater Treatment Plant discharges to Silver Creek, a tributary to Nippersink Creek. Nippersink Creek has been determined to have a phosphorus related impairment. A phosphorus related impairment means the Illinois EPA has listed Nippersink Creek impaired due to dissolved oxygen and/or offensive condition (algae and/or aquatic plant growth) impairments that are related to excessive phosphorus levels. The purpose of this project is to provide water quality monitoring data for use in the development of the Village of Woodstock Northside WWTP's NARP.

1.4 Project/Task Description

The monitoring effort will include continuous monitoring and discrete water quality sampling of selected water quality parameters upstream and downstream of the Village of Woodstock's Northside WWTP. To accomplish this, Fehr Graham will provide the necessary staff, equipment, and services. A project coordinator from Fehr Graham will be identified and will be responsible for the coordination necessary for the successful execution.

Continuous water quality monitoring will be conducted at 2 sites between May 1 and October 31. Discrete water quality samples will be collected 8 times during this period, once in May, June, September, and October and twice in July and August. Table 1-3 lists the type of data collection being conducted at each site.

1.4.1 Continuous Water Quality Monitoring

As detailed in Table 1-3, continuous monitoring will be conducted at 2 stations on Silver Creek. Continuously monitored parameters include dissolved oxygen, temperature, pH, and conductivity. These measurements will be collected using YSI EXO sondes. The location of the sondes within the cross section will be determined utilizing DO profiles so that the data obtained at the sonde location is representative of the river/stream at that sampling location. DO profiles will be collected prior to the monitoring effort. The sondes will be set to record at 15-minute increments with their internal data-loggers. Fehr Graham will provide and maintain the sondes needed for the project. Fehr Graham will be responsible for pre-deployment and post-deployment sonde calibration as well as sonde pre-deployment and post-deployment activities.

Table 1-3. Sampling locations for Village of Woodstock NARP Water Quality Monitoring Project

Stream & Location	Cross-Section Profiles	Continuous Monitoring	Discrete Sampling	Benthic Algae	Flow Measurements
Site WN-01 – Upstream of WWTP effluent	X	X	X	X	X
Site WN-02 – Downstream of WWTP effluent	X		X	X	
Site WN-03 – Upstream of Confluence with Nippersink Creek	X	X	X	X	X

1.4.2 Discrete Water Quality Sampling

Discrete water quality sampling and sestonic algae sampling will be conducted at 3 stations on Silver Creek as shown in Table 1-3. Discrete water quality samples and sestonic algae (i.e., chlorophyll a) sampling will be collected using an Equal-Width-Increment sampling technique described in Edwards and Glysson (1999). Samples will be analyzed for the constituents listed in Table 1-4.

Table 1-4. Nutrient and physical analysis to be performed by Pace Analytical

Analysis	*Abbreviation*	*Frequency*
Ammonia	NH_3	Once in May, June, September, October. Twice in July and August
Nitrite	NO_2	
Nitrate	NO_3	
Total Kjeldahl Nitrogen	TKN	
Total Phosphorus	TP	
Carbonaceous Biological Oxygen Demand	CBOD5	
Sestonic Chlorophyll a	Chl a	
Benthic Chlorophyll a	Chl a	

The sampling team of two-trained field technicians will collect water quality samples at the three sites, as well as in-situ DO, temperature, pH, and conductivity measurements using a spot meter during each sampling event. Fehr Graham staff will be responsible for laboratory courier services. Approximately 10% of the total sampling effort will be used for QA/QC purposes.

1.4.3 Benthic Algae Sampling

Benthic algae sampling will be conducted at 3 stations along Silver Creek. The benthic algae sampling and processing will be collected using the procedures outlined in Chapter 4 of *Revised protocols for sampling algal, invertebrate, and fish communities as part of the National Water-Quality Assessment Program,* USGA Open-File Report 02-150 (Moulton et.al.2002). Immediately following the sample collection, the sample will be poured into an amber one liter bottle. Refer to appropriate SOP (Appendix B) for additional details on the benthic algae sampling methods. Benthic algae sampling will be conducted during each sampling event. One team of 2 field technicians will collect the benthic algae samples.

1.4.4 Total Flow Measurements

Fehr Graham will be responsible for performing all flow measurements. Flow data will be collected continuously at one upstream and downstream location (Table 1-3). Total flow measurements will be collected using an ISCO 2150 flowmeter.

1.5 Quality Objectives and Criteria for Measurement Data

The purpose of this project is to gather data for the development of a NARP.

1.5.1 Field Measurements and Observations

To collect data of the highest quality, extensive preventative maintenance and calibration are essential. Tables 1-5 and 1-6 show the parameters to be measured, meters to be used, measurement range of meter, accuracy of meter, and resolution of meter, as they pertain to the water quality monitoring project. Records will be kept of all calibrations and routine maintenance. The data will be analyzed to ensure that all data collected is of the highest quality.

Table 1-5. Specifications for Meters to be used during the Continuous Monitoring

Parameter	Meter	Meter Range	Accuracy	Resolution
Continuous Monitoring				
Water temperature	YSI EXO	-5 to +50°C	±0.01°C	0.001°C
DO	YSI EXO	0-50 mg/L	0-20 mg/L -- ±0.1 mg/L or ±1% of reading, whichever is greater 20-50 mg/L -- ±5% of reading	0.01 mg/L
pH	YSI EXO	0 to14 units	±0.1 pH units within ±10 °C of calibration temperature; ±0.2 pH units for entire temperature range	0.01 unit
Wiped Conductivity	YSI EXO	0 to 200 mS/cm	0-100 mS/cm	±1% of reading or 2 µs/cm w.i.g.

Table 1-6. Specifications for Spot Meters to be used during the Discrete Sampling

Parameter	Meter	Meter Range	Accuracy	Resolution
Discrete Monitoring				
Water temperature	ProDSS	-5 to +70°C	±0.2°C	0.1°C
DO	ProDSS	0-50 mg/L	0-20 mg/L (±0.1 mg/L or ±1% of reading, whichever is greater) 20-50 mg/L (±8% of reading)	0.1 or 0.01 mg/L (user selectable)
pH	ProDSS	0 to14 units	±0.2 units	0.01 unit
Conductivity	ProDSS	0 to 200 mS/cm	0-100 mS/cm ±0.5% of reading or 0.001 mS/cm, whichever is greater 100-200 mS/cm ±1% of reading	0.001, 0.01 or 0.1 mS/cm range dependent

1.6 Special Training and Certification

Only individuals who are trained in the various sampling protocols necessary for this study and have read and become familiar with this QAPP and Standard Operating Procedures (SOPs) will conduct sample collection. SOPs are compiled in Appendix B of this document. Prior to the sampling period, each member from Fehr Graham will undergo a 1-day training to ensure that staff are familiar with the various sampling protocols and associated SOPs contained within the QAPP.

1.7 Documents and Records

Fehr Graham will be responsible for managing the QAPP including version control, updates, distribution, and disposition. In the case of a revision, all appropriate project personnel will receive the revised version electronically in "*.pdf*" format.

Laboratory data will be reported to Fehr Graham in electronic forms.

Data collected during field activities will be reported to Fehr Graham in hardcopy and electronic forms. Field Sampling data forms have been developed for all aspects of data collection. Copies of these data forms are included in Appendix A.

All final data will be formatted and populated in an Excel database. In addition, all field sheets, notes or other field documents will be scanned and entered into the project database. Fehr Graham will be responsible for the final data review and formatting. Fehr Graham will provide finalized data to the modelers for analysis.

Fehr Graham will be responsible for managing and archiving all data including the sampling and analytical procedures, field logs, calibration logs, laboratory analytical results, management reports, communications, etc. pertaining to this project. All field records, logs, and electronic data will be retained for a minimum of five years.

2.0 Data Generation and Acquisition

2.1 Study Sites

As previously discussed in Section 1.4, field measurements, discrete water quality sampling, sestonic algae, and benthic algae will be sampled at 3 locations along Silver Creek. The sites were selected based on their location with respect to the Village of Woodstock WWTPs. Continuous monitoring and flow measurements will be performed at two stations along the Silver Creek.

Sampling sites are provided in Table 2-1. Figures 2-1 through 2-4 are maps of the sampling locations.

Table 2-1. Sampling Site Code and Name

Site Code	Site Name	Figure
	Study Area	2-1
WN-01	Silver Creek at bike path bridge off Melody Lane	2-2
WN-02	Silver Creek downstream of effluent	2-3
WN-03	Silver Creek at IL Route 47	2-4

Figure 2-1. Woodstock NARP Study Area

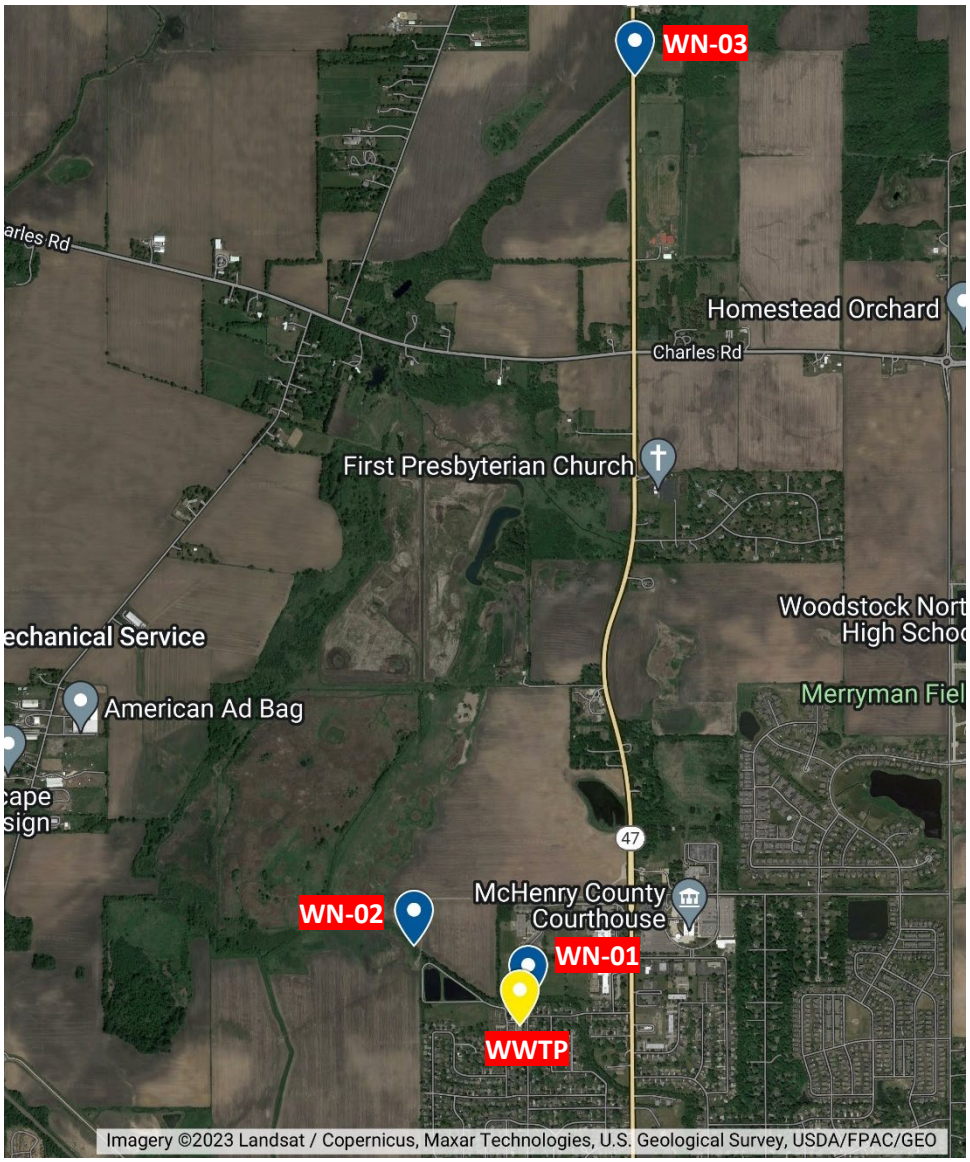


Figure 2-2. Site WN-01

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

Figure 2-3. Site WN-02

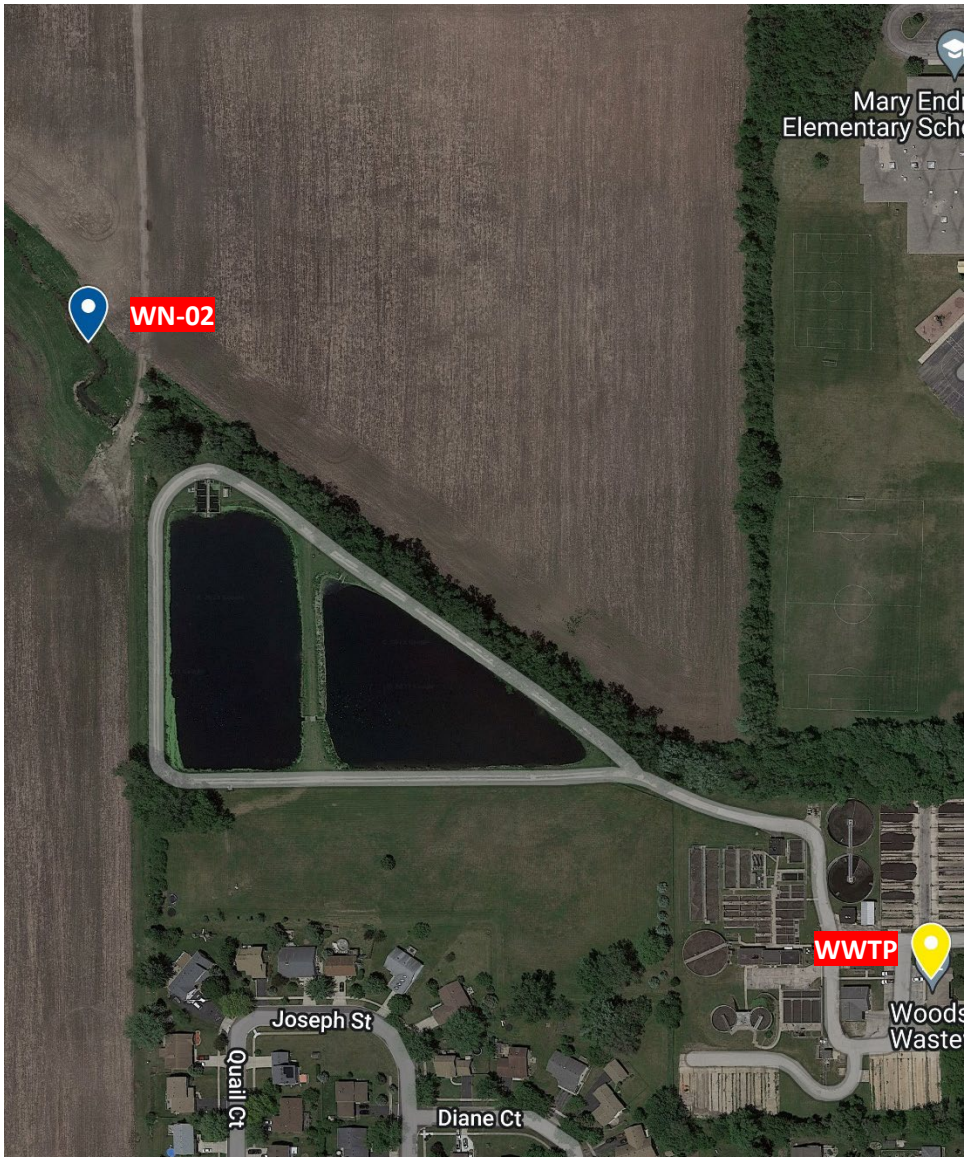
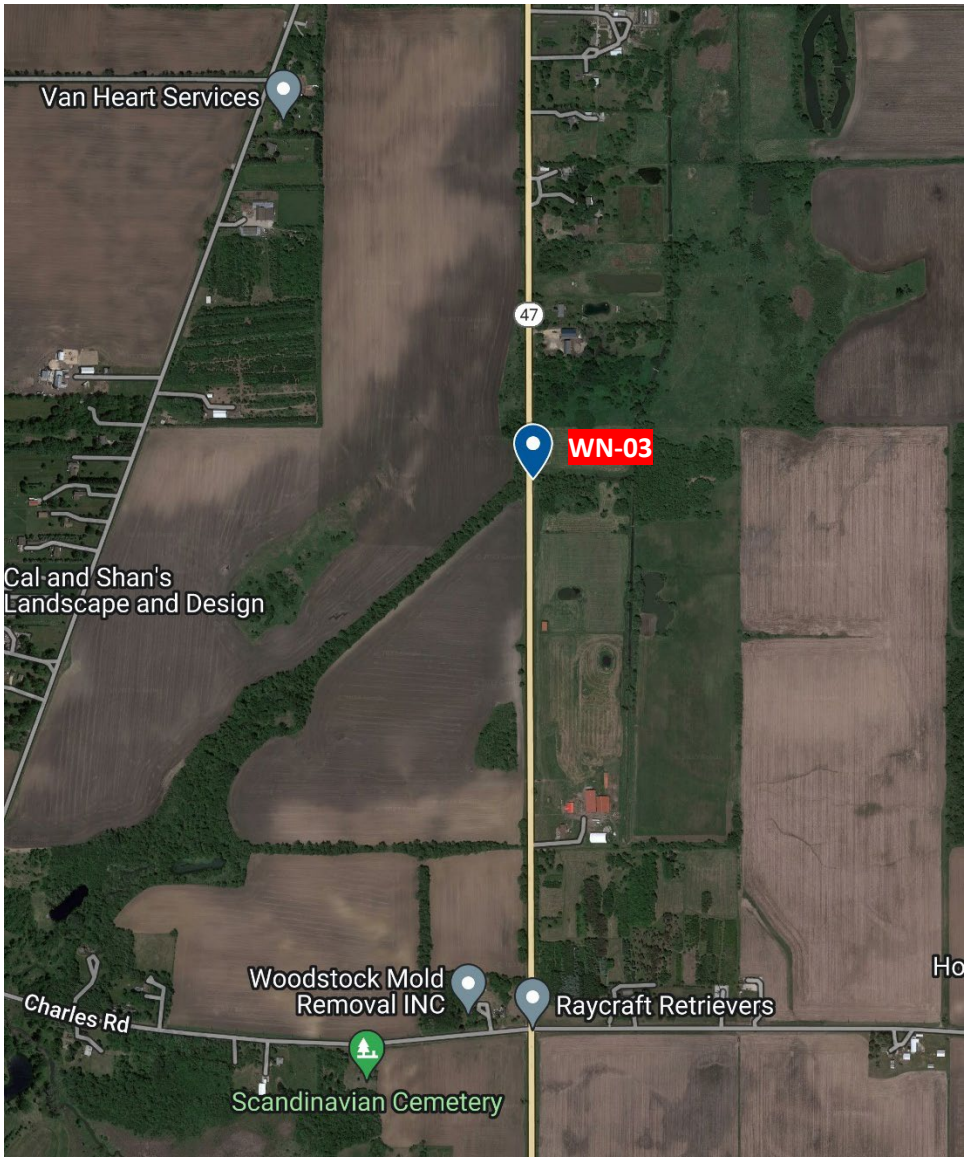


Figure 2-4. Site WN-03



2.2 Sampling Methods

As previously discussed, the monitoring project encompasses four sampling efforts: continuous water quality monitoring, discrete water quality sampling, benthic algae sampling, and total flow monitoring.

A standard operating procedure (SOP) manual has been developed detailing the step-by-step sampling process to be utilized in the field (Appendix B). The sections below discuss general field sampling methods.

2.2.1 Continuous Water Quality Monitoring

All water quality cross-section profiles will be collected using a spot meter. Continuous monitoring will be utilizing a YSI EXO data sonde. Data sonde specifications for range, accuracy, and resolution are summarized in Table 1-5 for the parameters of concern.

The sondes will be calibrated as recommended by the manufacturer. See Section 2.6 for details regarding sonde calibration. Calibration information is recorded on the Continuous Monitoring Log sheet, which can be found in Appendix A. Methods for sonde set-up, data download, deployment, and retrieval will be based on professional experience. Methods are detailed in the appropriate SOP (Appendix B). During the project DO, temperature, pH and conductivity measurements will be taken at 15-minute intervals and logged by the sonde. The sondes will be inspected, cleaned, and downloaded during each water quality sampling visit. At the time of retrieval, the sonde's calibration will be checked using a second calibrated sonde, placed as close to the deployed sonde as possible, to quantify sensor drift and/or effects of fouling. Once the deployed sonde has been retrieved a post-deployment calibration check, where the deployed sonde is cleaned, and all parameters are checked against known standards will be done.

2.2.2 Discrete Water Quality Monitoring / Sestonic Algae

2.2.2.1 Field Measurements

In-situ measures of water quality will be collected using YSI ProDSS spot meters. Meter specifications for range, accuracy, and resolution are summarized in Table 1-6 for the parameters of concern.

See Section 2.7 for details regarding the spot meter calibration. A copy of the Spot Meter Calibration Log can be found in Appendix A. At each site, the spot meters will be lowered directly into the water and allowed to stabilize prior to recording the data. Between sites, the meters will be rinsed and stored as recommended by the manufacturer.

2.2.2.2 Collection of Water Samples

Water samples will be collected using an Equal-Width-Increment sampling technique described in Edwards and Gylsson (1999). Wadeable channels will be sampled by submerging an open-mouthed bottle into the stream by hand using the methods outlined in Edwards and Gylsson (1999).

Samples will be collected at 10 verticals across the channel that will be pre-determined using an equal-width-increment sampling method. The water samples collected across channel will then be composited in a churn splitter before transferring into prepared bottles provided by the laboratory. Once all the bottles are filled, the bottles will be returned to the labeled bag from which they were removed and placed in an iced cooler for transportation to the laboratory.

Pace will provide a packaged, labeled set of bottles for each of the samples to be collected. The package will contain all the bottles necessary for the collection of the correct volume for analysis. In addition, these bottles will contain any necessary preservatives required for proper analysis as described in the analytical methods for each of the parameters to be measured. This ensures proper fixation of the samples and limits improper preservation and possible accidents associated with such chemical preservation.

2.2.3 Benthic Algae Sampling

The collection of benthic algal samples can be a complex exercise due to the variability of stream features such as depth, substratum flow velocity, and bottom characteristics. Several stream habitats may be encountered during the benthic algae sampling that each require appropriate method selection:

- Epilithic – benthic habitat consisting of course-grained substrates, bedrocks, or artificial hard substrates.
- Epidendric – benthic habitat consisting of woody substrate.
- Epiphytic – benthic habitat consisting of plants.
- Epipsammic – benthic habitat consisting of sand-sized (>0.064-2mm) particles.
- Epipelic – benthic habitat consisting of silt-sized (<0.064 mm) particles

Benthic algae sampling will be conducted at 3 stations along Silver Creek. The benthic algae sampling and processing will be collected using the procedures outlined in Chapter 4 of *Revised protocols for sampling algal, invertebrate, and fish communities as part of the National Water-Quality Assessment Program,* USGA Open-File Report 02-150 (Moulton et.al.2002). Immediately following the sample collection, the sample will be poured into an amber one liter

bottle. Refer to appropriate SOP (Appendix B) for additional details on the benthic algae sampling methods.

2.2.4 Total Flow Measurements

An ISCO 2150 flow meter will be deployed to collect total flow measurements. Flow measurements will be conducted at two sites that are not currently monitored by USGS gauges. The meters will be programed as recommended by the manufacturer. Methods for meter set-up, data download, deployment, and retrieval will be based on professional experience. Methods are detailed in the appropriate SOP (Appendix B). During the project flow measurements will be taken at 15-minute intervals and logged by the meter.

2.3 Sample Handling and Custody Requirements

All water quality samples will be transferred to an ice-filled cooler immediately following completion of sampling at a site. Samples will be transported to the laboratory while on ice as requested by the laboratory. At no time during the sample transport will the samples be removed from the cooler. Details about preservation techniques and holding times can be found in Table 2-2.

As samples are collected, the sample number, station code, date and time, and requested analyses are recorded on the chain of custody record. This chain of custody will accompany these samples as they progress through collection and analysis procedures. Upon arrival at the laboratory, the samples are relinquished to laboratory staff by a member of the sample collection team. As part of the relinquishment process, the recipient of the samples signs the chain of custody record and presents the collection team with a duplicate chain of custody record prior to release of the samples into laboratory custody. The original chain of custody is then returned to the project manager with the hard copies of the analytical results. If any discrepancies arise in the chain of custody, the results associated with that chain will be examined thoroughly prior to their inclusion in any analysis. An example of the chain of custody record can be found in Appendix A.

Table 2-2. Analytical Methods, Container Size, Preservation, Storage, and Holding Times

Parameter	Method Reference	Container/Preservative	Storage	Holding Time
Chlorophyll a	SM 10200H-1992	1000mL Amber Poly/NT	≤ 6°C, Protect from exposure to light.	Filter 24 hours upon receipt. Stored frozen for 28 days.
NH3	EPA 350.1R2.0 or SM4500 NH3 G 2011	250ml Poly/ H2SO4	≤ 6°C	28 days
NO2	EPA 300R2.1	125mL HDPE / NT	≤ 6°C	48 hours
NO3	EPA 300R2.1	125ml HDPE / H2SO4	≤ 6°C	48 hours
TKN	EPA 351.2 R2.0	250ml HDPE / H2SO4	≤ 6°C	28 days
TP	SM 4500P 1999	250ml HDPE / H2SO4	≤ 6°C	28 days
CBOD5	SM 5210B-2001	500 mL HDPE/NT	≤ 6°C	48 hrs

Note: NT=non-treated

2.4 Analytical methods

Continuous Water Quality Monitoring/Flow Monitoring

All field measurement methodologies used under this program will be EPA recognized methods. All monitoring is performed in-situ; therefore, there is no need for laboratory analysis.

Discrete Water Quality Monitoring/Benthic Algae Monitoring

All discrete water quality monitoring and sestonic algae sample collection and analysis methodologies used under this program will be EPA recognized methods. Laboratory analysis methods conducted by Pace, and equipment used for analyses can be found in Table 2-3.

Table 2-3. Analytical methods, SOP numbers, and analysis equipment

Parameter	*Method Reference*	*Lab SOP Number*	*Equipment Used for Analysis*
Chlorophyll a	SM 10200H-1992	Bench Reference Chorophyll a	Spectrophotometer
NH3	EPA 350.1R2.0 or SM4500 NH3 G 2011	405.4 Ammonia, skalar	Automated Spectrophotometer
NO2	EPA 300R2.1	418.7 Nitrite	Spectrophotometer
NO3	EPA 300R2.1	417.5 Nitrate, skalar	Automated Spectrophotometer
TKN	EPA 351.2 R2.0	436.2 TKN, skalar	Automated Spectrophotometer
TP	SM 4500P 1999	421.6 Phosphorus	Spectrophotometer
CBOD5	SM 5210B-2001	705.1 BOD, 813.1 LIMS BOD	DO Meter

2.5 Quality Control

To ensure that all data used is of the highest quality, quality assurance procedures discussed below will be conducted on all aspects of this project before the resulting data is finalized.

2.5.1 Field Measurement and Sample Collection

Field QA/QC will be obtained by using trained staff for all field measurements and sample collection. Only those individuals who have read this QAPP and associated SOPs prior to sample collection will conduct all measurements and sample collection. All parties will have been trained in each of the measurements or collections procedures that they will participate in.

All equipment used for field measurements will be properly maintained and decontaminated as described in the QAPP. Logs describing the calibration and maintenance of equipment will be kept, documenting all procedures conducted on equipment throughout the project sampling. Frequency and methods of calibration can be found in Section 2.7.

Prior to the start of the discrete water quality sampling, all equipment utilized in the discrete water quality sampling activities and benthic sampling activities including the composite samplers, churn splitters, and dredges will be decontaminated by placing the equipment in a detergent bath (>4% Alconox solutions) for a minimum of 2 hours. Once this time period is met, the bottle will be removed and rinsed with a 5% hydrochloric acid solution. Subsequently the equipment will be rinsed with deionized (DI) water. Following the field sampling activities at

each site, all field equipment utilized in the collection of the discrete and benthic algae samples will be rinsed with DI water followed by a river water rinse obtained from the next sampling site to be sampled. At the end of each sampling day all equipment will be washed with an Alconox solution, rinsed with DI, and then rinsed with a 5% HCL solution. After the acid rinse all equipment will be rinsed at least twice with DI.

Field collections and sample handling, preservation, and transport procedures are subject to audit by the Project Manager and anytime during this project.

2.5.2 QA/QC Samples

QA/QC samples will comprise a minimum of 10% of the total number of samples collected over sampling period. The QA/QC samples will be dedicated to field blanks to ensure the cleaning procedures are adequate.

2.5.3 Laboratory Analysis

All samples received by laboratory will be stored as described by method and holding times met to ensure accurate results. Pace will submit all applicable laboratory QC for review as part of this project. Quality control samples including field blanks and matrix spikes will also be analyzed to ensure data received is valid. Laboratory duplicates at a frequency of one duplicate per twenty samples analyzed will be analyzed by the laboratory. Matrix spikes and matrix spike duplicates will be analyzed by the laboratory at a frequency of at least one per twenty samples analyzed.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

All sampling and measurement equipment will be inspected for damage, excessive wear and/or obvious contamination before every use. All sampling equipment is routinely washed with a laboratory grade detergent such as Alconox.

Field staff will routinely perform preventative maintenance on all equipment. Regular maintenance helps ensure the best possible product while minimizing downtime and providing a margin of safety to the user. Each field vehicle is supplied with commonly required supplies and spare parts for the equipment being used. Each piece of equipment is maintained in accordance with the manufacturer's guidelines or in the case of some water quality sampling equipment, the requirements of a specific analytical method. Some procedures for specific equipment commonly used are outlined below.

2.6.1 Sondes

YSI EXO multi-parameter sondes are cleaned before and after each deployment with deionized water and wiped clean of fouling as per manufacturer instructions. Probes that fail to calibrate correctly, fail diagnostic checks, or otherwise appear compromised are replaced and sent to the manufacturer for repair. O-rings are lubricated yearly to ensure flexibility and watertightness. Voltage of internal batteries are checked before deployment and replaced if needed.

2.6.2 Spot meters

A YSI ProDSS multi-parameter sonde is used as a spot meter. This sonde is cleaned before and after each deployment with deionized water and wiped clean of fouling as per manufacturer instructions. Probes that fail to calibrate correctly, fail diagnostic checks, or otherwise appear compromised are replaced and sent to the manufacturer for repair. O-rings are lubricated yearly to ensure flexibility and watertightness.

2.7 Instrument/Equipment Calibration and Frequency

All calibrations will be conducted as recommended by the manufacturer. Calibration procedures and frequency for the Village of Woodstock Water Quality Monitoring can be found in Tables 2-4 and 2-5. If during the time of collection any values seem to fall outside of the expected range, these values will be noted and calibrations will be conducted upon completion of the sampling to verify the measurements taken. All calibration will be documented in the Calibration Log.

Table 2-4. Calibration Requirements for Meters to be used during the Continuous Monitoring

Parameter	Unit	Calibration / Verification	Calibration Frequency
Temperature	degrees C	NIST traceable thermometer	Once /year
DO	mg/L	Air-saturated Water	Within 24 hours prior to deployment and bimonthly
pH	Standard units	2 point; 7 and 10 standards	Within 24 hours prior to deployment and bimonthly
Wiped Conductivity	mS/cm	1 point;1.000 mS	Within 24 hours prior to deployment and bimonthly

Table 2-5. Calibration Requirements for Spot Meters to be used during the Discrete Monitoring

Parameter	Unit	Laboratory Calibration / Verification	Calibration Frequency
Temperature	degrees C	NIST traceable thermometer	Once /year
DO	mg/L	Air saturated Water (Air Calibration Chamber	Once /week
pH	Standard units	2 point; 7 and 10 standards	Once /week
Conductivity	mS/cm	1 point; 1.000 mS	Once /week

2.8 Data Management

The collected data stream consists of five main components: (1) Water Quality Profile Measurements (2) Continuous Water Quality Monitoring Data (3) Flow Measurement Data, (4) Water Quality Samples, and (5) Field Sheets. Data reduction, validation and reporting are outlined below. All field records, logs, and electronic data will be retained by Fehr Graham for a minimum of five years.

2.8.1 Water Quality Profiles

Cross-section profiles of stream water quality are performed at each site before deployment of continuous monitoring sondes. Measurement location, depth, time, and result values are recorded for each spot measurement on a cross-section survey site log (Appendix A).

Site logs are scanned, and all site log data are entered to Excel. Site log data and electronic records are reviewed by a second staff member and then graphed to produce a visual representation of cross-section conditions.

2.8.2 Continuous Water Quality Monitoring

Continuously monitored water quality data are downloaded from each sonde as *.csv files. All files are saved on field laptops and stored on a server which is regularly backed up.

2.8.3 Total Flow Measurements

Total flow measurements are collected using ISCO 2150 flow meters. Readings are taken every 15 minutes and logged in the meter. During each water quality sampling visit, data is downloaded to a field laptop and saved on the server upon returning to the office.

2.8.4 Water Quality Samples

All information describing the collection of water quality samples is recorded on a Water Quality Sampling Site Log (Appendix A) and is then transferred from the field sheets to the appropriate chain of custody sheet. Complete chain of custody documentation is included when samples are relinquished to the lab. Upon receipt of the samples, a laboratory staff member signs the chain of custody record and retains the originals. Example chain of custody forms are found in Appendix A. Sample information is manually entered to Excel.

Laboratory staff delivers results electronically to appropriate project staff to update the project database. Upon receipt results are imported to an Excel worksheet and reviewed and verified to ensure completeness and accuracy of data. COC information and results are reviewed by field personnel. The data manager is responsible for notifying appropriate project and laboratory staff of any corrections in sample information so that all parties may correct their records.

2.8.5 Field Sheets

Calibration logs of spot meters are compared with electronic calibration records to check for accuracy and completeness. The logs are scanned and all data are entered to Excel for further analysis. All data entry is reviewed by a second staff member.

During each field site visit, field staff complete a site log describing all aspects of the site conditions, methods followed and sample times (Appendix A). Once field personnel have returned from the field site logs are reviewed by a second staff member for completeness and accuracy. Any corrections are made in red liquid-ink pen and initialed by the reviewer. These sheets are scanned and stored on a server which is regularly backed up.

2.9 Inspection/Acceptance for Supplies and Consumables

Sampling bottles are inspected and accepted by Pace in accordance with all laboratory procedures and specifications contained in Analytical Laboratory, Inc. QAPP. The laboratory supervisors are responsible for verifying that supplies and consumables meet the specifications contained in the method SOPs.

All other equipment will be inspected and cleaned by the procedures previously discussed in this QAPP and applicable SOPs.

3.0 Assessment and Oversight

3.1 Assessments and Response Actions

Assessment activities occur routinely throughout the data collection effort. The Project Manager will verify the following on a regular basis:

- Data collection is occurring as planned.
- Field sheets and chain of custody forms are being properly completed.
- Sufficient written documentation and supporting photographs exist.
- Water quality samples are being collected using proper techniques.
- Data review is being properly completed and in a timely fashion.
- All paper field sheets are scanned to create electronic copies.
- All electronic data is being backed up and stored in multiple locations.

The results of these assessment activities are provided to project staff so that any corrective action can be initiated to ensure that data quality and data timeliness are not impacted.

3.1.1 Assessment of Sensor Performance

At the end of each continuous deployment, a newly calibrated sonde is deployed next to the sampling sonde. Sondes used for deployment undergo a calibration check after retrieval against known standards to determine calibration drift. All values are recorded onto the site log.

Sensor performance will be assessed using a combination of field observations, simultaneous reads between the deployed sensor and a freshly calibrated sensor, and post-deployments readings of calibration standards. Data grades will be assigned to rate the sensor performance. These grades (discussed in Section 4.0) are based on sensor error due to fouling and calibration drift.

The quality of discrete data will be determined by instrument drift, which is calculated using post-deployment reads of standard solutions after it has been used in the field.

The quality of continuous data is determined by instrument drift and fouling, which is calculated using simultaneous reads and post-deployment reads of calibration standards. A simultaneous read (SR) is when a freshly calibrated field meter is placed next to a deployed field meter so

they take readings under the same conditions. The difference in measurements between the deployed meter and the SR meter is used to determine the total amount of drift plus fouling that affected the deployed meter. This difference is presented both in terms of absolute and percent correction needed. Post-deployment reads of standard solutions are used to calculate drift. The amount of error due to fouling (as a percentage) is then assumed to be the difference between the total error as determined by simultaneous reads and the error due to drift.

3.1.2 Corrective Action for Out-of-Control Situations

Out-of-control situations are defined as those times when instrumentation utilized in the data collection process fails to collect the data or produces data or results that seem out of range. Despite careful planning and close attention to protocols and procedures, out-of-control situations may arise at any time in the field or laboratory due to malfunctioning equipment or human error.

When out-of-control situations occur in the field, personnel must recognize the situation, identify the problem, and initiate corrective action. Corrective action in the field generally consists of the repair, adjustment, reprogramming and/or re-calibration of the malfunctioning equipment. If this cannot be satisfactorily accomplished, then personnel will replace the equipment in question. Logbook and site log entries are made in the field to clearly define the situation as it was discovered, and to describe the corrective actions taken. No data are ever deleted or edited at this time.

Out-of-control situations in the laboratory are most often indicated by results from conditions at the site at the time the of data collection. If the situation still cannot be resolved, staff should contact the laboratory to verify the concentration results and to ask for any bench observations that might influence the concentration. Personnel will not modify data without a logical, fact-based, and verifiable reason for doing so. Staff should clearly mark any changes to the data or field sheets with a red liquid-ink pen, include a rationale for the change, and include initials by the person initiating the change.

3.2 Reporting and Resolution of Issues

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-limit QC performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. All corrective action proposed and implemented should be documented in the QA sections of project deliverables. Corrective action should only be implemented after approval by the Senior Environmental Scientist, or their designee. If

immediate corrective action is required, approvals secured by telephone from the Senior Environmental Scientist should be documented in an additional memorandum.

When a noncompliance issue is identified, the person who identifies the problem is responsible for notifying the Senior Environmental Scientist. Once notified, the Senior Environmental Scientist will then immediately develop and implement a formal corrective action program.

Any nonconformance with the established QC procedures in the QAPP will be identified and immediately corrected in accordance with the QAPP. The Senior Environmental Scientist or their designee will also issue a nonconformance report for each nonconformance condition.

3.3 Reports to Management

Those on the distribution list identified in Table 1-1 will receive all investigation and corrective action reports concerning quality control problems, noncompliance issues, and non-conformance issues from field personnel, Pace. The investigation and corrective action reports written by the Project Manager will be disseminated on an "as required" basis. These reports will identify the respective data set, the basis for its identification as invalid, and measures taken due to the findings.

Following the completion of the project, Fehr Graham will provide all data and photographs via a shared drive.

4.0 Data Validation and Usability

4.1 Data Review, Verification, and Validation

All monitoring data is processed and reviewed by the Senior Environmental Scientist following standard operating procedures (SOPs) to ensure the integrity of the data. The data review process can be summarized as follows:

- Raw or unit value data are never modified.
- Any changes/modifications/corrections to provisional data are documented with justification.
- All modifications are then reviewed by the Senior Environmental Scientist responsible for those data.
- All data are reviewed by a second party before deemed "final data".
- All files (raw, provisional, and final) are saved, catalogued and archived throughout the review process.
- All files are maintained in designated locations as outlined in the SOPs.

To comply with the requirements of this QAPP, all project data and quality control data will be critically reviewed by the Senior Environmental Scientist to determine if there are any issues that compromise data usability.

All data elements that are generated by this project will undergo a review process prior to their analysis and subsequent release in report form. There will be various levels of review scheduled to ensure that the data generated are valid for analysis. The data validation methods and procedures are discussed below.

4.2 Verification and Validation Methods

The procedures used to evaluate field data will include checking procedures utilized in the field, ensuring that field measurement equipment was properly calibrated, checking for transcription errors, and comparing the data to historic data or verifying its "reasonableness". Evaluation of the field data will be the responsibility of the Senior Environmental Scientist or their designee (a qualified individual who is not a part of the field team).

4.2.1 Continuous Monitoring and Spot Meter Data

The data grades presented in Table 4-1 are based on established data grade recommendations by Wagner et al. (2006) and the British Columbia Ministry of the Environment (2007)

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

The absolute value of the sum of calibration drift error and fouling is used to determine whether data correction is needed and to assign a quality rating. The data quality rating is applied to the entire deployment record and ranges from "Excellent" to "Not Valid". Any measurements of error that rate as "Not Valid" are considered of such poor quality that none of the record should be published unless ancillary information can determine when the record became invalid. Any record graded as "Excellent" does not undergo any data correction and is reported as measured. Records with lower grades are considered usable but must be corrected for calibration and fouling errors.

In cases where simultaneous readings or post-deployment reads of calibration standards are not available, that record will be assigned a rating of "DQNA" meaning "Data Quality Not Assessed".

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

Table 4-1. Data Grades for Water Quality Sensor Performance

		Excellent	Very Good	Good	Fair	Poor	Not Valid
Analyte	Measured Value	if less than or equal to…					if greater than…
DO	≤ 4.0 mg/L	+/- 0.2 mg/L	+/- 0.2-0.4 mg/L	+/- 0.4-0.6 mg/L	+/- 0.6-1.0 mg/L	+/- 1.0-2.0 mg/L	+/- 2 mg/L
	> 4.0 mg/L	+/- 5 %	+/- 5-10 %	+/- 10-15 %	+/- 15-25 %	+/- 25-40 %	+/- 40 %
pH		+/- 0.2	+/- 0.2-0.4	+/- 0.4-0.6	+/- 0.6-1	+/- 1-2	+/- 2
SpCond	< 100 µS/cm	+/- 3 µS/cm	+/- 3-6 µS/cm	+/- 6-9 µS/cm	+/- 9-15 µS/cm	+/- 15-30 µS/cm	+/- 30 µS/cm
	> 100 µS/cm	+/- 3 %	+/- 3-6 %	+/- 6-9 %	+/- 9-15 %	+/- 15-30 %	+/- 30 %
Temperature		+/- 0.2°C	+/- 0.2-0.4°C	+/- 0.4-0.6°C	+/- 0.6-0.8°C	+/- 0.8-2°C	+/- 2°C

4.2.2 Analytical Water Quality Data

Water quality data measured in the laboratory are assessed on accuracy, precision, representativeness, and completeness.

4.2.2.1 Accuracy

Accuracy is the degree of congruity between a measured value and the true, or accepted, reference value. Accuracy is influenced by: contamination, sample preservation, sample handling, sample matrix, sample preparation, and analytical techniques. Field staff will periodically collect field blanks to identify if sample contamination could be occurring and to help identify the source if contamination is documented. The laboratory will analyze lab blanks (reagent water) and lab control samples (LCS) (spiked with known concentrations of target analytes) to determine bias. Bias is evaluated by taking the spiked samples and calculating percent recovery as follows:

Percent Recovery = [(S - C) / T] *100
Where:
S = Measured spiked sample concentration
C = Sample concentration
T = True or actual concentration of the spike

Fehr Graham staff will compile all incidences of field blanks producing data above detection limits.

4.2.2.2 Precision

Precision concerns the variability among independent measurements performed under the same process in similar conditions. Split samples, or samples pulled from one larger sample, are used to test the precision of field practices under the influence of sample preservation, handling, and storage. Split samples can also provide insight into the precision of the analytical process.

Up to 10% of all samples will be field blanks or split samples. Further analysis of the analytical precision is obtained by comparing analysis of control samples (e.g. deionized water).

4.2.2.3 Representativeness

Representativeness refers to the ability of a sample to represent traits of the population of interest precisely and accurately, variability at a discrete sampling point, or characteristics of

a stream condition. Laboratory staff will ensure and evaluate representativeness using appropriate preservation techniques, adhering to holding time limits, and by analyzing lab blanks for contaminants. Data considered un-representative may be used only with qualifiers and limits of uncertainty.

4.2.2.4 Completeness

Laboratory staff will also perform a variety of tasks to ensure completeness. The labs will perform all requested procedures or document reasons for non-performance, record all pertinent dates, perform QC checks on each batch of samples, and ensure that constituents are within lab reporting limits (Table 4-2). In addition, Fehr Graham staff will compare received results with submitted COCs to ensure all requested analyses have been completed.

An independent assessment of the laboratory data will be performed by the Data Manager. The overall completeness of the data package will be evaluated. Completeness checks will be administered on all data to determine whether deliverables specified in the QAPP are present. At a minimum, deliverables will include all chain-of-custody forms, analytical results, and QC summaries. The reviewer will determine whether all required items are present and request copies of missing deliverables. In addition, holding times and the results of all internal laboratory QA/QC analyses will be reviewed/ evaluated.

Table 4-2. Measurement Quality Objectives

Analysis	*RDL*	*MDL*	*CCVS*	*LCS*	*Matrix Spike*		*Sample RPD %*
			Limit %	Limit%	Limit %	RPD %	
Chlorophyll a	1.0 mg/m3	NA	NA	NA	NA	NA	20
NH3	0.05 mg/L	0.027 mg/L	+/-10	NA	+/-10	20	20
NO2	0.01 mg/L	0.004 mg/L	+/-10	NA	+/-25	20	20
NO3	0.10 mg/L	0.05 mg/L	+/-10	NA	+/-10	20	20
TKN	1.0 mg/L	0.3 mg/L	+/-10	+/-20	+/-10	20	20
TP	0.01 mg/L	0.004 mg/L	+/-10	+/-20	+/-25	20	20
CBOD5	1 mg/L	NA	84-114	NA	NA	NA	NA

4.3 Reconciliation with User Requirements

QUALITY ASSURANCE PROJECT PLAN
FOR VILLAGE OF WOODSTOCK NORTHSIDE WASTEWATER TREATMENT PLANT
WATER QUALITY MONITORING

The QAPP will always govern the operations of the project. Each of the project participants will adhere to the procedural requirements of the QAPP and ensure that all co-participants do likewise.

If the project continues beyond the current project time frame, the QAPP will be reviewed annually to ensure that the project will achieve all intended purposes. All the individuals identified on the distribution list (Table 1-1) will participate in the QAPP review process. The annual review will include every aspect of the QAPP including:

1. The location of each sampling location
2. The adequacy of sampling frequency at each location
3. Sampling procedures
4. The appropriateness of the parameters monitored at each location
5. Changes in data quality objectives
6. Analytical procedures
7. Corrective actions taken during the previous year for field and laboratory procedures
8. Review of other user requirements and recommendations

Following the annual QAPP review, Fehr Graham will prepare the annual QAPP update.

The project may also be modified as directed by the Village of Woodstock. The Senior Project Manager will be responsible for the implementation of the changes and document the elective date of all changes. Following approval, an addendum documenting each of the authorized changes will be prepared by the Senior Project Manager or a designee and disseminated to all those on the distribution list and those working on the project.

5.0 References

Illinois Environmental Protection Agency (IEPA), 2018. The IEPA Illinois Water Quality Report 2018. (http://www.epa.state.il.us/water/)

Moulton, S.R., J.G. Kennen, R.M. Goldstein, and J.A. Hambrook. 2002. Revised protocols for sampling algal, invertebrate, and fish communities as part of the National Water-Quality Assessment Program. USGS Open-File Report 02-150.

Thomann, R. V., and Mueller, J.A., 1987, Principles of surface water quality modeling and control: New York, Harper and Row, p. 291–293.

United States Environmental Protection Agency (USEPA). 1994. SOP #2016 Rev. #0.0.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A. 2006. Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments.

APPENDIX A

FORMS

Form	Revision Date
Spot Meter Calibration Log	3/19/2021
Water Quality Cross-Section Survey Log	6/18/2012
Continuous Monitoring Site Log	3/7/2023
Water Quality Sampling Site Log	3/7/2023
Benthic Algae Site Log	3/7/2023
Stream Physical Characteristics Log	3/7/2023
Pace Chain of Custody (COC)	3/7/2023
Flow Meter Installation Form	3/7/2023
Flow Meter Maintenance Data Sheet	3/7/2023

Spot Meter Calibration Log

Equipment:_____ Sonde/Cable Serial # _____

Measurement Type (check one)	□ Calibration □ Post deploy	□ Calibration □ Post deploy	□ Calibration □ Post deploy	□ Calibration □ Post deploy	□ Calibration □ Post deploy
Handheld Serial #					
Date					
Time					
Initials					
Cup Temperature					
Barometer					
Zero Conductivity Check (test again if ≠ 0)					
Sp Cond - Standard Value					
Sp Cond - Pre-cal/Post deploy					
Sp Cond - Post-cal reading					
pH 7 - Standard Value					
pH 7 - Pre-cal/Post-deploy					
pH 7 - Post-cal reading					
pH 10 - Standard Value					
pH 10 - Pre-cal/post-deploy					
pH 10 - Post-cal reading					
DO mg/L - Pre-cal/post-deploy					
DO %Sat - Std.Val. (barometer/7.6)					
DO %Sat - Pre-cal/post-deploy					
DO %Sat - Post-cal reading					
DO mg/L - Post-cal reading					
Battery Voltage					
pH 7 Buffer mV (Range -50 to +50 mV)					
pH 10 Buffer mV (Range -230 to -130 mV)					
pH Buffer diff. (pH10 buffer - pH7 buffer)					
DO Cup Temperature					
Cond Cell Const (Range 4.55 to 5.45)					
DO Sensor Value/ODO gain					

Comments:

Project: _____

Field WQ Cross-Section Survey Site Log

Site ID:_____ Site Name:_____ Date:_____/_____/_____

Personnel:_____ CST Time In:_____ Time Out:_____

Weather:_____ Appearance of Water/Debris:_____

Equipment Model:_____ Serial No._____ Cable Serial No. _____

GPS: (LDB / RDB): N_____ W_____ ±_____ (LDB / RDB): N_____ W_____ ±_____

Approx. Location of XS:_____ XS width:_____

Vertical No.	Dist. From: LDB / RDB (circle one) units: _____	Total Depth (ft)	Measure-ment Depth below surface (ft)	Time (CST)	Temp (C)	Barometer (mm Hg)	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Specific Conduct-ance (µS/cm)	pH

Comments (note substrate at each vertical):_____

_____

_____

Project: ___________________________

Field WQ Cross-Section Survey Site Log

Page _________ of ________

Site ID: ________________________ Date: _______/_______/__________

Vertical No.	Dist. From: LDB / RDB (circle one) units: __________	Total Depth (ft)	Meas. Depth below surface (ft)	Time (CST)	Temp (C)	Barometer (mm Hg)	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Specific Conduct ance (µS/cm)	pH

Rev. 6/18/2012 (jih)

Village of Woodstock NARP - Continuous-Monitoring Log Sheet

SITE VISIT

Date: _____ Staff: _____ Site Name: _____

Calibration of simultaneous read (SR) sonde

Date: _____ Time: _____ Technician: _____

SR Sonde ID: _____ Cup Temp (°C): _____ BP (mm Hg): _____

	Sp Cond uS/cm	pH 7 Units	pH 10 Units	DO % Sat	DO mg/L	
Standard:						BP / 7.6 = % Saturation Standard
Pre-Calibrated:						
Post Calibrated:						

Battery V	pH 7 Buffer mV	pH10 Buffer mV	Cond. Const	DO Gain
change if < 80%	range -50 to +50 mV	range -230 to -130 mV	range 4.55 to 5.45	range 0.7 to 1.4

Arrival Time: _____ Departure time: _____ Flow at nearest USGS gauge: _____ cfs @

Air Temp: _____ % cloud cover: _____ Precip: [ ] None [ ] Light [ ] Medium [ ] Heavy

Wind speed (mph): [ ] 0-5 [ ] 5-10 [ ] 10-15 [ ] 15+ Wind Direction: _____

Purpose of Visit: [ ] Deployment [ ] Maintenance [ ] Retrieval

Pre deployment/retrieveal SR sonde instream readings

Temp °C	Sp Cond uS/cm	pH Units	DO % Sat	DO mg/L	BP mm Hg	Time CDT

Condition/Description of sonde upon retrieval: _____

Approximate Location of Sonde

Sonde ID: _____ Cup Temp (°C): _____ BP (mm Hg): _____

Rev. 3/7/2023 (lrd)

	Temp °C	Sp Cond uS/cm	pH Units	DO % Sat	DO mg/L	BP mm Hg	Time CDT
SR Sonde							
River Sonde							

Calibrate if not within +/- 5%

	Sp Cond uS/cm	pH 7 Units	pH 10 Units	DO % Sat	DO mg/L	
Stan.						BP / 7.6 = % Saturation Standard
Pre						
Post						

	Chlorophyll RFU		Chlorophyll ug/L		BGA-PC RFU		BGA-PC ug/L		Calibration Temp.
Stan.	0.00		0.00		0.00		0.00		
Pre									
Post									

Calibration Parameters

Battery V	pH 7 Buffer mV	pH10 Buffer mV	Cond. Const	DO Gain
change if < 80%	range -50 to +50 mV	range -230 to -130 mV	range 4.55 to 5.45	range 0.7 to 1.4

File Name: _____ (Site code Year Month Day)

Installation of Sonde

Placement of Sonde:

_____

GPS: N _____ W _____ ± _____

Stream Depth at placement of sonde: _____ (ft)

Placement depth of sonde: _____ (ft) **Below Surface**

~ 2/3 depth below surface and > 6 inches above the bed or [ ] 6 inches from bottom [ ] used heavy mount

Channel Unit of Sonde placement: [ ] Riffle [ ] Run [ ] Pool

Sonde start time: _____ (24 hr CDT) Sonde time interval (min): 15

Post deployment SR sonde instream readings

Temp °C	Sp Cond uS/cm	pH Units	DO % Sat	DO mg/L	BP mm Hg	Time CDT

Comments/Notes

_____

_____

_____

_____

_____

_____

Rev. 3/7/2023 (lrd)

Village of Woodstock NARP Water Quality Monitoring Site Log

Site ID: _____ Site Description: _____

Date_____/_____/_____ CDT Time In_____ Time Out_____ Personnel: _____

Weather: _____ Tape Down (ft):_____

Instantaneous Value Measurements @ _____ (CDT time) Percent of Cross-section Shaded: _____

% Temp (°C): _____ DO (% sat): _____ SpCond (µS/cm): _____

BP (mm Hg): _____ DO (mg/L): _____ pH: _____

Sample No.	Time (CDT)	Sampling Location or Station (s)	Sampler Used	Analysis Requested		
				CBOD5, NO2,	TP, DRP,NO3, NH3, TKN,	Chlorophyll a

Village of Woodstock NARP Water Quality Monitoring Site Log

Site ID: _____ Site Description: _____

Date_____/_____/_____ CDT Time In_____ Time Out_____ Personnel: _____

Weather: _____ Tape Down (ft):_____

Instantaneous Value Measurements @ _____ (CDT time) Percent of Cross-section Shaded: _____

% Temp (°C): _____ DO (% sat): _____ SpCond (µS/cm): _____

BP (mm Hg): _____ DO (mg/L): _____ pH: _____

Sample No.	Time (CDT)	Sampling Location or Station (s)	Sampler Used	Analysis Requested		
				CBOD5, NO2,	TP, DRP, NO3, NH3, TKN,	Chlorophyll a

Notes: _____

_____

_____

_____

_____

_____

Site Information

Station ID: _____

Personnel: _____

DATE_____/_____/_____

Site Name: _____

CDT 24-hr Time In _____ Time Out _____

GPS Location N_____, W_____

Precipitation: □ light □ moderate □ heavy □ none

Water Clarity (circle): very turbid turbid slightly turbid clear

Riparian Shading (circle): exposed partial full sun

Water Color: _____

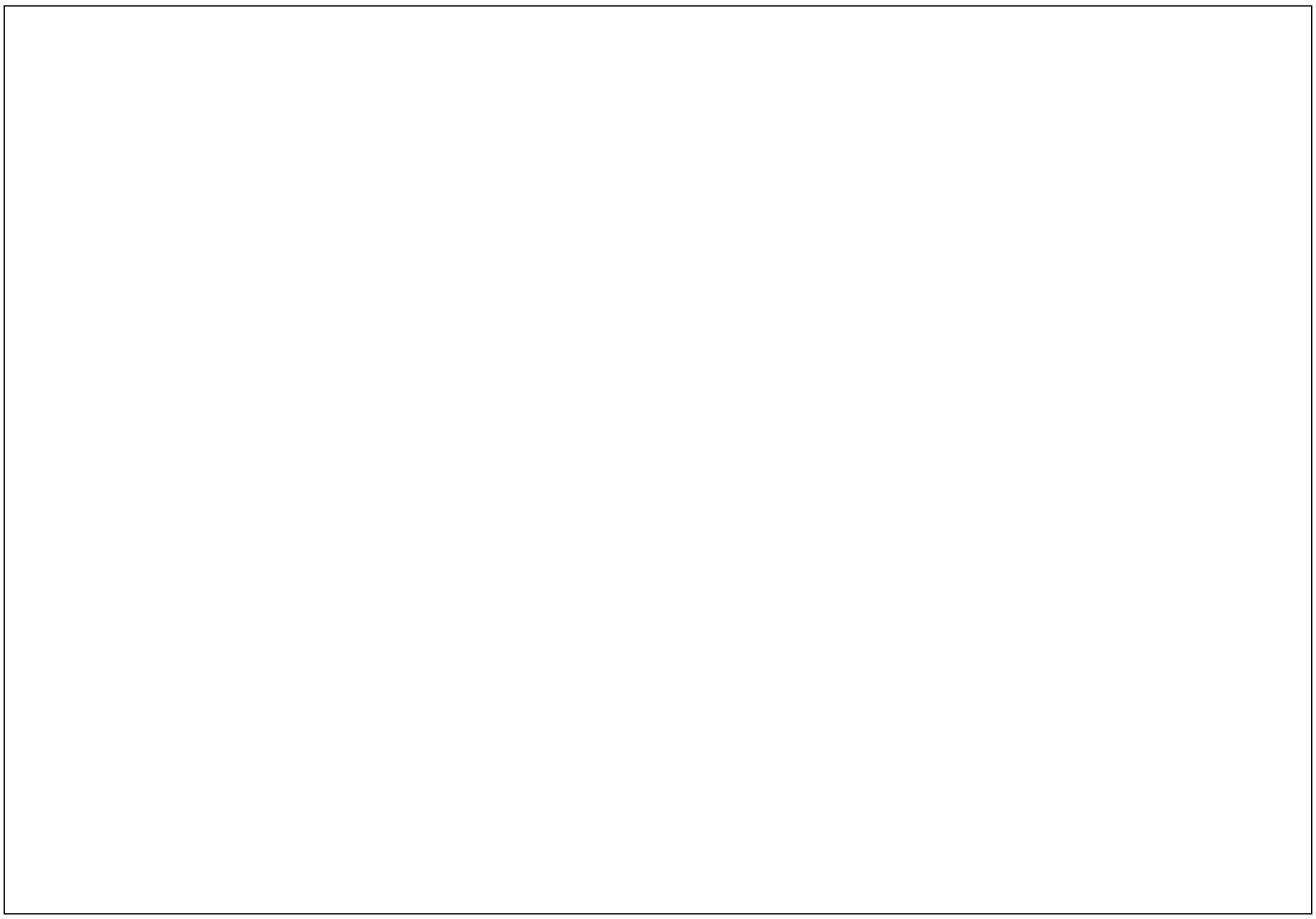
Sampling Information

Periphyton Microhabitat Type Sampled	
Sampling Method or Device	
Area Sampled by Device (surface area)	
Number of areas sampled	
Sample numbers	

Notes for surface area calculation

Location ID _____

Site and Sample Location Sketch



Notes

_____

_____

_____

_____

_____

_____

_____

_____

_____

Location ID _____

Filamentous Algae Measurements: Use View Bucket

Segment No.	Water Depth	% SAV Cover*	% Filamentous Algae Cover	Algae Thickness	Notes

***submerged aquatic vegetation**

Site Information

Station ID: _____

Personnel: _____ _____

DATE_____/_____/_____

Site Name: _____

Weather: _____

Appearance of Water/Debris: _____

Total Wetted Width of Stream _____

Vertical No.	**Distance from LDB/RDB (circle one)**	**Total Depth**	**Substrate Type*:**		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

***Substrate Type: Si = Silt, Sa = sand, G = gravel, C = cobble, B = boulders, O = other, specify in notes.**

Erosion (circle one): None/Little Moderate Heavy/Severe

Riparian Width: Wide >50 m, Moderate 10-50m, Narrow 5-10m, Very Narrow <5 m, None **(circle one)**

Current Velocity: Torrential, Very Fast, Fast, Moderate, Slow,
(circle all that apply) Interstitial, Intermittent, Eddies

Canopy Cover Measurements: Densiometer (Score: 0-17 max)

Vertical No.	Upstream	Left	Downstream	Right
LDB				
3				
5				
7				
RDB				

Instream Coverage in Channel

Constituent	Score *
Filamentous Algae	
Aquatic Macrophytes	
Woody Debris (>0.3 m)	
Brush/Woody Debris (<0.3 m)	
Live Trees or Roots	
Overhanging Vegetation <= 1 m of surface	
Undercut Banks	
Boulders	
Artificial Structures	
Shallows (in slow waters)	
Oxbows, Backwaters	
Other (specify)	

* Scoring: 0 = absent, 1 = sparse (<10%), 2 = moderate (10-40%),
3 = heavy (40-75%), 4 = (>75%)

Company Name/Address:
Fehr Graham Engineering & Environmental
230 Woodlawn Avenue
Aurora, IL 60506

Billing Information:
Fehr Graham Engineering & Environmental
101 West Stephenson Street
Freeport, Illinois 61032

Report to: **Leonard Dane**

Email To: **ldane@fehrgraham.com**

Project Description: Village of Woodstock North NARP Monitoring

City/State Collected: **Illinois**

Please Circle: PT MT CT ET

Phone: **630-423-0479**

Client Project # **23-215**

Lab Project #

Collected by (print):

Site/Facility ID #

P.O. #

Collected by (signature):

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed

Chain of Custody Page ___ of ___

Pace
PEOPLE ADVANCING SCIENCE

12065 Lebanon Rd Mount Juliet, TN 37122
Phone: 615-758-5858 Alt: 800-767-5859

Submitting a sample via this chain of custody constitutes acknowledgment and acceptance of the Pace Terms and Conditions found at: https://info.pacelabs.com/hubfs/pas-standard-terms.pdf

SDG #

Table #

Acctnum:

Template:

Prelogin:

PM:

PB:

Shipped Via:

Sample ID	Comp/Grab	Matrix*	Depth	Date	Time	No. of Cntrs	Pres Chk	NH3, NO3, TKN, TP, DRP, TSS	NO2, BOD5	Chl-a							Remarks	Sample # (lab only)
WN-01-XX-u/s of WWTP	Comp	OT						X	X	X								
WN-01-99-XX-u/s of WWTP	Comp	OT								X								
WN-02-XX-d/s of WWTP	Comp	OT						X	X	X								
WN-02-99- XX - d/s of WWTP	Comp	OT								X								
WN-03-xx-u/s conf w/Nippersink	Comp	OT						X	X	X								
WN-03-99-xx-u/s conf w/Nippersi	Comp	OT								X								

* Matrix:
SS - Soil **AIR** - Air **F** - Filter
GW - Groundwater **B** - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other_____

Remarks:

pH _____ Temp _____

Flow _____ Other _____

Samples returned via:
__ UPS __ FedEx __ Courier __ _____

Tracking #

Sample Receipt Checklist
COC Seal Present/Intact: __NP __Y __N
COC Signed/Accurate: __Y __N
Bottles arrive intact: __Y __N
Correct bottles used: __Y __N
Sufficient volume sent: __Y __N
If Applicable
VOA Zero Headspace: __Y __N
Preservation Correct/Checked: __Y __N
RAD Screen <0.5 mR/hr: __Y __N

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCL / MeoH TBR	
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Temp: °C Bottles Received:	If preservation required by Login: Date/Time
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: Time:	Hold: / Condition: NCF / OK

Flow Meter Installation Form

Date: _____

Installer(s): _____

Flow Meter Serial # : _____

Bank Height Under Maximum Level _____

Width at Top of Bank _____

Width at Stream Bed _____

Current Stream Level - Measured _____

Flow Meter Serial # : _____

Bank Height Under Maximum Level _____

Width at Top of Bank _____

Width at Stream Bed _____

Current Stream Level - Measured _____

Notes:

Date: _____

Flow Meter Downloads and Battery Check

Silver Creek - Village of Woodstock - NARP Monitoring

Fehr Graham Job # 23-215

Flow Meter #	Location	Download	Battery Check	Battery Change	Desiccant Check

APPENDIX B

Standard Operating Procedures

SOP	Revision Date
Continuous Monitoring Using YSI EXO	3/7/2023
Discrete Measurements of Water Quality	3/7/2023
Discrete Sampling	3/7/2023
Benthic Algae Sampling	3/7/2023
Total Flow Measurements	3/7/2023
Equipment Cleaning	3/7/2023
Stream Canopy Cover Measurement	3/7/2023

STANDARD OPERATING PROCEDURE: CONTINUOUS MONITORING USING YSI EXO SONDES

1.0 Introduction

1.1. Scope
This Standard Operating Procedure (SOP) is applicable to the continuous monitoring of dissolved oxygen, temperature, pH, conductivity and chlorophyll using YSI EXO sondes in rivers and streams.

1.2. The purpose of this SOP is to provide a framework for the continuous monitoring of dissolved oxygen, temperature, pH, conductivity and chlorophyll (reference point only) using YSI EXO3. These procedures include instructions on sonde calibration, selection of sonde deployment locations, sonde deployment, sonde retrieval, and sonde data download.

2.0 Definitions

2.1. Aeration Stone: A stone used to diffuse injected air into water.

2.2. Conductivity: The ability of an aqueous solution to carry an electrical current.

2.3. Dissolved Oxygen: A relative measure of the amount of oxygen (O_2) dissolved in the water.

2.4. In-situ: In place. An *in-situ* environmental measurement is one that is taken in the field, without removal of a sample to the laboratory.

2.5. Material Safety Data Sheets (MSDS): A compilation of information required under the OSHA Communication Standard on the identity of hazardous chemicals, health, and physical hazards, exposure limits, and precautions.

2.6. pH: A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

2.7. Chlorophyll: Any of several related green pigments found in the chloroplast of algae and plants.

2.8. Phycocyanin: Any of a group of blue photosynthetic pigments represented in cyanobacteria.

2.9. Sonde: Water quality monitoring device having self-contained power and data storage to allow for unattended continuous monitoring of selected water quality parameters.

3.0 Health and Safety Warnings

3.1. When using the standards avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the Material Safety Data Sheets (MSDS) for prompt action.

3.2 All standard solutions for calibrating pH contain the following compounds: pH 7 Solutions: Sodium Phosphate (dibasic), Potassium Phosphate (Monobasic), Water. pH 10 Solutions: Potassium Borate (Tetra), Potassium Carbonate,

Potassium Hydroxide, Sodium (di) Ethylenediamine Tetraacetate, Water. Avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the MSDS for prompt action.

3.3 Rhodamine dye will stain hands and clothes.

3.4 Risk of injury may exist while deploying sondes in streams. Deployment and retrieval may result in exposure to sewage and bacteriologically contaminated water. All field-sampling personnel should therefore be adequately protected against risk of exposure to such contaminants.

3.5 While working in the field, the field crew shall carry a complete first-aid kit that provides materials for disinfection and protection of any skin cuts or abrasions and water for washing off chemical exposures. Personnel will promptly attend to any such cuts or abrasions and seek medical attention if appropriate.

3.6 Walking in streams requires the use of waders. Care should be taken to establish footing before moving forward.

3.7 There shall be no fewer than two people on site while deploying or retrieving a sonde.

3.8 Each field crew should have a cellular phone in case of emergencies.

4 Interferences

4.1 Interference may result from using contaminated equipment, solvents, reagents, sample containers, or sampling in a disturbed area.

4.2 Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. Clean and decontaminate all sampling equipment prior to use and between each sampling sites. See the SOP for Field Cleaning of Sampling Equipment for details on the cleaning and decontamination procedures.

4.3 Interferences can also occur during the course of an unattended deployment. For example, physical damage to probe membranes can be caused by natural or manmade debris; debris such as leaves or plastic can cover probes, or sediment can partially or completely cover probes. Also, oils, paints or other substances in the water may come into contact with probe membranes causing inaccurate readings.

5 Personnel Qualifications

5.1 Personnel will be trained in the proper use and calibration of all sampling equipment by an experienced person prior to data collection.

5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP) for the FRSG DO Monitoring Project.

STANDARD OPERATING PROCEDURE:
CONTINUOUS MONITORING USING YSI EXO SONDES

---

6 Materials

- 6.1 Toughbook/laptop computer
- 6.2 pH Standards of 7 and 10
- 6.3 Conductivity standards of 1.000 mS
- 6.4 0.625 mg/L Rhodamine solution (prepare daily, good for 24 hours)
- 6.5 DI water
- 6.6 YSI EXO sonde with attached pH, temperature/conductivity, dissolved oxygen, and total algae sensors
- 6.7 Protective guard and calibration cup for sondes
- 6.8 Protective enclosure for sondes
- 6.9 YSI Pro DSS
- 6.10. Engineer's folding rule
- 6.10 Range finder
- 6.11 Buoys/heavy mount
- 6.12 Personal floatation jacket
- 6.13 Clipboard
- 6.14 Calibration logs
- 6.15 Deployment/Retrieval logs
- 6.16 Pen

7 Pre-sampling

- 7.1 Obtain the necessary sampling equipment.
- 7.2 Prepare a schedule and coordinate with staff.
- 7.3 Inspect and calibrate sondes using procedures outlined in the EXO User Manual. Any damaged equipment not working within manufactures recommended tolerances will be repaired or replaced prior to deployment.

8 Procedures

- 8.1 Calibration Procedures. The sonde is cleaned before each calibration. Calibrating in order of dissolved oxygen, specific conductance, pH and then total algae provides the most efficient use of cleaning and greatest accuracy of standard values. The most common values of standards are: Specific Conductivity – 1.000 millisiemens/cm, pH – 7 and 10 at 25C, DO – 100% saturation at 760 mm Hg, Total algae - 125 mg/L Rhodamine WT standard prepared from a commercially obtained Rhodamine WT 2.5% solution. The 125 mg/L solution is diluted to 0.625 mg/L for field use.
  - 8.1.1 Specific Conductivity
    - 8.1.1.1 Specific conductivity is a 1-point calibration but utilizes a 0-value check.
    - 8.1.1.2 Remove calibration cup, fill with DI for a rinse. Rinse by reattaching cup filled with DI and gently shaking to remove particulates.

8.1.1.3 Pour out DI and use black brush to clean ports of conductivity probe. Use Kimwipes to wipe down all probes and the calibration cup.
8.1.1.4 While dry, record value from probe. If not 0.000 ms/cm, clean again and use compressed air to dry the electrodes of the probe. Record value from probe.
8.1.1.5 Pour several ml's of Conductivity Standard into the calibration cup, reattach cup and rinse probes with the Standard.
8.1.1.6 Discard rinse and fill to line with clean standard. Lay sonde on its side so that entire conductivity probe is under the solution. Gently shake the sonde to remove air bubbles from the conductivity probe.
8.1.1.7 Allow the Sonde to stabilize (at least 1 minute) record temperature and sp. cond. value.
8.1.1.8 Observe the pre-calibration value readings and the data stability and when they are stable, click Apply to accept the calibration.
8.1.1.9 Click complete. View the calibration summary screen and the QC score.
8.1.1.10 Record pre- and post-calibration readings on the Continuous Monitoring Log Sheet.
8.1.1.11 Click Exit to return to the sensor calibration menu.
8.1.1.12 Unscrew calibration cup, discard solution.

8.1.2 Dissolved Oxygen

8.1.2.1 Use a 1-point calibration
8.1.2.2 Calibrate using the water- saturated air method
8.1.2.3 Use Kimwipes to dry off sonde probes.
8.1.2.4 Put 1/8" of water in calibration cup. Screw the calibration cup on one quarter of a turn, do not tighten. Make sure that probes are above water. Wait 1 minute.
8.1.2.5 Select ODO calibration.
8.1.2.6 Enter current Barometric Pressure in mmm of Hg (inches of Hg x 25.4 = mm Hg) or read it from the Pro DSS.
8.1.2.7 Observe the pre-calibration value readings and data stability and when they are stable, click Apply to accept the calibration point. Click Complete.
8.1.2.8 View the Calibration Summary screen and QC score.
8.1.2.9 Record the pre- and post-calibration values on the Continuous Monitoring Log Sheet.
8.1.2.10 Click exit to return to calibration menu.

8.1.3 pH

8.1.3.1 Use a 2-point calibration.
8.1.3.2 Select pH calibration, 2-point option
8.1.3.3 Fill with several ml's of pH 7 solution, rinse cup and probes. Discard solution.

8.1.3.4 Fill calibration cup to line with pH 7 standard. Use the appropriate pH value adjusted for temperature. Wait at least one minute for temperature to stabilize

8.1.3.5 Observe pre-calibration pH value and wait for it to stabilize. Select Calibrate.

8.1.3.6 Select add another Cal Point. Rinse with DI and add the 10-buffer solution.

8.1.3.7 Allow temperature to stabilize at least one minute, then repeat calibration procedure.

8.1.3.8 Record the pre- and post-calibration values on the Continuous Monitoring Log Sheet.

8.1.4 Total Algae (TAL)

8.1.4.1 This is a 2-point calibration.

8.1.4.2 The chlorophyll (chl) channel and the phycocyanin (PC) channel are calibrated separately. Calibrate for both RFU and ug/L.

8.1.4.3 Prepare a 0.625 mg/L Rhodamine solution.

8.1.4.4 Select the channel to be calibrated (chl or PC) and the units you intend to use (RFU or ug/L).

8.1.4.5 Fill calibration cup with clean water that is free of particles. Place sensor in cup. A graph will show while the sensor is stabilizing. Enter a "Standard Value" of 0 when the data stability indicates "Stable" click to "Apply" the calibration.

8.1.4.6 Select "Add Another Cal Point" and proceed.

8.1.4.7 Fill the calibration cup with the 0.625 mg/L Rhodamine solution. Enter the temperature-compensated value for this solution found at the end of this SOP.

8.1.4.8 After entering the value wait for the sensor to show "Stable" and then click "Apply".

8.1.4.9 Record the pre- and post-calibration values on the Continuous Monitoring Log Sheet.

8.1.4.10 Select "Complete Calibration" and then "Exit.

8.1.4.11 Select the channel to be calibrated (chl or PC) and the units you intend to use (RFU or ug/L).

8.1.4.12 Continue to calibrate until both channels are calibrated to RFU and ug/L.

8.1.5 Diagnostic Values. After calibration is complete, record the diagnostic values for specific conductivity, dissolved oxygen and pH. Ensure that meet manufacturer specifications. Replace any probe that fails to calibrate properly.

8.2 Procedure for selecting sonde deployment locations.

8.2.1 Select appropriate deployment apparatus for the stream cross-section to be measured and mount appropriate DO and temperature sensing equipment.

8.2.2 At each sampling site, measure the stream width using a range finder or other appropriate measuring device. Be sure to approach each measurement location from a downstream location.

8.2.3 After the total stream width is determined, divide the stream width by 10. Divide the resultant by 2 and add this number to the water's edge measurement. This is the location of the first measurement vertical. Each of the subsequent 9 verticals are spaced according to the resultant of the stream width divided by 10. *Example:* A stream that is 100' in width and an initial water's edge of zero would have its first station at 5 feet (100/10 =10, 10/2=5) and the subsequent station at 15 (5+ 100/10), 25, 35… 85, and 95 feet from the initial water's edge.. Note the sections must be at least 6 inches apart.

8.2.4 At each equal distant location, measure the total stream depth. At each distance measure water quality parameters at multiple depths spaced 1ft apart. The shallowest measurement will be 1 ft below the surface. The deepest measurement will be 0.5 ft above the bottom.

8.2.5 For each measurement record distance, depth, time, and water quality results on the cross-section survey site log.

8.2.6 Data will be graphed and evaluated in order to determine the deployment location at each site that is most representative of the entire stream width.

8.3 Sonde Deployment Procedures

8.3.1 Place the sonde, in a location determined to be representative of the channel cross section in water that is at least one foot deep. Suspend the sonde at least 6 inches above the stream bottom and at least 6 inches below the surface of the water with the sensors facing downstream to minimize chances of damage from debris carried by stream current.

8.3.2 Set the frame in the stream bottom, place the sonde into the protective housing, and suspend the housing at the appropriate depth on the frame. Attach a cable to the assembly and fasten the cable to a fixed object such as a tree or a stake. Secure the cable and the assembly with locks. If a buoy system is to be utilized for deployment, set anchor weight upstream of desired location an adequate distance to allow for the proper scope. Attach sonde to buoy line at the proper depth, again allowing for scope, and then attach a properly sized buoy to the buoy line. All buoys used should be blue and white in color and should clearly identify the Rock River Watershed Group and Fehr Graham and that monitoring equipment has been deployed.

8.3.3 Complete the "Deployment" section of the Continuous Monitoring Log Sheet, recording information such as:

- monitoring location/station (e.g., Rock River at Stateline; station P-09)
- location of sonde at site (i.e., channel unit, placement depth)
- profile drawing of cross section of wetted channel at placement site of sonde

- start (of monitoring period) date and time
- end (of monitoring period) date and time
- time interval of sonde readings (e.g., one reading per every 0.25 hours)
- channel cross-section dimensions (e.g., wetted width, avg. depth) at start and end of monitoring period
- channel cross-section discharge at start and end of monitoring period
- identification number of sonde (tag and serial numbers)
- miscellaneous comments

8.4 Sonde Retrieval Procedures

8.4.1 Approach deployment location from a downstream location

8.4.2 Use a second sonde or other appropriate instrument(s) to independently measure each relevant parameter in the water as close as possible to the sensors of the continuously monitoring sonde before it is retrieved from the water. Preferably these independent measures are obtained within a few feet of the sensors of the continuously monitoring sonde. In some situations, the independent measurements may be obtained at a greater distance, provided that they are obtained as close as feasibly possible and within the same channel unit, thereby representing the physicochemical water conditions immediately near the continuously monitoring sonde. This simultaneous read (SR) sonde should be allowed time to equilibrate to stream conditions. Once stabilized, log one sample in the SR sonde.

8.4.3 Remove pin and carefully remove sonde from housing unit. If deployed using a buoy carefully retrieve buoy until sonde is brought aboard. Do not detach deployment line from buoy until after sonde is aboard vessel,

8.4.4 Carefully rinse body of sonde with stream water.

8.4.5 Complete "Retrieval" section of the Continuous Monitoring Log sheet.

8.4.6 Replace the probe guard with the calibration cup filled with 0.5 inches of native water.

8.4.7 Once sonde is secured inspect sonde and remove all fouling. Care should be taken not to scratch either the DO membrane or the glass bulb on the pH probe. Recesses on the conductivity probe will need to be cleaned using a wipe or fine brush as appropriate.

8.5 Post deployment calibration check

8.5.1 The post deployment calibration check is done using the same standards and procedures as used for calibration and described in section 8.1 of this SOP. Since this step is only a calibration check once the post-deployment readings of calibration standards have been recorded there is no need to actually calibrate the instrument.

8.5.2 Review the post deployment log sheet and verify that all required information has been entered.

9 Data and Records Management

9.1 Deployed sonde data files will be named with the station code (i.e. "P09"). SR sonde data files will be named with the station code followed by an "s" (i.e. "P09").

9.2 Files will be transferred from the portable data loggers to the laptops during each visit or at the end of each day. Both sonde and simultaneous read files are uploaded by default to This PC\Documents\YSI. All files should then be transferred to the project data folder on the laptop: …(project)\Data\SondeFiles. All files will also be backed up to an external flash drive at this time.

9.3 Upon returning to the office, all files will be copied to the designated folder on the Fehr Graham server.

9.4 After retrieval of sondes, site logs are reviewed for completeness and accuracy. Any missing or incorrect information will be brought to the attention of the field crew and revised.

10 Quality Control and Corrective Action

10.1 At the end of the monitoring period, for each parameter, quantify the total inaccuracy of the measurements obtained during the monitoring period. To do so, use measurements obtained from the SR sonde. On the Continuous Monitoring Log Sheet, record the independent measurement for each parameter and the time that it was obtained. Try to obtain the results as close to the next time the deployed sonde will log a sample.

10.2 Compare the continuously monitoring sonde measurement to the SR sonde measurement for pH, specific conductance and dissolved oxygen to determine the calibration drift. To do so download the data from the deployed sonde. If the deployed sonde and the SR are less than 5% apart, then no calibration is need. However, if the values are more than 5% different, then recalibrate the deployed sonde for the appropriate parameter. For each parameter during the monitoring period, calibration drift is quantified as the difference between the "*Post-retrieval Calibration Check*" reading (Continuous Monitoring Log Sheet) and the standard value for that parameter (Continuous Monitoring Log Sheet).

11 References

11.1 YSI Incorporated, "EXO User Manual", www.ysi.com

11.2 USGS. 2000. Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting. U.S. GEOLOGICAL SURVEY Water-Resources Investigations Report 00–4252

STANDARD OPERATING PROCEDURE:
CONTINUOUS MONITORING USING YSI EXO SONDES

Attachment A
Rhodamine Dye Solution for Total Algae Sensor Calibration

Preparation

Use the following procedure to prepare Rhodamine WT solutions for use as a sensor stability check reagent for the EXO Total Algae (Chlorophyll and Blue-green Algae Phycoerythrin) sensor:

1. 2.5% Rhodamine WT dye in solution form purchased commercially.
2. Accurately transfer 5 mL of the Rhodamine WT solution into a 1000 mL volumetric flask and dilute with deionized or distilled water to make a 0.0125% solution. Transfer this standard to a brown glass bottle and retain it for future use.
3. Accurately transfer 5 mL of the solution prepared in step 2 to a 1000 mL volumetric flask and then fill the flask to the volumetric mark with deionized or distilled water to make a 0.0000625% or 0.625 mg/L solution.
4. Store the concentrated standard solution in a glass bottle in a refrigerator to retard decomposition. The dilute standard prepared in step 3 should be used within 24 hours.
5. Run a 2-point calibration on a monthly basis.
6. All other times, run a blank to check for 0 RFU's on both Chlorophyll and BGA readings

Use the following table when calibrating the Total-Algae sensor with Rhodamine dye prepared above. For the 2-point calibration, enter the µg/L or RFU value from the table below that corresponds with the temperature of the standard.

Temp °C	RFU Chlorophyll	µg/L Chlorophyll	RFU BGA-PC	µg/L BGA-PC
16	18.3	73.5	19.1	19.1
18	17.6	70.8	17.5	17.5
20	17.0	68.4	17.1	17.1
22	16.4	66.0	16.0	16.0
24	15.8	63.5	15.0	15.0
26	15.2	61.3	14.1	14.1
28	14.6	58.7	13.1	13.1

STANDARD OPERATING PROCEDURE: DISCRETE MEASUREMENTS OF WATER QUALITY

1.0 Scope and Application

1.1 This Standard Operating Procedure (SOP) addresses the use of water quality spot meters to take discrete measurements of water quality in streams.

2.0 Summary of Method

2.1 Qualified persons use a specialized monitoring device (hereafter, called a *spot meter*) at specified sites to take a discrete measurement. The spot meter measures and records physicochemical conditions in the water column, such as pH, specific conductance, temperature, and dissolved oxygen. Each spot meter has multiple *sensors*, each designed to measure a particular parameter. The spot meter can be used at one spot in a stream to obtain a representative measurement of the water or be used to develop a multi-vertical cross-sectional profile of the stream. The spot meter can be lowered to any depth in the water column to properly observe any stratification. Each sensor needs to be calibrated within 24 hours of use and the calibration check against known standards within 24 hours of completion of sampling. All data and calibration information is stored within the handheld computer of the spot meter.

2.2 Data are exported as CSVs, named following a specific format, and saved in specific directories.

2.3 Each measurement is assigned a grade based on its quality. Data quality is determined using post-deployment reads of calibration standards.

3.0 Definitions

3.1 A *spot meter* is a sensor or group of sensors connected via a cable with a handheld recording unit or electronic data logger to display and/or record the output from the sensor(s).

3.2 A *sensor* is the part of the spot meter that measures a particular parameter.

3.3 *Calibration drift* refers to changes in the accuracy of sensor/instrument calibration between calibrations

4.0 Interferences and Corrective Action

Inaccuracy of sensor measurements obtained during the monitoring period is attributable to two sources: calibration drift and physical damage/fouling to sensors. For each parameter, at the end of each monitoring period, users quantify calibration drift by place the sensors in

known standard and comparing the reading to calibrated values. Physical damage to sensors is determined by observation to ensure that all sensors are intact. Common issues seen are fouling due to contact with bottom sediments, broken glass bulbs on the pH sensor, damaged membranes on the DO sensor and electrolyte corrosion on the DO sensor. Damaged sensors are replaced or repaired and then re-calibrated.

5.0 Safety

Monitoring surface waters involves risk of harm to participants. Follow health and safety guidelines in DCN 151: *Surface Water Section Field Safety Manual* (Illinois EPA 2009, draft available on the IEPA Bureau of Water intranet or from the IEPA Bureau of Water Quality Assurance Officer) as well the ISWS *Boating Safety Manual* (2005).

6.0 Qualifications and Training of Personnel

The use of a spot meter is conducted by persons who have received formal training from qualified and experienced users of the procedures. Qualifications include the demonstrated ability to independently conduct the monitoring activities described in this document.

7.0 Equipment and Supplies

7.1 YSI ProDSS to measure parameters such as pH, specific conductance, temperature, and dissolved oxygen
7.2 Appropriate site log such as Water Quality Cross-Section Survey Log (Appendix A)

8.0 Maintenance of Instruments and Equipment

Before each measurement, thoroughly clean all surfaces of the spot meter. Clean the surface of optical dissolved-oxygen and other sensors, as needed, according to instructions in the instrument manufacturer's operating manuals. Clean and lubricate all seals and connections of instruments and equipment if needed. Remove sediment and other contaminants from the protective cable guard by rinsing with clean water between uses.

9.0 Calibrating the Instrument

9.1 The spot meter should be calibrated in the morning before use in the field.

9.2 Follow calibration procedures according to manufacturer's recommendations. Specific conductance will be calibrated to 1000 µS/cm and will include a zero check with a "dry" conductivity probe. Use both pH 7 and pH 10 buffers to complete a two-point pH calibration. Dissolved oxygen will be calibrated to 100%

STANDARD OPERATING PROCEDURE: DISCRETE MEASUREMENTS OF WATER QUALITY

saturation using a water saturated air method. Temperature sensors require no calibration but are checked for accuracy on a defined maintenance schedule.

9.3 Write each calibration value in the calibration log (see Appendix A) as the instrument is calibrating.

9.4 Record the Conductivity Cell Constant and the DO Sensor Value.

10.0 Collecting Data – YSI ProDSS

10.1 Select the appropriate site under the site name.

10.2 Deploy the spot meter by removing the calibration cup with the sensor guard and lowering the cable into the water. The cable is graduated to ensure the sensors are placed at the correct depth.

10.3 Record the sample time and field measurements in the site log. The spot meter can be moved from depth to depth or vertical to vertical without cleaning.

10.4 If the water is stagnant, move the spot meter up and down a few inches to ensure the sensors are in fresh native water. When moving between sites clean any obvious fouling and rinse with native water.

11.0 Collecting post-deploy reads

11.1 Post-deploy reads should be collected after field work is completed for the day and within 24 hours of the end of sampling.

Post-deploy reads can be done either in the office or in the field. Rinse the sensors with deionized water and the wipe the sensors with a Kimwipe to remove fouling. If the pH probe is fouled, use a Q-tip instead of a Kimwipe to protect the glass bulb. Follow manufacturer's recommendations for calibrating, but do not log the calibration. Instead, read the "pre-calibrated value".

11.2 Record values on calibration log

12.0 Calibration Data Entry and Review

12.1 Calibration logs are reviewed for accuracy and completeness. Check that all values were entered in the correct fields and are associated with the correct handheld and cable serial number. All revisions to calibration logs are done in red pen and are dated and initialed in red pen.

12.2 All data from calibration logs are then entered to Excel.

13.0 Assigning Data Grades

Each measurement is assigned a data grade based on the quality of data, as determined by post-deploy reads as outlined in the project QAPP.

14.0 References

Illinois Environmental Protection Agency. 2009. DCN 151: *Surface Water Section Field Safety Manual.* Bureau of Water, Springfield, IL.

Illinois State Water Survey. 2005. *Boating Safety Manual*. Illinois State Water Survey, Champaign, IL.

YSI Incorporated. 2009. *YSI Professional Plus User Manual, Item # 605596, Rev D*. Accessed online April 2012. http://www.ysi.com.

STANDARD OPERATING PROCEDURE: DISCRETE SAMPLING

1.0 Introduction

1.1 Scope

This Standard Operating Procedure (SOP) is applicable to the collection of representative discrete water quality and sestonic algae samples as part of the Village of Huntley Water Quality Monitoring Project.

1.2 Summary of Methods

This SOP described the procedures for the collection of representative water samples via boat, wading, and from bridges using depth-integrated and point samplers.

2.0 Definitions

2.1 Churn Splitter: A device used to mix water from multiple stream samples for compositing.

2.2 Discharge: The volume of water that passes a given river cross-section in a given period of time

2.3 Equal-Width-Increment (EWI) Sampling: A method used to collect a series of water quality samples to represent a single stream cross-section. The stream width is divided into a number of equal-width intervals which are sampled. The EWI method is used during sampling conditions where a discharge measurement is not made before sampling; where the period of discharge record is insufficient to develop stage-discharge rating curves; where the streambed material is mobile, resulting in a poor stage-discharge relationship; or where inflow from a tributary is not well mixed in the sampling section.

2.4 Sestonic Algae: Algae that is free floating and growing in the water column.

3.0 Health and Safety Warnings

3.1 All proper personal protection clothing must be worn including close-toed shoes and latex gloves.

3.2 Field crew members sampling from a boat must wear a personal floatation device.

3.3 Field crew members sampling from bridges must wear a reflective safety vest.

3.4 Care should be taken when cleaning the field equipment with 5% hydrochloric acid solution to prevent spillage on the skin or splatter into eyes.

3.5 Care should be taken when filling laboratory bottles that have been pre-filled with acid preservative to prevent spillage on the skin or splatter into eyes.

4.0 Interferences

4.1 Interference may result from using contaminated equipment, solvents, reagents, sample containers, or sampling in a disturbed area.

4.2 Cross contamination problems can be eliminated or minimized using dedicated sampling equipment. Clean and decontaminate all sampling equipment prior to

use and between each sampling site. See the SOP for Cleaning of Sampling Equipment for details on the cleaning and decontamination procedures.

4.3 Interference can come when using a depth integrated sampler if the orifice becomes clogged with debris, the sampler disturbs bottom sediment, or improper transit rates are used.

5.0 Personnel Qualifications

5.1 Field crew members will be trained in all sampling equipment and procedures by an experienced sampler before initiating the sampling procedure.

5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP) for the Village of Huntley Water Quality Monitoring Project.

6.0 Materials

6.1 Sampling collection equipment
6.2 Churn splitter
6.3 Waders or hip boots
6.4 Laboratory-supplied sampling bottles
6.5 Coolers
6.6 Field logs
6.7 Pen
6.8 Chain of custody forms
6.9 Gloves

7.0 Pre-sample collection

7.1 Determine the number of samples and quality control (QC) samples specified in the QAPP.

7.2 Obtain the necessary sampling equipment.

7.3 Decontaminate or clean equipment and ensure that it is in working condition. See the SOP for Cleaning of Sampling Equipment for details on the cleaning and decontamination procedures.

7.4 Prepare a schedule and coordinate with staff and laboratory.

7.5 Use buoys, stakes, and/or spray paint to mark all sampling locations.

8.0 Procedures

8.1 Procedures for determining equal-width-increment sampling locations

8.1.1 A minimum of 10 verticals will be used for streams over 5 feet wide. For streams less than 5 feet wide, as many verticals as possible should be used, if they are spaced a minimum of 3 inches apart, to allow for discrete sampling of each vertical and to avoid overlaps. The width of the increments to be sampled, or the distance between verticals, is determined by dividing the stream width. For example, if the stream width determined from the tagline at the sample cross section is 160

feet, and the number of verticals necessary is 10, then the width (W) of each sampled increment would be 16 feet.

8.2 Procedures to identify the EWI sampling locations

8.2.1 At each site the width of the stream will be measured using a steel or fiberglass tape. Sampling stations will be determined as described above. Stations will be identified from directly reading the tape.

9.0 Procedures for discrete water quality sampling.

9.1 Collection of water quality samples and sestonic algae will be collected using the Equal-Width-Increment (EWI) Method described in Edwards and Glysson (USGS, 1999). The EWI sampling method requires that all verticals be traversed using the transit rate (Figure 1) established at the highest velocity in the cross section. The descending and ascending transit rates must be equal during the sampling traverse of each vertical, and they must be the same at all verticals. By using this equal-transit-rate technique with a standard depth- or point-integrating sampler at each vertical, a volume of water proportional to the flow in the vertical will be collected (Figure 1).

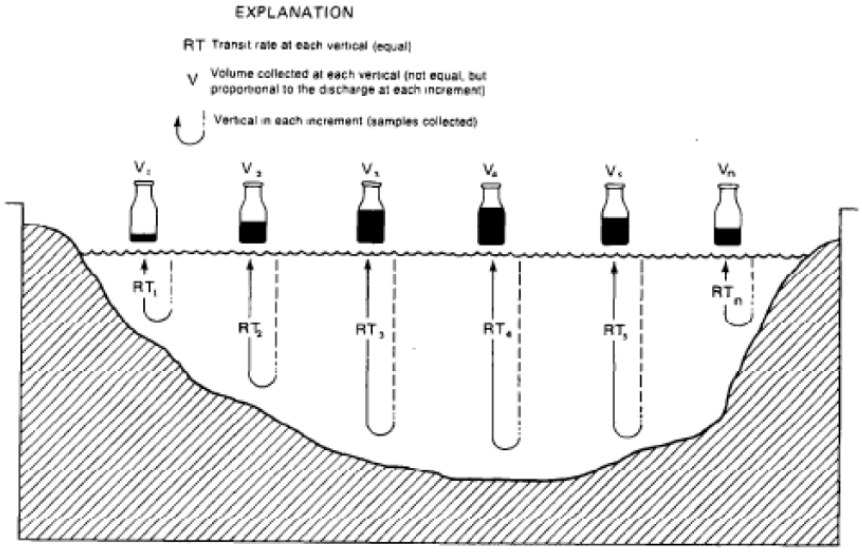


FIGURE 1
Equal-width-increment vertical transit rate relative to sample volume, which is proportional to water discharge at each vertical.

STANDARD OPERATING PROCEDURE:
DISCRETE SAMPLING

9.1.1 Collecting water samples

9.1.1.1 In shallow streams, less than two feet in depth, a sample will be collected by submerging an open-mouthed bottle into the stream by hand. The mouth should be pointed upstream and the bottle held at approximately a 45degree angle from the streambed. The bottle should be filled by moving it from the surface to the streambed and back. Care should be taken to avoid touching the mouth of the bottle to the streambed. An un-sampled zone of about 3 inches should be maintained to obtain samples that are compatible with depth-integrated samples collected at higher velocities.

If the stream is not wadeable or greater than 2 feet deep, a Van Dorn or Kemmerer type sampler will be used. The total depth of the stream will be measured and the sample will be collected at mid-depth. An un-sampled zone of about 3 inches should be maintained in order to prevent disturbance of the bed material. If bed material is disturbed and collected in the sampler, the sample will be discarded and a new sample collected.

9.1.2 Procedures for discrete water sampling by wading in streams.

9.1.2.1 Don waders with belt or hip boots depending on water depth.

9.1.2.2 Always approach the sampling location slowly from the downstream.

9.1.2.3 Once you have reached the sampling location, allow the water to return to a pre-disturbed condition.

9.1.2.4 Lower the sample bottle into the water following procedure in section 8.2.1.

9.1.2.5 Pour the collected sample into the cleaned churn splitter.

9.1.2.6 Move to the next sampling location and repeat above steps.

9.1.3 Mixing composited sample and filling laboratory sample bottles. An overview of sampling requirements is provided in Figure 2. To obtain necessary volumes, samples will be manually collected from multiple verticals and composited in the churn splitter. Sestonic algae (chlorophyll) samples will also be manually collected from multiple verticals (quarter-points) but will not be composited in the churn splitter.

STANDARD OPERATING PROCEDURE:
DISCRETE SAMPLING

9.1.3.1 Upon collection of the required vertical samples, return the churn splitter to the riverbank or bridge for sample processing.

9.1.3.2 The sample should be stirred at a uniform rate by raising and lowering the churn at a rate of approximately 9 inches per second. If faster or slower churning rates are used, maximum errors of 45% to 65% are possible. As the volume of sample in the splitter decreases, the round-trip frequency should be increased so that the churning disc velocity is constant. The disc should touch bottom, and every stroke length should be as long as possible without breaking the water surface. If the stroke length, and or disc velocity, is increased beyond the recommended rate, there is a sudden change of sound and churning effort which is accompanied by the introduction of excessive air into the mixture. This is undesirable because excessive air may tend to change the dissolved gases, bicarbonate, pH and other characteristics. Inadequate stirring may result in non-representative sub-samples. The sample in the splitter shall be stirred at the uniform churning rate for about 10 strokes prior to the first withdrawal to establish the desired churning rate of 9 inches per second and to insure uniform dispersion of suspended matter.

9.1.3.3 Remove the sample bottles from the pre-labeled plastic bag for the given site. Care should be taken when placing the bottle on the ground to prevent potential contamination of the outside of the bottle.

9.1.3.4 The sample bottles should be filled in the following order:

9.1.2.4.1 500 mL HDPE (CBOD5, NO2)

9.1.2.4.2 250 ml glass amber bottle with H2SO4 (Total-P, NH3, NO3, TKN)

9.1.2.5 Be sure to fill the bottles completely with the water so that no air is present between the water sample and the cap.

9.1.2.6 Sample bottles with acid preservative should not be over or under filled to prevent potential change in the pH of the preserved sample.

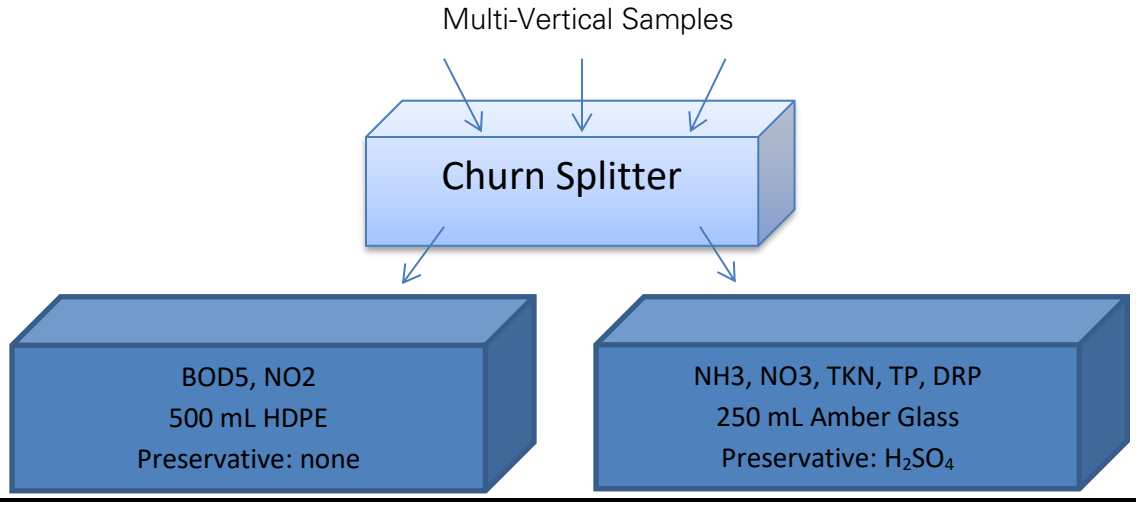
9.1.2.7 Sub-samples should not be withdrawn when water reaches a point below about 1.5 inches (4 cm) above the spigot intake.

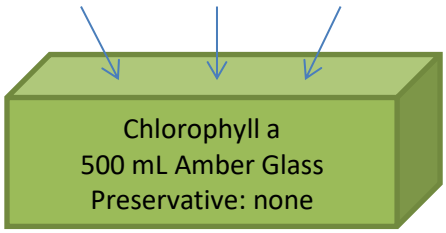
STANDARD OPERATING PROCEDURE:
DISCRETE SAMPLING

9.1.2.8 Upon completion of filling all the sample bottles, the bottles shall be placed back in the pre-labeled plastic bag and Chain of Custody filled out.

9.1.2.9 The sample bag shall be placed in the provided cooler and covered with several inches of wet ice.

9.1.3 Procedures for measuring DO, temperature, conductivity and pH are outlined in the SOP for Spot Meters.





Containers to Fill:
Each Round:

- 1 x 500mL HDPE bottle (CBOD5, NO2)
- 1 x 250mL Amber glass bottle (NH3, NO3, TKN, TP)
- 1 x 1000mL Amber glass bottle (Chlorophyll)

Total Containers = 3

Figure 2. Water Quality Sampling Protocol

STANDARD OPERATING PROCEDURE: DISCRETE SAMPLING

10.0 Water Quality Site Log

10.1 Water Quality Site Logs (Appendix A) will be used to record details of water quality sampling. One site log should be filled out per site per visit. There is space for multiple sampling sites on a single log.

10.2 Record the date, time in, time out, personnel, and weather during each visit. Take a tape down measurement and note instantaneous water quality measurement values in the log. For each sample collected, note the sample number, collection time, location where the sample was pulled, what sampling equipment was used, and the requested analyses for the sample.

10.3 Sample numbers are assigned using the following format: (STN)-(##) where (STN) is the station code and (##) is an incremental number beginning with "01" for each sample collected at a site. For example, the first, second, and third samples collected at station 101 would have sample IDs "101-01," "101-02," and "101-03."

10.4 Requested analyses are pre-checked in the logs. The chlorophyll sample will be assigned its own sample ID due to differing sampling procedures.

11.0 Chain of Custody

11.1 Record sample information from the water quality site log onto the chain of custody for each sample collected. See section 12 for guidelines on sample numbers and station codes for QA samples.

11.2 Chain of custody forms should always stay with the samples. When samples are not in custody of the sampler or designated person (who signs the form), the samples should be maintained under lock and key.

12.0 Quality Control/Quality Assurance and Decontamination

12.1 Representative samples are required. The sampler will evaluate the site-specific conditions to assure the sample will be representative.

12.2 All sampling equipment must be completely decontaminated prior to use. See the Cleaning of Sampling Equipment SOP for additional information.

12.3 Two field blanks will be collected throughout the monitoring period

12.3.1 Blank codes are assigned using the following format: 99Blank# where # is an incremental letter beginning with "A" for each blank collected. For example, the first blank would have sample ID "99BLANKA" and the second blank will have sample ID "99BLANKB"

12.3.2 Check all requested analyses. Analyses for QA samples will be Total Phosphorus, TKN, Ammonia, Nitrate, and Nitrite.

STANDARD OPERATING PROCEDURE:
DISCRETE SAMPLING

14.0 References

14.1 USGS. 2002. *Operator's Manual for the US DH-81 Depth-Integrating Suspended-Sediment Sampler*, Federal Interagency Sedimentation Project, Waterways Experiment Station.

14.2 Edwards, T.K., and G.D. Glysson. 1999. *Field Methods for Measurement of Fluvial Sediment, Book 3, Chapter C2*. Techniques of Water-Resources Investigations of the United States Geological Survey, U.S. Government Printing Office, Washington, DC.

14.3 Shelton, L. R., 1994. *Field Guide for Collecting and Processing Stream Water Samples for the National Water-Quality Assessment Program*, Open-File Report 94-455, United States Geological Survey, Sacramento, California. 14.4 Federal Interagency Sedimentation Project. Date Unknown. *Operator's Manual for the US DH-81 Depth-Integrating Suspended-Sediment Sampler, Operator's Manual for the US DH-81 Depth-Integrating Suspended-Sediment Sampler11*, available at the FISP website: http://fisp.wes.army.mil.

STANDARD OPERATING PROCEDURE: BENTHIC ALGAE SAMPLING

1.0 Introduction

1.1 Scope

This Standard Operating Procedure (SOP) is applicable to the sampling of benthic algae as part of the Village of Huntley Water Quality Monitoring.

1.2 Purpose

The purpose of this SOP is to provide a framework for the sampling of benthic algae as part of the Village of Huntley Water Quality Monitoring. These methods were developed by Moulton et al. 2002.

2.0 Definitions

2.1 Eckman Dredge: A brass or stainless-steel box shaped soft sediment sampling device with spring operated jaws on the bottom. This should not be used where the bottom material contains rock, pebbles, or gravel.

2.2 Epilithic: Benthic habitat consisting of natural, coarse-grained substrates (for example, gravels, cobbles, or boulders) or bedrocks, or artificial hard substrates such as submerged concrete on which organisms are attached or loosely associated.

2.3 Epidendric: Benthic habitat consisting of woody substrates (for example, woody snags) on which organisms are attached or loosely associated.

2.4 Epiphytic: Benthic habitat consisting of plants on which organisms are attached or loosely associated.

2.5 Episammic: Benthic habitat consisting of sand-sized (> 0.064–2 mm) particles on which organisms are attached or loosely associated.

2.6 Epipelic: Benthic habitat consisting of silt-sized (< 0.064 mm) streambed sediments on which organisms are loosely associated. This habitat is commonly found in areas of low velocities, such as pools and side-channel areas, where silt can deposit.

2.7 Gravel Sampler: 7.6 diameter plumbing clean out pipe with threaded cap with a beveled bottom edge to improve coring.

2.8 Non-wadeable: Streams in which less than half the sampling area cannot be safely accessed using waders. Typically streams with greater than 3-feet of depth.

2.9 Periphyton: Layer of small plants and animals attached to surfaces projecting above the bottom.

2.10 Ponar Dredge: An aluminum/steel device also used in collecting sediment samples whenever a corer cannot be utilized. The jaws of the Ponar dredge, which close on the bottom, provide a sharp cutting action. The wide jaws function to prevent stones from jamming the shutting mechanism.

2.11 SG-92 Sampler: Consists of the barrel of a plastic syringe (20 mL and 30 mL, respectively) fitted with a rubber gasket. A rock is selected for sampling and gently removed from the stream. The sampler is then pressed against the upward-facing surface (referring to its original orientation on the streambed) of

STANDARD OPERATING PROCEDURE: BENTHIC ALGAE SAMPLING

the rock, a small volume of water added, and the enclosed area brushed thoroughly. The detached algae are removed with a pipette.

2.12 Slack Sampler: Employs a 0.5 m wide rectangular kick-net frame to which a net with 425-µm mesh openings is attached. The sampler is held perpendicular to the direction of flow and pressed tightly against the stream bottom.

2.13 Wadeable: Streams in which more than half the sampling area can be safely accessed at summer low flow so that representative samples can be collected from the stream bottom or other stable habitats using waders. These streams are typically less than 3-feet in depth.

3.0 Health and Safety Warnings

3.1 All proper personal protection clothing must be worn.

3.2 Field crew members sampling in wadeable streams and from a boat must wear a personal floatation device.

3.3 Instream sampling may result in exposure to sewage and bacteriologically contaminated water. All field-sampling personnel must therefore be adequately protected against risk of exposure to such contaminants.

3.4 Field personnel shall wear rubber gloves or suitable hand protection during the collection of instream samples.

3.5 While working in the field, the field crew shall carry a complete first-aid kit that provides materials for disinfection and protection of any skin cuts or abrasions and water for washing off chemical exposures. Personnel will promptly attend to any such cuts or abrasions and seek medical attention if appropriate. Any need for first aid or medical attention shall be recorded in the field log, including information on time and location of any injury to personnel and description of first-aid treatment applied.

3.6 Walking in streams requires the use of waders. Care should be taken to establish footing before moving forward.

3.7 There shall be no fewer than two people conducting instream sampling.

3.8 Each field crew should have a cellular phone in case of emergencies.

4.0 Interferences

4.1 Interference may result from using contaminated equipment, solvents, reagents, sample containers, or sampling in a disturbed area.

4.2 Cross contamination problems can be eliminated or minimized using dedicated sampling equipment. Clean and decontaminate all sampling equipment prior to use and between each sampling site. See the SOP for "Procedures for Equipment Cleaning" for details on the cleaning and decontamination procedures.

5.0 Personnel Qualifications

STANDARD OPERATING PROCEDURE: BENTHIC ALGAE SAMPLING

5.1 Personnel will be trained in all sampling equipment by an experienced person before initiating the sampling procedure.
5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP) for the Village of Huntley NARP Water Quality Monitoring.
5.3 The sampling activities will be under the direction of Karen Clementi, team leader.

6.0 Materials
6.1 Eckman dredges
6.2 PONAR dredges
6.3 SG-92 samplers
6.4 Gravel sampler
6.5 Slack samplers
6.6 Plastic dishpans
6.7 Brushes
6.8 Pocket knifes
6.9 Poultry basters
6.10 Funnels
6.11 Forceps
6.12 Petri dishes
6.13 Aluminum foil
6.14 Epoxy adhesive
6.15 Emory cloth
6.16 Epoxy adhesive
6.17 Spatula
6.18 Laboratory provided sample collection bottles

7.0 Pre-sampling
7.1 Obtain the necessary sampling equipment.
7.2 Prepare a schedule and coordinate with staff.

8.0 Procedures
8.1 Procedures for benthic algae sampling in wadeable streams.
8.1.1 Procedures for benthic algae sampling in epilithic habitats.
8.1.1.1 Procedures for using the SG-92 to sample epilithic habitats.
8.1.1.1.1 Assemble the SG-92 sampling device and periphyton brushes. This step should be completed before going into the field; also, prepare several SG-92 samplers and periphyton brushes.
8.2.1.1.2 Remove the end of a 30-mL syringe barrel opposite the syringe flanges. Sand the cut end of the barrel smooth.

8.2.1.1.3 Flatten one side of a rubber O-ring (inside diameter, 2.06 cm; outside diameter, 2.70 cm) using emory cloth.

8.2.1.1.4 Using cyanoacrylate adhesive, cement the flattened side of the O-ring to the flanged end of the syringe barrel.

8.2.1.1.5 Construct periphyton brushes by affixing (with epoxy adhesive) small, circular bristles from a stiff-bristled toothbrush to the ends of 0.64-cm diameter plastic rods.

8.2.1.1.6 Trim the bristles to a length of about 4 mm.

8.2.1.1.7 Collect five cobbles from each of five locations in riffles distributed throughout the reach (a total of 25 cobbles per reach). Place cobbles in a plastic dishpan and transport them to an on-site processing station to collect periphyton from each cobble.

8.2.1.1.8 Place the SG-92 barrel on a smooth part of the cobble. Press down on the O-ring and rotate slightly to create a tight seal. Maintain this seal while the collection is made.

8.2.1.1.9 Using a pipettor, squirt about 5 mL of distilled water into the SG-92 barrel on the cobble. If the water leaks from the barrel, select another place on the cobble and try again. If the water does not leak, insert the periphyton brush into the barrel and scrub the enclosed area on the cobble to remove the periphyton.

8.2.1.1.10 Remove the periphyton and water mixture with the pipette and dispense it in a 100-mL graduated cylinder. [Note: dispensing into a graduated cylinder instead of a 1000-mL amber sample bottle is recommended in case the SG-92 seal fails while collecting the sample, thereby causing the collector to start over. If the seal fails, then only the contents of the graduated cylinder are discarded.] Repeat this process several times until all of the visible periphyton is removed. Pour the contents of the graduated cylinder into a 1000-mL amber sample bottle.

8.2.1.1.11 Repeat the sampling procedure for a single area on each of the cobbles selected (the composited

sample is composed of 25 discrete collections taken from 25 cobbles). Ensure that the sample volume does not exceed 975 mL. Place the bottle on ice inside a cooler and keep in the dark until the sample is processed.

8.2.1.1.12 Measure the diameter of the area sampled by the SG-92 at the beginning and end of sampling. Record these diameters on the Quantitative Targeted-Habitat Periphyton Field Data Sheet to establish an average diameter from which the sampling area can be calculated.

8.2.1.1.13 Once the sample has been collected, cap the 1,000-ml amber bottle and return the bottle to the plastic bag provided by the laboratory

8.2.1.1.14 Place sample bottle into a cooler ensuring that the bottle is in ice but not totally immersed in water.

8.2.1.1.15 Record all data on the field data sheet.

8.2.1.1.16 Calculate the total sampling area by using the following formula:

Total sampling area (cm^2) = $(n)(\pi)(d/2)^2$

where,
n = number of discrete SG-92 collections, π = 3.1416,
and d = average diameter of the sampled areas, in centimeters.

8.2.1.2 Procedures for using the top-rock scrape method to sample epilithic habitats.

8.2.1.2.1 Collect five cobbles from each of five locations in riffles distributed along the sampling transect for a total of 25 cobbles per transect. Place cobbles in a plastic dishpan and transport them to an on-site processing station to collect periphyton from each cobble.

8.2.1.2.2 Identify the area on each cobble where periphyton is attached by using a red wax pencil to draw a line around the middle (side) of the cobble. The area above this line represents the sampling area to be scraped.

8.2.1.2.3 Using a small brush or pocket knife, scrape the periphyton from the sampling area on each cobble (typically the top and sides) down to the red line.

8.2.1.2.4 Rinse the periphyton from each cobble into the dishpan using a poultry baster and distilled water. Ensure that the sample volume does not exceed 975 mL.

8.2.1.2.5 Pour the contents of the dishpan through a funnel into a 1000-mL amber sample bottle. Place the bottle on ice inside a cooler and keep in the dark until the sample is processed.

8.2.1.2.6 Wrap aluminum foil around the surface of each cobble, covering the area that was scraped down to the red line. Mold the foil tightly (Figure 1b.) and trim the excess foil from the bottom edge of the scraped area.

8.2.1.2.7 Remove the formed foil from each cobble and flatten by making a series of radial cuts.

8.2.1.2.8 Place the foil templates in a labeled re-sealable plastic bag and determine the area of each template in the field office. The areas for all rocks sampled in the reach are summed and the total area recorded on the Quantitative Targeted-Habitat Periphyton Field Data Sheet and sample labels.

8.2.1.2.9 Once the sample has been collected, cap the 1,000-ml amber bottle and return the bottle to the plastic bag provided by the laboratory

8.2.1.2.10 Place sample bottle into a cooler ensuring that the bottle is in ace but not totally immersed in water.

8.2.1.2.11 Record all data on the field data sheet.

8.2.1.3 Procedures for using the gravel sampler to sample epilithic habitats.

8.2.1.3.1 Assemble the gravel sampler from a plumbing "clean-out" (7.6-cm diameter) (fig. 1c). Attach the threaded cap; bevel the bottom edge of the clean-out by using a grinding wheel to improve the coring capability of the sampler. Obtain a large masonry trowel wide enough to completely enclose the bottom of the sampler.

8.2.1.3.2 Select 5 to 10 sampling locations throughout the reach.

8.2.1.3.3 Press the beveled end of the sampler into the gravel substrate. After the sampler is in place,

carefully remove the gravel surrounding the outside of the sampler and insert the masonry trowel.

8.2.1.3.4 Slide the sampler onto the trowel and carefully lift it out of the water.

8.2.1.3.5 Quickly invert the sampler to contain the gravel and water in the sampler cap.

8.2.1.3.6 Pour each discrete collection into a dishpan and rinse the sampler before taking another discrete collection.

8.2.1.3.7 Repeat these steps to complete 5 to 10 discrete collections, which form the composited sample.

8.2.1.3.8 Extract macroalgal filaments (if present) from the gravel with forceps and then cut them into fine pieces.

8.2.1.3.9 Brush and rinse (with dishpan water) the gravel. Recycle rinse water to keep the sample volume less than 975 mL.

8.2.1.3.10 Pour the sample from the dishpan through a funnel into a 1000-mL amber sample bottle. Place the bottle on ice inside a cooler and keep in the dark if the sample is not processed immediately.

8.2.1.3.11 Calculate the total sampling area by using the formula presented for the SG-92 sampling method.

8.2.1.3.12 Once the sample has been collected, cap the 1,000-ml amber bottle and return the bottle to the plastic bag provided by the laboratory

8.2.1.3.13 Place sample bottle into a cooler ensuring that the bottle is in ice but not totally immersed in water.

8.2.1.3.14 Record all data on the field data sheet.

8.2.2 Procedures for benthic algae sampling in epidendric habitat. Collecting quantitative microalgal periphyton samples from epidendric habitats (or woody snags) presents a challenge because they generally have an irregular surface and are difficult to remove without loss of algal biomass. Samples will only be collected from epidendric habitats if they are the dominant instream habitat along the sampling transect. If the woody snag has a smooth surface, it can be sampled in a similar manner to epilithic habitats by using the SG-92. See Section 4.1.1 for procedures. Otherwise, periphyton is collected from woody snags by using the cylinder scrape method.

8.2.2.1 Select one woody snag in each of five locations throughout the reach.

8.2.2.2 Identify the part of the woody snag that will be sampled for periphyton. Carefully remove a 10- to 20-cm long section with pruning shears or by sawing and place in a plastic dishpan.

8.2.2.3 Scrub the entire surface of each woody snag section in the dishpan with a stiff brush. Rinse the brush and each section in the dishpan. Recycle rinse water to keep the sample volume less than 975 mL.

8.2.2.4 Pour the sample from the dishpan through a funnel into a 1000-mL sampling bottle.

8.2.2.5 Once the sample has been collected, cap the 1,000-ml amber bottle and return the bottle to the plastic bag provided by the laboratory.

8.2.2.6 Place sample bottle into a cooler ensuring that the bottle is in ice but not totally immersed in water.

8.2.2.7 Record all data on the field data sheet.

8.2.2.8 Measure the length and diameter of each cleaned woody snag section and calculate the total sampling area by using the following formula (assumes a cylinder):

Total Sampling Area (cm^2) = $\sum_{i=1}^{n}(\pi)(d_i)(l_i)$

where,
n = number of discrete collections,
π = 3.1416,
d_i = diameter of each woody snag section, in centimeters,
l_i = length of each woody snag section, in centimeters.

Alternatively, a foil template can be used (see top-rock scrape method) for irregularly shaped woody snag sections.

8.2.3 Procedures for benthic algae sampling in epiphytic habitats. Epiphytic samples from macrophytes with small or finely dissected leaves such as *Elodea canadensis, Ceratophyllum demersum, or Myriophyllum spicatum* are difficult to quantify because the surface area of periphyton colonization cannot be reliably determined in the field. However, quantitative samples should be collected from these macrophytes if the epiphytic periphyton microhabitat represents the dominant instream habitat along the sampling transect.

8.2.3.1 Select five locations in the reach from which macrophytes can be sampled.

8.2.3.2 Carefully place a 50- x 50-cm square frame (for example, Slack sampler with area template) over one of the macrophyte beds. Do not disturb the macrophyte leaves; epiphytes are often loosely attached.

8.2.3.3 Cut the plants at their bases within the frame and place them in a plastic bag. Alternatively, macrophytes can be placed carefully in the Slack sampler net.

8.2.3.4 Rinse the macrophytes with water in the plastic bag; additional agitation or brushing might be necessary to remove epiphytic periphyton. Set the rinsed macrophytes aside to determine their surface area.

8.2.3.5 Repeat this collection procedure in four additional macrophyte beds in the reach.

8.2.3.6 Combine the discrete collections contained in the plastic bags. Ensure that the sample volume does not exceed 975 mL.

8.2.3.7 Pour the sample through a funnel into a 1000-mL amber sample bottle. Place the sample on ice inside a cooler and keep in the dark until the sample is processed.

8.2.3.8 Determine the surface area of the sampled macrophytes. If necessary, save examples and record the number of each different macrophyte by pressing and drying for identification in the field office.

8.2.3.9 Once the sample has been collected, cap the 1,000-ml amber bottle and return the bottle to the plastic bag provided by the laboratory.

8.2.3.10 Place sample bottle into a cooler ensuring that the bottle is in ice but not totally immersed in water.

8.2.3.11 Record all data on the field data sheet.

8.2.4 Procedures for benthic algae sampling in episammic/epipelic habitats. Quantitative microalgal periphyton samples are collected from the upper 5- to 7-mm layer of episammic (sand) or epipelic (silt) habitat in depositional areas of the reach. Samples will only be collected from episammic or epipelic habitats if they are the dominant instream habitat along the sampling transect.

8.2.4.1 Select five locations in the reach that have a depositional zone consisting of either sand or silt substrates.

8.2.4.2 At each location, hold the lid of a small plastic petri dish (about 47- mm diameter) upside down in the water; rub the inside of the lid to remove air bubbles.

STANDARD OPERATING PROCEDURE:
BENTHIC ALGAE SAMPLING

8.2.4.3 Turn the inside of the lid toward the substrate that will be sampled without disturbing the sediment.

8.2.4.4 Carefully and slowly press (in cookie cutter fashion) the lid

8.2.4.5 Slide the lid onto a spatula (Figure 1d.) to enclose the discrete collection. Holding the petri dish tight against the spatula, carefully wash extraneous sediment from the spatula, and then lift out of the water.

8.2.4.6 Invert the lid and remove the spatula.

8.2.4.7 Rinse the sediment from the lid with distilled water into a 1000-mL amber sample bottle.

8.2.4.8 Repeat this collection procedure at each additional sampling location in the reach.

8.2.4.9 Combine the five discrete collections in a 1000-mL amber sample bottle (the total area sample will be about 85 cm2).

8.2.4.10 Once the sample has been collected, cap the 1,000-ml amber bottle and return the bottle to the plastic bag provided by the laboratory.

8.2.4.11 Place sample bottle into a cooler ensuring that the bottle is in ice but not totally immersed in water.

8.2.4.12 Record all data on the field data sheet.

9.0 Sampling Handling, Preservation, and Storage

9.1 Don necessary safety equipment.

9.2 Fill the laboratory supplied bottles with the composite water sample from the churn splitter and cap the bottles. Be sure to fill the bottles completely with the water so that no air is present between the water sample and the cap.

9.3 Place the filled bottles back into the laboratory provided plastic bag.

9.4 Load all samples into a cooler ensuring that the bottles are in the ice but not totally immersed in the water.

9.5 Record all data on the field log.

10.0 Chain of Custody

10.1 Chain of custody forms should stay with the samples at all times. When samples are not in custody of the sampler or designated person (who signs the form), the samples should be maintained under lock and key.

11.0 Data Management

11.1 All data and information shall be recorded on the field logs.

11.2 The chain of custody form is signed over to the laboratory. A copy is kept with the sampling records.

11.3 The sampling data is stored at with Deuchler for at least 5 years.

12.0 Quality Control/Quality Assurance and Decontamination

12.1 Representative samples are required. The sampler will evaluate the site-specific conditions to assure the sample will be representative.

12.2 All sampling equipment must be decontaminated between sampling sites. See the Field Cleaning of Sampling Equipment SOP for additional information.

12.3 All field QC sample requirements in the QAPP must be followed.

13.0 References

13.1 Moulton, S.R., J.G. Kennen, R.M. Goldstein, and J.A. Hambrook. 2002. Revised protocols for sampling algal, invertebrate, and fish communities as part of the National Water-Quality Assessment Program. USGS Open-File Report 02-150.

13.2 United States Environmental Protection Agency (USEPA). 1994. SOP #2016 Rev. #0.0.

STANDARD OPERATING PROCEDURE: TOTAL FLOW MEASUREMENTS

1.0 Introduction

1.1 This Standard Operating Procedure (SOP) is applicable to the measurement of total flow as part of the Rock River Watershed Group (RRWG) Nutrient Assessment Reduction Plan (NARP) Water Quality Monitoring.

1.2 Purpose

The purpose of this SOP is to provide a framework for the Total Flow monitoring as part of the RRWG NARP Water Quality Monitoring.

2.0 Definitions

2.1 Total Flow: The volume of water that passes a given point in a period of time

2.2 In-situ: In place. An *in-situ* environmental measurement is one that is taken in the field, without removal of a sample to the laboratory.

2.3 Stage: The water-surface elevation referenced to the gage datum. Gage height often is used interchangeably with the more general term "stage," although gage height is more appropriate when used with a reading on a gage.

3.0 Health and Safety Warnings

3.1 All proper personal protection clothing must be worn.

4.0 Interferences

4.1 Interference may result from selecting an improper stream cross-section, sampling in areas with moving bed material, and operator error due to improper training or use of equipment.

5.0 Personnel Qualifications

5.1 Personnel will be pre-trained in all sampling/measuring equipment by an experienced person before initiating the sampling procedure.

5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP) for the Village of Huntley Water Quality Monitoring.

6.0 Materials

6.1 ISCO 2150 Area Velocity Flowmeter with AV Senor

6.2 Engineering rule or engineering tape

6.3 Laser Range Finder

6.4 Field logs

7.0 Pre-sampling

7.1 Obtain the necessary sampling equipment.

7.2 Prepare a schedule and coordinate with staff.

8.0 Procedures

STANDARD OPERATING PROCEDURE: TOTAL FLOW MEASUREMENTS

8.1 Place the AV Sensor in a location determined to be representative of the channel cross section in water that is at least one foot deep. Mount the sensor to a sensor mounting plate at least 3 inches above the stream bottom and at least 3 inches below the surface of the water with the sensor facing upstream.
Set the frame in the stream bottom, place the AV Sensor on the mounting plate
Attach a cable to the 2150 Area Velocity Meter and fasten the cable and meter to a fixed object such as a tree or a stake. Secure the cable and the assembly with locks.

8.2 Use Flowlink software and enter the site information under the "DATA" tab

8.2.1 Under Flow Rate verify the measurement will be recorded in cubic feet per second (cfs)

8.2.2 Enter the bank height under maximum level

8.2.3 Enter the width at top of bank

8.2.4 Enter the width at the stream bed

8.2.5 Verify the conversion type is set to Area Velocity

8.2.6 Verify channel type is set to Trapezoidal

8.2.7 Under the Level tab enter the current stream level

8.2.8 Verify that the readings will be logged every 15 minutes

9.0 Sampling Handling, Preservation, and Storage
Not applicable

10.0 Chain of Custody
Not applicable

11.0 Data Management

11.1 All installation data will be recorded in the Flow Meter Installation Form

11.2 All data and information shall be downloaded and saved to the server.

11.2 The data is stored for at least 5 years.

12.0 Quality Control/Quality Assurance and Decontamination

12.1 The records generated in the procedure are subject to review during data validation, in accordance with the Quality Assurance Project Plan (QAPP).

13.0 References

13.1 Teledyne ISCO, "2150 Area Velocity Flow Module and Sensor Installation and Operation Guide", www.teledyneisco.com

STANDARD OPERATING PROCEDURE: EQUIPMENT CLEANING

1.0 Introduction

1.1 Purpose

To ensure effective cleaning of the sampling equipment prior to and during the sampling period to prevent cross-contamination between sampling sites.

1.2 Summary of Methods

This portion of the Standard Operating Procedure (SOP) will provide specific instruction for cleaning the sampling equipment in the field prior to and during the sampling period.

2.0 Definitions

2.1 Native Rinse: Refers to collecting water from the same source as the intended sample prior to sampling, for use as a rinse of the sampling equipment. The purpose is to further remove trace residue of any constituent in the containers.

2.2 Churn Splitter: A device used to mix water from multiple stream samples for compositing.

3.0 Health and Safety Warnings

3.1 All proper personal protection clothing must be worn including gloves and closed toed shoes.

4.0 Interferences

Not applicable

5.0 Personal Qualifications

5.1 Personnel will be trained in all sampling equipment procedures by an experienced sampler before initiating the sampling procedure.

5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP) for the RRWG NARP Water Quality Monitoring.

6.0 Materials

6.1 Sampling collection equipment
6.2 Churn splitter
6.3 SG-92 samplers
6.4 Gravel sampler
6.5 Plastic dishpans
6.6 Brushes
6.7 Pocket knifes
6.8 Poultry basters
6.9 Funnels
6.10 Forceps
6.11 Latex gloves

STANDARD OPERATING PROCEDURE: EQUIPMENT CLEANING

6.12 5% HCL solution
6.13 >4% Liqui-Nox solution

7.0 Pre-cleaning procedures
- 7.1 Obtain the necessary sampling equipment.
- 7.2 Prepare a schedule and coordinate with staff.

8.0 Cleaning Procedures
- 8.1 Laboratory cleaning of sampling equipment prior to sampling activities
  - 8.1.1 While wearing disposable gloves, soak all equipment listed in Sections 6.1 through 6.10 in a greater than 4% Liqui-Nox solution. Care should be taken to run all cleaning and rinse solutions through any spigots or other dispensing mechanisms.
  - 8.1.2 Rinse equipment with Deionized (DI) water. Swirl the DI water in the equipment to rinse out residues.
  - 8.1.3 Rinse the equipment with a 5% hydrochloric acid solution.
  - 8.1.4 Rinse equipment with DI water. Be sure to swirl the DI water in the equipment to rinse out residues.
  - 8.1.5 Allow containers to dry.
  - 8.1.6 For containers that come equipped with lids (mason jars, churn splitter, etc.) replace lids.
- 8.2 Field cleaning of sampling equipment between sampling sites
  - 8.2.1 Upon arrival at a sampling site, all equipment that will meet native waters that are being sampled should be rinsed with DI.
  - 8.2.2 Do a native rinse of the equipment prior to collecting the next sample.
  - 8.2.3 Discard the native rinse water either downstream of sampling location or on the ground.

9.0 Quality Control/Quality Assurance and Decontamination
- 9.1 All QC requirements in the QAPP should be followed to assure the highest quality and consistency of data.
- 9.2 Quality Control of field cleaning procedures is determined using equipment blanks as described in the Discrete Sampling SOP and section 2.5.2 of the QAPP.

STANDARD OPERATING PROCEDURE: STREAM CANOPY COVER MEASUREMENT

1.0 Introduction

1.1 Purpose

To measure riparian canopy cover over the stream to quantify the role of shading in stream temperature and other conditions that may affect the QUAL2K model.

1.2 Summary of Methods

This portion of the Standard Operating Procedure (SOP) will provide specific instruction on how to use a forestry densiometer that has been modified for use in stream assessment.

2.0 Definitions

2.1 Densiometer: A tool usually used to estimate forest canopy coverage Concave Spherical Densiometers allow accurate, inexpensive, one-person measurement of tree canopies using a spherical-shaped reflector mirror engraved with a cross-shaped grid of twenty-four 1⁄4" squares.

2.2 Modified Densiometer: For stream use, the densiometer shall be modified by affixing vinyl tape in a V-shape as shown in the figure below. 17 points will be visible. This modification is described fully in Strickler (1959).

3.0 Health and Safety Warnings

3.1 All proper personal protection clothing must be worn including gloves and closed toed shoes.

4.0 Interferences

Not applicable

5.0 Personal Qualifications

5.1 Personnel will be trained in all sampling equipment procedures by an experienced sampler before initiating the sampling procedure.

5.2 All personnel shall be responsible for complying with the Quality Assurance Project Plan (QAPP) for the Village of Huntley Water Quality Monitoring.

6.0 Materials

6.1 Modified convex spherical densiometer

6.2 Data sheet

7.0 Pre-cleaning procedures

Not applicable

8.0 Basic Transect Procedures

STANDARD OPERATING PROCEDURE:
STREAM CANOPY COVER MEASUREMENT

8.1 Establish 5 transect points along the sample reach. These should be located at approximately 1 meter from each bank, the center stream, and the midpoint between the center stream point and each bank point.

8.2 Stand at the first transect point, facing upstream.

8.3 Hold the densiometer 0.3 meters (approximately 1 foot) above the water surface.

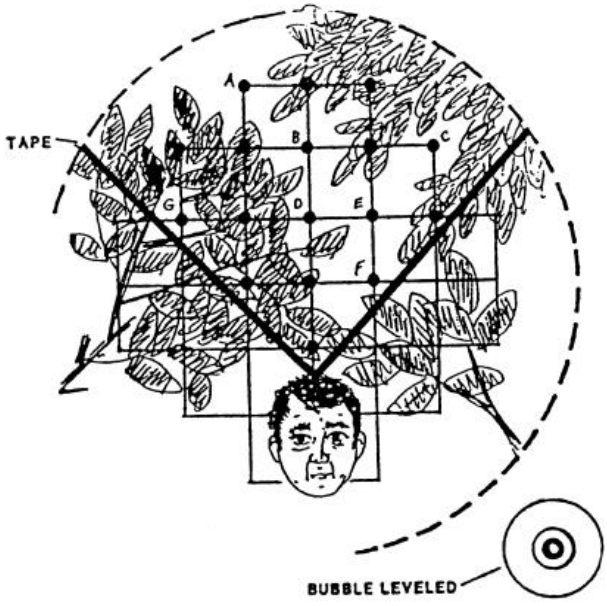
8.4 Hold the densiometer so that it is level, using the level bubble indicator and the top of your head just reflects into the point of the "V" as in the figure below.

8.5 Count the number of points covered by vegetation. Values will be between 0 for completely open and 17 for entirely covered canopy.

8.6 Record the value on the canopy cover section of the data sheet under the appropriate box.

8.7 Repeat steps 8.3 to 8.6 at the location, facing towards the right descending bank, downstream and left descending bank. Record on the canopy cover section of the data sheet.

8.8 Stand on the next sample point, repeating steps 8.3 to 8.6 at the location, facing upstream, towards the right descending bank, downstream and left descending bank. Record on the canopy cover form.



Schematic of modified convex spherical canopy densiometer. (Mulvey et al. 1992).

9.0 Sampling Handling, Preservation, and Storage

Not applicable.

STANDARD OPERATING PROCEDURE:
STREAM CANOPY COVER MEASUREMENT

10.0 Chain of Custody
Not applicable

11.0 Data Management
Not applicable

12.0 Quality Control/Quality Assurance and Decontamination

12.1 All QC requirements in the QAPP should be followed to assure the highest quality and consistency of data.

13.0 References

Mulvey, M., L. Caton, and R. Hafele. 1992. Oregon Nonpoint Source Monitoring Protocols Stream Bioassessment Field Manual for Macroinvertebrates and Habitat Assessment. Oregon Department of Environmental Quality, Laboratory Biomonitoring Section. 40 pp.

Strickler, Gerald S., 1959. Use of the densiometer to estimate density of forest canopy on permanent sample plots. USDA Forest Service, Pacific Northwest Forest and Range Exp. Sta. Research Note 180, Portland, Oregon, 5 pp.