

# Northeast Lakeshore Volunteer Surface Water Monitoring Program

## Northeast Lakeshore TMDL

### 2023 Annual Report



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# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Project Summary

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### Project Location

The Northeast Lakeshore (NEL) Volunteer Surface Water Monitoring Program supports the Northeast Lakeshore Total Maximum Daily Load (TMDL), which was approved on October 30, 2023. The program monitors twelve surface water monitoring sites on twelve different rivers and streams throughout the NEL region. These rivers and streams contribute nutrients and sediment directly to Lake Michigan. The NEL is approximately 2,000 square miles and covers eight counties (Brown, Calumet, Door, Fond du lac, Kewaunee, Manitowoc, Ozaukee, and Sheboygan). There are three major river basins within the NEL: Kewaunee, Manitowoc, and Sheboygan basins.

The volunteer monitoring program relies on citizen volunteers to collect surface water samples from twelve monitoring sites, there are four sites within each river basin of the NEL. The goal is to add additional monitoring sites in future seasons. The monitoring sites are displayed in Figure 1 and more detailed location information can be found in Appendix A.

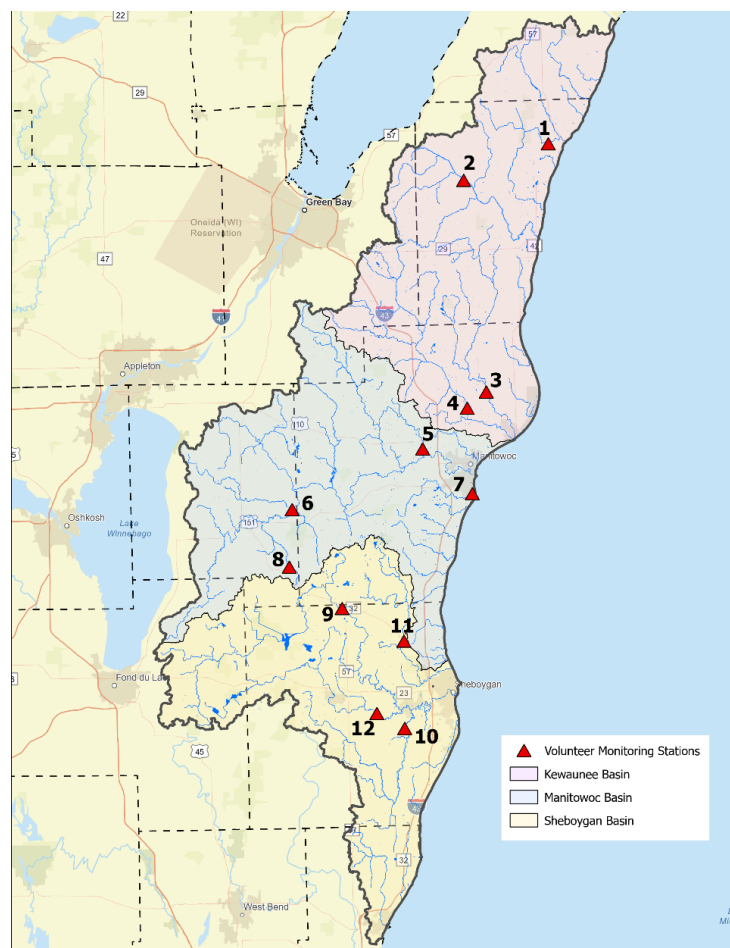


Figure 1: Map of volunteer monitoring sites in Northeast Lakeshore.

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### *Project Background*

The Northeast Lakeshore TMDL was approved by the EPA in October of 2023. The TMDL provides a framework to address total phosphorus (TP) and total suspended solids (TSS) reductions with the goal of achieving water quality standards. The TMDL sets goals for total TP and TSS concentrations in surface waters across the NEL. Loading capacities are defined, which is the maximum amount of a pollutant a waterbody can safely contain while still meeting the water quality standards set in the TMDL. As TMDL implementation progresses, one objective is to evaluate long-term water quality trends across the NEL.

The NEL Volunteer Monitoring Program began in 2023 to achieve some of the monitoring objectives resulting from the TMDL. Because this program started six months prior to the TMDL approval this sampling will also gather baseline data before implementation happens due to the TMDL. The volunteer monitoring program samples twelve sites across twelve different streams, the sites are distributed across the three basins within the NEL. The sites were chosen because they are good representations of water quality in the surrounding watershed, they were monitored during the development phase of the TMDL, and there is historical data to compare to.

Given the time commitment and spatial location of the monitoring sites, the assistance of volunteers is vital to the success of the program. Volunteers serve the essential role of data collectors, as they collect monthly (May – October) surface water samples at twelve monitoring sites. Volunteers are trained on the proper sampling protocol before the sampling season by Wisconsin Department of Natural Resources (WDNR) staff to ensure reliable and accurate results are collected each month.

### *Problem Statement*

Surface waters in the NEL are impaired due to excessive phosphorus and sediment loading. TMDL implementation focuses on restoring waters impaired by excessive sediment and/or high phosphorus concentrations. Phosphorus and sediment cause numerous impairments to waterways, including oxygen depletion, degraded habitat, and nuisance algae growth. These impairments adversely impact fish and aquatic life, water quality, and recreation.

Every two years, Sections 303(d) and 305(b) of the Clean Water Act (CWA) requires states to publish a list of all waters not meeting water quality standards and an overall report on surface water quality status of all waters in the state. All twelve of the streams sampled in the program are impaired for TP on the 2022 303(d) Impaired Waters List. Appendix B includes more information about the impaired monitoring streams.

Within the Northeast Lakeshore there is one Area of Concern (AOC), the Sheboygan River, which includes the lower 14 miles of the river and the Sheboygan harbor. This is an AOC primarily due to contamination from industrial waste, including polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). There were originally nine beneficial use impairments (BUIs) listed, but four have been removed due to ongoing work in the area. One of the BUIs removed was for eutrophication or undesirable algae, which causes reduced oxygen in the water, altered food web dynamics, and reduced water quality in general. The BUI was listed

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in 1987 and has since been removed. There are still water quality improvements needed, which is what the NEL TMDL discusses and why the volunteer monitoring program is important. We want to monitor the current conditions of the water and document improvements over time due to implementation.

### *Project Goals*

There are two main goals for this project: (1) increase public awareness and involvement of water quality issues by engaging the public in citizen science and (2) the collection of reliable surface water quality data to assess long-term water quality trends/success. This program aims to increase community awareness on local water quality issues and the impact of land use decisions in the watershed. The focus is to raise awareness through building a volunteer base and increasing community involvement and engagement.

Through citizen science the program goal is to collect reliable data to characterize TP, dissolved reactive phosphorus (DRP), TSS, and total nitrogen (TN) during the primary algae and aquatic plant “growing season” of May through October. The monitoring data brings focus to which streams are affected by elevated phosphorus and sediment concentrations.

It is important to note, however, that research is currently underway into the relationship between the reduction of TP, DRP, and TN, and the biological responses. The collection of these parameters will help strengthen the understanding of these relationships and effects they may have on biological responses in the NEL.

Additional goals of this project include:

1. Evaluate nutrient and sediment concentrations in the rivers, streams, and tributaries in the Northeast Lakeshore region
2. Monitor the health of the watershed over time at a regional scale
3. Evaluate the long-term effectiveness of implementation of the Northeast Lakeshore TMDL

### *Proposed Work and Sampling Procedure*

2023 was the first year for the NEL Volunteer Monitoring program. Implementation of volunteer monitoring efforts were coordinated by WDNR staff. Specifically, the WDNR:

- Continues to develop a well-trained volunteer base through various means of recruitment and community engagement:
  - o Volunteers are trained to follow Water Action Volunteer (WAV) (<https://wateractionvolunteers.org/>) monitoring protocol to ensure consistency is being met in each sample
  - o Volunteers collect and ship surface water samples in iced coolers to the Wisconsin State Lab of Hygiene (WSLH) for analysis of TP, DRP, TSS, and TN
  - o Volunteers collect streamflow and transparency data at the time of surface water sample collection (if able)

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- One duplicate sample was collected at a randomly selected site throughout the sampling season (Appendix G). Duplicates are collected on the same day and at the same time as the regular sample
- Continues to provide support to volunteers as needed:
  - Ensures safe access and suitability at each monitoring site
  - Orders, prepares, and maintains supplies for volunteers to successfully carry out monitoring activities and shipment of samples
  - Fosters an open line of communication with volunteers to ensure that all sites are being monitored at the frequency outlined in the project QAPP
- Confirms that all twelve monitoring locations are monitored monthly from May to October for a total of six monitoring events annually
- Compiles monthly sampling data results to share with volunteers and stakeholders
  - Records data into tables and graphs for analysis
  - Develops an annual report complete with data and figures to share with stakeholders to assess annual water quality

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## 2023 Sampling Season

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### Summary

2023 was the first year for the NEL volunteer monitoring program. Recruitment started and supply orders were sent to the State Lab of Hygiene in April, while sampling started in May. All the supplies and lab slips were put together by the WDNR coordinator with help from WDNR Central Office. Because all the volunteers in this program were new, the supplies were given to the volunteers when they were trained. In future seasons supplies will be shipped to the volunteers either from the State Lab of Hygiene or from the WDNR office.

Sample collection completeness for the season was 94%. There were only two sites with missed samples, Sheboygan River at STH 57 and Pigeon River at STH 42. The missed samples for both sites happened in July and August, the sites were monitored by the same volunteer. There was a lack of communication between the volunteer and WDNR coordinator, which could be why the samples were missed. Sample completeness for each monitoring site can be found in Table 1.

US Postal Service (USPS) Priority Mail was used to ship samples. Different couriers have been tested for similar volunteer programs and USPS became the primary courier in 2021. USPS allows for convenient package drop off for volunteers sampling in more remote areas. All shipping labels were printed and provided to volunteers at the start of the season. This season there were many shipping issues that were of no fault to the volunteers. Multiple times a volunteer dropped off both their coolers to the post office at the same time yet one of their coolers arrived to the WSLH two weeks later. There were other coolers that arrived at the lab late and one cooler was shipped back to the volunteer. Many of these issues happened around the summer holidays, Memorial Day and 4<sup>th</sup> of July, so volunteers will be asked to avoid sampling around those dates in future seasons. The WDNR will monitor for future shipping issues and decide if USPS will continue to be the courier for this program.

A total of 47 DRP samples (including duplicate samples), or 68% of DRP samples collected, were flagged in 2023 due to samples exceeding the 48-hour hold time for DRP analysis. Although these samples are flagged by the lab for exceeding the analysis holding time, they are still able to be processed and the data is usable. Volunteers are trained to ship samples immediately after collection or as early as possible the next day. They are also instructed to sample at the

Sample Collection Completeness (%) Out of 72 samples per year (6 samples/site)	
Monitoring Site	2023
Silver Creek at Willow Road	100%
Kewaunee River	100%
East Twin River	100%
West Twin River	100%
Branch River	100%
South Br. Manitowoc River	100%
Pine Creek	100%
Silver Creek at CTH LS	100%
Sheboygan River	67%
Pigeon River	67%
Onion River	100%
Mullet River	100%
<b>Combined Percentage</b>	<b>94%</b>

*Table 1: Sample collection completeness by monitoring site.*

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beginning of the week; volunteers should avoid sampling Thursday-Sunday because the samples have a low likelihood of making it to the lab within the 48-hour hold time. The WSLH may not have the capacity to analyze samples immediately after receiving them in the busy summer season, which also impacts sample analysis. Getting samples to the lab and analyzed within 48 hours will be an area for improvement next season.

The twelve sites were monitored by twelve volunteers. There was a group of six volunteers who traded off sampling the four Kewaunee sites, and there were two volunteers who each had two sites. All the volunteers were trained in May, most of the volunteers were trained by taking the May sample with the WDNR coordinator. This style of training worked well because it ensured the volunteer was sampling at the right location and it saved them an extra trip to their site in May. Most of the volunteers plan on returning for the 2024 season.

Volunteer recruitment was a challenging part of the 2023 season because the new WDNR coordinator started the position the last week of March, which only left one month to recruit volunteers before the sampling season started in May. Recruitment was done by sharing the NEL Volunteer Monitoring Fact Sheet (Appendix I) with WDNR contacts, county land and water departments, and local environmental groups. The main groups contacted for the NEL were Lakeshore Trout Unlimited, Lakeshore Natural Resource Partnership, Friends of Crescent Beach, and Sheboygan River Basin Partnership. These groups and county land and water departments were the main sources of volunteers in 2023.

### *Outreach*

The WDNR coordinator attended two outreach events in 2023. One of the events was a naturalist class through the YMCA at the end of April, the class was learning about water quality and the coordinator taught the sampling method and discussed the program. The teacher of the class agreed to be a volunteer for two of the NEL sites, none of those participating in the class became a volunteer but seemed interested in the program. Also, in November the coordinator talked about the volunteer program to a group of outdoor enthusiasts at the Ledgeview Nature Center, at least one new volunteer for the 2024 season was gained through this event. It is important to spread the word about this program and participate in future events like these to recruit volunteers and make the community aware of the work the WDNR is doing in their area.



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## Water Quality Data

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### Wisconsin Listing Methodology

To evaluate stream water quality and TP concentration reductions, the WDNR follows a standard assessment procedure which accounts for sample methods, timing, variability, sample size and statistical confidence to more confidently determine whether a stream meets water quality criteria. The NEL TP sampling data is compared to Wisconsin's TP water quality criteria (WQC) for streams (0.075 mg/L) and rivers (0.100 mg/L) by calculating a 90% confidence limit around the Growing Season Median (GSM) of the TP sample dataset. A stream is considered impaired for TP if the lower confidence limit (LCL) of the GSM (May – October) TP concentration exceeds the TP WQC. The LCL is used to ensure a stream exceeds the criteria with a predetermined level of confidence before it is listed. A stream that is impaired for TP will be de-listed if the upper confidence limit (UCL) of the GSM TP subsequently drops below, or clearly attains, the criteria.<sup>1</sup> See Figure 2.

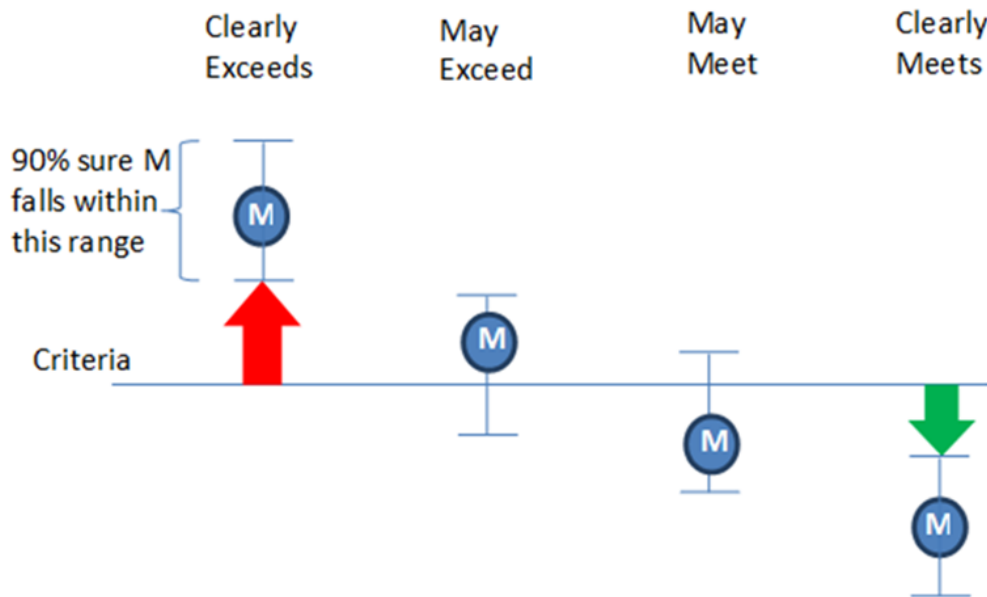


Figure 2: Wisconsin TP criteria confidence table. Criteria line indicates the 0.075 mg/L water quality criteria limit and M represents the Median value.

90% confidence limits are calculated for each monitoring location each year of data collection. A minimum of six samples, one per month from May – October, are needed to calculate the confidence limits. In years with less than six data points at a location, a data point from the same month from the most recent year of a full dataset is used instead; because this is the first year of sampling there is not a previous dataset to use for missing data points. There were two

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<sup>1</sup> WDNR 2020. Guidelines for Monitoring for Watershed Restoration Effectiveness. Wisconsin Department of Natural Resources, Bureau of Water Quality. Madison, Wisconsin. EGAD#3200-2020-26

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sites missing data points in 2023, a confidence limit was still calculated despite the missing data points, but this confidence limit cannot be used for listing purposes and the results are flagged due to missing data. A confidence limit table for each monitoring site is provided in Appendix E.

In 2023 there were five sampling streams where the water quality “Clearly Meets” the State TP WQC, these streams are Silver Creek (Willow Road), East Twin River, West Twin River, Branch River, and Mullet River. The remaining seven streams “Clearly Exceeds” the State TP WQC, meaning the LCL for these streams is above the TP WQC. The TP WQC for 11 of the monitoring streams is 0.075 mg/L, the Sheboygan River is the only monitoring site with a TP WQC of 0.100 mg/L according to the NEL TMDL.

Although the confidence limits calculated for five of the monitoring sites indicate WQC for TP IS being met in 2023, that does not mean improvement in water quality isn’t needed. 2023 had less precipitation than average and when there is less precipitation there is less runoff, which lowers how much phosphorus is entering the waterbodies. It is important to continue to monitor these sites and calculate confidence limits for many years because weather variability can be a factor. Implementation across the NEL will increase due to the TMDL, additional sampling data will be useful for detecting changes in water quality.

### *Total Phosphorus Analysis*

Although sample collection was less than 100% at some monitoring locations in 2023, TP median values were still calculated. The median values were calculated from only the samples collected during the sampling year. Table 2 breaks down the median TP value for each monitoring site. Red values indicate years with less than 100% sample collection, these values may not be a proper representation of the median TP value at that stream location for the specific year due to the missing data points. The median is calculated instead of the mean according to Wisconsin Consolidated Assessment and Listing Methodology (WisCALM) protocol. Median is used for datasets with high variability to ensure results are not skewed by one extremely high or low value; streams and rivers tend to have higher variability in concentrations compared to lakes where the mean is used.

Median TP (mg/L)	
Monitoring Site	2023
Silver Creek at Willow Road	0.0566
Kewaunee River	0.1510
East Twin River	0.0458
West Twin River	0.0524
Branch River	0.0522
South Br. Manitowoc River	0.2235
Pine Creek	0.1770
Silver Creek at CTH LS	0.1240
Sheboygan River	0.1265
Pigeon River	0.1615
Onion River	0.1995
Mullet River	0.0568

*Table 2: NEL median TP by monitoring site. Red values indicate at least one sample was missed that year.*

In 2023 five of the sites had a yearly median value below the State WQC of 0.075 mg/L. There was at least one site in each subbasin with a median TP value below the WQC. The Sheboygan River has a TP WQC of 0.100 mg/L because it is a large river, the 2023 median TP result was

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above this criteria. Appendix D contains a graph displaying the yearly median TP concentration by monitoring site compared to the TP WQC. All monitoring data for 2023 can be found in Appendix C.

Total phosphorus is a key indicator of water quality. It is an essential nutrient for plant growth however, when excess amounts are introduced to a waterbody, water quality can decrease and lead to harmful algal blooms. In 2023, 26 of 64 (41%) TP samples met the WQC for streams, which is 0.075 mg/L. The individual TP results for the Sheboygan River were not included in this count because the WQC for this river is 0.100 mg/L. Only one of the four TP samples taken for the Sheboygan River was below 0.100 mg/L.

Table 3 compares the number of TP samples meeting and not meeting the stream WQC, Sheboygan River samples were not included. This data will serve as a baseline for how many samples are meeting the TP WQC. As monitoring continues in the years to come, Table 3 will be useful for assessing water quality improvements across all monitoring locations.

TP Samples Below 0.075 mg/L	2023
# Monitoring Sites	11
# Samples Collected	64
# Above 0.075 mg/L	38
# Below 0.075 mg/L	26
<b>% Below 0.075 mg/L</b>	<b>41%</b>

*Table 3: TP Samples compared to TP WQC for 11 of the monitoring sites, Sheboygan River samples not included.*

### ***Dissolved Reactive Phosphorus Analysis***

While TP is a key indicator of water quality, DRP also plays an important role in water quality. DRP is the soluble form of phosphorus and is readily available for plant and algae growth. DRP concentrations can vary widely over short time periods due to plants taking it up and releasing it. Excessive amounts of DRP can also lead to harmful algal blooms and cause poor water quality. It is important to monitor how much of the TP concentrations are made up of DRP concentrations across all monitoring sites. Appendix F compares each sampling event’s TP and DRP concentrations.

Table 4 breaks down the DRP percentage ranges. The DRP percentage range with the most samples in 2023 was 60 – 80% (27 of 67 samples), meaning that percentage of the TP concentration was made up of DRP. Another 31% (21 of 67 samples) have 40 – 60% of their TP concentrations coming from DRP. This data shows the DRP percentage ranges are high, meaning harmful algae blooms have more of an opportunity to bloom. These algae blooms decrease water quality, which is why it’s important to monitor DRP concentrations over time. As sampling continues, this data will be useful for evaluating implementation progress and effectiveness.

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DRP Percentage of TP Ranges								
Year	# Sites	# Samples Collected	< 20% DRP	20 - 40% DRP	40 - 60% DRP	60 - 80% DRP	80 - 100% DRP	> 100% DRP
2023	12	67	3	12	21	27	3	1
<i>Percent of Total</i>			<b>4%</b>	<b>18%</b>	<b>31%</b>	<b>40%</b>	<b>4%</b>	<b>1%</b>

Table 4: *DRP Percentage of TP (DRP >100% due to sample variance).*

### ***Total Suspended Solids Analysis***

Although there is not a statewide TSS WQC, the NEL TMDL defines a TSS target concentration of 12mg/L. High TSS levels are associated with degraded habitat in streams because excess TSS reduces light penetration, which affects plant growth, and it can interfere with fish feeding patterns. The TSS target of 12mg/L will help reduce the negative effects of excess TSS across the NEL.

The median TSS concentrations for the monitoring sites and the NEL TSS target are shown in Figure 3. The median concentration for every site, except the South Branch Manitowoc River, is below the TSS target of 12mg/L. As stated previously there was less rain than average in 2023 which means there is less runoff, this reduces how much sediment is being transferred into the waterbodies. The South Branch Manitowoc River median TSS concentration is much higher than the other monitoring sites, this could be due to surrounding land use, sampling timing (if samples were taken directly after rain events), or how large the drainage basin for the river is compared to the other monitoring sites. It will be important to monitor how TSS concentrations change over time and if there are patterns noted across the monitoring sites.

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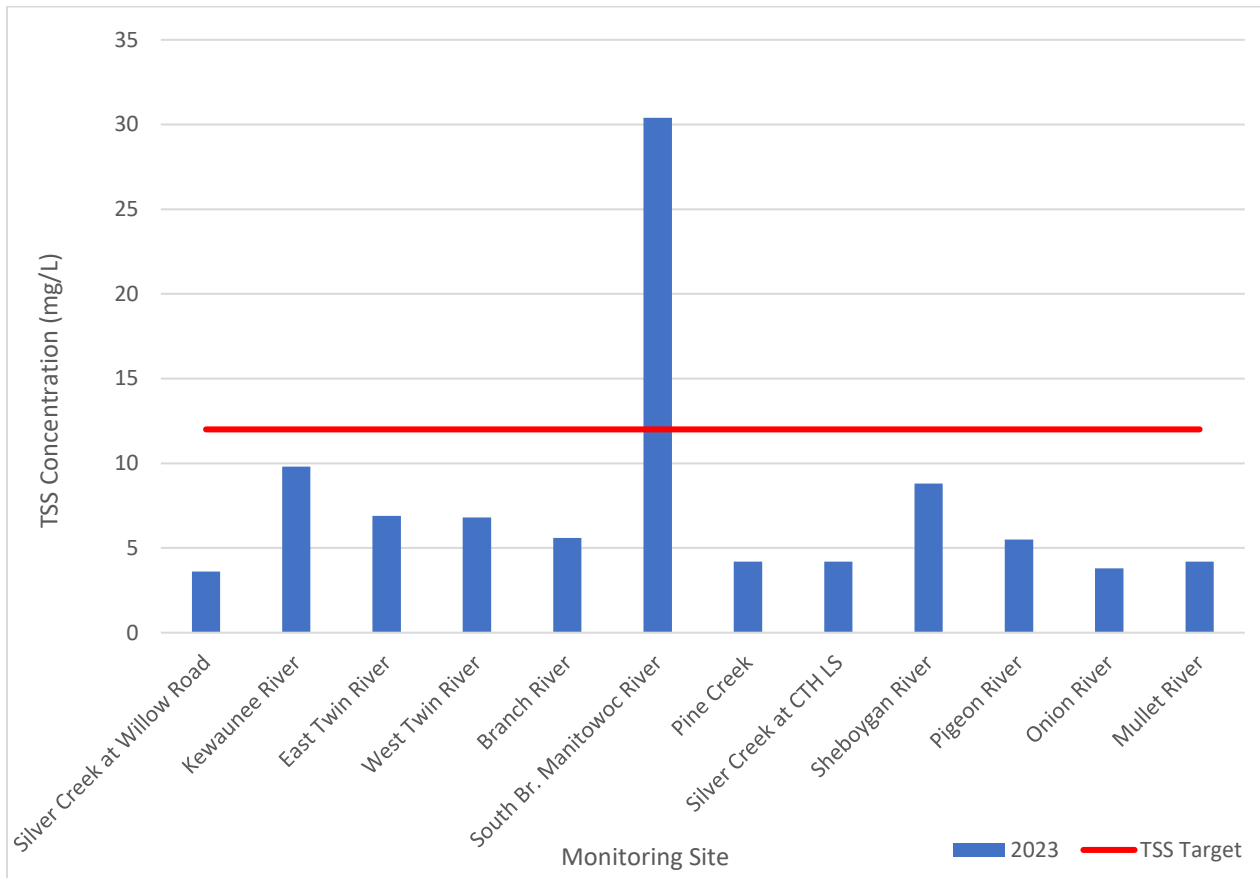


Figure 3: Yearly TSS median concentrations by monitoring site compared to the TSS target of 12mg/L.

## ***Field Quality Assurance/Quality Control Duplicate Samples***

To document the accuracy and precision of the field data collected by volunteers, one of the twelve sites was chosen to participate in collection of additional quality assurance/quality control (QA/QC) samples. The samples are randomly selected from the list of sites that are monitored. These QA/QC tests document the accuracy and precision of the data collected and look at natural variability and sampling error.

Duplicate samples are collected on the same day and time as the regular samples. The duplicate sample is an additional sample for each parameter, it is sampled using the same protocol and shipped to the lab with the regular sample. Duplicate sample results were compared to the regular sample result and an absolute difference was calculated. The absolute difference between the two sets of samples is compared to each test's Level of Quantification (LOQ) and is considered good data quality if the value falls below the LOQ. Relative percent difference between the regular and duplicate samples was also calculated, the results are flagged if the percentage is greater than 30% as this indicates a variance between the two sample results. The absolute difference for each parameter in 2023 was below the relative LOQ, meaning the data is good quality. The relative percent difference for each parameter was below 30%, with

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two of the parameters having a difference of zero (TSS and TN). Duplicate sample results are in Appendix G.

### *Stream Flow and Transparency*

In addition to collecting water chemistry samples (TP, DRP, TSS, TN) each month, volunteers measure stream flow and water transparency. Streamflow can only be measured when there is at least two volunteers sampling, the stream has 20 ft. section of stream that is straight and accessible, and the stream is wadable. Many of the monitoring streams in the NEL don't meet this criteria, in 2023 there was only two streamflow data points. Transparency was able to be measured at every site with only a few months missing transparency data.

Stream flow is affected by the amount of water within a watershed and increases with rainstorms or snowmelt and decreases during dry periods. Flow defines the shape, size, and course of the stream. Volunteers measure streamflow using a velocity-area approach. A 20 ft. length of stream is assessed followed by measuring the width and the water depth at numerous locations across the width. Water velocity is determined by measuring the time it takes for a tennis ball to float along the stream length. Streamflow data can be found in Appendix H.

Water transparency is collected each month with a 120 cm transparency tube. Water clarity is affected by suspended sediment, dissolved material, and algae. When there is more dissolved material in the water, transparency numbers decrease. The highest transparency reading is 120cm, this means the water is clear and there is minimal dissolved material. Seven of the monitoring sites had a median transparency reading of 120cm. Transparency data can be found in Appendix H.

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### *Key Takeaways for 2023*

- In 2023 there was less precipitation than average during the sampling season which can affect the results of all parameters, it is important to continue this program and draw conclusions based on multiple years of data
- Five sites had median TP concentrations below the State TP WQC for streams of 0.075mg/L. These five sites had confidence intervals that “Clearly Meets” the TP WQC, the remaining seven sites “Clearly Exceeds” the TP WQC
  - The TP median for the Sheboygan River was above the TP river criteria of 0.100 mg/L
- DRP concentrations make up a large part of TP concentrations, 40% of the TP samples had 60-80% of their concentration coming from DRP. DRP contributes to excess algae growth and potentially harmful algal blooms, it will be important to monitor DRP concentrations as implementation increases across the NEL
- The median TSS concentration for all monitoring sites, except South Branch Manitowoc River, was below the TSS target of 12mg/L. The lower amount of precipitation in 2023 could be a reason the median TSS concentrations were low, it will be important to monitor these medians in future years
- Total nitrogen results varied by monitoring site. There was no correlation between TN and the other parameters and there is not a defined TN WQC

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### *Data Conclusions*

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2023 was the first year of monitoring for the NEL volunteer monitoring program. The NEL TMDL was approved in October of 2023, meaning implementation and best management practices will increase across the NEL in future years. The future data collected may evaluate water quality changes over time in respect to changes in implementation, climate, and land use.

Raw data may suggest that variations in weather patterns, temperature, and time of year may have an impact on the TP, DRP, TSS, and TN concentrations. 2023 was a dryer year than average and when there is less precipitation there is less runoff going into the waterbodies, this may cause concentrations of TP, DRP, TSS, and TN to be lower than average. It is important to note extreme weather conditions each season and to keep these conditions in mind when analyzing the data. The NEL volunteer program should continue so water quality trends can be monitored over time, conclusions cannot be made after one year of data.

In 2023 there were seven streams with median TP concentrations over the State TP WQC of 0.075 mg/L, all these streams had a confidence limit that “Clearly Exceeds” the TP WQC. The Sheboygan River is included in these seven streams as the median TP concentration was above the TP WQC for rivers, which is 0.100 mg/L. These streams are impaired by total phosphorus and demonstrate the need for best management practices and implementation in the NEL. There are five streams that “Clearly Meets” the TP WQC, but implementation should still happen in these watersheds.

DRP made up a large portion of total phosphorus concentrations across the monitoring streams. Appendix F provides a table of the percentage of DRP making up each TP sample and Table 4 categorizes the values into percentage categories. In 2023, 27 of the 67 samples had a DRP percentage range of 60 – 80%, which is 40% of the samples. The dissolved form of phosphorus is readily available for plant uptake and contributes to harmful algal blooms, when there is a high percentage of DRP algal blooms can form more easily. It will be important to monitor how DRP concentrations change over time as implementation increases due to the NEL TMDL.

There were multiple TSS samples that reported no detect (ND), these samples occurred in the Autumn months, September and October. The median TSS result for eleven of the monitoring sites was below the TSS target of 12mg/L defined by the NEL TMDL. The one site that was above the TSS target was the South Branch Manitowoc River, this could be due to surrounding land use, timing of sampling, and size of the watershed.

There is not a State WQC for TN and the TMDL does not define a target for nitrogen. The TN results for the monitoring sites were variable and showed no correlation with other parameters. As more TN data is collected, the relationship between TN and other parameters will be evaluated because it is hard to draw conclusions from one year of data. It is important to



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continue to test for TN because nitrogen is often found in agricultural settings and there is high agricultural activity in the NEL region.

### *Program Conclusions*

The main goal of the Northeast Lakeshore Volunteer Monitoring Program is the engagement of the public and increasing their awareness on water quality issues. There were twelve volunteers in 2023, but multiple volunteers were part of larger organizations, possibly making the volunteer contribution much higher. With the knowledge the volunteers possess, they can teach others and be an extension of the program. The volunteers can talk about their experiences with others, which allows the information to be carried out to even more individuals in the basin.

Volunteer recruitment was carried out in several ways, mainly through reaching out to county land and water departments and local environmental groups. Presentations were also given during the sampling season to gain interest from future volunteers and to spread awareness about water quality issues in the area. These presentations garnered interest from individuals who were unsure how they could participate when it came to improving water quality. These outreach events were successful and there will be more in the future.

Communication proves to be the most important aspect of the WDNR coordinators position. Because this was the first year for the NEL volunteer program there was a lot of training to coordinate and new volunteers to manage. The volunteers were grateful for the high level of communication and appreciated the WDNR coordinator was available for questions and help with sampling when needed.

There are plans to add monitoring sites for the next sampling season. This program was successful and with the NEL TMDL approval there will be more interest in water quality monitoring in the area. Sites will be chosen based on sampling data from other programs and their representation of more watersheds in the basin.

This water quality monitoring data is also important in measuring implementation progress. There are six active 9 Key Element Plans within the NEL TMDL area. These plans assess the causes and sources of pollution and prioritize restoration and protection strategies to address water quality problems. Watersheds with active 9 Key Element Plans include CalMan Lakes (2018), Pine Creek (2019), North Branch of the Manitowoc River (2019), Ahnapee River (2020), Upper Ahnapee River (2020), and Pigeon River (2023). The active 9 Key Element watershed plans focus on non-point source agricultural implementation, while the NEL TMDL will focus on implementation across all sources of pollution in the watershed. As implementation of these plans continue, monitoring data can be utilized to help track implementation progress and assist in determining where additional data and information is needed to track progress.

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

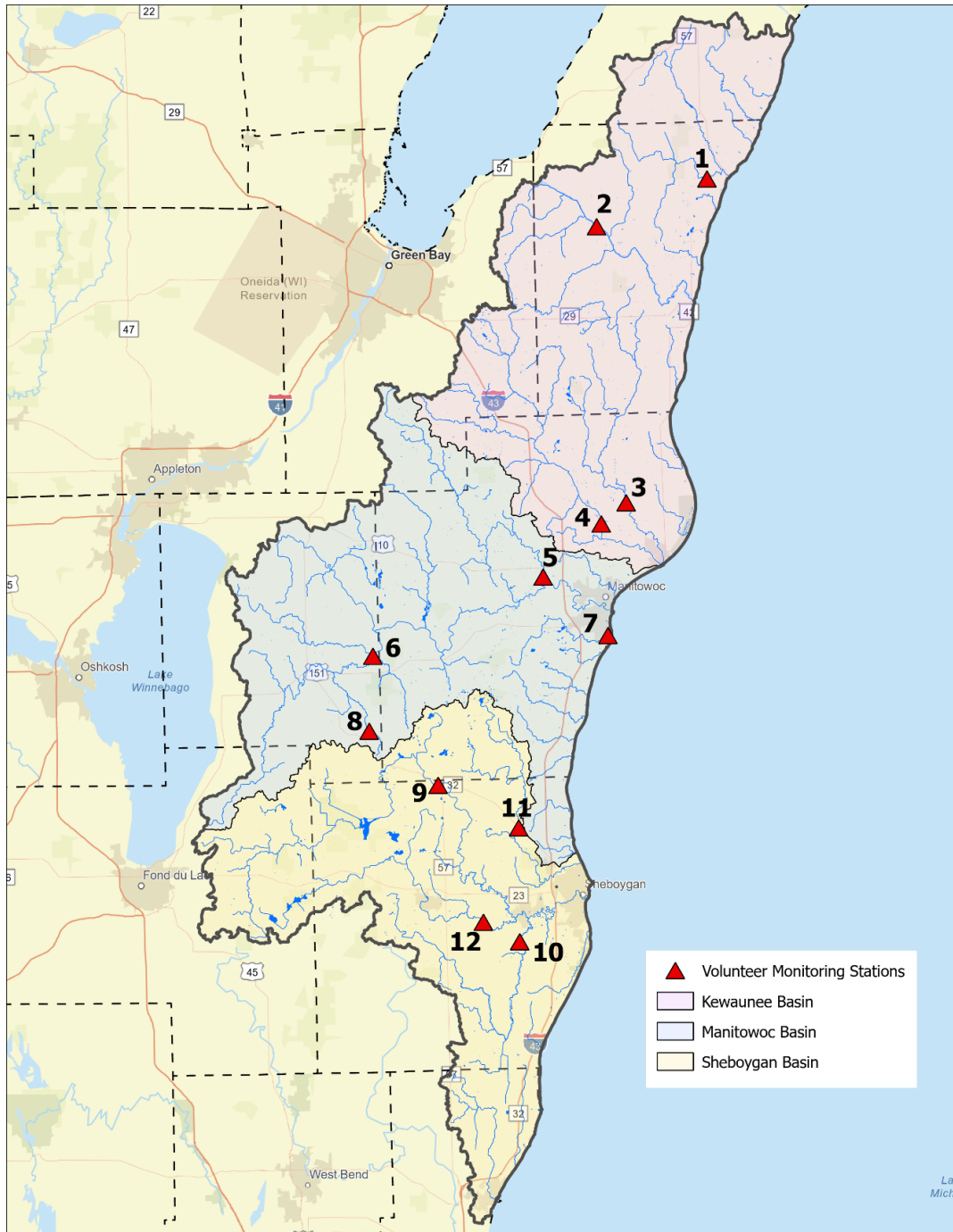
## *Acknowledgements*

Thank you to all the volunteers who made the 2023 monitoring season in the Northeast Lakeshore possible. Thank you to the WDNR and the WAV program for funding and support. The WAV program manages a nutrient data database, where results can be viewed for monitoring sites across the state, including the Northeast Lakeshore volunteer monitoring sites ([WAV Data Dashboard \(wisc.edu\)](https://wisc.edu/wav)).

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Appendices

### Appendix A: Northeast Lakeshore Volunteer Monitoring Sites and TMDL Basin Boundaries



## Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

	<b>Stream Name</b>	<b>WBIC</b>	<b>SWIMS ID</b>	<b>SWIMS Station Name</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Impairment</b>
<b>1</b>	<b>Silver Creek</b>	94900	10020779	Silver Creek at Willow Rd	44.60788	-87.47114	TP
<b>2</b>	<b>Kewaunee River</b>	90700	10029954	Kewaunee River at Hillside Rd	44.55438	-87.65939	TP
<b>3</b>	<b>East Twin River</b>	84000	10008207	East Twin River at Steiners Corners Rd	44.22131	-87.62302	TP
<b>4</b>	<b>West Twin River</b>	87000	10029482	West Twin River at CTH V	44.19678	-87.66578	TP
<b>5</b>	<b>Branch River</b>	71300	363299	Branch River at N Union Rd	44.13479	-87.76542	TP
<b>6</b>	<b>South Branch Manitowoc River</b>	77900	363375	South Branch Manitowoc River at Lemke Rd	44.03367	-88.06298	TP
<b>7</b>	<b>Silver Creek</b>	67300	363228	Silver Creek at CTH LS	44.06227	-87.65994	TP
<b>8</b>	<b>Pine Creek</b>	79900	10020831	Pine Creek at CTH T	43.9548	-88.06231	TP
<b>9</b>	<b>Sheboygan River</b>	50700	10021359	Sheboygan River at STH 57	43.8873	-87.95099	TP
<b>10</b>	<b>Onion River</b>	51200	603480	Onion River at Ourtown Rd	43.69669	-87.82086	TP
<b>11</b>	<b>Pigeon River</b>	62300	603294	Pigeon River at STH 42	43.78144	-87.74747	TP
<b>12</b>	<b>Mullet River</b>	53400	10049358	Mullet River at Sumac Rd	43.72143	-87.88	TP

\*SWIMS – Surface Water Integrated Monitoring System; a Wisconsin DNR information system that holds chemistry (water, sediment), physical, and biological (macroinvertebrate, aquatic invasive species) surface water data.

## Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

### Appendix B: Impaired Monitoring Streams

Local Waterbody Name	Waters ID	WBIC	County	Total Size (mi)	Cycle Listed	TMDL Priority	Source Category	Pollutant	Impairment	Listing Condition Category
Branch River	9899	71300	Manitowoc	12.4	2020	High	PS/NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	482183			7.7			NPS	Total Phosphorus	Impairment Unknown	
East Twin River	10205	84000	Kewaunee	7.8	2014	High	NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	10206			6.7				Total Phosphorus	Degraded Biological Community	TMDL Needed (5A)
	18071			10.5				Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	4700226		Kewaunee, Manitowoc	15.9	2018			Total Phosphorus	Impairment Unknown	
Kewaunee River	18061	90700	Kewaunee	10.9	2020	High	NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	482871		Brown, Kewaunee	11.53			PS/NPS	Total Phosphorus	High Phosphorus Levels	TMDL Needed (5A)
Manitowoc River (South Branch)	9924	77900	Calumet, Manitowoc	12.6	2012	High	PS/NPS	Total Phosphorus	High Phosphorus Levels	TMDL Needed (5A)
					2016	Low	PS/NPS	Unknown Pollutant	Elevated Water Temperature	

## Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

Mullet River	9839	53400	Sheboygan	17.8	2012	High	PS/NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	9842			5.9	2020			Total Phosphorus	Impairment Unknown	
Onion River	3987353	51200	Sheboygan	31.8	2012	High	PS/NPS	Total Phosphorus	Degraded Biological Community	TMDL Needed (5A)
Pigeon River	1496062	62300	Manitowoc, Sheboygan	18.1	2012	High	PS/NPS	Total Phosphorus	High Phosphorus Levels	TMDL Needed (5A)
Pine Creek	9931	79900	Calumet	5.5	2020	High	NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	9932			3.6	2016			Total Phosphorus	High Phosphorus Levels	TMDL Needed (5A)
Sheboygan River	11354	50700	Sheboygan	13.6	2014	High	PS/NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	11356		Calumet, Manitowoc, Sheboygan	20.2	2020			Total Phosphorus	Degraded Biological Community	TMDL Needed (5A)
	5753343		Sheboygan, Fond du Lac	20.8				Total Phosphorus	High Phosphorus Levels	
Silver Creek (Havel Creek)	10212	94900	Kewaunee	5.5	2018	High	NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
Silver Creek	9872	67300	Manitowoc	8.4	2014	High	NPS	Total Phosphorus	Impairment Unknown	Phosphorus Only (5P)
	8106635			9.3			PS/NPS			
West Twin River	9948	87000	Manitowoc	9.5	1998	High	NPS	Total Phosphorus	Low DO	TMDL Needed (5A)
	9949			0.4						

## Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

	9950			1.4									
	18050			5.9						2016	PS/NPS	Unknown Pollutant	Elevated Water Temperature
										1998			
	18051			1.3						2016	NPS	Unknown Pollutant	Elevated Water Temperature
										1998			

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Appendix C: Sampling Data

		TP (mg/L)	DRP (mg/L)	TSS (mg/L)	TN (mg/L)
Monitoring Site	Month	2023	2023	2023	2023
Silver Creek at Willow Road	May	0.0801	0.0496	3.6	2.61
	June	0.0586	0.0277	3.25	5.55
	July	0.075	0.0417	5	2.41
	August	0.0545	0.0229	4.8	2.08
	September	0.0409	0.0174	3.2	2.63
	October	0.0298	0.00947	ND	2.33
Kewaunee River	May	0.157	0.0967	7.4	6.62
	June	0.131	0.0824	3.75	9.42
	July	0.159	0.104	16.6	6.02
	August	0.385	0.3	14.4	5.33
	September	0.145	0.0902	11.6	4.37
	October	0.0998	0.0544	8	3.43
East Twin River	May	0.0398	0.0132	3.5	3.59
	June	0.0518	0.0231	4	3.71
	July	0.111	0.0688	11.6	2.27
	August	0.0921	0.0493	9.8	2.69
	September	0.0373	0.0169	17.8	3.16
	October	0.0321	0.0138	3.6	4.25
West Twin River	May	0.0557	0.0106	8.75	2.31
	June	0.049	0.0165	2.2	2.4
	July	0.0802	0.05	9.4	1.82
	August	0.0672	0.0329	6.8	2.14
	September	0.0191	0.00593	2.2	2.07
	October	0.024	-	ND	2.41
Branch River	May	0.0554	0.0204	5.2	3.71
	June	0.0496	0.0252	5.6	2.98
	July	0.0566	0.016	5.6	1.59
	August	0.0547	0.027	7	1.82
	September	0.0284	0.00998	4.4	2.18
	October	0.0235	0.00656	ND	2.38
South Branch Manitowoc River	May	0.289	0.173	48.6	3.02
	June	0.19	0.0877	24.6	2.86
	July	0.252	0.149	29.2	1.78
	August	0.26	0.146	31.6	2.17
	September	0.195	0.0757	51.8	2.53
	October	0.121	0.0706	5.8	2.44
Pine Creek	May	0.0925	0.0588	3.6	2.61

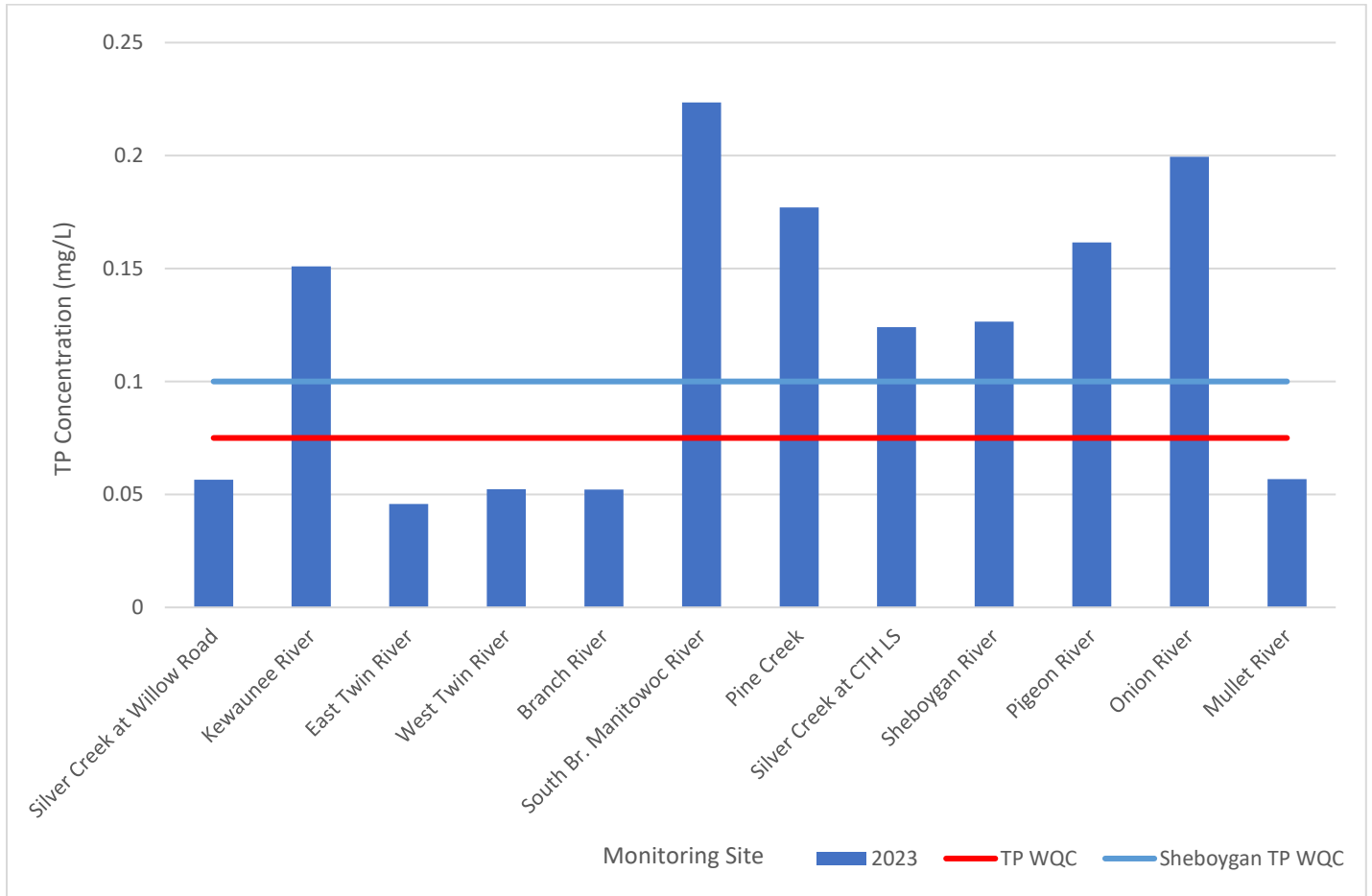


## Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

	June	0.16	0.119	4.8	3.62
	July	0.194	0.155	4.4	4.71
	August	0.252	0.194	3.4	2.63
	September	0.293	0.0646	4	5.06
	October	0.144	0.0884	6.8	1.92
Silver Creek at CTH LS	May	0.141	0.111	6.4	2.34
	June	0.107	0.0671	2.6	1.04
	July	0.214	0.136	5.4	1.34
	August	0.191	0.123	16.2	1.08
	September	0.101	0.0636	3	0.988
	October	0.103	0.0613	2	1.04
Sheboygan River	May	0.124	0.0557	7.8	1.94
	June	0.129	0.0255	9.8	1.96
	July	0.164	0.0257	17	1.5
	August	-	-	-	-
	September	-	-	-	-
	October	0.0874	0.0593	3	2.15
Pigeon River	May	0.105	0.0713	4.4	1.66
	June	0.272	0.218	9	0.868
	July	0.218	0.158	6.6	1.29
	August	-	-	-	-
	September	-	-	-	-
	October	0.101	0.0599	3.4	4.47
Onion River	May	0.103	0.0634	4.25	1.92
	June	0.281	0.223	ND	0.84
	July	0.249	0.201	2.8	2.33
	August	0.231	0.189	3.6	1.52
	September	0.134	0.0993	ND	0.76
	October	0.168	0.113	4	2.37
Mullet River	May	0.0608	0.0216	10	2.63
	June	0.0601	0.0291	4.2	2.93
	July	0.056	0.0367	3	4.57
	August	0.0575	0.0459	ND	3.04
	September	0.0401	0.0147	ND	3.8
	October	0.00964	0.0242	ND	3.09

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Appendix D: Median Total Phosphorus Concentration by Monitoring Site



**TP WQC is 0.075 mg/l for all sites except Sheboygan River, Sheboygan River TP WQC is 0.100 mg/L.**

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Appendix E: 2023 Confidence Interval Table

Monitoring Site	TP Calculation	2023
Silver Creek at Willow Road	U90% (mg/L)	0.0684
	Median (mg/L)	0.05655
	L90% (mg/L)	0.0447
	Relation to Criteria	Clearly Meets
Kewaunee River	U90% (mg/L)	0.2141
	Median (mg/L)	0.151
	L90% (mg/L)	0.0879
	Relation to Criteria	Clearly Exceeds
East Twin River	U90% (mg/L)	0.0659
	Median (mg/L)	0.0458
	L90% (mg/L)	0.0257
	Relation to Criteria	Clearly Meets
West Twin River	U90% (mg/L)	0.0670
	Median (mg/L)	0.05235
	L90% (mg/L)	0.0377
	Relation to Criteria	Clearly Meets
Branch River	U90% (mg/L)	0.0612
	Median (mg/L)	0.05215
	L90% (mg/L)	0.0431
	Relation to Criteria	Clearly Meets
South Branch Manitowoc River	U90% (mg/L)	0.2610
	Median (mg/L)	0.2235
	L90% (mg/L)	0.1860
	Relation to Criteria	Clearly Exceeds

Monitoring Site	TP Calculation	2023
Pine Creek	U90% (mg/L)	0.2220
	Median (mg/L)	0.177
	L90% (mg/L)	0.1320
	Relation to Criteria	Clearly Exceeds
Silver Creek at CTH LS	U90% (mg/L)	0.1540
	Median (mg/L)	0.124
	L90% (mg/L)	0.0940
	Relation to Criteria	Clearly Exceeds
Sheboygan River	U90% (mg/L)	<b>0.1488</b>
	Median (mg/L)	<b>0.1265</b>
	L90% (mg/L)	<b>0.1042</b>
	Relation to Criteria	Clearly Exceeds
Pigeon River	U90% (mg/L)	<b>0.2220</b>
	Median (mg/L)	<b>0.1615</b>
	L90% (mg/L)	<b>0.1010</b>
	Relation to Criteria	Clearly Exceeds
Onion River	U90% (mg/L)	0.2424
	Median (mg/L)	0.1995
	L90% (mg/L)	0.1566
	Relation to Criteria	Clearly Exceeds
Mullet River	U90% (mg/L)	0.0690
	Median (mg/L)	0.05675
	L90% (mg/L)	0.0445
	Relation to Criteria	Clearly Meets

**Red numbers indicate there were less than six samples taken over the sampling season, relation to criteria is an estimate.**

## Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

### Appendix F: Percentage of Total Phosphorus Concentrations from Dissolved Reactive Phosphorus

DRP % of TP												
	Silver Creek @Willow Road	Kewaunee River	East Twin River	West Twin River	Branch River	South Branch Manitowoc River	Pine Creek	Silver Creek @CTH LS	Sheboygan River	Pigeon River	Onion River	Mullet River
May 2023	62%	<b>62%</b>	33%	19%	37%	<b>60%</b>	64%	<b>79%</b>	45%	68%	62%	36%
June 2023	47%	<b>63%</b>	45%	34%	51%	<b>46%</b>	<b>74%</b>	63%	20%	<b>80%</b>	<b>79%</b>	48%
July 2023	56%	<b>65%</b>	62%	62%	28%	<b>59%</b>	<b>80%</b>	<b>64%</b>	16%	<b>72%</b>	<b>81%</b>	66%
August 2023	42%	<b>78%</b>	54%	49%	49%	<b>56%</b>	<b>77%</b>	<b>64%</b>	-	-	<b>82%</b>	80%
September 2023	43%	<b>62%</b>	45%	31%	35%	<b>39%</b>	22%	63%	-	-	<b>74%</b>	37%
October 2023	32%	55%	43%	-	28%	58%	<b>61%</b>	60%	68%	59%	<b>67%</b>	<b>251%</b>

*Red percentages indicate the DRP concentration exceeded the TP concentration (DRP >100%).*

*Italicized and bold percentages indicate the DRP sample concentration was above the 0.075 mg/L TP criteria. TP criteria is 0.100 mg/L for Sheboygan River.*

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Appendix G: Duplicate Sample Data

Site Name	Date	Parameter	Duplicate Sample	Regular Sample	Absolute Difference		Relative Percent Difference
Mullet River- Sumac Rd	8/9/2023	RESIDUE TOTAL NFLT (TOTAL SUSPENDED SOLIDS)	ND	ND	-	MG/L	-
	8/9/2023	PHOSPHORUS TOTAL	0.0561	0.0575	0.0014	MG/L	2.46
	8/9/2023	PHOSPHATE ORTHO AS PO4 DISS	0.0403	0.0459	0.0056	MG/L	12.99
	8/9/2023	NITROGEN TOTAL	3.04	3.04	0	MG/L	0.00

	Level of Detection (LOD) mg/L	Level of Quantification (LOQ) mg/L
TP	0.00900	0.0300
DRP	0.00400	0.0130
TSS	2.0	2.0
TN	0.058	0.192

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Appendix H: Stream Flow and Transparency Data

Monitoring Site	Month	Streamflow (CFS)	Transparency (CM)
Silver Creek at Willow Road	May	-	120
	June	-	120
	July	-	120
	August	-	120
	September	-	120
	October	-	-
	Kewaunee River	May	-
June		-	120
July		-	58
August		-	45
September		-	75
October		-	70
East Twin River	May	-	120
	June	-	120
	July	-	107.5
	August	-	90
	September	-	85
	October	-	120
West Twin River	May	-	120
	June	-	120
	July	-	120
	August	-	120
	September	-	120
	October	-	120
Branch River	May	-	120
	June	-	120
	July	-	120
	August	-	120
	September	-	120
	October	-	120
South Branch Manitowoc River	May	-	27.25
	June	-	30
	July	-	28
	August	-	31
	September	-	19
	October	-	84
Pine Creek	May	-	120
	June	-	120
	July	-	120
	August	-	120
	September	-	76
	October	-	120

Monitoring Site	Month	Streamflow (CFS)	Transparency (CM)
Silver Creek at CTH LS	May	-	120
	June	-	120
	July	-	-
	August	-	67
	September	-	120
	October	-	120
	Sheboygan River	May	2.25
June		-	54
July		-	45
August		-	-
September		-	-
October		-	-
Pigeon River	May	1.25	64.4
	June	-	51
	July	-	-
	August	-	-
	September	-	-
	October	-	-
Onion River	May	-	120
	June	-	120
	July	-	120
	August	-	120
	September	-	-
	October	-	110
Mullet River	May	-	113.3
	June	-	120
	July	-	120
	August	-	120
	September	-	120
	October	-	120

# Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

## Appendix I: Northeast Lakeshore Volunteer Monitoring Fact Sheet

### Northeast Lakeshore Monitoring Fact Sheet

The Northeast Lakeshore Total Maximum Daily Load (TMDL) was approved on October 30, 2023. The TMDL identifies the need for pollutant reductions in waterbodies throughout the basin to meet water quality standards. There are 51 stream segments and 12 lakes in the Northeast Lakeshore region listed as impaired due to excess phosphorus and/or sediment loading.

Phosphorus is an essential nutrient for plant growth, but can have detrimental effects on lakes, rivers, and streams when excessive amounts are introduced to these systems. Common forms of pollutant delivery in these systems include surface runoff from urban and agricultural areas and discharges from wastewater treatment facilities, industrial businesses, and farms. Excess phosphorus in a river system can create harmful algal blooms during the summer months which impact human, plant, and animal life.

In 2023, the Northeast Lakeshore Volunteer Monitoring program began to help achieve the monitoring goals outlined in the TMDL. There are 12 stream monitoring locations across 12 tributary streams which are monitored by citizen volunteers. Volunteers are relied upon to collect surface water samples following WDNR protocol on a monthly basis between the months of May and October. Water samples are shipped to the State Lab of Hygiene in Madison and are analyzed for Total Phosphorus, Total Suspended Solids, and Total Nitrogen.

#### Basin Facts:

- Watershed area: ~2,000 square miles
- Includes 8 counties (Brown, Calumet, Door, Fond du Lac, Kewaunee, Manitowoc, Ozaukee, and Sheboygan)
- 63 impaired waterbody segments
- 69 Concentrated Animal Feeding Operations (CAFOs)
- 10 MS4s\*
- 49 Dischargers
  - 32 municipal
  - 17 industrial

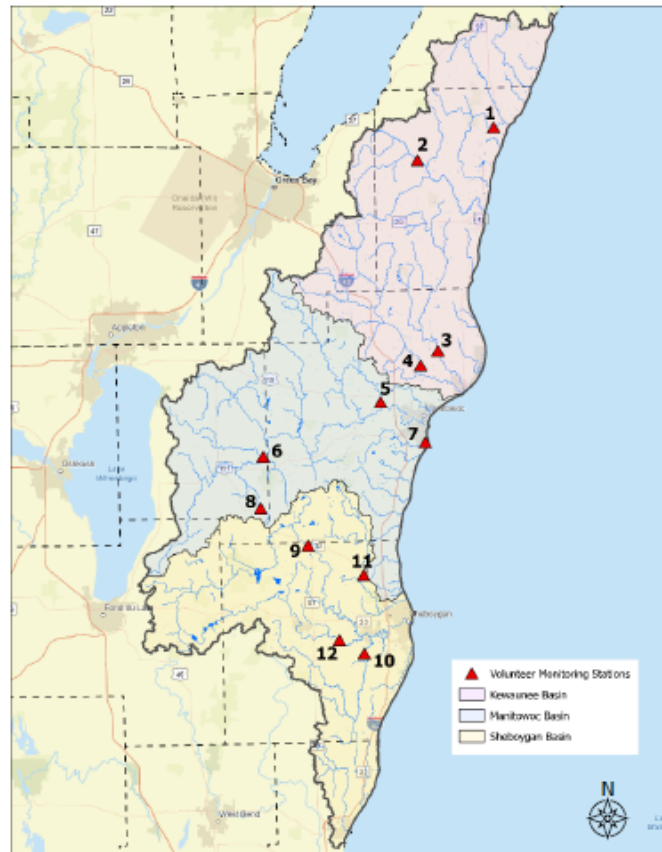
#### Want to get involved or have questions?

##### Contact:

Katherine Wendorf  
Water Resource Management Specialist  
Natural Resource Program Coordinator  
(920) 296-5126

[Katherine.wendorf@wisconsin.gov](mailto:Katherine.wendorf@wisconsin.gov)

\*MS4s - municipal separate storm sewer system; municipalities with WPDES permits for stormwater management.



More information can be found at: <https://dnr.wisconsin.gov/topic/TMDLs/NELakeshore.html>

See backside for exact sample locations

## Northeast Lakeshore Volunteer Surface Water Monitoring Program 2023 Annual Report

	<i>Stream Name</i>	<i>WBIC</i>	<i>SWIMS ID</i>	<i>SWIMS Station Name</i>	<i>Latitude</i>	<i>Longitude</i>	<i>Impairment</i>
<b>1</b>	Silver Creek	94900	10020779	Silver Creek at Willow Rd	44.60788	-87.47114	TP
<b>2</b>	Kewaunee River	90700	10029954	Kewaunee River at Hillside Rd	44.55438	-87.65939	TP
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