



# **Northeast Ohio Regional Sewer District**

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## **2023 Shaw Brook Biological, Water Quality, and Habitat Study**



**Water Quality and Industrial Surveillance  
Environmental Assessment Group  
February 2024**

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## Introduction

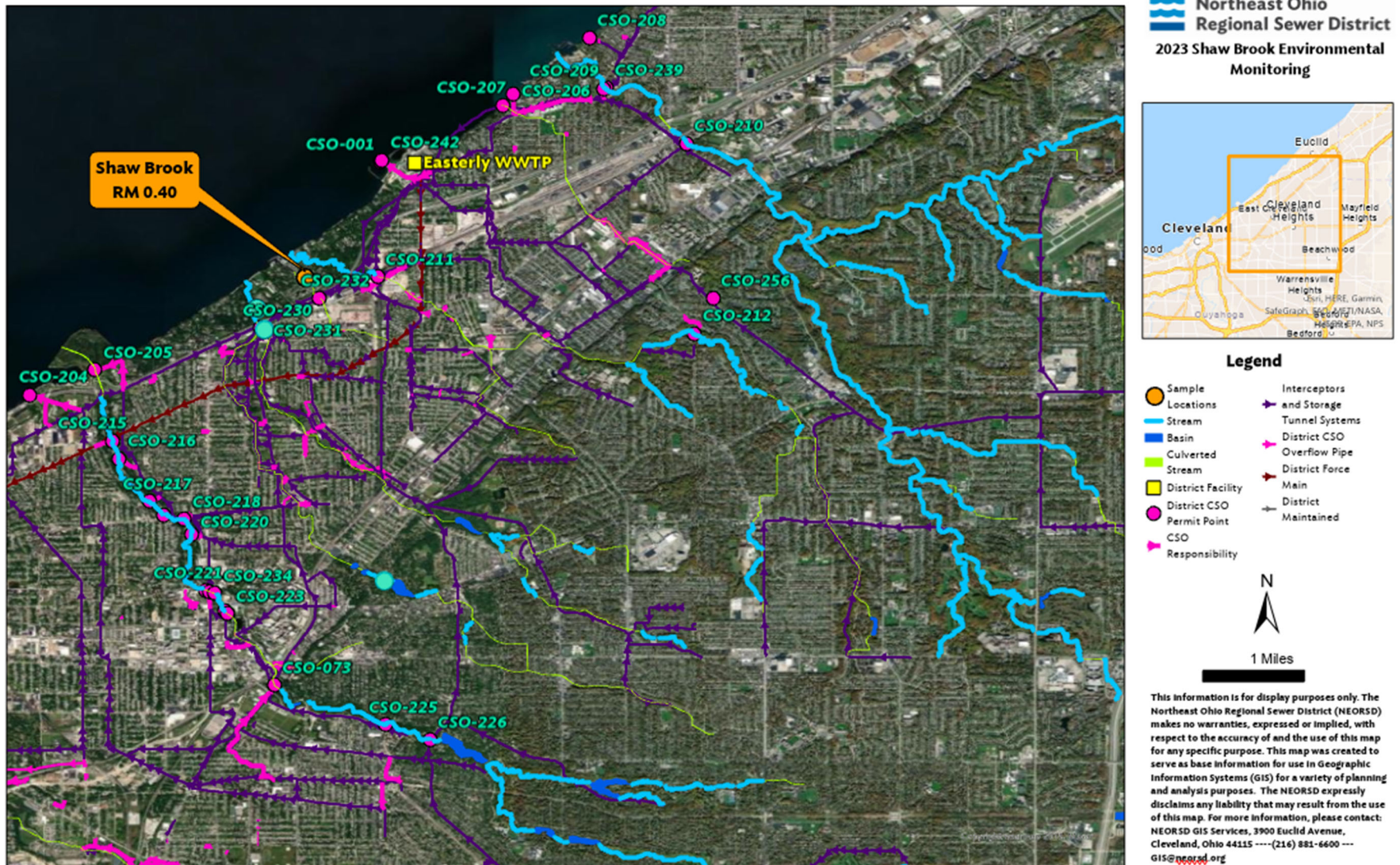
In 2023, the Northeast Ohio Regional Sewer District (NEORS) monitored environmental and biological conditions at Shaw Brook to determine the effectiveness of recently completed construction projects in improving water quality conditions, habitat, and fish and macroinvertebrate communities. Water quality improvements in Shaw Brook, as well as other tributaries of Lake Erie, have been a long-term target of the NEORS “Project Clean Lake” infrastructure projects. Project Clean Lake primary goals are to improve water quality impacts through the reduction of sanitary sewer overflows and surcharged sewers, elimination of common trench sewers, illicit discharges, and areas of clustered septic systems. The storage tunnel systems are integral parts of the larger gray infrastructure capital improvements of Project Clean Lake. The project includes significant investments in large-scale green infrastructure projects that are aimed at reducing combined sewer overflow (CSO) events and increasing storage capacity within the sanitary collection system.

The specific infrastructure project which is anticipated to have an impact on Shaw Brook is the Dugway Storage Tunnel (DST). The primary goal of this project was to improve the conveyance of wastewater and stormwater during wet-weather events and reduce the occurrence of CSO discharges to Lake Erie. Additionally, the site on Shaw Brook is included in the NEORS’s *2023 East Side Tributaries Environmental Monitoring* project and was assessed in support of Ohio EPA Permit #3PA00002\*JD. Site surveys were conducted by the Environmental Assessment (EA) group of the NEORS Water Quality and Industrial Surveillance (WQIS) Division.

Sampling was conducted by NEORS Level 3 Qualified Data Collectors (QDCs) certified by the Ohio Environmental Protection Agency (EPA) in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat as explained in the NEORS project study plan *2023 East Side Tributaries Environmental Monitoring*. All sampling and environmental assessments occurred between June 15, 2023 and September 30, 2023 (through October 15 for fish sampling assessments), as required in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life Volume III* (1987b). The results gathered from these assessments were evaluated using the Ohio EPA’s Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), and the NEORS Macroinvertebrate Threshold Model. Water chemistry data was validated per methods outlined by the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (2023a) and compared to the Ohio Water Quality Standards for their designated use to determine attainment (Ohio EPA, 2023b). An examination of the individual metrics that comprise the IBI and NEORS’s Macroinvertebrate Threshold Model were used in conjunction with the water chemistry data and QHEI scores to assess the health of the stream.

Figure 1 shows a map of the sampling location, and Table 1 indicates the sampling location with respect to river mile (RM), latitude/longitude, description, and surveys conducted. A digital photo catalog of the sampling location is available upon request by contacting the WQIS Division.





**Figure 1.** 2023 Shaw Brook Environmental Monitoring Sampling Location

| <b>Table 1. 2023 Shaw Brook Sampling Location</b>  |          |           |            |            |                        |                    |
|--|----------|-----------|------------|------------|------------------------|--------------------|
| Location   | Latitude | Longitude | River Mile | Station ID | Drainage Area (sq. mi) | Sampling Conducted |
| Shaw Brook   | 41.5554  | -81.6018  | 0.40       | 302509     | 0.04                   | F, M, C            |
| F = Fish community biology (includes habitat assessment)<br>M = Macroinvertebrate community biology<br>C = Water chemistry |          |           |            |            |                        |                    |

The Ohio EPA assigns designated uses to establish minimum water quality requirements for surface waters. These requirements represent measurable criteria for assessing the chemical, physical, and biological integrity of Ohio’s surface waters consistent with Clean Water Act requirements. The proposed beneficial use designations for Shaw Brook are listed below in Table 2 (Ohio EPA, 2021).

| <b>Table 2. Beneficial Use Designations for Shaw Brook</b>   |                                    |   |   |   |   |   |              |   |   |            |   |   |  |
|--|------------------------------------|---|---|---|---|---|--------------|---|---|------------|---|---|--|
| Stream   | <b>Beneficial Use Designation*</b> |   |   |   |   |   |              |   |   |            |   |   |  |
|  | Aquatic Life Habitat (ALU)         |   |   |   |   |   | Water Supply |   |   | Recreation |   |   |  |
|  | S                                  | W | E | M | S | C | P            | A | I | B          | P | S |  |
|  | R                                  | W | W | W | S | W | W            | W | W | W          | C | C |  |
|  | W                                  | H | H | H | H | H | S            | S | S | W          | R | R |  |
| Shaw Brook   |                                    | + |   |   |   |   |              | + | + |            | + |   |  |
| SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat;<br>MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat;<br>LRW = limited resource water<br>PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply;<br>BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.<br>*Proposed by Ohio EPA |                                    |   |   |   |   |   |              |   |   |            |   |   |  |

## Water Chemistry and Bacteriological Sampling

### Methods

Water chemistry and bacteriological sampling was conducted five times between June 21, 2023 and July 19, 2023, at the site listed in Table 1. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (2023). Chemical water quality samples from the site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and one 125-mL plastic bottle. The first 473-mL plastic bottle was field preserved with trace nitric acid,

the second was field preserved with trace sulfuric acid and the third bottle received no preservative. The sample collected in the 125-mL plastic bottle (dissolved reactive phosphorus) was filtered using a 0.45- $\mu$ m PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles and preserved with sodium thiosulfate. At the time of sampling, measurements for dissolved oxygen (DO), DO percent, pH, temperature, conductivity, and specific conductance were collected using a YSI EXO1 sonde. Duplicate samples and field blanks were each collected at randomly selected sites, at a frequency of not less than 5% of the total samples collected in NEORSD's 2023 *Eastside Tributaries Environmental Monitoring* study. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

$$\text{Formula 1:} \quad \text{RPD} = \left( \frac{|X-Y|}{((X+Y)/2)} \right) * 100$$

X= is the concentration of the parameter in the primary sample

Y= is the concentration of the parameter in the duplicate sample

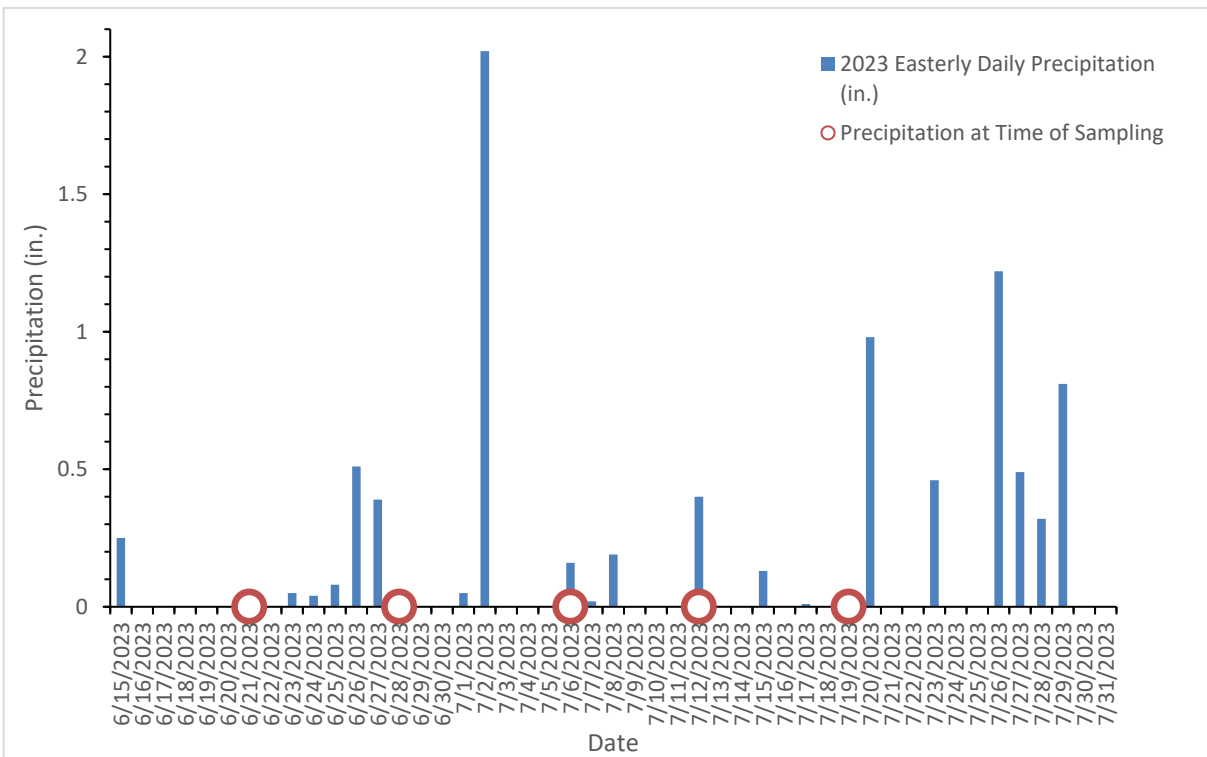
The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2019).

$$\text{Formula 2:} \quad \text{Acceptable \% RPD} = [(0.9465X^{-0.344}) * 100] + 5$$

X = sample/detection limit ratio

Those RPDs that were higher than acceptable may indicate potential problems with sample collection and, as a result, the data was not used for comparison to the water quality standards.

Water chemistry analysis sheets for Shaw Brook are available upon request from the NEORSD WQIS Division. Dates of water chemistry sampling compared to rain gauge data from NEORSD's Easterly precipitation gauge are shown below in Figure 2.



**Figure 2.** 2023 Rainfall Data at NEORS D's Easterly Precipitation Gauge with NEORS D Water Chemistry Sampling Dates

**Results and Discussion**

Over the course of the five sampling events in 2023, one field blank and one field duplicate (field split) sample were collected and analyzed for all parameters. The parameter that showed possible contamination from the field blank collected on June 21, 2023, included ammonia and is shown in Table 3 below. It is unclear how the field blank became contaminated and may be due to inappropriate sample collection, handling, and/or contaminated blank water. The result listed for ammonia was downgraded to “Level 2” data due to the result being between three to five times higher than the field blank.

| Table 3. Parameters with Field Blank Concentrations Showing Possible Contamination |           |           |             |                         |            |
|--|-----------|-----------|-------------|-------------------------|------------|
| Site Location  | Date      | Parameter | Result ug/L | Field Blank Result ug/L | QA/QC Code |
| Shaw Brook RM 0.40   | 6/21/2023 | Ammonia   | 0.475       | 0.111                   | Level 2    |

One field duplicate sample was collected in support of quality assurance and quality control (QA/QC) guidelines for field sampling. The field duplicate sample was collected on July 19, 2023.



The chemical parameter total strontium was rejected based on an RPD value outside of the acceptable RPD range for this sample as shown in Table 4 below.

| <b>Table 4. Duplicate Samples with RPDs Greater than Acceptable</b> |           |                 |                |            |
|---|-----------|-----------------|----------------|------------|
| Site Location   | Date      | Parameter       | Acceptable RPD | Actual RPD |
| Shaw Brook RM 0.40  | 7/19/2023 | Total Strontium | 10.6           | 12.6       |

Paired parameters, wherein one parameter is a subset of another, were also evaluated in accordance with QA/QC protocols for all samples collected at Shaw Brook. There were no instances in which the data for the paired parameters needed to be qualified because the sub-parameter was greater than the parent value in the data set.

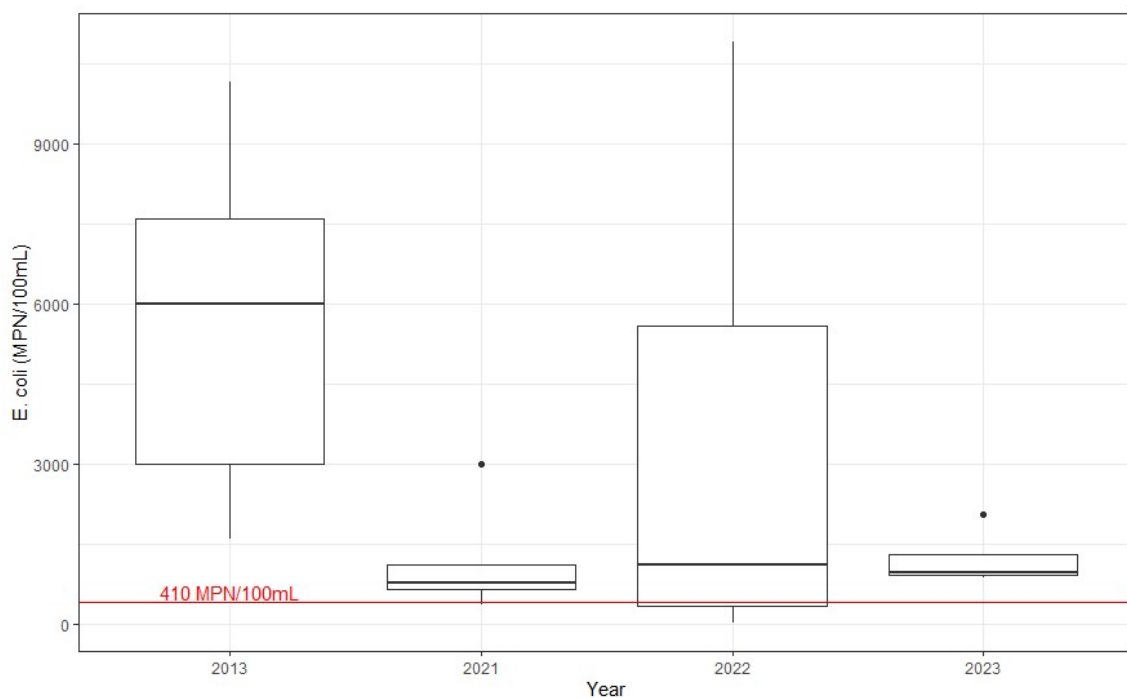
Attainment of the primary contact recreation (PCR) designated use is determined using *Escherichia coli* (*E. coli*), a fecal indicator bacteria commonly found in the intestinal tract and feces of warm-blooded animals (USEPA, 2012). The PCR criteria include an *E. coli* criterion not to exceed a Statistical Threshold Value (STV) of 410 colony counts or most-probable number (MPN) per 100mL in more than ten percent of the samples taken during any 90-day period and a 90-day geometric mean criterion of 126 colony counts or MPN per 100mL (Ohio EPA, 2023). In accordance with Ohio EPA procedure and practice to qualify *E. coli* exceedances for the PCR criteria, the geometric mean and STV are only calculated and compared when a minimum of five bacteriological samples have been collected.

Every sample collected exceeded the STV of 410 colony counts/100mL, resulting in PCR impairment in Shaw Brook in 2023. Additionally, the site exceeded the 90-day geometric mean criterion of 126 colony counts/100mL (Table 5). None of the five samples were sampled during a wet-weather event, which can lead to elevated *E. coli* densities due to urban runoff and potential sanitary sewer overflows. *E. coli* exceedances may also have been a result of domestic and/or wild animal waste and improper sanitary sewage connections to stormwater outfalls upstream of the sampling location. *E. coli* exceedances have been historically observed at Shaw Brook. Figure 3 below shows *E. coli* results from previous surveys. As shown, *E. coli* levels at Shaw Brook have historically exceeded the 410 MPN/100mL threshold.

| Table 5. 2023 <i>E. coli</i> Densities (MPN/100mL) |                    |
|--|--------------------|
| Date   | Shaw Brook RM 0.40 |
| 6/21/2023  | 866                |
| 6/28/2023  | 2,069              |
| 7/6/2023   | 1,302              |
| 7/12/2023  | 980                |
| 7/19/2023  | 923                |
| 90-day Geomean                                     | 1,161              |

Exceeds statistical threshold value of 410 MPN/100mL  
 Exceeds geometric mean criterion for 90-day period of 126 MPN/100mL

\*Wet-weather Event: greater than 0.10 inches of rain, but less than 0.25 inches, samples collected that day and the following day are considered wet-weather samples; greater than 0.25 inches, the samples collected that day and the following two days are considered wet-weather samples.



**Figure 3.** Historical *E. coli* Results

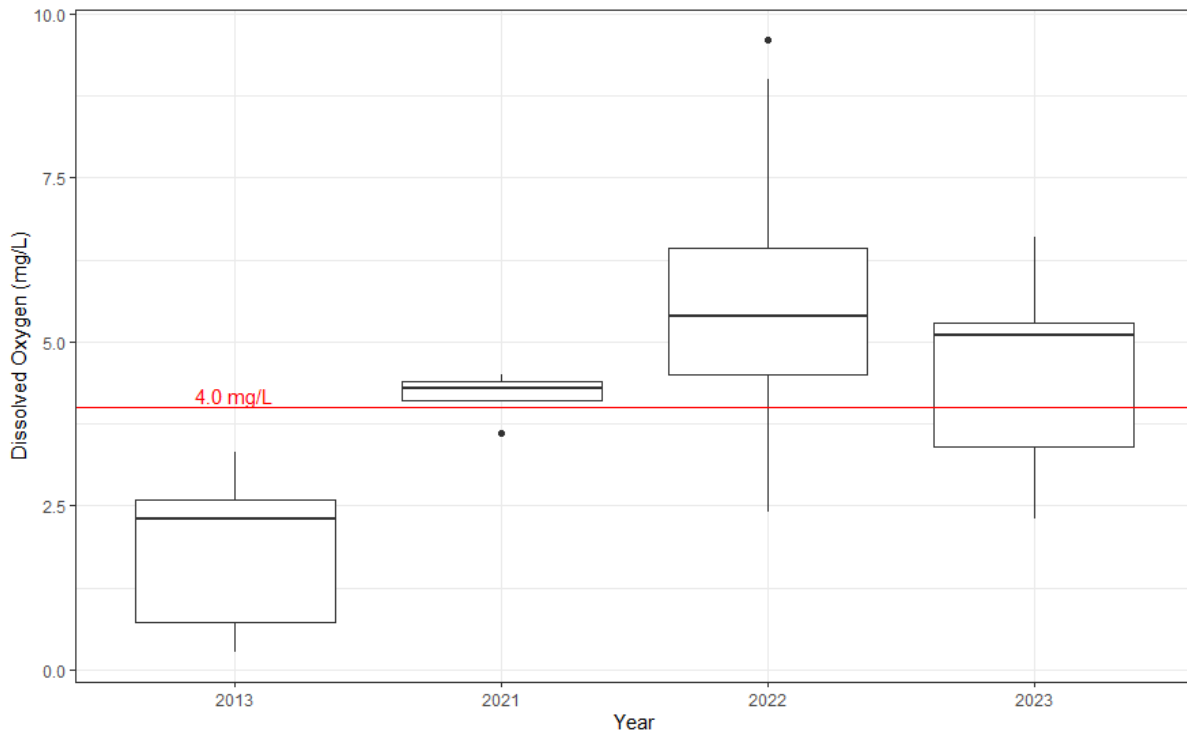
Mercury analysis for all the sampling events was analyzed using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), it generally cannot be determined if the site was in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above those levels typically found in the stream. Mercury was detected above the detection limit on the sample collected on June 21, 2023. The result for the June 21, 2023, sample was qualified and an estimated

result was used. Results above the detection limit for the June 21, 2023, sampling event are listed in Table 6 below. Mercury was not detected above the detection limit in any other samples collected.

| <b>Table 6. Mercury Samples Results Above Detection Limit</b> |            |                  |             |
|---|------------|------------------|-------------|
| Site Location   | Date       | Estimated Result | MDL         |
| Shaw Brook RM 0.40  | 06/21/2023 | 0.024 ug/L       | 0.0199 ug/L |

Dissolved oxygen (DO) exceeded the Aquatic Life OMZA standard at Shaw Brook RM 0.40 on June 21, 2023, and June 28, 2023, as shown in Table 7 below. For the protection of aquatic life, the minimum required DO criterion is 4 mg/L. Low oxygen can be due to low flow, higher water temperatures, and organic enrichment. Shaw Brook is almost completely culverted and there is minimal flow in Shaw Brook north of Interstate 90 under normal conditions. It is likely that modifications to the streams flow regime have impacted DO levels in the stream. Since NEORS D began monitoring Shaw Brook in 2013, each survey has included at least one sample below the DO criterion of 4 mg/L. Figure 4 below shows DO results from the 2023 survey as well as past surveys. As shown, DO levels at Shaw Brook RM 0.40 are commonly at or below 4.0 mg/L. Based on the sampling that was conducted, no additional exceedances of water quality standards were found for the other parameters that were monitored at Shaw Brook in 2023.

| <b>Table 7. Dissolved Oxygen Results Below Aquatic Life OMZA Standard</b> |            |          |
|---|------------|----------|
| Site Location   | Date       | Result   |
| Shaw Brook RM 0.40  | 06/21/2023 | 2.3 mg/L |
|   | 06/28/2023 | 3.4 mg/L |



**Figure 4.** Historical Dissolved Oxygen Results

*Stream Nutrient Assessment*

In 2015, the Ohio EPA Nutrients Technical Advisory Group released a proposed Stream Nutrient Assessment Procedure (SNAP) designed to determine the degree of impairment in a stream due to nutrient enrichment. SNAP assigns designations for quality of surface waters based on factors including DO swings, benthic chlorophyll *a*, total phosphorous (TP), and dissolved inorganic nitrogen (DIN) (Ohio EPA, 2015). NEORSRD did not assess DO swings or benthic chlorophyll *a* in 2023; however, nutrients were assessed.

Table 8 shows the nutrient concentrations Shaw Brook RM 0.40. The results of DIN and TP were compared to Table 2 listed in the SNAP document (Figure 5) and applicable nutrient concentrations and narrative level can be seen in Table 9. According to the SNAP table, Shaw Brook is in an enriched condition. Increased TP was the primary driver for the nutrient enrichment at Shaw Brook RM 0.40, and there is a statical relationship between mean TP concentrations in headwater streams greater than 0.12 mg/L and decreases in IBI and ICI scores (Ohio EPA, 1999). Table 9 shows TP concentrations at Shaw Brook RM 0.40 are greater than 0.12 mg/L.

| <b>Table 8. Nutrient Analysis (Geometric Means)</b> |            |             |   |            |            |
|---|------------|-------------|---|------------|------------|
| Waterbody   | River Mile | DIN (mg/L)* | NO <sub>3</sub> -NO <sub>2</sub> (mg/L) | DRP (mg/L) | TP (mg/L)* |
| Shaw Brook  | 0.40       | 0.574**     | 0.274                                   | 0.065      | 0.136      |
| * Data used in Table 2 of SNAP (Ohio EPA 2015)      |            |             |   |            |            |
| ** Data used contains “Level 2” qualified data      |            |             |   |            |            |



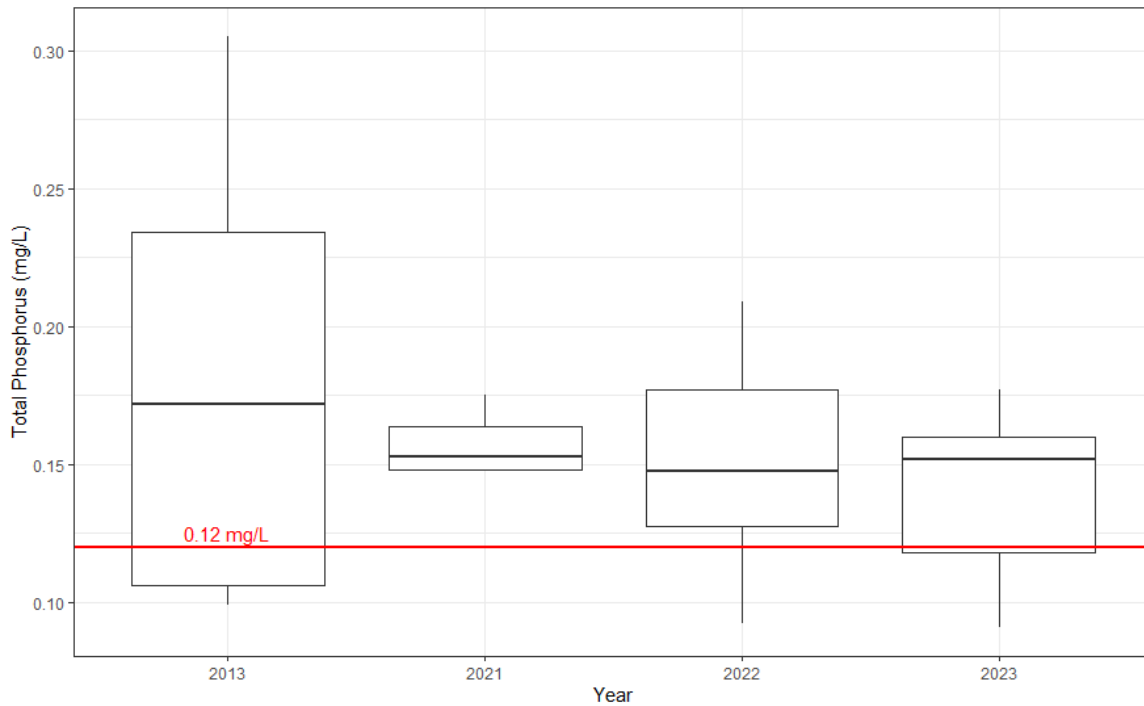
|                    |                          | ← DECREASING RISK  |   |  |  |   |
|--------------------|--------------------------|--|---|--|--|---|
| TP Conc.<br>(mg/l) | DIN Concentration (mg/l) |  |   |  |  |   |
|                    | <0.44                    | 0.44 < 1.10  | 1.10 < 3.60   | 3.60 < 6.70  | ≥6.70  |   |
| DECREASING RISK ↑  | <0.040                   | background levels typical of least disturbed conditions  | levels typical of developed lands; little or no risk to beneficial uses                                       | levels typical of modestly enriched condition in phosphorus limited systems; low risk to beneficial use if allied responses are within normal ranges | levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated     | characteristic of tile-drained lands; otherwise atypical condition with moderate risk to beneficial use if allied responses are elevated (1.1% of observations) |
|                    | 0.040- <0.080            | levels typical of developed lands; little or no risk to beneficial uses  | levels typical of developed lands; little or no risk to beneficial uses                                       | levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges  | levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated     | characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.1% of observations)                                   |
|                    | 0.080- <0.131            | levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges | levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges | levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges  | characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated; increased risk with poor habitat | characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.0% of observations)                                   |
|                    | 0.131- <0.400            | levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges | levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges | levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges; increased risk with poor habitat      | enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat | enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors  |
|                    | ≥0.400                   | atypical condition (1.3% of observations)  | atypical condition (1% of observations);  | enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat             | enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat | enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors  |

"allied responses" = allied response indicators (24-hour DO swing, benthic chlorophyll)

**Figure 5.** Table 2 of the Stream Nutrient Assessment Procedure (Ohio EPA, 2015b)

| Table 9. Applicable SNAP Analysis with Narrative Level (Geometric Means) |            |           |             |   |
|--|------------|-----------|-------------|---|
| Waterbody  | River Mile | DIN Range | TP Range    | Narrative Level   |
| Shaw Brook   | 0.40       | 0.44<1.10 | 0.131<0.400 | Levels typical of enriched condition; low risk to beneficial use if allied responses are withing normal range |

Shaw Brook has been in an enriched condition in each of the previous NEORS D surveys, which is believed to be caused by little to no flow into the open section of Shaw Brook. Dry-weather flow upstream of Interstate-90 discharges directly into a NEORS D interceptor and is sent to the Easterly Wastewater Treatment Plant (WWTP) for treatment. Figure 6 below shows TP results from previous surveys. Even though Shaw Brook has been designated as having an enriched condition, average total phosphorus concentrations have been reduced since the first survey in 2013. However, average concentrations from the 2023 survey are similar to concentrations observed in the 2021 and 2022 surveys.



**Figure 6.** Historical Total Phosphorus Results

## Habitat Assessment

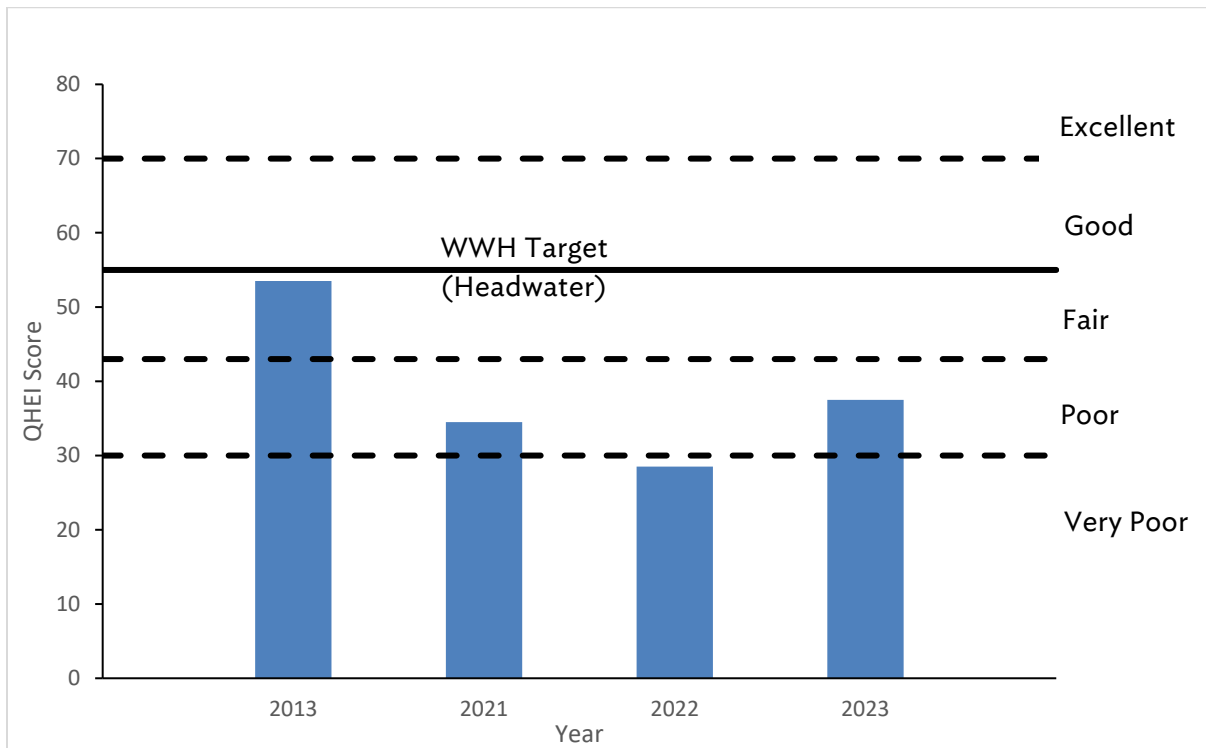
### Methods

Instream habitat assessments were conducted once at Shaw Brook in 2023 using the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species by evaluating the physical attributes of a stream. The index is based on six metrics: stream substrate, instream cover, channel morphology, riparian zone and bank condition, pool and riffle quality, and stream gradient. The QHEI has a maximum score of 100, and a score greater than 55 for streams with less than 20 mi<sup>2</sup>, which applies to Shaw Brook RM 0.40, suggests that sufficient habitat exists to support a fish community that attains the warmwater habitat criterion (Ohio EPA, 2006). Scores greater than 70 frequently demonstrate habitat conditions that have the ability to support exceptional warmwater faunas. A more detailed description of the QHEI can be found in Ohio EPA's *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006). The QHEI field sheet is available upon request from the NEORSW WQIS Division.

### Results and Discussion

Shaw Brook is in a heavily urbanized area and is culverted throughout most of the reach with a significant portion of the upper reach of the stream being directly discharged to NEORSW's Easterly WWTP. The QHEI score did not achieve the Ohio EPA Warmwater target score of 55 for

headwater streams, suggesting Shaw Brook at RM 0.40 does not have sufficient habitat to support a healthy fish community. NEORSD has performed QHEI assessments at Shaw Brook RM 0.40 in 2013, 2021, 2022, and 2023. Results from the 2023 assessment and previous assessments are shown below in Figure 7. None of the previous assessments achieved the Ohio EPA Warmwater target score of 55.



**Figure 7.** Historical QHEI Scores

The habitat for the stream segment at Shaw Brook RM 0.40 was assessed on June 22, 2023. The QHEI assessment was calculated at 37.5 (*Poor*), which falls short of the headwater target score of 55. The most prominent types of substrate present consisted of sand and muck with a “heavy to moderate” silt narrative. The reach is not channelized and was characterized by additional morphology features of medium sinuosity and poor development. No riffles are present in the reach which is a primary factor in the low QHEI score. A sparse amount of instream cover only included two distinct habitat types, root wads and boulders, which was another key factor in reducing the QHEI score for the reach. The sample site at RM 0.40 is one of the only non-culverted sections of Shaw Brook, as the upstream sections are almost completely culverted and void of habitat.

NEORS D has conducted a QHEI assessment at Shaw Brook RM 0.40 four times since 2013 with scores ranging from 53.5 (*Fair*) to 28.5 (*Very Poor*). Shaw Brook at RM 0.40 has never obtained the WWH target score of 55. The highest scored assessment was completed in 2013 and assigned a narrative rating of *Fair*. The three following assessments occurred in consecutive years starting in 2021. The scores in 2021, 2022, and 2023 were very similar with scores ranging from 37.5 (*Poor*) to 28.5 (*Very Poor*). All four assessments scored similar in every metric besides instream cover. The 2013 assessment scored the instream cover amount as extensive and moderate, whereas the following three assessments scored instream cover amount as sparse or nearly absent. Since RM 0.40 is one of the only non-culverted sections of Shaw Brook, even if sufficient habitat was available, Shaw Brook is unlikely to support a fish community that meets the WWH criterion.

The individual components of the QHEI for the site were categorized as being indicative of either a WWH or MWH to further evaluate whether the site is capable of meeting its proposed WWH designated use as shown below in Table 10. Shaw Brook RM 0.40 received eight MWH attributes, six of the attributes were found to have moderate influence on fish communities, whereas the other two were found to have a high influence. The presence of four or more moderate or one high influences characteristics have been found to lower IBI scores. Shaw Brook RM 0.40 received the lowest possible IBI score of 12 with a narrative rating of *Very Poor*. This will further be evaluated in the *Fish Community Biology Assessment* section of this report.



**Table 10.** 2023 Qualitative Habitat Evaluation Index Score and Physical Attributes

| Stream     | River Mile | QHEI Score | Narrative Rating | MWH Attributes                 |                                  |                      |                            |                         |                          |                     |                                 |                   |                                |                      |                            |                      |              |                 |                                  |                                 |                    |                           |                          |                       |               |                      |                           |                 |                                |                               |           |                                     |                              |                              |
|------------|------------|------------|------------------|--------------------------------|----------------------------------|----------------------|----------------------------|-------------------------|--------------------------|---------------------|---------------------------------|-------------------|--------------------------------|----------------------|----------------------------|----------------------|--------------|-----------------|----------------------------------|---------------------------------|--------------------|---------------------------|--------------------------|-----------------------|---------------|----------------------|---------------------------|-----------------|--------------------------------|-------------------------------|-----------|-------------------------------------|------------------------------|------------------------------|
|            |            |            |                  | WWH Attributes                 |                                  |                      |                            |                         |                          |                     |                                 |                   | High Influence                 |                      | Moderate Influence         |                      |              |                 |                                  |                                 |                    |                           |                          |                       |               |                      |                           |                 |                                |                               |           |                                     |                              |                              |
|            |            |            |                  | No Channelization or Recovered | Boulder/Cobble/Gravel Substrates | Silt Free Substrates | Good/Excellent Development | Moderate/High Sinuosity | Extensive/Moderate Cover | Fast Current/Eddies | Low-Normal Overall Embeddedness | Max. Depth >40 cm | Low-Normal Riffle Embeddedness | Total WWH Attributes | Channelized or no Recovery | Silt/Muck Substrates | No Sinuosity | Sparse/No Cover | Max Depth < 40 cm (WD, HW sites) | Total High Influence Attributes | Recovering Channel | Heavy/Moderate Silt Cover | Hardpan Substrate Origin | Fair/Poor Development | Low Sinuosity | Only 1-2 Cover Types | Intermittent & Poor Pools | No Fast Current | High/Mod. Overall Embeddedness | High/Mod. Riffle Embeddedness | No Riffle | Total Moderate Influence Attributes | (MWH-H.I.+1) / (WWH+1) Ratio | (MWH M.I.+1) / (WWH+1) Ratio |
| Shaw Brook | 0.40       | 37.5       | Poor             | x                              |                                  |                      |                            | x                       |                          |                     |                                 | x                 |                                |                      |                            |                      | 3            |                 | x                                |                                 | x                  |                           |                          |                       |               | x                    |                           | x               |                                | x                             |           | 6                                   | 0.8                          | 1.8                          |

## Fish Community Biology Assessment

### Methods

One quantitative electrofishing passes was conducted at Shaw Brook in 2023. There is no United States Geological Survey (USGS) flow data available for Shaw Brook. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.15 kilometers and followed the Ohio EPA methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified, weighed, and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

The electrofishing results were compiled and utilized to evaluate fish community health. The Index of Biotic Integrity (IBI) incorporates twelve community metrics representing structural and functional attributes (Table 11). The structural attributes are based upon fish community aspects such as fish abundance and diversity. The functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances, and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional*, *Good*, *Marginally Good*, *Fair*, *Poor* or *Very Poor*.

| <b>Table 11. IBI Metrics</b>            |
|---|
| Number of indigenous fish species       |
| Number of darter species                |
| Number of headwater species             |
| Number of minnow species                |
| Number of sensitive species             |
| Percent tolerant species                |
| Percent omnivore species                |
| Percent insectivore species             |
| Percent pioneering species              |
| Number of individuals (minus tolerants) |
| Number of simple lithophilic species    |
| Percent DELT anomalies                  |

Shaw Brook is located completely within the Erie-Ontario Lake Plains (EOLP) ecoregion and follows the EOLP IBI metric scoring. The WWH IBI scoring criterion in the EOLP ecoregion is 40 and sites are considered to be within non-significant departure if the score falls within 4 IBI units of the criterion (Table 12).

| <b>Table 12. Fish Community Biology Scores for Headwater Sites in the EOLP Ecoregion</b> |                |       |       |                 |            |           |             |
|--|----------------|-------|-------|-----------------|------------|-----------|-------------|
| Ohio EPA Narrative   | Very Poor      | Poor  | Fair  | Marginally Good | Good       | Very Good | Exceptional |
| IBI Score  | 12-17          | 18-27 | 28-35 | 36-39           | 40-45      | 46-49     | 50-60       |
| Ohio EPA Status  | Non-Attainment |       |       | NSD             | Attainment |           |             |
| NSD – Non-Significant Departure of WWH attainment  |                |       |       |                 |            |           |             |

## Results and Discussion

The electrofishing pass at Shaw Brook RM 0.40 was conducted on June 22, 2023. No fish were collected, which defaults to the lowest possible score of 12 with a narrative rating of *Very Poor*. Therefore, this stream segment was not in attainment of the IBI WWH designated use criterion. There is a culverted control point upstream, which reduces dry-weather flow into the reach. Additionally, there is another culvert immediately downstream of the reach, which impacts the recruitment of fish into the reach. Even with the reduction in CSO events upstream of the site, in its current state, Shaw Brook is unlikely to support a healthy fish assemblage in the future without signification restoration efforts. Results for the electrofishing survey for the Shaw Brook RM 0.40 site can be seen in Table 13 below.

| <b>Table 13. 2023 Shaw Brook Fish Community Assessment Score</b>  |            |             |
|---|------------|-------------|
| Waterbody   | River Mile | IBI Score   |
| Shaw Brook  | 0.40       | <u>12</u> * |
| *Significant departure from biocriterion (>4 IBI; >0.5 MIwb units).<br>Underlined scores are in the <i>Poor</i> or <i>Very Poor</i> narrative range<br><sup>ns</sup> non-significant departure from biocriterion (≤4IBI; ≤0.5 MIwb units)<br><sup>E</sup> Exceptional WWH score |            |             |

From the results of the habitat assessment, the QHEI score of 37.5 fell short of reaching the target score of 55 for warmwater habitat. As mentioned above, due to a culverted control point upstream, which mostly eliminates dry-weather flow, as well as a culvert immediately downstream of the site, the reach is unlikely to support a fish population in its current state. NEORSD has conducted electrofishing surveys at the site in 2013, 2021, 2022, and 2023. No fish have ever been collected at Shaw Brook RM 0.40. IBI scores from previous surveys can be seen in Table 14 below.

| <b>Table 14. Shaw Brook RM 0.40 Historical IBI Results</b>  |             |
|---|-------------|
| Year  | Score       |
| 2013  | <u>12</u> * |
| 2021  | <u>12</u> * |
| 2022  | <u>12</u> * |
| 2023  | <u>12</u> * |
| *Significant departure from biocriterion (>4IBI units). Underlined scores are in the <i>Poor</i> or <i>Very Poor</i> narrative range<br><sup>ns</sup> non-significant departure from biocriterion (≤4IBI units) |             |

## Macroinvertebrate Community Biology Assessment

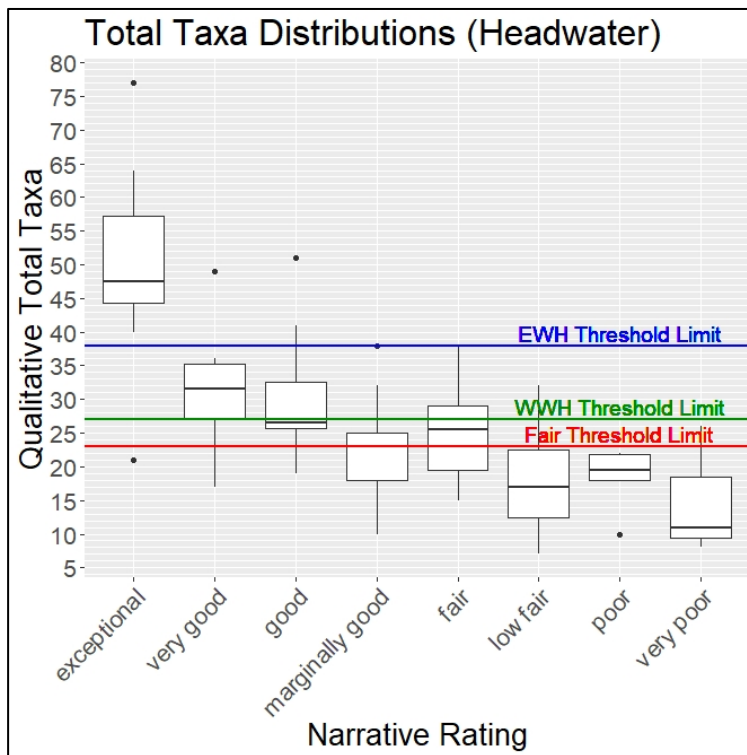
### Methods

Macroinvertebrates were sampled in a qualitative assessment of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly), also referred to as EPT taxa, inhabiting available habitats. The macroinvertebrate samples were sent to Third Rock Consultants, LLC for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as defined by the Ohio EPA (1987b). Lists of the species collected during the qualitative sampling are available upon request from the NEORSD WQIS Division.

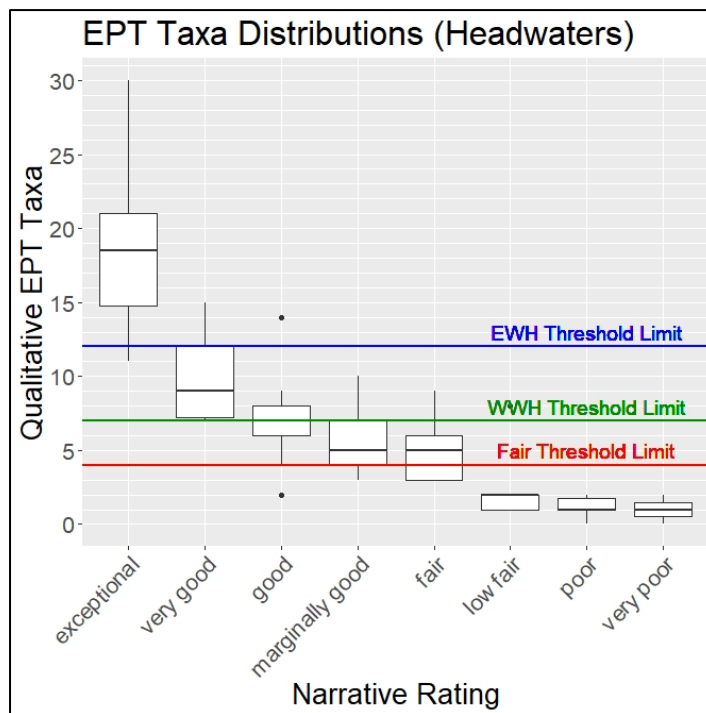
The macroinvertebrate sampling methods followed Ohio EPA protocols as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). A Hester-Dendy (HD) sampler was not installed in 2023 due to unsuitable stream conditions; therefore, the rating assessment was performed for the site based on the results of the qualitative sampling. The overall aquatic macroinvertebrate community in the stream was evaluated using expectations developed by NEORSD in 2021 using threshold limit models in lieu of the Invertebrate Community Index (ICI). These models were developed using QDC Level 3 macroinvertebrate data provided by the Ohio EPA from the EOLP from the ten-year period between 2005 and 2014 (threshold limit model analysis available upon request). Table 15 provides the expectation threshold limits for qualitative total taxa, qualitative EPT taxa, and qualitative sensitive taxa metrics for headwater sites. Figures 8 through 10 provide distributions of these metrics grouped by ICI narrative rating category developed by NEORSD in comparison with the expectation threshold limits.

| <b>Table 15. NEORSD Recommended Expectation Threshold Limits for Narrative Rating Assignments in the EOLP</b> |             |                        |                      |                            |
|---|-------------|------------------------|----------------------|----------------------------|
| Drainage Category   | Designation | Qualitative Total Taxa | Qualitative EPT Taxa | Qualitative Sensitive Taxa |
| Headwater (0-20 miles <sup>2</sup> )  | EWH         | 38                     | 12                   | 6                          |
|   | WWH         | 27                     | 7                    | 2                          |
|   | Fair        | 23                     | 4                    | 1                          |

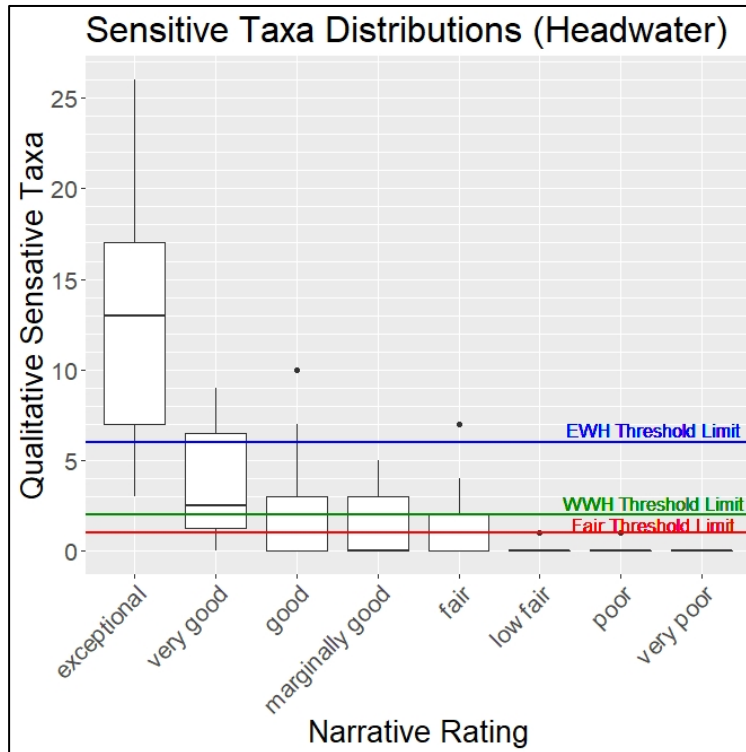




**Figure 8.** Distribution of the number of qualitative total taxa in EOLP headwater streams grouped by ICI score narrative rating category with expectation threshold limits.



**Figure 9.** Distribution of the number of qualitative EPT taxa in EOLP headwater streams grouped by ICI score narrative rating category with expectation threshold limits.



**Figure 10.** Distribution of the number of qualitative sensitive taxa in EOLP headwater streams grouped by ICI score narrative rating category with threshold limits.

## Results and Discussion

As previously mentioned, a modified HD was not installed at Shaw Brook RM 0.40 due to unsuitable stream conditions. Therefore, a narrative rating assessment was performed at the site based on the results of the qualitative sample. A qualitative kick sample was conducted at the site on July 14, 2023. The site has a drainage area of 0.04 square miles, which is on the low end of the headwater drainage category. A total of 19 taxa were collected in the qualitative sample, which scores below the *Fair* rating. No sensitive taxa were collected, which also scores below the *Fair* rating. Field observations indicated that the two most predominant groups were Chironomidae and Turbellaria. Additionally, this site was assigned a field narrative rating of *Very Poor* at the time of sampling. Due to the sampled taxa and culverted control point upstream that limits dry weather flow and significantly impacts water quality, the site was assigned a narrative rating of *Very Poor* in 2023.

Table 16 provides a summary of 2023 Shaw Brook RM 0.40 macroinvertebrate data as well as a comparison to historical data. HDs have not been installed at Shaw Brook RM 0.40 since the first time the reach was surveyed. No EPT taxa have ever been collected in Shaw Brook and only one moderately intolerant taxa, *Tipulidae Pseudolimiphila sp.*, was collected in 2021. Chironomidae and Turbellaria have been the most predominant organisms found in each survey at Shaw Brook

RM 0.40 and the reach has been assigned a narrative rating of *Very Poor* in each of the last three surveys.

| Table 16. Shaw Brook Macroinvertebrate Results  |      |                                    |                 |                         |                                |   |     |                      |
|---|------|------------------------------------|-----------------|-------------------------|--------------------------------|---|-----|----------------------|
| Stream RM   | Year | Density Qt. (ft <sup>2</sup> )/Ql. | Ql./ Total Taxa | Ql. EPT/ sensitive Taxa | Qt. % Tolerant/ Sensitive taxa | Predominant orgs. on natural substrates | ICI | Narrative Evaluation |
| <b>Shaw Brook (19-044-000)</b>  |      |                                    |                 |                         |                                |   |     |                      |
| 0.40  | 2013 | 12.8/M-L                           | 11/19           | 0/0                     | 70.3%/0                        | Turbellaria, Chironomidae               | 14  | Low Fair             |
|   | 2021 | ---/L                              | 11/--           | 0/1                     | ---                            | Turbellaria, Chironomidae               | --  | Very Poor            |
|   | 2022 | ---/L                              | 17/---          | 0/0                     | ---                            | Turbellaria, Chironomidae               | --  | Very Poor            |
|   | 2023 | ---/L                              | 19/---          | 0/0                     | ---                            | Chironomidae, Turbellaria               | --  | Very Poor            |
| Qt. Quantitative sample collected on Hester-Dendy artificial substrates<br>Ql. Qualitative sample collected from natural stream substrates<br>Qualitative sample relative density: L=Low, M=Moderate, H=High<br>Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List (2019) as <i>Moderately Intolerant</i> , no <i>Intolerant</i> taxa were collected |      |                                    |                 |                         |                                |   |     |                      |

## Conclusions

The proposed aquatic life habitat use designation for the stream segment in this study is WWH. According to the Ohio EPA (2021), warmwater habitats are capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified reference sites within its respective ecoregion. The results of NEORS D’s 2023 Shaw Brook Study, which included water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys, indicate limiting conditions exists at the site. Shaw Brook RM 0.40 was not found to be in attainment of the designated aquatic life use criteria in 2023 (Table 17).

Shaw Brook did not meet any of the necessary standards and was not in attainment for the designated ALU at RM 0.40 during the 2023 sampling season. The results of water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys conducted by NEORS D indicated that the Shaw Brook watershed may be impacted by a variety of environmental stressors, as mentioned previously. Water chemistry sampling found that exceedances of the applicable water quality standards occurred for *E. coli* densities during all sampling events. Stormwater runoff during wet-weather events are likely responsible for the elevated *E. coli* densities found in Shaw Brook. Additionally, water quality sampling found low levels of DO which exceeded the Aquatic Life OMZA standard minimum concentration of 4.0 mg/L. With limited DO available, it is unlikely that Shaw Brook can successfully support a healthy

fish community. Furthermore, SNAP analysis concluded that Shaw Brook is in an enriched condition with elevated total phosphorus being the primary driver of the nutrient enrichment.

| Table 17. 2023 Survey Results   |                       |                   |             |           |             |  |   |
|---|-----------------------|-------------------|-------------|-----------|-------------|--|---|
| RM  | DA (mi <sup>2</sup> ) | Attainment Status | IBI Score   | ICI Score | QHEI Score  | Cause(s)   | Source(s)   |
| <b>Shaw Brook</b> (WWH Existing)  |                       |                   |             |           |             |  |   |
| 0.40 <sup>H</sup>   | 0.04                  | Non               | <u>12</u> * | <u>VP</u> | <u>37.5</u> | Sedimentation; Nutrient enrichment; Toxic metals; Poor habitat; and Flow alterations | Urbanization and urban runoff; Culverted stream reaches; and Atmospheric deposition |
| <p>*Significant departure from biocriterion (&gt; 4 ICI; &gt; 4 IBI; &gt; 0.5 MIwb units).<br/>Underlined scores are in the <i>Poor</i> or <i>Very Poor</i> narrative range<br/><sup>H</sup> Headwater scoring criteria<br/><sup>ns</sup> non-significant departure from biocriterion (≤4 ICI; ≤4 IBI; ≤0.5 MIwb units)<br/><sup>VP</sup> <i>Very Poor</i> narrative rating</p> |                       |                   |             |           |             |  |   |

With a QHEI score of 37.5, stream habitat in Shaw Brook was found to be in poor condition, which falls short of the target score of 55 to support a warmwater fish community. The fish and macroinvertebrate communities received narrative ratings of *Very Poor* and *Very Poor*, respectively, in 2023. No fish were collected, and the macroinvertebrate assemblage was comprised of only relatively pollution-tolerant species. As previously mentioned, Shaw Brook is almost completely culverted and the upper portion of the reach discharges into the NEORS D’s Easterly Interceptor during dry-weather conditions, thus resulting in minimal flow through the downstream section of the stream. Even with the reduction in CSO events upstream of the site, the site still is in an enriched condition with water quality impairments. In its current state, Shaw Brook unlikely can attain the WWH ALU without signification restoration efforts.

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