Northeast Ohio
Regional Sewer District

# 2023 Dugway Brook Biological, Habitat, and Water Quality Assessment Study

**Water Quality and Industrial Surveillance**

**Environmental Assessment Group**

**April 2024**

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## Introduction

In 2023, the Northeast Ohio Regional Sewer District (NEORSD) conducted environmental monitoring at Dugway Brook, a tributary to Lake Erie, as part of the general watershed monitoring program. Water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate surveys were overseen by NEORSD's Environmental Assessment (EA) staff members. Water quality improvement in Dugway Brook has been one of several long-term targets of the NEORSD's "Project Clean Lake" infrastructure program. The specific infrastructure projects that have anticipated impacts on Dugway Brook include the Dugway Storage Tunnel (DST), the Dugway East Interceptor Relief Sewer (DEIRS), the Dugway West Interceptor Relief Sewer (DWIRS), among other associated relief sewer and regulator upgrades. The goal of these projects is the improved conveyance of wastewater and stormwater during wet-weather events, reducing the occurrence of combined sewer overflow (CSO) discharges to Lake Erie via its tributary streams. As of 2020, these projects were fully completed and are now receiving sanitary and stormwater flows. Additionally, the sites were assessed in support of Ohio EPA Permit #3PA00002*JD.

Dugway Brook is primarily culverted and is a heavily urbanized stream. It flows through the eastside suburbs of Cleveland before flowing beneath Interstate 90, through Bratenhal, and discharging into Lake Erie. Based on data previously collected by NEORSD, the Ohio Environmental Protection Agency (EPA) recommended that Dugway Brook receive WWH aquatic life use designations (Ohio EPA, 2021a)(Table 1).

**Table 1.** Applicable Beneficial Use Designation for Dugway Brook in 2023

| Stream | Beneficial Use Designation* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aquatic Life Habitat (ALU) | | | | | | | Water Supply | | | Recreation | | |
| | SRW | WWH | EWH | MWH | SSH | CWH | LRW | PWS | AWS | IWS | BW | PCR | SCR |
| Dugway Brook | | o | | | | | | | o | o | | o | |

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat;
MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat;
LRW = limited resource water
PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply;
BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.
*Proposed by Ohio EPA
o Designated use recommended by Ohio EPA based on NEORSD data

Sampling was conducted by NEORSD Level 3 Qualified Data Collectors (QDCs) certified by the Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessments as explained in the NEORSD 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 were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) and Index of Biotic Integrity (IBI), and NEORSD's 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, 2021b). An examination of the individual metrics that comprise the IBI and NEORSD Threshold Model was 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 locations, and Table 2 indicates the sampling locations with respect to stream, river mile (RM), latitude and longitude, and station identification where applicable. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD's Water Quality and Industrial Surveillance (WQIS) Division.

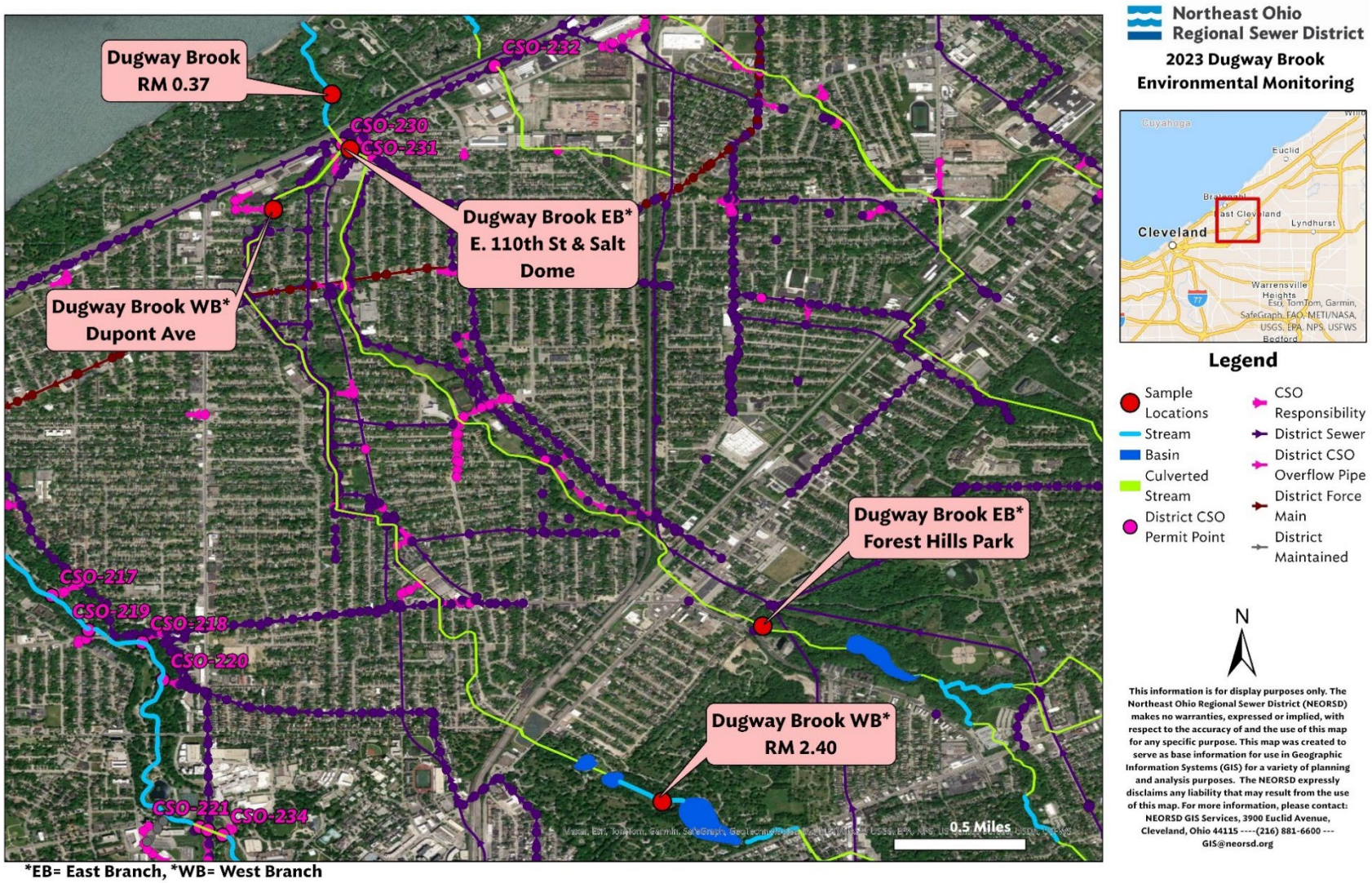


**Figure 1.** Sampling Locations.

| **Table 2.** 2023 Sampling Locations | | | | | | |
|---|---|---|---|---|---|---|
| Location | River Mile/Location | Drainage Area | Latitude | Longitude | Station ID | Sampling Conducted |
| Dugway Brook West Branch | 2.40 | 2.6 | 41.5122 | -81.5905 | 301431 | Habitat, Fish, Macroinvertebrates, and Water Chemistry |
| Dugway Brook West Branch | Culverted- Dupont Ave. | N/A | 41.5446 | -81.6118 | N/A | Water Chemistry |
| Dugway Brook East Branch | Culverted-Forest Hills Park | N/A | 41.5218 | -81.5850 | N/A | Water Chemistry |
| Dugway Brook East Branch | Culverted-E. 110$^{th}$ St. | N/A | 41.5479 | -81.6076 | N/A | Water Chemistry |
| Dugway Brook Main Branch | 0.37 | 6.3 | 41.5509 | -81.6086 | 301430 | Habitat, Fish, Macroinvertebrates, and Water Chemistry |

## Water Chemistry and Bacteriological Sampling

### Methods

Water chemistry and bacteriological sampling was conducted at each site five times between August 2 and August 30, 2023, and analyzed for all parameters. 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 each 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-µm PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in 250 mL sterilized plastic bottles. At the time of sampling, measurements for dissolved oxygen, dissolved oxygen percent, pH, temperature, conductivity, and specific conductance were collected using a YSI EXO1 sonde. Replicate, duplicate, and field blank samples were each collected at randomly selected sites at a frequency not less than 5% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate/replicate sample (Formula 1).

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

X= is the concentration of the parameter in the primary sample
Y= is the concentration of the parameter in the duplicate/replicate sample

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

Formula 2: 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 each site are available upon request from the NEORSD WQIS Division.

## Results and Discussion

*Data Validation QA/QC Checks*

Over the course of the five sampling events in 2023, one field blank, one duplicate sample, and one replicate sample were collected and analyzed for all parameters. There were no parameters that showed possible contamination in the field blank. This indicates that samples were collected and handled properly by EA staff members.

Of the duplicate/replicate samples collected, there were five instances that occurred in which the acceptable RPD was exceeded (Table 3). Potential reasons for this discrepancy include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity, and/or improper handling of samples.

**Table 3**. Duplicate Samples with RPDs Greater than Acceptable

| River Mile | Date | Parameter | Acceptable RPD | Actual RPD |
|---|---|---|---|---|
| RM 0.37 | 8/2/2023 | Barium | 23.1% | 25.9% |
| | | Calcium | 20.3% | 25.6% |
| | | Magnesium | 14.6% | 22.9% |
| | | Sodium | 14.7% | 24.8% |
| | | Strontium | 11.1% | 26.1% |

The final QA/QC check was for paired parameters, or those parameters in which one is a subset of the other. There were two instances in which the data for the paired parameters were qualified because the sub-parameter value was greater than the parent value (Table 4). The results for total dissolved solids and total solids for Dugway Brook Culvert – Dupont Avenue on August 9, 2023, were rejected. The results for total dissolved solids and total solids for Dugway Brook Culvert - Forrest Hills on August 16, 2023, were downgraded to an estimated value.

**Table 4.** Paired Parameters with Sub-Parameter Values Greater Than Parent Values

| Stream | Location | Date | Sub Parameter | Parent Parameter | Qualifier |
|---|---|---|---|---|---|
| Dugway Brook Culvert | Dupont Avenue | 8/9/2023 | Total Dissolved Solids (mg/L) | Total Solids (mg/L) | Rejected |
| | | | 536 | <10 | |
| Dugway Brook Culvert | Forrest Hills | 8/16/2023 | Total Dissolved Solids (mg/L) | Total Solids (mg/L) | Estimated |
| | | | 559 | 522 | |

*Bacteriological Data*

Open sections of Dugway Brook are proposed to be designated as a warmwater habitat (WWH) and primary contact recreation according to the Ohio EPA Water Quality Standards (2021b). Exceedances of the recreational bacteriological criteria for primary contact recreation occurred at all five sites on Dugway Brook during the 2023 sampling season. The recreational criteria for *E. coli* consist of two components: a 90-day geometric mean and a statistical threshold value (STV) not to be exceeded in more than 10% of the samples collected during a 90-day period. For streams designated as primary contact recreation, these criteria are 126 colony counts/100mL or most-probable number (MPN)/100mL and 410 colony counts/100mL or MPN/100mL, respectively. These calculations are formulated when there are at least five samples collected within a rolling 90-day period.

Both primary contact recreation criteria were exceeded at all five sites for the 90-day periods starting when the first sample was collected (Table 5). Therefore, all sites (excluding culverted locations for which the standards don't apply) were in non-attainment of both criteria in 2023. Out of all locations sampled during the study, the Dugway Brook Culvert – Dupont Avenue reported the highest geometric mean value of 5518 MPN/100 mL with 100 percent of the samples exceeding the STV criterion. Table 6 provides a summary of the recreational use criteria exceedances for all sites assessed in 2023.

These exceedances may be due to significant wet-weather events[1] which occurred on three of the five sampling dates. Potential sources of bacteria inputs may include stormwater runoff, illicit discharges, CSOs, and failing household sewage treatment systems (HSTS).

**Table 5.** 2023 Dugway Brook *E. coli* Densities (MPN/100mL)

| Date | RM 2.40 | RM 0.37 | Dugway Forest Hills Park** | Dugway E. 110th Street** | Dugway Dupont Avenue** |
|---|---|---|---|---|---|
| 8/2/2023 | 1046 | 2605 | 248 | 1986 | 5650 |
| 8/9/2023* | 1986 | 4200 | 579 | 9350 | 21,870 |
| 8/16/2023* | 613 | 921 | 2200 | 78 | 1733 |
| 8/24/2023* | 46,040 | 21,760 | 15,380 | 11,910 | 15,380 |
| 8/30/2023 | 199 | 3890 | 411 | 1414 | 1553 |
| 90-day Geomean (8/2-10/30) | 1635 | 3856 | 1148 | 1894 | 5518 |

Exceeds statistical threshold value of 410 MPN/100mL

Exceeds geometric mean criterion for 90-day period of 126 MPN/100mL

*Wet-weather Event

** Primary contact recreation standards do not apply at these sites but are listed here for reference.

[1] 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.

| **Table 6.** 2023 Summary of Recreational Use Criteria Exceedances for All Sites | | | | |
|---|---|---|---|---|
| Site | 90-Day Geomean % Exceedance | STV % Exceedance | Max 90-Day Geomean Value (MPN/100 mL) | Seasonal Geomean* |
| **Dugway Brook** | | | | |
| RM 2.40 | 80 | 80 | 3027 | 1635 |
| Forest Hills Culvert** | 100 | 100 | 2514 | 1148 |
| East 110th St Culvert ** | 100 | 100 | 4104 | 1894 |
| Dupont Ave Culvert** | 100 | 100 | 5518 | 5518 |
| RM 0.37 | 100 | 100 | 9200 | 3856 |
| *Seasonal Geomean does not apply. Calculated for comparative purposes only. ** Primary contact recreation standards do not apply at these sites but are listed here for reference. | | | | |

*Statistical Analysis of the Impact of the DEIRS and DWIRS on E. coli Densities and Total Phosphorus Concentrations*

Additional statistical analysis was performed in order to determine the impact of the DEIRS and DWIRS on *E. coli* densities and total phosphorus concentrations in Dugway Brook at the downstream site RM 0.37. All available historical *E. coli* and total phosphorus data from the period between 2012 and 2023 was used. Data prior to this time period were excluded as there was no available rain gage data before 2012. Wet weather was defined as a period in which the total 48-hour precipitation was greater than 0.1 inches using the Easterly rain gage. Both CSO control tunnels were fully operational in 2020. The data was grouped as before (2012-2019) and after (2021-2023) CSO control tunnel completion. The Wilcoxon rank sum test was used to test for changes in parameter concentrations between the before and after groups for both dry- and wet-weather conditions. Figures 2 and 3 show dry- and wet-weather boxplot distributions of *E. coli* densities and total phosphorus concentrations at RM 0.37 before and after CSO controls tunnel completion. No significant improvement in either parameter was observed in both dry- and wet-weather conditions.

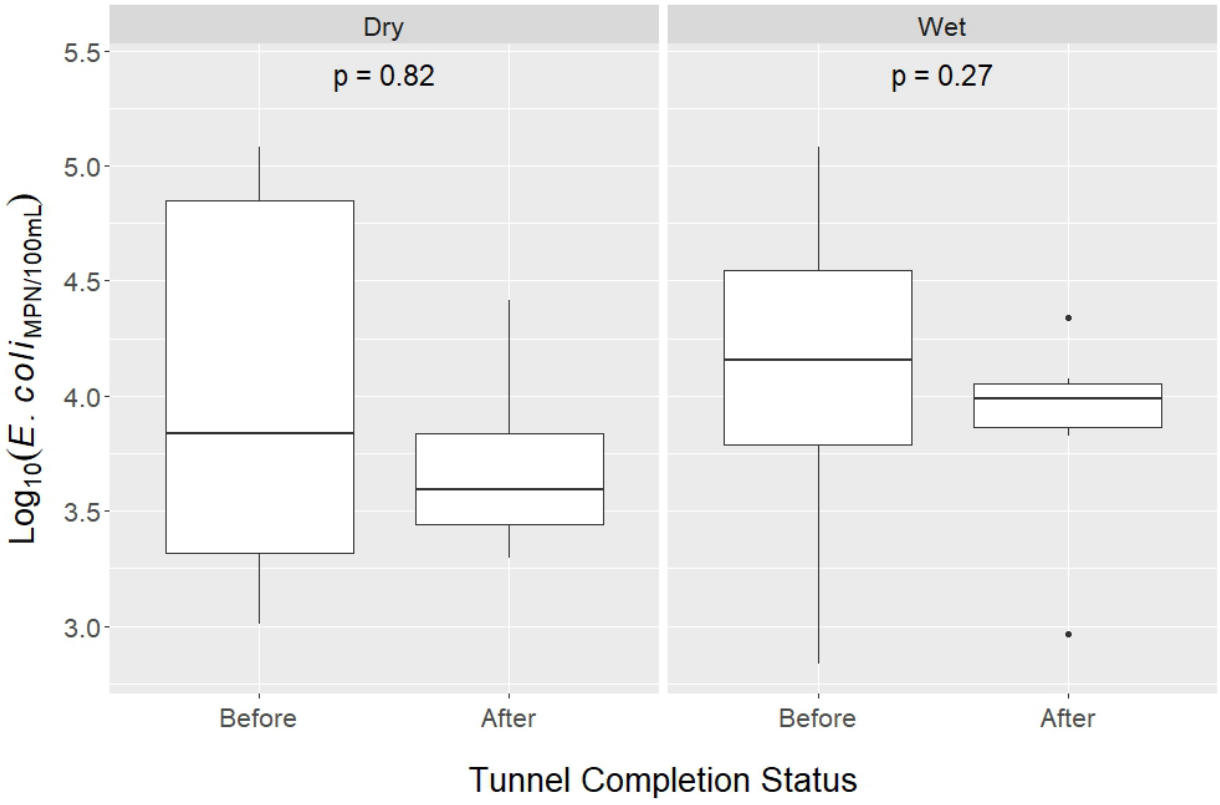


**Figure 2.** Boxplot distributions of *E. coli* densities before and after tunnel completion with p-values from Wilcoxon rank sum test.

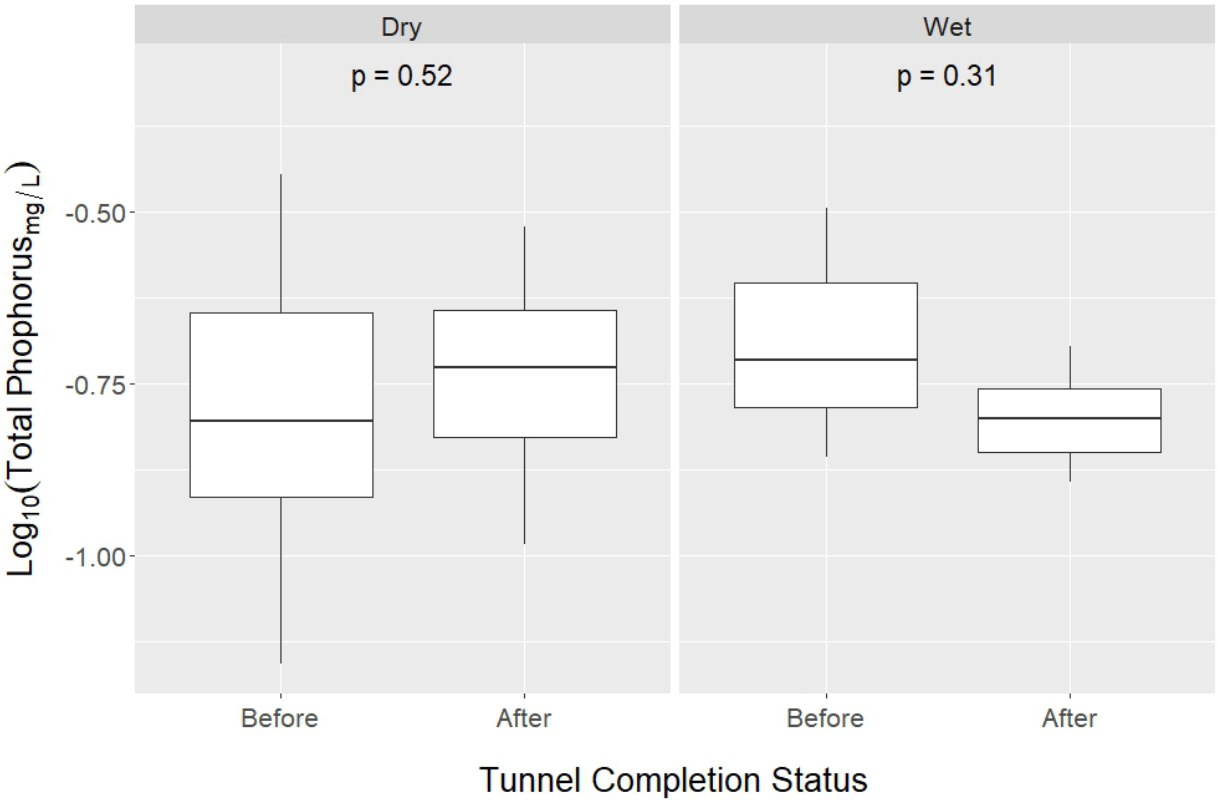


**Figure 3.** Boxplot distributions of total phosphorus concentrations before and after tunnel completion with p-values from Wilcoxon rank sum test.

*Metals and Other Exceedance Data*

Mercury was analyzed using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health and Protection of Wildlife OMZAs, it cannot be determined if the sites were 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 streams. All the mercury results were below the MDL. It is expected that the use of a low-level mercury analysis like EPA Method 1631E, instead of EPA Method 245.1, may have resulted in exceedances of the criteria throughout the sampling period. It is possible that mercury may be introduced into these streams from urban runoff, industrial wastewater discharge, and atmospheric deposition within the watershed. There were no additional exceedances for the data collected during the 2023 sampling season on Dugway Brook.

*Nutrient Assessment Data*

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 dissolved oxygen (DO) swings, benthic chlorophyll *a*, total phosphorous, and dissolved inorganic nitrogen (Ohio EPA, 2015).

Maintenance of low levels of nutrients such as nitrogen and phosphorus in Dugway Brook will help limit loading to Lake Erie. An excess of nitrogen and phosphorus can lead to nutrient enrichment in the lake, fueling harmful algal blooms (HABs), which can contribute to hypoxic or anoxic (low or oxygen depleted) zones. Hypoxia degrades water quality, impacting biogeochemical cycling and can be fatal to aquatic life.

Some species of cyanobacteria responsible for HABs can produce toxins like microcystins. Microcystins are potent toxins that are harmful to human and animal health. Exposure can occur through ingestion, inhalation, or dermal contact. Acute effects include vomiting, headache, rashes, fever, diarrhea, and abdominal pain. Additional research is needed to determine long-term health effects and the fate of microcystins in the environment, but the toxin has high potential as a carcinogen.

Table 7 shows the 2023 nutrient concentrations for all sampling sites. The results of dissolved inorganic nitrogen (DIN) and total phosphorous (TP) were compared to Table 2 listed in the SNAP document (Figure 4; Ohio EPA, 2015). According to this section of SNAP, Dugway Brook RM 2.40 and Forest Hills Culvert received an ecological risk narrative described as "levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges". The sites on Dugway Brook at East 110$^{th}$ Street Culvert, Dupont Culvert, and RM 0.37 received an ecological risk narrative described as "levels of typical enriched condition; low risk to beneficial use if allied responses are within normal ranges; increased risk with poor habitat".

**Table 7.** 2023 Nutrient Analysis (Geometric Mean) for All Samples

| Stream | Location | DIN (mg/L) | $NO_3$-$NO_2$ (mg/L) | DRP (mg/L) | TP (mg/L) |
|---|---|---|---|---|---|
| Dugway Brook | RM 2.40 | 1.05 | 0.96 | 0.29 | 0.33 |
| | Forest Hills | 1.45 | 1.34 | 0.09 | 0.12 |
| | East 110$^{th}$ | 1.25 | 1.15 | 0.08 | 0.14 |
| | Dupont Ave | 1.32 | 1.11 | 0.11 | 0.22 |
| | RM 0.37 | 1.18 | 1.05 | 0.08 | 0.16 |

Data used in Table 2 of SNAP (Ohio EPA, 2015b)

Geometric means for DIN, $NO_3$-$NO_2$, DRP, and TP (*n=5,* unless otherwise noted)

| | | ← DECREASING RISK | | | | |
|---|---|---|---|---|---|---|
| | TP Conc. (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 4.** Table two of the Stream Nutrient Assessment Procedure (Ohio EPA, 2015b)

Benthic chlorophyll *a* was not assessed by NEORSD in 2023, creating a potential limitation to the interpretation of risk presented using the provisional method.

## Habitat Assessment

### Methods

Instream habitat assessments were conducted at all in-stream sites 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, with slightly different narrative ranges for streams based on total drainage area (Table 8). For headwater streams, a score greater than 55 suggests that sufficient habitat exists to support a fish community that attains the warmwater habitat criterion (Ohio EPA, 2006). Scores greater than 70 for headwaters frequently demonstrate habitat conditions that can support exceptional warmwater fauna. 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). QHEI field sheets for each site are available upon request from the NEORSD WQIS Division.

| **Table 8.** Narrative Ranges Assigned to QHEI Scores | |
|---|---|
| Narrative Rating | QHEI Range |
| | Headwaters (drainage ≤ 20 sq miles) |
| *Excellent* | ≥70 |
| *Good* | 55-69 |
| *Fair* | 43-54 |
| *Poor* | 30-42 |
| *Very Poor* | <30 |

**Results and Discussion**

QHEI assessments were performed at Dugway Brook RM 0.37 and RM 2.40 in 2023. Dugway Brook RM 0.37 met the QHEI target for the respective stream size and should be of high enough quality to support fish assemblages. Dugway Brook RM 2.40 did not meet the WWH QHEI target for headwater stream habitat. A narrative rating of *Good* was given to Dugway Brook RM 0.37 while the site at Dugway Brook RM 2.40 received a narrative rating of *Fair.*

The site at RM 2.40 had cobble and gravel as the dominant substrate types. Although there was a normal amount of silt present, the substrate embeddedness was considered to be moderate. The sparse instream cover was only comprised of shallows in slow-moving water and boulders. This section of stream was straight, with no sinuosity, and had fair to good development of the pool-riffle-run complexes as the maximum pool depth was only 45 cm. The maximum riffle depth was greater than 10 cm and generally the riffles were moderately stable to stable, but embeddedness in those areas was still considered moderate.

The site at RM 0.37 had gravel and sand as the dominant substrate types with heavy silt cover and moderate to extensive embeddedness. The moderate amount of instream cover consisted of undercut banks, deep pools, aquatic macrophytes, rootmats, and logs/woody debris. Although the site was not channelized, development was fair due to the absence of a run, only one small riffle, and numerous glide areas.

Individual components of the QHEI can also be used to evaluate whether a site can meet its WWH designated use (Table 9). This is done by categorizing specific attributes as indicative of either a WWH or modified warmwater habitat (MWH) (Rankin, 1995). Attributes that are considered characteristic of MWH are further classified as being a moderate or high influence on fish communities. The presence of one high or four moderate influence characteristics has been found to result in lower IBI scores, with a greater prevalence of these characteristics usually preventing a site from meeting WWH attainment (Ohio EPA, 2006). The site at RM 2.40 in 2023 had one high influence characteristics and both had four or more moderate influence characteristics indicating that there was a greater prevalence of characteristics that have the potential to prevent a site from meeting WWH attainment.

**Table 9.** QHEI Scores and Physical Attributes

| | | | **WWH Attributes** | | | | | | | | | | **MWH Attributes** | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | High Influence | | | | | | Moderate Influence | | | | | | | | | | | | | |
| **Sampling Location** | **QHEI Score** | **Habitat Rating** | 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 | Sand Substrates (Boat) | 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** |
| Dugway Brook RM 2.40 | 53.00 | *Fair* | X | X | | X | | | | | X | | **4** | | | X | X | | **2** | | | | | X | | X | | X | X | X | | **5** | 0.6 | 1.2 |
| Dugway Brook RM 0.37 | 61.50 | *Good* | X | X | | | | X | | | X | | **4** | | | | | | **0** | | X | | | X | X | | | X | X | X | | **6** | 0.2 | 1.4 |

## Fish Community Biology Assessment

### Methods

Two quantitative electrofishing passes were conducted at Dugway Brook RMs 2.40 and 0.37 in 2023. A list of the dates when the surveys were completed is shown in Table 10. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while wading from downstream to upstream. The sampling zone at both headwater sites 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 and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). With drainage areas less than twenty square miles at both sites, the number of fish collected were counted, following Ohio EPA headwater protocol. No weights of fish were documented. All fish were then released to the waters from which they were collected, except for vouchers and/or those that could not be easily identified in the field.

**Table 10.** 2023 Dugway Brook Electrofishing Dates

| Date | Sites sampled |
|---|---|
| 6/22/2023 | RM 2.40 |
| 8/4/2023 | RM 0.37 |
| 9/5/2023 | RM 2.40 |
| 9/25/2023 | RM 0.37 |

The electrofishing results were compiled and utilized to evaluate fish community health through the application of one of two Ohio EPA indices. With both sampling locations being classified as headwater sites, only the Index of Biotic Integrity (IBI) was utilized. The 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*.

| **Table 11.** Headwater IBI Metrics |
|---|
| 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 |

The streams evaluated are located completely within the Erie-Ontario Lake Plains (EOLP) ecoregion and follow the EOLP IBI metric scoring. The WWH IBI scoring criterion in the EOLP ecoregion is 40 for headwater sites. A site is within non-significant departure if the score falls within 4 IBI units (Table 12). Lists of the species diversity, abundance, pollution tolerances, and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD WQIS Division.

| **Table 12.** Fish Community Biology Scores in the EOLP Ecoregion | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ohio EPA Narrative | Very Poor | Poor | Fair | Marginally Good | Good | Very Good | Exceptional |
| Headwaters | | | | | | | |
| 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 2023 IBI scores from each assessment location on Dugway Brook are listed below in Table 13. Due to a variety of factors, neither site on Dugway Brook was found to be in attainment of the WWH criterion.

| **Table 13.** 2023 IBI Results | | | |
|---|---|---|---|
| Location | IBI (Narrative) | | |
| | 1st Pass | 2nd Pass | Average |
| Dugway Brook RM 2.40 | 16 (*Very Poor*) | 16 (*Very Poor*) | 16 (*Very Poor*) |
| Dugway Brook RM 0.37 | 24 (*Poor*) | 30 (*Fair*) | 27 (*Poor*) |
| **WWH criterion: Headwaters = IBI ≥ 40** | | | |

An IBI score of 16 was calculated at RM 2.40, which resulted in a narrative rating of *Very Poor* and non-attainment of the fish community WWH criterion. Both sampling events resulted in only one species collected, the Northern Fathead Minnow (*Pimephales promelas*), totaling 283 individuals during the first pass and 183 individuals during the second pass, respectively. The Fathead Minnow is a highly pollution tolerant, pioneering stream species with a preference for habitats similar to what is found at RM 2.40. For both sampling events, the lack of species diversity including the absence of key taxa such as darters and headwater species, no sensitive species, and no insectivorous species negatively impacted the IBI score. No DELTS were observed in either sampling event which positively contributed to the IBI score. This reach is relatively shallow, embedded, and open, leaving no habitat for deeper water species or species that require instream cover or interstitial spaces. It is likely that the overall location of the reach negatively impacted the fish score by limiting recruitment of other fish species. This stretch of Dugway Brook is a short open stretch downstream of the Lakeview Cemetery Dam and upstream of a culverted stretch of the stream. Additionally, this section of stream empties into a small impoundment that is just over an acre in size. Therefore, it faces fish migration barriers from both upstream and downstream. The QHEI score of 53 (*Fair*) also indicates that habitat conditions may be influencing the absence of other fish species. This IBI score was comparable to what has been calculated in past surveys (Figure 5).

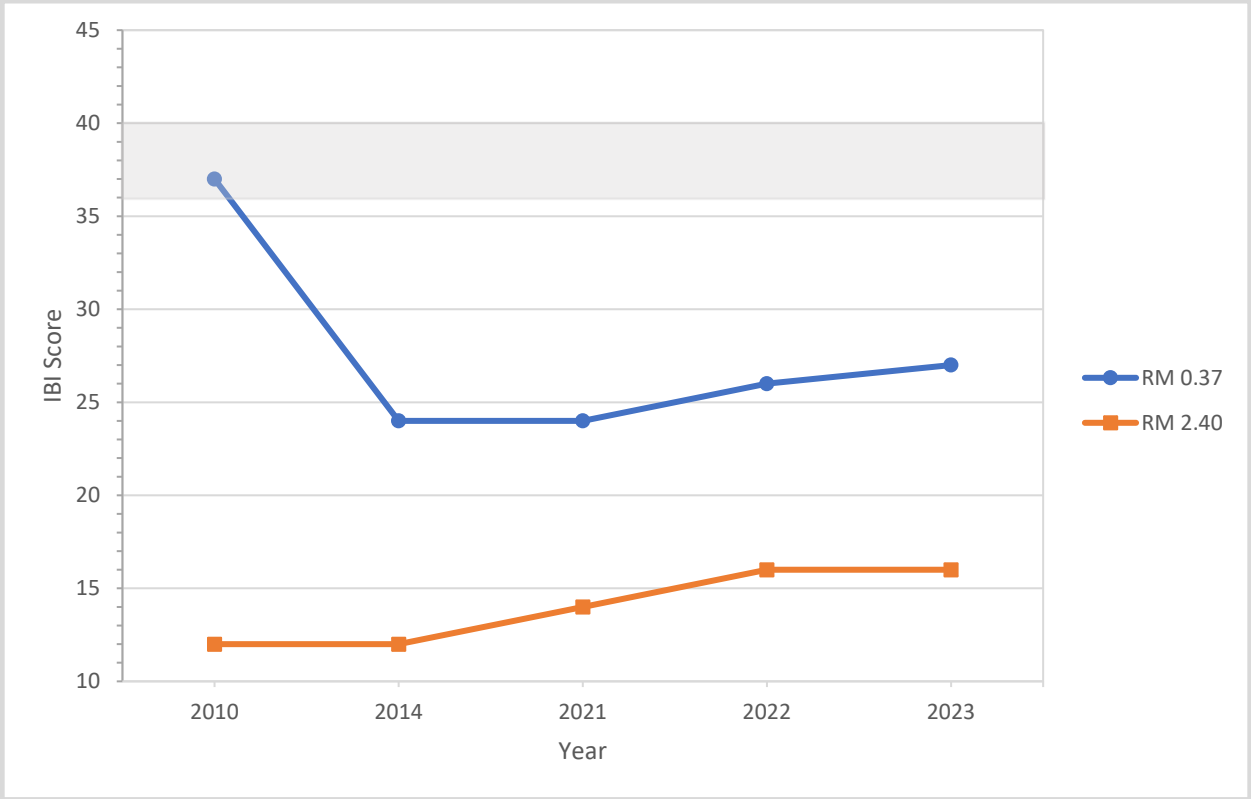


**Figure 5.** Historic IBI Scores for Dugway Brook Headwater Sites. Gray box represents range of WWH attainment and NSD from wading criterion.

For both passes at RM 0.37, the average IBI score was calculated at 27 (*Poor*) and was not in attainment of the WWH criterion. A total of fourteen species were collected between the two electrofishing surveys. The most dominant fish collected was the Common White Sucker, representing twenty-one percent of the total fish collected. There was one moderately intolerant species collected during both assessments, the Sand Shiner (*Notropis stramineus*). Another moderately intolerant species, the Logperch (*Percina caprodes*), was collected during the second pass. Due to this site being near Lake Erie, it is likely that elevated numbers of sunfish, trout, shiners, and gobies may have entered the brook from Lake Erie. With RM 0.37 being near the confluence of Lake Erie, IBI scores may be influenced by different fish populations migrating to and from the lake. The time of year will also have an impact on what species travel between the lake and brook. This can have a potential impact on IBI scores depending on when sampling takes place. Even with the influence of Lake Erie, the low number of total fish collected during both surveys impacted the IBI scores. This reach is a relatively slow-moving section of Dugway Brook that is immediately downstream of a culverted section and a floatable control structure. These conditions lead to the deposition of silt and accumulation of muck along the electrofishing zone. Although RM 0.37 received a QHEI score of 61.5 and a narrative rating of *Good*, the silt and muck are having a negative impact on available habitat. Due to the limited instream habitat conditions, including extensive embeddedness, heavy silt, and poor substrate quality, it is unlikely that the site

can support a robust fish community. Combined with the present habitat, anthropogenic sources of pollution, the high percentage of impervious surface contributing to stormwater runoff, and CSO discharges may also be affecting the fish population negatively.

## Macroinvertebrate Community Biology Assessment

### Methods

Macroinvertebrates were not sampled quantitatively using modified Hester-Dendy (HD) samplers in 2023 due to unsuitable conditions for HD installation. A qualitative sampling event at each site was conducted to assess Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) taxa within all available habitats within the stream reach. These taxa are also referred to as EPT taxa. Qualitative sampling was conducted at both locations listed in Table 14.

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 at each site are available upon request from NEORSD WQIS Division.

**Table 14.** 2023 Qualitative Sampling Dates

| Site | HD Installation Date(s) | Qualitative Sample Date |
|---|---|---|
| Dugway Brook RM 2.40 | N/A* | 7/14/23 |
| Dugway Brook RM 0.37 | N/A* | 7/14/23 |
| **HD was not installed due to unsuitable stream conditions.* | | |

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). Had HD samplers been installed, the overall aquatic macroinvertebrate community in the stream would have been evaluated using Ohio EPA's Invertebrate Community Index (ICI). The ICI consists of ten community metrics (Table 15), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while metric 10 is based on the qualitative EPT taxa collected. The sum of the individual metric scores results in the overall ICI score. This scoring evaluates the macroinvertebrate community against Ohio EPA's reference sites for each specific eco-region. The WWH ICI criterion in the EOLP ecoregion is 34 (Table 16) and a site is within non-significant departure if the score falls within 4 ICI units of the criterion. Due to HDs not being installed on Dugway Brook in 2023, only narrative ratings were given to each site.

| **Table 15.** ICI Metrics |
|---|
| Total Number of Taxa |
| Number of Mayfly taxa |
| Number of Caddisfly taxa |
| Number of Dipteran taxa |
| Percent Mayflies |
| Percent Caddisflies |
| Percent Tanytarsini Midges |
| Percent Other Diptera and Non-Insects |
| Percent Tolerant Organisms (as defined) |
| Number of Qualitative EPT Taxa |

| **Table 16.** Invertebrate Community Index (ICI) Range for EOLP Ecoregion | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ohio EPA Narrative | Very Poor | Poor | Low Fair | Fair | Marginally Good | Good | Very Good | Exceptional |
| ICI Score | 0-6 | 8-12 | 14-20 | 22-28 | 30-32 | 34-40 | 42-44 | 46-60 |
| Ohio EPA Status | Non-Attainment | | | | NSD | Attainment | | |
| NSD – Non-Significant Departure of WWH attainment | | | | | | | | |

## Results and Discussion

Table 17 shows the results for locations that had a qualitative sample only. For the 2023 sampling season, both sites on Dugway Brook were in non-attainment of WWH criterion.

| **Table 17.** 2023 Macroinvertebrate Results | | | | | | | |
|---|---|---|---|---|---|---|---|
| Stream RM | Density Qt. ($ft^2$) /Ql. | Ql./ Total Taxa | Ql. EPT/ sensitive Taxa | Qt. % Tolerant/ Sensitive taxa | Predominant orgs. on natural substrates | ICI | Narrative Evaluation |
| **Dugway Brook (19-131-000)** | | | | | | | |
| 2.40 | ---/L-M | 33/--- | 5/1 | --- | Baetid mayflies, Chironomids, Gastropods | -- | *Fair* |
| 0.37 | ---/L-M | 30/--- | 2/1 | --- | Baetidae, Chironomidae, Simulidae | -- | *Low Fair* |
| 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 *Moderately Intolerant*, no *Intolerant* taxa were collected. | | | | | | | |

*Macroinvertebrate Narrative Rating Assignments*

HDs were not installed at Dugway Brook RMs 0.37 and 2.40 due to unsuitable conditions for HD installation. Therefore, narrative rating assessments were performed for these sites based on the results of qualitative sampling. The qualitative sample data was compared to expectations developed by NEORSD using threshold limit models (NEORSD, 2023). These models were developed using QDC Level 3 macroinvertebrate data provided by the Ohio EPA from the Erie Ontario Lake Plain ecoregion (EOLP) from the ten-year period between 2005 and 2014 (threshold limit model analysis available upon request). Table 18 provides the expectation threshold limits for qualitative total taxa, qualitative EPT taxa, and qualitative sensitive taxa metrics, grouped by drainage area category. Figures 6-8 provide distributions of these metrics grouped by ICI narrative rating category in comparison with the expectation threshold limits provided in Table 18.

**Table 18.** NEORSD Recommended Expectation Threshold Limits for Narrative Rating Assignments in the EOLP

| Drainage Category | Designation | Qualitative Total Taxa | Qualitative EPT Taxa | Qualitative Sensitive Taxa |
|---|---|---|---|---|
| Headwater (0-20 miles$^2$) | EWH | 38 | 12 | 6 |
| | WWH | 27 | 7 | 2 |
| | Fair | 23 | 4 | 1 |
| Wadable (20-200 miles$^2$) | EWH | 51 | 18 | 12 |
| | WWH | 41 | 11 | 6 |
| | Fair | 33 | 8 | 2 |
| Small River (200-1,000 miles$^2$) | EWH | 44 | 16 | 10 |
| | WWH | 36 | 11 | 7 |
| | Fair | 29 | 9 | 5 |

Dugway Brook RM 0.37 was assigned a narrative rating of *Low Fair*. This site has a drainage area of 6.3 square miles placing it in the headwater drainage area category. A total of 30 taxa were collected in the qualitative sample which scores above the WWH expectation of 27 for a headwater stream. Only two EPT taxa were collected which falls below the *fair* expectation of four for the number of EPT taxa. EPT taxa included one mayfly species, *Baetis flavistriga*, and one caddisfly taxa, *Hydropsyche depravata group*. One sensitive taxa, the moderately intolerant snail, *Elimia sp*, was collected which meets the *fair* expectation of one for number of sensitive taxa. Field observations indicated that the most predominant group was Chironomidae followed by Turbellaria, Hirudinea, and Gastropoda. Caddisflies and Chironomidae midges were also noted as common. The site was assigned a field narrative rating of *Poor* at the time of sample collection. Taking into consideration the low number of EPT and sensitive taxa and the high relative abundance of pollution tolerant groups the site was assigned a narrative rating of *Low Fair* in 2023.

Dugway Brook RM 2.40 was assigned a narrative rating of *Fair*. This site has a drainage area of 2.6 square miles placing it near the low end of the headwater drainage area category. A total of 33 taxa were collected in the qualitative sample which scores above the *WWH* expectation of 27 for a headwater stream. Five EPT taxa were collected which falls between the fair and WWH expectations of four and seven for number of EPT taxa. EPT taxa included one mayfly species, *Baetis flavistriga*, and four caddisfly taxa, *Chimarra aterrima*, *Cheumatopsyche sp*, *Hydropsyche depravata group*, and *Hydroptila sp.* One sensitive taxa, the moderately intolerant caddisfly, *Chimarra aterrima*, was collected which meets the *fair* expectation for number of sensitive taxa in a headwater stream. Field observations indicated that the most predominant groups included Turbellaria, Baetidae, Chironomidae, and Simuliidae. The site was assigned a field narrative rating of *Fair* at the time of sample collection. Taking into consideration the above listed data, the site was assigned a narrative rating of *Fair* in 2023, the same as 2022 sampling results.

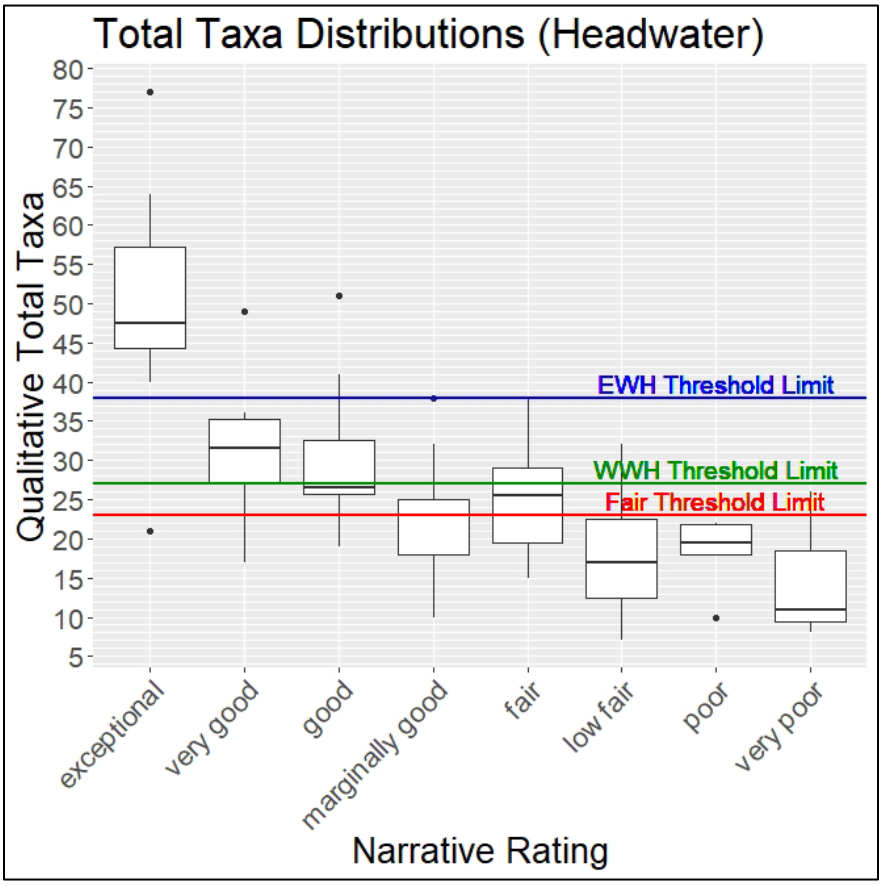


**Figure 6.** Distribution of the number of qualitative total taxa in EOLP headwater streams grouped by ICI score narrative rating category with EWH, WWH, and Fair expectation threshold limits developed by NEORSD.

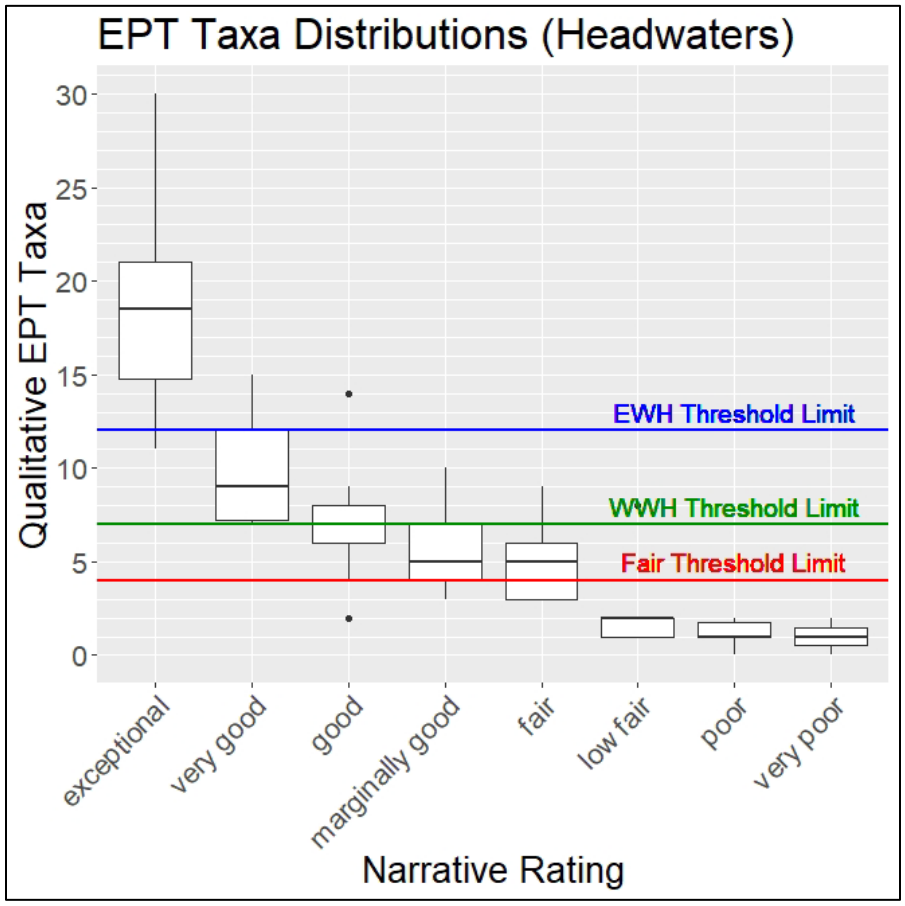


**Figure 7.** Distribution of the number of qualitative EPT taxa in EOLP headwater streams grouped by ICI score narrative rating category with EWH, WWH, and Fair expectation threshold limits developed by NEORSD.

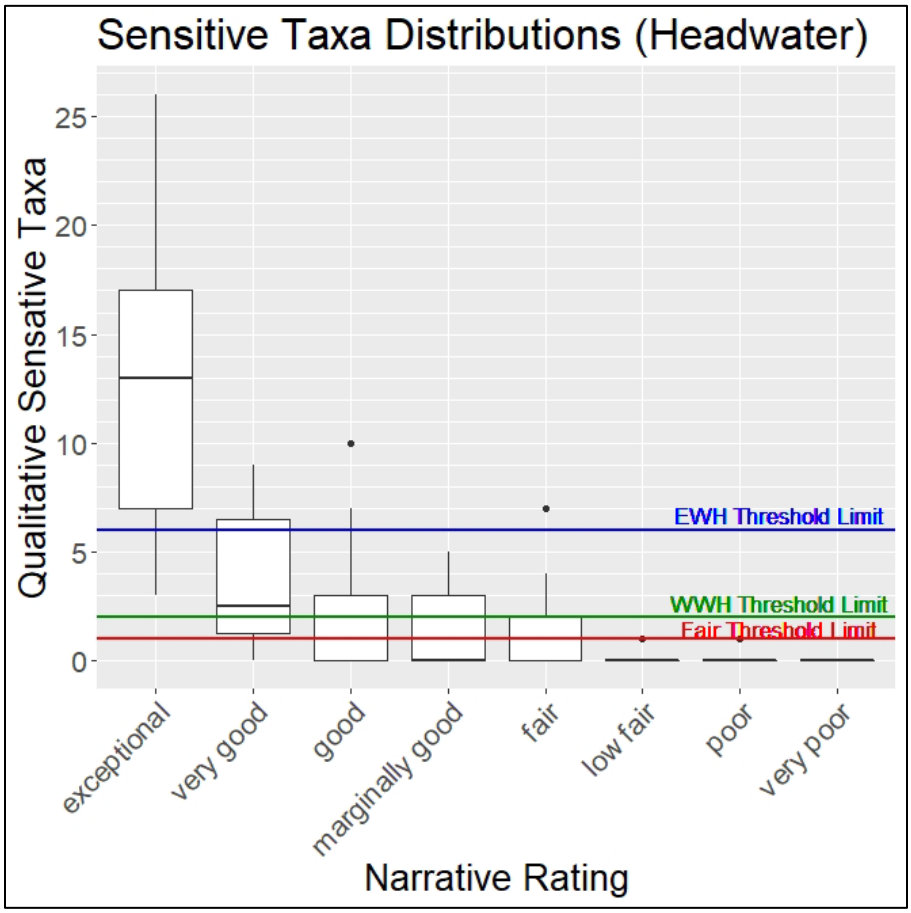


**Figure 8.** Distribution of the number of qualitative sensitive taxa in EOLP headwater streams grouped by ICI score narrative rating category with EWH, WWH, and Fair expectation threshold limits developed by NEORSD.

## Conclusions

The results of NEORSD's 2023 water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys indicate that despite Project Clean Lake infrastructure improvements, Dugway Brook is likely still impacted by a variety of anthropogenic-driven habitat limitations and environmental stressors listed in Table 19.

**Table 19.** 2023 Survey Results

| RM | DA ($mi^2$) | Attainment Status | IBI Score | MIwb Score | ICI Score | QHEI Score | Cause(s) | Source(s) |
|---|---|---|---|---|---|---|---|---|
| **Dugway Brook** (WWH Existing) | | | | | | | | |
| 2.40 [H] | 2.6 | NON | 16* | --- | F | 53 | Sedimentation. Nutrient enrichment. Poor habitat development. Flow alterations. | Urbanization and urban runoff. Culverted stream reaches. Atmospheric deposition/urbanization. |
| 0.37 [H] | 6.3 | NON | 27* | --- | LF | 61.50 | Sedimentation. Nutrient enrichment. Poor habitat development. Flow alterations. | Urbanization and urban runoff. Culverted stream reaches. Atmospheric deposition/urbanization. |

*Significant departure from biocriterion (>4 ICI; >4 IBI; >0.5 MIwb units). Underlined scores are in the *Poor* or *Very Poor* narrative range.
[H] Headwater scoring criteria
[LF] Low Fair narrative rating
[F] Fair narrative rating

Instream habitat at Dugway Brook RM 2.40 is degraded and limited likely due to the large impoundment and multiple culverted sections located both upstream and downstream. Poor habitat quality, a moderately embedded riffle, flow modifications, and the small drainage area are likely limiting factors contributing to the *Very Poor* and *Fair* biological index scores for fish and macroinvertebrates, respectively. The pollution-tolerant Northern Fathead Minnow was the only fish species collected in both passes, and the total number of EPT taxa collected during the qualitative sample at this reach was low (*Baetis flavistriga, Chimarra aterrima, Cheumatopsyche sp, Hydropsyche depravata group, and Hydroptila sp.*) *E. coli* densities also exceeded water quality criteria, which is indicative of water quality impacts from urbanization.

Stream habitat at Dugway Brook RM 0.37 has been historically modified and impacted by multiple sources of impairment upstream of the reach including CSOs, illicit discharges, and a floatable control structure. Flow modifications upstream including large, culverted sections, a significant amount of impervious surface from the urbanized region, and the small drainage area likely have contributed to heavy siltation and poor water quality. The two electrofishing passes resulted in fish IBI scores that were *Poor* and did not meet WWH habitat expectations. One

moderately intolerant species, the Sand Shiner, was collected during both passes, and another moderately intolerant species, the Logperch, was collected on the second pass; however, the total number of overall fish collected was low. The macroinvertebrate assemblage at RM 0.37 was given a narrative of *Low Fair* and only two EPT taxa were collected, *Baetis flavistriga* and *Hydropsyche depravata group.* Urbanization in the region also resulted in exceedances of water quality criteria for *E. coli* as well.

Exceedances of both bacteriological criteria for primary contact recreation occurred at both sites during the 2023 recreation season. The primary contact recreation standards do not apply at the three culverted sites but would have also exceeded the criteria for all sampling events (Table 8). Potential sources of bacterial inputs may include stormwater runoff, illicit discharges, common trench sewer inflow and infiltration, failing household sewage treatment systems (HSTS), and CSOs. Overall, these potential sources may be continuing to impact the water quality in Dugway Brook even after completion of the Dugway Storage Tunnel and associated projects.

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