Level 3 Project Study Plan

2010 Dugway Brook Environmental Monitoring

(1) Objectives

Beginning in the summer of 2010, the Northeast Ohio Regional Sewer District (NEORSD) Dugway Brook East Interceptor Relief Sewer Alignment (DEIRS) project will resume in order to reduce the number overflows per year to the East Branch of Dugway Brook. The DEIRS project will provide wet weather flow relief in the existing Dugway East Interceptor Sewer through the cities of Cleveland and East Cleveland. In 2009, baseline data was collected on the East and West Branches of Dugway Brook during wet and dry weather conditions prior to project completion. In 2010, construction activity is progressing forward for the DEIRS project; however, no relief sewers have yet been abandoned or sanitary sewage overflows redirected to the Dugway East Interceptor. Therefore, additional baseline data can be collected. If the stormwater management program is implemented in 2010, NEORSD will not be completing the sampling on the east and west branches of Dugway Brook.

Although the DEIRS project will not affect current conditions on the West Branch, baseline data will be collected on that branch as well, prior to completion of the Dugway West Interceptor Relief Sewer Project (DWIRS). Data collection on both the East and West Branches of Dugway Brook will consist of water chemistry samples to assess the chemical and bacteriological water quality conditions upstream and downstream on Dugway Brook. Fish, macroinvertebrate and habitat assessment will also be conducted on Dugway Brook downstream of the culvert where the brook becomes open water and on a site on the West Branch downstream of Lakeview Cemetery and a NEORSD flood control dam. These results will be evaluated using the Ohio Environmental Protection Agency's (EPA) Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), and Invertebrate Community Index (ICI). An examination of the individual metrics that comprise these indices will be used in conjunction with water quality data to identify impacts to the biotic communities.

(2) Point/Nonpoint Sources

Point Sources	Nonpoint Sources
Storm Sewer Outfalls	Urban runoff
Combined Sewer Overflows	Spills
Sanitary Sewer Overflows	

A map has been provided in Appendix A to show point sources that may be influencing the water quality at each sample location. These sources of pollution,

along with the nonpoint sources listed in the table above, may be impacting the health of the fish and benthic macroinvertebrate communities in Dugway Brook and will need to be taken into account when evaluating changes to these communities following completion of the DEIRS and DWIRS projects.

(3) Parameters Covered

Fish specimens will be identified to species level, counted, and examined for the presence of external anomalies including DELTs (deformities, eroded fins, lesions and tumors). An Ohio EPA Fish Data Sheet will be completed during each assessment. Quantitative fish sampling will be conducted at all locations.

Macroinvertebrate community assemblages will be collected from each location and shipped to AMT (Ravenna, Ohio)[1] for identification and enumeration. Aquatic Macroinvertebrate Taxonomy (AMT) will identify the specimens to the lowest practical taxonomic level and whenever possible, to the level of taxonomy recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989; November 8, 2006; and August 26, 2008)[2].

The NEORSD Macroinvertebrate Field Sheet (Appendix B) will be completed at each site during sampler retrieval. In addition, stream habitat will be measured by scoring components of the QHEI at all locations, including the substrate, instream cover, channel morphology, riparian zone and bank erosion, pool/glide and riffle/run quality and gradient.

Water chemistry samples will be collected at each electrofishing/ macroinvertebrate site. Appendix C lists the parameters to be tested along with the detection limits and practical quantitation limits. Field measurements for dissolved oxygen, pH, temperature, and specific conductance will also be performed. A Surface Water Condition Sampling Field Data Form will be completed at each site during each sampling event (Appendix D).

(4) Field Collection and Data Assessment Techniques

Field collections for fish will be conducted at two sites (see Table in Section 5). Sampling will be conducted using longline electrofishing techniques and will consist of shocking all habitat types within a sampling zone, which is 0.15

[1] It is anticipated that AMT will be contracted to complete all macroinvertebrate identification. The contract has been approved by the Northeast Ohio Regional Sewer District Board of Trustees, however, to date, it has not been accepted by AMT. An amended study plan will be submitted if someone else is awarded the contract.
[2] See Appendix I for a list of all references.

kilometers in length, while moving from downstream to upstream. The stunned fish will be collected and placed into a live well for processing.

Fish will be identified to species level, counted, and examined for the presence of external anomalies including DELTs. Fish easily identified (commonly collected from year to year) will be returned to the site from which they are collected. Subsamples of difficult-to-identify species will be brought back to the laboratory for verification by NEORSD Level 3 Fish Qualified Data Collectors (QDC) and, if necessary, sent to The Ohio State University Museum of Biological Diversity for verification by the Curator and/or Associate Curator of Fish. Voucher specimens will be collected as described in section (14). Endangered species and those too large for preservation will not be collected as voucher specimens, but will instead be photographed. Photographed vouchers will include features that permit definitive identification of the particular species.

Fish will be preserved in 10 percent formalin in the field, soaked in tap water for 24 to 48 hours after 5 to 7 days, then transferred to solutions of 30 and 50 percent ethanol for 5 to 7 days each and, finally, to 70 percent ethanol for long-term storage. Specimens larger than six inches will be slit along the right side and then soaked in formalin for approximately 10 to 14 days before being transferred to water and solutions of 30, 50 and 70 percent ethanol. Label information will include location (description and coordinates), date, time, collectors' names, and sample identification code for each specimen collected.

Macroinvertebrate sampling will be conducted using quantitative and qualitative sampling techniques. Quantitative sampling will include installation of five replicates of modified Hester-Dendy multi-plate artificial substrate sampler (HD) that is colonized for a six-week period. Multiple HD samplers will be installed at one or all of the locations in case samplers are lost due to vandalism, burial, etc. Qualitative sampling will be conducted using a D-frame dip net when HD samplers are retrieved. The NEORSD Macroinvertebrate Field Sheet will be completed during the HD retrieval. Voucher specimens will be collected as described in section (14). All macroinvertebrate community assemblages will be sent to a Level 3 QDC for identification and enumeration. The Level 3 QDC will identify specimens to the lowest practical taxonomic level and when the condition of the specimen allows, to the level of taxonomy recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989; November 8, 2006; and August 26, 2008). Voucher specimens will be collected as described in section (14). Stream flow will be measured with a Marsh-McBirney FloMate Model 2000 Portable Flow Meter, which measures flow in feet per second, when the HD samplers are installed and retrieved.

A detailed description of the sampling and analysis methods utilized in the fish community and macroinvertebrate surveys, including calculations of the IBI and ICI, can be found in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987, updated January 1, 1988; November 8, 2006; and August 26, 2008) and *III* (1987, updated September 30, 1989; November 8, 2006; and August 26, 2008).

Water chemistry and bacteriological sampling will be completed at all sites. Techniques used for water quality sampling and chemical analyses will follow the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2009). Chemical water quality samples from each site will be collected with two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. All water quality samples will be collected as grab samples. One duplicate sample and one field blank will be collected at a randomly selected site, at the frequency not less than 10% of the total samples collected, for this study plan. The acceptable relative percent difference (RPD) for field duplicate samples will be ≤30 percent; results outside this range will trigger further evaluation and investigation into causes for disparities. RPD values above 30 percent, with results less then ten times the practical quantitation limit, will be reviewed on a case-by-case basis to determine if there is any merit for further investigation. Acid preservation of the samples, as specified in the NEORSD laboratory's standard operating procedure for each parameter, will occur in the field. Appendix C lists the analytical method, method detection limit, and practical quantitation limit for each parameter analyzed. Field analyses include the use of a either a YSI-556 MPS Multi-Parameter Water Quality Meter or YSI 600XL sonde to measure dissolved oxygen, water temperature, specific conductivity and pH; and when necessary, a Hanna HI 98129 meter to measure pH. Specifications for these meters have been included in Appendix E.

The QHEI, as described in Ohio EPA's, *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006) will be used to assess aquatic habitat conditions at each sample location by Level 3 QDCs.

Species assemblages and individual metrics will be analyzed. Graphs that show current and historic QHEI, IBI, and ICI scores and how these scores compare to attainment status of biocriteria will be prepared. Water chemistry data collected will be compared to Ohio Water Quality Standards to determine whether any excursions from the applicable water quality criteria have occurred. Comparisons between water quality and biological community health will only be made if at least three water quality samples have been collected from that site.

(5) Sampling Locations

The following chemistry, habitat, electrofishing, and macroinvertebrate sample locations, listed from upstream to downstream on Dugway Brook, will be surveyed during the 2010 field season. HD and water chemistry collection sites are located within each electrofishing zone, indicated by River Mile, unless otherwise noted. GPS coordinates are recorded at the downstream end of each electrofishing zone.

Location	Latitude	Longitude	River Mile	Description	Quadrangle	Purpose
Forest Hills Park Forest Hills Blvd. and Forest Hills Ave.	N41.5218°	W81.5850°	N/A	Dugway Brook, East Branch Upstream of DEIRS Alignment	East Cleveland	Evaluate water chemistry prior to DEIRS Alignment
East 110th Street Salt Dome Road	N41.5479°	W81.6076°	N/A	Dugway Brook, East Branch Downstream of DEIRS Alignment	East Cleveland	Evaluate water chemistry prior to DEIRS Alignment
North of Lakeshore Blvd. North of NEORSD Netting facility	N41.5509°	W81.6086°	0.37	Dugway Brook Main Branch North of Lakeshore Blvd.	East Cleveland	Evaluate water chemistry, fish, habitat and macroinvertebrates
Lakeview Cemetery downstream of NEORSD flood control dam.	N41.5122°	W81.5905°	N/A	Dugway Brook, West Branch Upstream section	East Cleveland	Evaluate water chemistry, fish, habitat and macroinvertebrates prior to DWIRS alignment
10658 Dupont Avenue	N41.5446°	W81.6118°	N/A	*Dugway Brook, West Branch	East Cleveland	Evaluate water chemistry prior to DWIRS alignment
*This is the furthest downstream access location of all regulators tributary to the West Branch of Dugway Brook. It should be noted that there are two regulators (D-61 & D-03A) downstream of this location that will not be captured during sample collection as there is no access to the culvert downstream of this location.						

(6) Schedule

At least one electrofishing survey per site where applicable will be conducted between June 15 and October 15, 2010. Specific dates have not been scheduled. Stream flow and weather conditions will be assessed weekly to determine when each electrofishing pass will be conducted.

Artificial substrate samplers will be installed on Dugway Brook once, between June 15 and August 19, 2010, at all applicable sites and retrieved six weeks later. During retrieval of the HD, a qualitative sample will also be obtained. Specific

dates have not been scheduled. Stream flow and weather conditions will be assessed weekly to determine when the HD installations and retrievals will be conducted.
Water quality samples will be collected at each site a minimum of three times between June 15 and October 15, 2010.

QHEI habitat evaluations will be conducted one time at applicable sites in 2010 between June 15 and October 15. These evaluations will be conducted around the same time as one of the electrofishing surveys.

(7) QA/QC

Quality assurance and quality control of sampling and analysis methods for habitat, fish, and macroinvertebrate evaluations will follow Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987, updated January 1, 1988, November 8, 2006, and August 26, 2008) and *III* (1987, updated September 30, 1989, November 8, 2006, and August 26, 2008), and *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006).

Electrofishing equipment will be used according to the guidelines listed in the operation and maintenance manual provided by Smith-Root, Inc. Malfunctioning equipment will not be used to conduct surveys. Proper steps will be taken to correct the problem as soon as possible, whether by repairing in the field or at the NEORSD Environmental & Maintenance Services Center (EMSC), or by contacting the supplier or an appropriate service company.

Subsamples of difficult-to-identify fish species will be brought back to the laboratory for verification by Level 3 Fish Qualified Data Collectors (QDC), and if necessary, sent to The Ohio State University College Museum of Biological Diversity for verification by the Curator and/or Associate Curator of Fish. Voucher specimens will be collected as described in section (14). Endangered species and those too large for preservation will not be collected as voucher specimens, but will instead be photographed. Photographed vouchers will include features that permit definitive identification of the particular species.

All macroinvertebrate community assemblages will be collected and shipped to AMT for identification and enumeration. AMT will identify specimens to the lowest practical taxonomic level and when the condition of the specimen allows, to the level of taxonomy recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989, November 8, 2006, and August 26, 2008). The AMT QA/QC manual is attached in Appendix F. All macroinvertebrate specimens will be returned to NEORSD.

Voucher specimens for each site will be separated into individual vials and maintained as described in section (14). The remaining specimens for each site will be returned in a single container labeled with the site number and collection method and date. All specimens and accompanying chain-of-custody documentation will be retained by NEORSD and stored at EMSC for a period not less than ten years.

Water samples obtained for chemical analyses will be collected, labeled, and then placed on ice inside the field truck. The field truck will remain locked at all times when not occupied/visible. Sampling activities, including sample time and condition of surface water sampled, will be entered in a QDC log book and on the Surface Water Condition Sampling Field Data Form. The samples will then be delivered immediately to the NEORSD Analytical Services cooler, after which the door to the cooler will be locked, and the samples will be transferred to the custody of Analytical Services. The NEORSD Analytical Services Quality Manual and associated Standard Operating Procedures are on file with Ohio EPA. The Quality Assurance Officer at Analytical Service will send updates, revisions, and any information on document control to Ohio EPA as needed.

(8) Work Products

Within one year of completion of the project, fish data (species, numbers, pollution tolerances, the incidence of DELT anomalies, IBI scores), macroinvertebrate data (types and numbers of macroinvertebrates collected and ICI scores), habitat data (QHEI raw data and scores), and water chemistry results will be submitted to the Ohio EPA. Additionally, reports summarizing, interpreting, graphically presenting, and discussing the IBI, ICI and QHEI scores in relation to restoration activities and excursions from water quality standards may be prepared for internal use.

(9) Qualified Data Collectors

The following Level 3 Qualified Data Collectors (QDC) will be involved with this study:

Name	Address	Email Address	Phone Number	QDC Specialty(s)
[1]John W. Rhoades	4747 East 49th Street Cuyahoga Hts., Ohio 44125	rhoadesj@neorsd.org	216-641-6000	QDC – 008 CWQA /FCB/SHA/BMB
Cathy Zamborsky	4747 East 49th Street Cuyahoga Hts., Ohio 44125	zamborskyc@neorsd.org	216-641-6000	QDC - 009 CWQA/SHA
[2,5]Seth Hothem	4747 East 49th Street Cuyahoga Hts., Ohio 44125	hothems@neorsd.org	216-641-6000	QDC - 010 CWQA/FCB/SHA
Kathryn Crestani	4747 East 49th Street Cuyahoga Hts., Ohio 44125	crestanik@neorsd.org	216-641-6000	QDC - 011 CWQA/SHA
[6]Tom Zablotny	4747 East 49th Street Cuyahoga Hts., Ohio 44125	zablotnyt@neorsd.org	216-641-6000	QDC - 018 CWQA/FCB/SHA
[3] Ron Maichle	4747 East 49th Street Cuyahoga Hts., Ohio 44125	maichler@neorsd.org	216-641-6000	QDC - 145 CWQA/SHA/BMB
Francisco Rivera	4747 East 49th Street Cuyahoga Hts., Ohio 44125	riveraf@neorsd.org	216-641-6000	QDC - 262 CWQA
[4]Tiffany Moore	Aquatic Macroinvertebrate Taxonomy 8927 Weaver Road, Revenna, Ohio,44266	tiffany@digitaldesignmedia.com	330-626-2310	QDC - 017 BMB

[1] Lead Project Manager
[2] Stream Habitat Assessment (SHA) Project Manager
[3] Benthic Macroinvertebrate Biology (BMB) Project Manager
[4] Benthic Macroinvertebrate Identification
[5] Fish Community Biology (FCB) Project Manager
[6] Chemical Water Quality Assessment (CWQA) Project Manager

The following is a list of persons not qualified as a QDC who may be involved in the project. Prior to the start of sampling, the project manager will explain to each individual the proper methods for sampling. Sampling will only be completed under the direct observation of a QDC. The lead project manager will be responsible for reviewing all reports and data analysis prepared by qualified personnel prior to completion.

Name	Address	Email Address	Phone Number
Nick Barille	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Barillen@neorsd.org	216-641-6000
Joseph Broz	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Brozj@neorsd.org	216-641-6000
Tim Dobriansky	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Dobrianskyt@neorsd.org	216-641-6000
Kyle Frantz	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Frantzk@neorsd.org	216-641-6000
Kristina Granlund	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Granlundk@neorsd.org	216-641-6000
Rae Grant	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Grantr@neorsd.org	216-641-6000
Eric Hinton	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Hintone@neorsd.org	216-641-6000
John Junkin	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Junkinj@neorsd.org	216-641-6000
Mark Matteson	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Mattesonm@neorsd.org	216-641-6001
Jillian Novak	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Novakj@neorsd.org	216-641-6000
Cathy O'Grady	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Ogradyc@neorsd.org	216-641-6000

Name	Address	Email Address	Phone Number
Kevin Roff	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Roffk@neorsd.org	216-641-6000
Frank Schuschu	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Schuschuf@neorsd.org	216-641-6000
Wolfram von Kiparski	4747 East 49th Street Cuyahoga Hts., Ohio 44125	Vonkiparskiw@neorsd.org	216-641-6000
Summer Co-op	4747 East 49th Street Cuyahoga Hts., Ohio 44125	To Be Determined	216-641-6000
Summer Co-op	4747 East 49th Street Cuyahoga Hts., Ohio 44125	To Be Determined	216-641-6000
Summer Co-op	4747 East 49th Street Cuyahoga Hts., Ohio 44125	To Be Determined	216-641-6000

(10) Documentation of approval of project manager and other personnel as level 3 qualified data collectors

See attached (Appendix G).

(11) Contract laboratory contact information

Any fish that is not positively identified in the field or NEORSD laboratory will be sent to The Ohio State University Museum of Biological Diversity for verification by the Curator and/or Associate Curator of Fish. Fish will be identified to the species level.

Dr. Ted Cavender, Curator of Fish / Mr. Marc Kibbey, Associate Curator of Fish
1315 Kinnear Road, Columbus, Ohio 43212
cavender.1@osu.edu / kibbey.3@osu.edu
614-292-7873

Identification of macroinvertebrates will be completed by AMT, Ravena, Ohio. Benthic macroinvertebrates will be identified to the lowest practical level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989, November 8, 2006, and August 26, 2008).

Tiffany Moore (QDC# 017)
AMT
8927 Weaver Road
Ravenna, Ohio 44266
tiffany@digitaldesignmedia.com
(330) 626-2310

(12) Copy of ODNR collector's permit

To be submitted electronically when issued to NEORSD by ODNR (Appendix H). Twenty-four hours prior to biological collection, the county ODNR wildlife officer will be contacted by a NEORSD QDC. See table below for contact information for ODNR Wildlife Officers by county. A message may be left instructing: type of sampling, location of sampling, and duration.

County	Contact Person	Phone Number
Cuyahoga County	Hollie J. Fluharty	(330) 245-3033

The most current wildlife officer contact information should always be checked at the following web address:
http://www.dnr.state.oh.us/Home/wild_resourcessubhomepage/about_the_division_landingpage/contactdefault/WildlifeOfficersbyCounty/tabid/7004/Default.aspx

(13) Catalog Statement

A digital photo catalog of all sampling locations will be maintained for 10 years and will include photos of the specific sampling location(s), the riparian zone adjacent to the sampling location(s) and the general land use in the immediate vicinity of the sampling location(s).

Print/Signature: John W. Rhoades / Date: _____

(14) Voucher Specimen Statement

NEORSD will maintain a benthic macroinvertebrate and fish voucher collection which includes two specimens, or appropriate photo vouchers, of each species or taxa collected during the course of biological sampling from any stream within the NEORSD's service area. When benthic macroinvertebrates from multiple surface waters are collected within the same year and identified by the same QDC, one voucher collection will be created to represent the specimens collected from those streams. When fish specimens from multiple surface waters are collected within the same year, one voucher collection will be created to represent the specimens collected from those streams. A separate collection for each sampling event will not be maintained.

NEORSD will provide specimens or photo vouchers to the Director upon request. This collection will be stored at the NEORSD laboratory in the Environmental and Maintenance Services Center.

Print/Signature: John W. Rhoades / Date: _____

(15) Trespassing Statement

I have not been convicted or pleaded guilty to a Violation of section 2911.21 of the Revised Code (criminal trespass) or a substantially similar municipal ordinance within the previous five years.

Print/Signature: John W. Rhoades / Date: _____

Print/Signature: Cathy Zamborsky / Date: _____

Print/Signature: Seth Hothem / Date: _____

Print/Signature: Kathryn Crestani / Date: _____

Print/Signature: Tom Zablotny / Date: _____

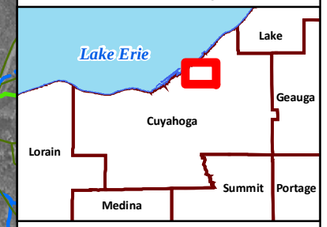
Print/Signature: Ron Maichle / Date: _____

Print/Signature: Francisco Rivera / Date: _____

Appendix A

Northeast Ohio Regional Sewer District
Protecting Your Health and Environment

Overview Map



Dugway East Interceptor Relief Sewer (DEIRS) Study

- CSO Outfall
- DEIRS Diversion Structure
- DEIRS Access Shaft
- DEIRS Regulator
- Proposed DEIRS Sewers
- Stream
- NEORSD Interceptor Sewer
- NEORSD Intercommunity Relief Sewer
- NEORSD CSO Control Sewer
- NEORSD CSO Responsibility Sewer
- Local Combined Sewer
- Local Sanitary Sewer
- Local Storm Sewer
- Local Culverted Stream
- Local Force Main

Study Sites

- -Dugway Brook North of Lakeshore Blvd.
  Lat. - 41.5509 Long. - -81.6086
- - Dugway Brook East Culvert at E.110
  Lat. - 41.5480 Long. - -81.6076
- - Dugway Brook West Culvert at Dupont
  Lat. - 41.5446 Long. - -81.6118
- - Dugway Brook East Culvert at Forest Hills
  Lat. - 41.5219 Long. - -81.5850
- - Dugway Brook West at Lakeview Dam
  Lat. - 41.5122 Long. - -81.5905

N

1,300

Feet

Date: March 2010

Sources: Orthophotos(2008), Street Centerline (2006), Cuyahoga County GIS; Streams(2005), SSURGO; Environmental Assessment Zones (2009), Collection System, NEORSD GIS;

2010_EnvAssessPlan_DEIRS_Tabloid.mxd

Appendix B

NEORSD Macroinvertebrate Field Sheet

Stream: _____ River Mile: _____ Year: _____

Location Description: _____ Project: _____

Latitude (°N)/Longitude (°W): _____

Hester-Dendy Deployment Information

Install Date: _____ Crew Initials (QDC Circled): _____
Current at HD (fps): _____ Depth (cm): _____ Pictures Obtained: Yes No

Reinstall Date: _____ Crew Initials (QDC Circled): _____
Current (fps): _____ Depth (cm): _____ Reason: _____

Reinstall Date: _____ Crew Initials (QDC Circled): _____
Current (fps): _____ Depth (cm): _____ Reason: _____

Sampling/Retrieval Information

Sampling Method: Hester-Dendy Dipnet Surber Grab Other: _____

Sampling Date: _____ Crew Initials (QDC Circled): _____

HD Condition- Current (fps): _____ Depth (cm): _____ Water Temp: _____ °F / °C
Number of HD Blocks Obtained: _____ Remarks: _____
Disturbed: Yes No Comments: _____
Debris: Yes No Comments: _____
Silt/Solids: None Slight Moderate Heavy

Dipnet- Time Sampled (min): _____ X Number of Crew: _____ = Total (min): _____
Habitats Sampled: Pool Riffle Run Margin Backwater

Samples Analyzed By: _____ QDC #: _____ Date: _____

River Sampling Conditions

Flow Condition:	Flood	Above Normal	Normal	Low	Interstitial	Intermittent	Dry
Current Velocity:	Fast	Moderate	Slow	Non-detect			
Channel Morphology:	Natural	Channelized	Channelized (Recovered)		Impounded		
Bank Erosion:	Extensive	Moderate	Slight	None			
Riffle Development:	Extensive	Moderate	Sparse	Absent			
Riffle Quality:	Good	Fair	Poor		Embedded:	Yes	No
Water Clarity:	Clear	Murky	Turbid		Other: _____		
Water Color:	None	Green	Brown	Grey	Other: _____		
Canopy:	Open	75 %	50 %	25 %	Closed		

Comment Section: _____

_____

_____

_____

_____

Physical Characteristics

Substrate Characteristics

	Pool	Units	Riffle	Units	Run	Units
Bedrock						
Boulder						
Rubble						
Coarse Gravel						
Fine Gravel						
Sand						
Silt						
Clay/Hardpan						
Detritus						
Peat						
Muck						
Other						
Macrophytes						
Algae						
Artifacts						
Compaction (F,M,S)						
Depth (Avg)						
Width (Avg)						

Predominant Land Use (Left, Right or Both)

Forest	Urban	Open Pasture
Shrub	Residential/Park	Closed Pasture
Old Field	Mining/Construction	
Rowcrop	Wetland	
Industrial	Other	

Predominant Riparian Vegetation

Left	Right	Type
_____	_____	Large Trees
_____	_____	Small Trees
_____	_____	Shrubs
_____	_____	Grass/Weeds
_____	_____	None

Margin Habitat

Margin Quality: Good Fair Poor

Undercut Banks	Root Mats
Grass	Water Willow
Shallows	Caly/Hardpan
Rip Rap	Bulkhead

Other _____

Biological Characteristics

Riffle:

Predominant Organisms: _____

Other Common Organisms: _____

Density: High Moderate Low

Diversity: High Moderate Low

Run:

Predominant Organisms: _____

Other Common Organisms: _____

Density: High Moderate Low

Diversity: High Moderate Low

Pool:

Predominant Organisms: _____

Other Common Organisms: _____

Density: High Moderate Low

Diversity: High Moderate Low

Margin:

Predominant Organisms: _____

Other Common Organisms: _____

Density: High Moderate Low

Diversity: High Moderate Low

Other Notable Collections: _____

V= Very Abundant; A= Abundant; C= Common; R= Rare; N= None

Overall Amount	
/ /	Porifera, Cnidaria, Bryozoa
/ /	Turbellaria, Oligochaeta, Hirudinea
/	Isopoda, Amphipoda
/	Decapoda, Hydracarina
	Ephemeroptera
	Baetidae
	Other _____
/	Zygoptera, Anisoptera
	Plecoptera
	Hemiptera
/	Megaloptera, Neuroptera
	Trichoptera
	Hydropsychidae
	Other _____
	Coleoptera
	Elimidae
	Other _____
	Diptera
	Other Dipteran
	Chironomidae
/	Gastropoda, Bivalvia
	Other _____
	Other _____
	Other _____

Appendix C

Parameter	Test	Minimum Detection Limit	Practical Quantitation Limit
Alkalinity	EPA 310.2	2.3 mg/L	10 mg/L
COD	EPA 410.4	5 mg/L	10 mg/L
Hex Chrome	SM 3500 Cr D. [1]	1 µg/L	5 µg/L
Mercury	EPA 245.1	0.016 µg/L	0.050 µg/L
NH3	EPA 350.1	0.002 mg/L	0.010 mg/L
NO2 + NO3	EPA 353.2	0.002 mg/L	0.010 mg/L
NO2	Method 4500-$N0_2^-$ B. [1]	0.002 mg/L	0.010 mg/L
NO3	EPA 353.2	0.002 mg/L	0.010 mg/L
Soluble-P	EPA 365.1	0.001 mg/L	0.010 mg/L
Total-P	EPA 365.1	0.001 mg/L	0.010 mg/L
Chlorophyll *a*	EPA 445.0	To be determined	2.0 µg/L
Chloride by IC	EPA 300.0	0.031 mg/L	5.000 mg/L
Sulfate by IC	EPA 300.0	0.061 mg/L	5.000 mg/L
BOD	EPA 405.1 (5 Day)	2 mg/L	
Ag	EPA 200.7	2.8 µg/L	10.00 µg/L
Al	EPA 200.7	26.3 µg/L	100.0 µg/L
As	EPA 200.7	13.9 µg/L	100.0 µg/L
Ba	EPA 200.7	0.70 µg/L	10.00 µg/L
Be	EPA 200.7	0.20 µg/L	1.00 µg/L
Ca	EPA 200.7	25.5 µg/L	275 µg/L
Hardness (calc.)	SM 2340 B	CaCO3 mg/L =(2.497*Ca mg/L)+(4.118*Mg mg/L)	
Cd	EPA 200.7	4.6 µg/L	10.00 µg/L
Co	EPA 200.7	2.0 µg/L	10.00 µg/L
Cr	EPA 200.7	4.6 µg/L	10.00 µg/L
Cu	EPA 200.7	1.9 µg/L	10.00 µg/L
Fe	EPA 200.7	3.3 µg/L	10.00 µg/L
K	EPA 200.7	590.0 µg/L	2000.0 µg/L
Mg	EPA 200.7	29.9 µg/L	100.0 µg/L
Mn	EPA 200.7	1.2 µg/L	10.00 µg/L
Mo	EPA 200.7	3.8 µg/L	10.00 µg/L
Na	EPA 200.7	59.5 µg/L	500.0 µg/L
Ni	EPA 200.7	6.2 µg/L	20.00 µg/L
Pb	EPA 200.7	13.4 µg/L	50.00 µg/L
Sb	EPA 200.7	17.0 µg/L	100.0 µg/L
Se	EPA 200.7	36.0 µg/L	75.00 µg/L
Sn	EPA 200.7	13.4 µg/L	50.00 µg/L
Total Metals	EPA 200.7	µg/L =(Cr µg/L)+(Cu µg/L)+(Ni µg/L)+(Zn µg/L)	
Ti	EPA 200.7	1.6 µg/L	10.00 µg/L
Tl	EPA 200.7	47.0 µg/L	100.0 µg/L
V	EPA 200.7	4.5 µg/L	10.00 µg/L
Zn	EPA 200.7	1.3 µg/L	10.00 µg/L
TS	SM 2540 B	0.5 mg/L	1.0 mg/L
TSS	SM 2540 D	0.5 mg/L	1.0 mg/L
TDS	SM 2540 C	0.5 mg/L	1.0 mg/L
Turbidity	EPA 180.1	0.1 NTU	0.2 NTU
E. coli	EPA 9213D	1 colony	
Field Parameter	**Test**	**(Value Reported in)**	
pH	SM 4500H-B	s.u.	
Conductivity	SM 2510A	µs/cm	
Dissolved Oxygen	SM 4500-0 G	mg/L	
Temperature	SM 2550B	°C	

[1] Standard Methods for the Examination of Water and Wastewater, 19th Edition

Appendix D

NEORSD Surface Water Condition Sampling Field Data Form

Stream: _____ Collectors: _____

Date: _____ Cuyahoga River Daily Mean Discharge*: _____ ft^3/sec

Was this sample taken during or following a wet weather event? YES / NO
If yes, when and how much rain occurred? _____

Water Quality Meters Used: _____

Time: _____ Site Location (RM): _____

Flow: Low Normal High Other: _____

HD Status: OK Buried Out of Water H-D was Reset

Unknown (river to high) Missing Not Installed Flow: _____ fps

Clarity: Clear Murky Turbid Other: _____

Color: None Green Brown Other: _____

Field Parameters: Dissolved Oxygen (mg/L): _____ Temperature (°C): _____

Specific Conductance (µmhos/cm): _____ pH (s.u.): _____

General Comments: _____

Sample ID: (Label Here)

Field Blank Site / Sample Duplicate Site

Time: _____ Site Location (RM): _____

Flow: Low Normal High Other: _____

HD Status: OK Buried Out of Water H-D was Reset

Unknown (river to high) Missing Not Installed Flow: _____ fps

Clarity: Clear Murky Turbid Other: _____

Color: None Green Brown Other: _____

Field Parameters: Dissolved Oxygen (mg/L): _____ Temperature (°C): _____

Specific Conductance (µmhos/cm): _____ pH (s.u.): _____

General Comments: _____

Sample ID: (Label Here)

Field Blank Site / Sample Duplicate Site

*USGS 04208000 @ Independence, OH

Modified November 06, 2008

NEORSD Surface Water Condition Sampling Field Data Form

Stream: _____ Collectors: _____

Date: _____ Cuyahoga River Daily Mean Discharge*: _____ ft^3/sec

Was this sample taken during or following a wet weather event? YES / NO
If yes, when and how much rain occurred? _____

Water Quality Meters Used: _____

Time: _____ Site Location (RM): _____

Flow: Low Normal High Other: _____

HD Status: OK Buried Out of Water H-D was Reset

Unknown (river to high) Missing Not Installed Flow: _____ fps

Clarity: Clear Murky Turbid Other: _____

Color: None Green Brown Other: _____

Field Parameters: Dissolved Oxygen (mg/L): _____ Temperature (°C): _____

Specific Conductance (µmhos/cm): _____ pH (s.u.): _____

General Comments: _____

Sample ID: (Label Here)

Field Blank Site / Sample Duplicate Site

Time: _____ Site Location (RM): _____

Flow: Low Normal High Other: _____

HD Status: OK Buried Out of Water H-D was Reset

Unknown (river to high) Missing Not Installed Flow: _____ fps

Clarity: Clear Murky Turbid Other: _____

Color: None Green Brown Other: _____

Field Parameters: Dissolved Oxygen (mg/L): _____ Temperature (°C): _____

Specific Conductance (µmhos/cm): _____ pH (s.u.): _____

General Comments: _____

Sample ID: (Label Here)

Field Blank Site / Sample Duplicate Site

*USGS 04208000 @ Independence, OH

Modified November 06, 2008

Appendix E

14.1 Sensor Specifications

Dissolved Oxygen		
Sensor Type		Steady state polarographic
Range:	*% air sat'n*	▪ 0 to 500% air saturation
	mg/L	▪ 0 to 50 mg/L
Accuracy:	*% air sat'n*	▪ 0 to 200% air saturation: ±2% of the reading or 2% air saturation; whichever is greater ▪ 200 to 500% air saturation: ±6% of the reading
	mg/L	▪ 0 to 20 mg/L: ±2% of the reading or 0.2 mg/L; whichever is greater ▪ 20 to 50 mg/L: ±6% of the reading
Resolution:	*% air sat'n*	▪ 0.1% air saturation
	mg/L	▪ 0.01 mg/L
Temperature		
Sensor Type:		YSI Precision™ thermistor
Range:		-5 to 45°C
Accuracy:		±0.15°C
Resolution:		0.01°C
Conductivity		
Sensor Type:		4-electrode cell with auto-ranging
Range:		0 to 200 mS/cm
Accuracy:		±0.5% of reading or ±0.001 mS/cm; whichever is greater–4 meter cable ±1.0% of reading or ±0.001 mS/cm; whichever is greater–20 meter cable
Resolution:		0.001 mS/cm to 0.1 mS/cm (range-dependent)
Salinity		
Sensor Type:		Calculated from conductivity and temperature
Range:		0 to 70 ppt
Accuracy:		±1.0% of reading or 0.1 ppt; whichever is greater
Resolution:		0.01 ppt

YSI 650 Multiparameter Display System

Rugged and Reliable Display and Data Logging System

The YSI 650 Multiparameter Display System

Easily log real-time data, calibrate YSI 6-Series sondes, set up sondes for deployment, and upload data to a PC with the feature-packed YSI 650MDS (Multiparameter Display System). Designed for reliable field use, this versatile display and data logger features a waterproof IP-67, impact-resistant case.

- **Compatible with EcoWatch® for Windows® data analysis software**
- **User-upgradable software from YSI's website**
- **Menu-driven, easy-to-use interface**
- **Multiple language capabilities**
- **Graphing feature**
- **Three-year warranty**

Feature-Packed Performance

Battery Life

With the standard alkaline battery configuration of 4 C-cells, the YSI 650 will power itself and a YSI 6600 sonde continuously for approximately 30 hours. Or, choose the rechargeable battery pack option with quick-charge feature.

Optional Barometer

Temperature-compensated barometer readings are displayed and can be used in dissolved oxygen calibration. Measurements can be logged to memory for tracking changes in barometric pressure.

Optional GPS Interface

Designed to NMEA protocol, the YSI 650 MDS will display and log real-time GPS readings with a user supplied GPS interfaced with YSI 6-Series sondes.

Memory Options

Standard memory with 150 data sets, or a high-memory option (1.5 MB) with more than 50,000 data sets; both options with time and date stamp.

Pure Data for a Healthy Planet.®

A powerful logging display for your data collection processes

The 650MDS can be used with YSI sondes for spot sampling as well as short-term data logging.

Supply a GPS with NMEA 0183 protocol, connect with the YSI 6115 kit, and collect GPS data along with water quality data.

Upload data from the 650 to EcoWatch® for instant data viewing.

YSI 650MDS Specifications

Temperature	Operating Storage	-10 to +60°C for visible display -20 to +70°C
Waterproof Rating		IP-67 for both the standard alkaline battery configuration and for the rechargeable battery pack option
Connector		MS-8; meets IP-67 specification
Dimensions	Width Length Weight with batteries	4.7 in, 11.9 cm 9 in, 22.9 cm 2.1 lbs, 0.91 kg
Display		VGA; LCD with 320 by 240 pixels with backlight
Power	Standard Optional	4 alkaline C-cells with detachable battery cover Ni metal hydride battery pack with attached battery cover and 110/220 volt charging system
Communications		RS-232 to all sondes, for data transfer to PC, and for software updates
Optional GPS		NMEA 0183; requires user-supplied GPS and YSI 6115 Y-cable
Backlight		4 LEDs illuminating LCD; user-selectable
Keypad		20 keys, including instrument on/off, backlight on/off, enter, esc, 10 number/letter entry keys, 2 vertical arrow keys, 2 horizontal arrow keys, period key, and minus key
Warranty		3 years

Ordering Information

650-01	Instrument, standard memory
650-02	Instrument, high memory
650-03	Instrument, standard memory, barometer
650-04	Instrument, high memory, barometer
6113	Rechargeable battery pack kit with 110 volt charger and adapter cable
616	Charger, cigarette lighter
4654	Tripod
614	Ultra clamp, C-clamp mount
5081	Carrying case, hard-sided
5085	Hands-free harness
5065	Form-fitted carrying case
6115	Y-cable for interface with user-supplied GPS system

The 650MDS can interface with any YSI sonde for
- *spot sampling*
- *short-term studies*
- *surface and ground water monitoring*
- *water level monitoring*

Packaged together, the 600QS system includes a 600R conductivity sonde, 650MDS, field cable, and additional sensor options such as pH, dissolved oxygen, ORP, and vented level.

To order, or for more information, contact YSI
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SonTek/YSI
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YSI Gulf Coast
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YSI Hydrodata (UK)
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Fax +44 1462 673 582
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Who's Minding the Planet?®

YSI 600XL and 600XLM Sondes

The YSI 600XL and 600XLM

Measure multiple parameters simultaneously

The YSI 600XL and YSI 600XLM compact sondes measure eleven parameters simultaneously:

Temperature	TDS
Conductivity	pH
Specific Conductance	ORP
Salinity	Depth or Level
Resistivity	Rapid Pulse™ DO (% and mg/L)

Connect with Data Collection Platforms

Either sonde can easily connect to the YSI 6200 DAS (Data Acquisition System), YSI EcoNet™ or your own data collection platform, via SDI-12 for remote and real-time data acquisition applications.

Economical Logging System

The YSI 600XLM is an economical logging system for long-term, *in situ* monitoring and profiling. It will log all parameters at programmable intervals and store 150,000 readings. At one-hour intervals, the instrument will log data for about 75 days utilizing its own power source. The 600XL can also be utilized in the same manner with user-supplied external power.

- **Either sonde fits down 2-inch wells**
- **Horizontal measurements in very shallow waters**
- **Stirring-independent Rapid Pulse® dissolved oxygen sensor**
- **Field-replaceable sensors**
- **Easily connects to data collection platforms**
- **Available with detachable cables to measure depth up to 200 feet**
- **Compatible with YSI 650 Multiparameter Display System**
- **Use with the YSI 5083 flow cell for groundwater applications**

Pure Data for a Healthy Planet.®

Economical, multiparameter sampling or logging in a compact sonde

Sensor performance verified*

The 6820 V2 and 6920 V2 sondes use sensor technology that was verified through the US EPA's Environmental Technology Verification Program (ETV). For information on which sensors were performance-verified, turn this sheet over and look for the ETV logo.

ETV

To order, or for more info, contact YSI Environmental.

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*Sensors with listed with the ETV logo were submitted to the ETV program on the YSI 6600EDS. Information on the performance characteristics of YSI water quality sensors can be found at www.epa.gov/etv, or call YSI at 800.897.4151 for the ETV verification report. Use of the ETV name or logo does not imply approval or certification of this product nor does it make any explicit or implied warranties or guarantees as to product performance.

YSI incorporated
Who's Minding the Planet?®

YSI 600XL & 600XLM Sensor Specifications

	Range	Resolution	Accuracy
Dissolved Oxygen % Saturation ETV 6562 Rapid Pulse™ Sensor*	0 to 500%	0.1%	0 to 200%: ±2% of reading or 2% air saturation, whichever is greater; 200 to 500%: ±6% of reading
Dissolved Oxygen mg/L ETV 6562 Rapid Pulse™ Sensor*	0 to 50 mg/L	0.01 mg/L	0 to 20 mg/L: ± 0.2 mg/L or 2% of reading, whichever is greater; 20 to 50 mg/L: ±6% of reading
Conductivity• ETV 6560 Sensor*	0 to 100 mS/cm	0.001 to 0.1 mS/cm (range dependent)	±0.5% of reading + 0.001 mS/cm
Salinity	0 to 70 ppt	0.01 ppt	±1% of reading or 0.1 ppt, whichever is greater
Temperature ETV 6560 Sensor*	-5 to +50°C	0.01°C	±0.15°C
pH ETV 6561 Sensor*	0 to 14 units	0.01 unit	±0.2 unit
ORP	-999 to +999 mV	0.1 mV	±20 mV
Depth & Level Medium Shallow Vented Level	0 to 200 ft, 61 m 0 to 30 ft, 9.1 m 0 to 30 ft, 9.1 m	0.001 ft, 0.001 m 0.001 ft, 0.001 m 0.001 ft, 0.001 m	±0.4 ft, ±0.12 m ±0.06 ft, ±0.02 m ±0.01 ft, 0.003 m

• Report outputs of specific conductance (conductivity corrected to 25° C), resistivity, and total dissolved solids are also provided. These values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (ed 1989).

YSI 600XL & 600XLM Sonde Specifications

Medium		Fresh, sea or polluted water
Temperature	Operating Storage	-5 to +50°C -10 to +60°C
Communications		RS-232, SDI-12
Software		EcoWatch®
Dimensions 600XL | 600XLM	Diameter Length Weight	1.65 in, 4.19 cm | 1.65 in, 4.9 cm 16 in, 40.6 cm | 21.3 in, 54.1 cm 1.3 lbs, 0.59 kg | 1.5 lbs, 0.69 kg
Power	External Internal (600XLM only)	12 V DC 4 AA-size alkaline batteries

YSI model 5083 flow cell and 600XL. This is an ideal combination for groundwater applications.

HI 98129

Combo pH/EC/TDS/Temperature Tester with Low Range EC

Description

The HI 98129 Combo waterproof tester offer high accuracy pH, EC/TDS and temperature measurements in a single tester! No more switching between meters for your routine measurements. The waterproof Combo (it even floats) has a large easy-to-read, dual-level LCD and automatic shut-off. pH and EC/TDS readings are automatically compensated for the effects of temperature (ATC). This technologically advanced tester has a replaceable pH electrode cartridge with an extendable cloth junction as well as an EC/TDS graphite electrode that resists contamination by salts and other substances. This gives these meters a greatly extended life. Your tester no longer needs to be thrown away when the pH sensor is exhausted.

The EC/TDS conversion factor is user selectable as is the temperature compensation coefficient (ß). Fast, efficient, accurate and portable, the Combo pH, EC/TDS and temperature tester brings you all the features you've asked for and more!

Specifications

Range	pH	0.00 to 14.00 pH
Range	EC	0 to 3999 µS/cm
Range	TDS	0 to 2000 ppm
Range	Temperature	0.0 to 60.0°C / 32 to 140.0°F
Resolution	pH	0.01 pH
Resolution	EC	1 µS/cm
Resolution	TDS	1 ppm
Resolution	Temperature	0.1°C / 0.1°F
Accuracy	pH	±0.05 pH
Accuracy	EC/TDS	±2% F.S.
Accuracy	Temperature	±0.5°C / ±1°F
Temperature Compensation		pH: automatic; EC/TDS: automatic with ß adjustable from 0.0 to 2.4% / °C
Calibration	pH	automatic, 1 or 2 points with 2 sets of memorized buffers (pH 4.01 / 7.01 / 10.01 or 4.01 / 6.86 / 9.18)
Calibration	EC/TDS	automatic, 1 point
TDS Conversion Factor		adjustable from 0.45 to 1.00
pH Electrode		HI 73127 (replaceable; included)
Environment		0 to 50°C (32 to 122°F); RH max 100%
Battery Type / Life		4 x 1.5V / approx. 100 hours of continuous use; auto-off after 8 minutes of non-use
Dimensions		163 x 40 x 26 mm (6.4 x 1.6 x 1.0")
Weight		100 g (3.5 oz.)

Appendix F

Aquatic Macroinvertebrate Standard Operating Procedures

Sample Processing

Hester-Dendy samplers (HD) for each site are rinsed and cleaned in a #30 sieve stacked upon a #40 sieve. The resulting #30 and #40 samples are labeled, pre-picked for rare and/or large taxa under 3X magnification and then, if needed, subsampled, using a Folsom sample splitter to achieve more manageable numbers of organisms (minimums of 100 midge larvae, 75 mayflies and 75 caddisflies for #30 sample and minimum of 100 organisms in #40 sample). The resulting macroinvertebrates are then sorted into major orders, using a dissecting scope with at least 10X magnification. The sorted macroinvertebrates are put into labeled vials and preserved in 70% ethanol.

Qualitative samples (QUAL) are not subsampled but are rinsed in a #40 sieve to remove the formalin solution. The sample is then placed in a labeled vial and preserved in 70% ethanol.

Macroinvertebrate Identification

Macroinvertebrates from #30 HD samples and QUAL samples are identified to the lowest practical taxonomic level using OEPA approved references. Exceptions include damaged and immature specimens, which are extrapolated into the counts of the larger, identified specimens. Macroinvertebrates, except for midge larvae, from #40 HD samples are identified, counted and extrapolated into the taxa identified in the corresponding #30 HD sample. Midge larvae from #40 HD samples are also counted and extrapolated into the corresponding #30 HD sample, except for six easily recognizable midge taxa (*Corynoneura spp*., *Thienemanniella spp*., *Nilotanypus fimbriatus*, *Labrundinia spp*., *Stemepellina spp*. and *Stempellinella spp*.) If found, these are removed, identified and counted separately from the #40 HD sample and included in the #30 HD sample.

Midge larvae are mounted directly onto labeled slides using CMC-10, which is a clearing agent and a mounting medium. Voucher slides will be ringed with clear nail polish to prevent air fingers from forming.

A voucher collection, consisting of at least two organisms in good condition for each taxon found, will be prepared and will represent all three projects. In the case that only one organism of a certain taxon is found, that organism will be the voucher.

For each site, identifications will be recorded on bench sheets provided by the OEPA. These sheets include identifications, raw counts, extrapolated counts and identification numbers.

Metric Calculations

Invertebrate Community Index (ICI) calculations will be figured by hand for each site containing both a HD sample and a QUAL sample. For samples consisting of only a QUAL sample, a Qualitative Community Tolerance Value (QCTV) score will be calculated by hand and will be based on the most recent Ohio EPA Macroinvertebrate Taxa List, which contains tolerance values.

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Appendix I

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