Northeast Ohio Regional Sewer District

Level 3 Project Study Plan

2023 Cuyahoga River Environmental Monitoring

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List of Acronyms

AOC	Area of Concern
CSO	Combined Sewer Overflow
EMSC	Environmental Maintenance Service Center
EPA	Environmental Protection Agency
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
MIwb	Modified Index of Well-Being
NEORSD	Northeast Ohio Regional Sewer District
NPDES	National Pollution Discharge Elimination System
QHEI	Qualitative Habitat Evaluation Index
RM	River Mile
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WQIS	Water Quality & Industrial Surveillance
WWTC	Wastewater Treatment Center

(1) Objective

The lower 46.5 miles of the Cuyahoga River has been designated as one of 42 Great Lakes Areas of Concern (AOC) by the International Joint Commission. Past monitoring indicated impairment of aquatic biota in the river and formed the basis for the establishment of Total Maximum Daily Loads (TMDLs) for the Lower Cuyahoga River. The causes of impairment to the river were classified as organic enrichment, toxicity, low dissolved oxygen, nutrients, habitat and flow alteration (Ohio EPA Draft, 2023). Recent monitoring by the Northeast Ohio Regional Sewer District (NEORSD) and the Ohio Environmental Protection Agency (OEPA), however, has shown recovery of the fish and macroinvertebrate biological communities in some reaches of the river. The purpose of this study is to determine the attainment status of the river segments in relation to point and nonpoint sources of potential stressors.

During this study, the fish communities, benthic macroinvertebrate communities, habitat, and water chemistry will be surveyed at five (5) sites in the Cuyahoga River. This sampling will be conducted by the NEORSD's Environmental Assessment group in the Water Quality and Industrial Surveillance (WQIS) Division. Samples will be collected by Level 3 Qualified Data Collectors (QDC). Sampling will occur from June 15 through 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)[1]. The results from these surveys will be used to characterize the overall fish and macroinvertebrate community health in the river.

Fish and macroinvertebrate community health will be evaluated using Ohio EPA's Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb) and Invertebrate Community Index (ICI). An examination of the biological communities will be used in conjunction with water quality data, the NEORSD Macroinvertebrate Field Sheet, and Qualitative Habitat Evaluation Index (QHEI) results to identify impacts to biological communities. Results will be compared to historical data to show temporal as well as spatial trends. Water chemistry data will also be compared to the Ohio Water Quality Standards to determine attainment of applicable uses (Ohio EPA, 2022).

In addition, sestonic chlorophyll *a* levels in the river may be measured at all five sites to assist in the determination of the impacts from nutrients in the river on algal production. If completed, data sondes may be deployed in situ as part of this sampling to provide a more comprehensive understanding of the relationship among algal production, nutrient levels, and diel trends in temperature, dissolved oxygen, pH, and conductivity.

[1] See Appendix H for a list of references.

(2) Non-Point/Point Sources

Table 1. Potential Sources of Pollution	
Point Sources (Location on river)	Nonpoint Sources
Sagamore Creek (RM 18.06)	Agricultural runoff
Tinkers Creek (RM 16.38)	Landfills
Mill Creek (RM 11.49)	Sedimentation
West Creek (RM 11.05)	Spills
Southerly WWTC (RM 10.57)	Urban stormwater runoff
Ohio Canal (RM 8.78)	
Combined Sewer Overflows	
Storm Sewer Outfalls	
Home Septic Systems	
NPDES permitted facilities	

A map has been provided below (Figure 1) to show the wastewater collection system that may be influencing the water quality at each sample location. These sources, along with the ones listed in the table above, may be impacting the health of the fish, benthic macroinvertebrate communities and water chemistry in the Cuyahoga River watershed. Conditions may also be influenced by periods of drought or precipitation during the study.

Please see "2023 NEORSD Watershed Monitoring Study Plan" for further details regarding study activities and supporting documentation.

(3) Sampling Locations

The following electrofishing and macroinvertebrate sampling locations, listed from upstream to downstream, will be surveyed during the 2023 field season and are summarized in Table 2 below. Benthic macroinvertebrate and water chemistry collection sites are located near the midpoint of each electrofishing zone, indicated by river mile, unless otherwise noted. GPS coordinates are recorded at the downstream end of each sampling zone.

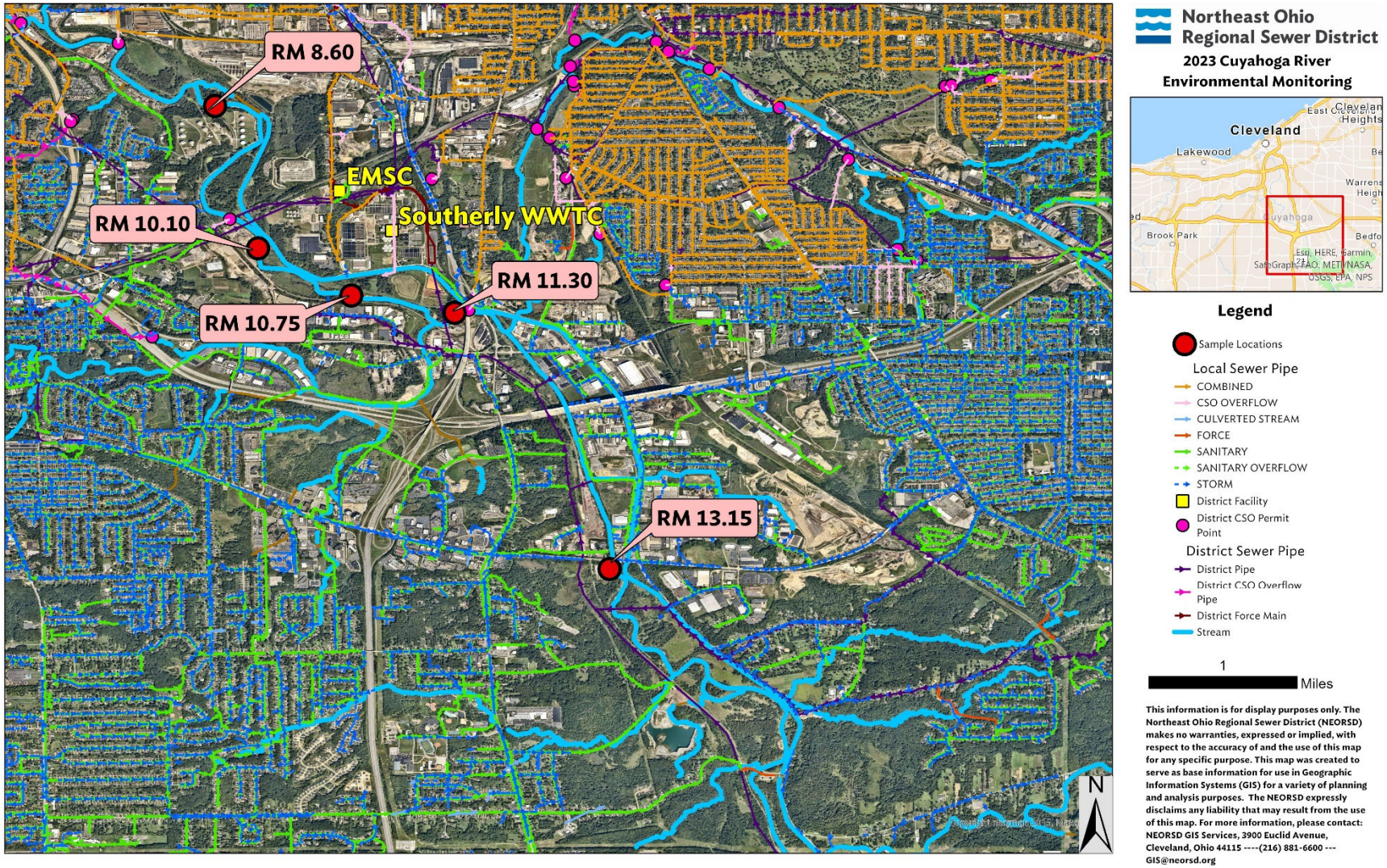

Figure 1. Map of Cuyahoga River Monitoring Sites.

Table 2. Cuyahoga River Monitoring Sites

Latitude	Longitude	River Mile	Station ID	Description	USGS HUC 8	Purpose
41.3929	-81.6295	13.15	502020	Upstream of Rockside Road	04110002 - Cuyahoga	Evaluate Southerly WWTC and CSO discharges on fish, habitat, macroinvertebrates, water chemistry, and chlorophyll *a* levels.
41.4179	-81.6446	11.30	F01S10	Downstream of confluence with Mill Creek	04110002 - Cuyahoga	Evaluate Mill and West Creek discharges on fish, habitat, and macroinvertebrates.
41.4196	-81.6547	10.75	F01A25	Upstream of Southerly WWTC effluent discharge	04110002 - Cuyahoga	Evaluate Southerly WWTC and CSO discharges on fish, habitat, macroinvertebrates, water chemistry and chlorophyll *a* levels.
41.4242	-81.6638	10.10	F99Q02	Downstream of Southerly WWTC effluent discharge	04110002 - Cuyahoga	Evaluate Southerly WWTC and CSO discharges on fish, habitat, macroinvertebrates, water chemistry and chlorophyll *a* levels.
41.4381	-81.6680	8.60	200025	Downstream of Southerly WWTC effluent discharge	04110002 - Cuyahoga	Evaluate Southerly WWTC and CSO discharges on fish, habitat, macroinvertebrates, water chemistry and chlorophyll *a* levels.

Northeast Ohio Regional Sewer District

2023 NEORSD Watershed Monitoring Study Plan

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List of Acronyms

DELTs	Deformities, Eroded Fins, Lesions & Tumors
EPA	Environmental Protection Agency
GPS	Global Positioning System
HD	Hester-Dendy
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
LIBI	Lacustuary Index of Biotic Integrity
LICI	Lacustuary Invertebrate Community Index
L-QHEI	Lacustuary Qualitative Habitat Evaluation Index
MIwb	Modified Index of Well-Being
NEORSD	Northeast Ohio Regional Sewer District
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene Fluoride
QDC	Qualified Data Collector
QHEI	Qualitative Habitat Evaluation Index
RM	River Mile
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
USGS	United States Geological Survey
WQIS	Water Quality & Industrial Surveillance

(3) Parameters Covered

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

Macroinvertebrate community assemblages will be collected from each location. An external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification will identify and enumerate the specimens collected from each site[1]. All specimens will be identified to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b) [2]. The NEORSD Macroinvertebrate Field Sheet (Appendix A) will be completed at each site during sample retrieval or when qualitative sampling is conducted.

Stream habitat will be measured by scoring components of the QHEI at all locations, including the substrate, instream cover, channel morphology, riparian zone, bank erosion, pool/glide and riffle/run quality and gradient. The Lacustuary QHEI (L-QHEI) will be performed at sites that are affected by the water level of Lake Erie. Examples of the Ohio EPA field sheets for the QHEI and the L-QHEI can be found in Appendix A.

Water chemistry samples will be collected at each electrofishing/macroinvertebrate sampling site included in the study. Water chemistry samples will be analyzed by NEORSD's Analytical Services Division. Appendix B lists the parameters to be tested along with the detection limits and practical quantitation limits. Field measurements for dissolved oxygen, pH, temperature, conductivity and turbidity will also be performed. A Surface Water Condition Sampling Field Data Form will be completed at each site during each sampling event (Appendix A).

Benthic and water column chlorophyll *a* samples may be collected from stream locations. Chemical and physical water quality parameters to be measured in conjunction with the chlorophyll *a* samples include total phosphorus, dissolved reactive phosphorus, nitrate+nitrite, ammonia, alkalinity, turbidity and suspended solids. In the Cuyahoga River, YSI EXO2 data sondes may be installed around the time that this sampling is conducted to more frequently monitor dissolved oxygen, temperature, conductivity, specific conductance and pH.

[1] The contractor responsible for doing this work as not been identified yet. Once this contract is awarded, their contact information will be submitted.

[2] See Appendix H for a list of all references.

(4) Field Collection and Data Assessment Techniques

Field collections for fish will be conducted at all stream locations unless noted in the sample location table for each study. Sampling will be conducted using longline, tote barge, backpack, or boat electrofishing techniques and will consist of shocking all habitat types within a sampling zone. Headwater and wading sites, which are 0.15 and 0.20 kilometers in length, respectively, will be surveyed by moving from downstream to upstream. Boat sites, which are 0.50 kilometers in length, will be surveyed by moving from upstream to downstream. The stunned fish will be collected and placed into a live well for later identification. The longline, tote barge, backpack, and boat electrofishing zones will be assessed one to three times during the field season (June 15 - October 15).

Fish will be identified to the species level, weighed, 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. Fish species difficult to identify will be brought back to the laboratory for verification by NEORSD Level 3 Fish Qualified Data Collectors (QDC). If necessary, vouchers will be 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 be done using a modified Hester-Dendy multi-plate artificial substrate sampler (HD) that is colonized for a six-week period. Multiple HD samplers may be installed at one or all sampling locations in case samplers are lost due to vandalism, burial, etc. or for the purposes of providing a replicate sample. 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 each HD retrieval.

Macroinvertebrate voucher specimens for both quantitative and qualitative sampling will be collected as described in section (14). Macroinvertebrate community assemblages collected will be shipped to an external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification for identification and enumeration. The Level 3

QDC will identify specimens to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b).

A detailed description of the sampling and analysis methods utilized in the fish community and macroinvertebrate surveys, including calculations of the IBI, MIwb, and ICI, can be found in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Methods for assessing fish and macroinvertebrate communities in lacustuary zones can be found in Ohio EPA's draft *Biological Criteria for the Protection of Aquatic Life, Volume IV* (1997).

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. The L-QHEI will be used where appropriate and will follow Ohio EPA's *Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1)* (2010).

Water chemistry sampling may occur across a variety of flow conditions. Techniques used for water chemistry sampling and chemical analyses will follow the *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2021a). Chemical water quality samples from each site will be collected with at least one 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. Water samples collected for analysis of dissolved reactive phosphorus will be filtered using a 0.45-μm PVDF syringe filter and will be collected in a 125-mL plastic bottle. Bacteriological samples will be collected in a sterile plastic bottle preserved with sodium thiosulfate. All water quality samples will be collected as grab samples. Duplicates and replicates will together comprise not less than 5% of total samples collected for each study plan. Field blanks will also comprise not less than 5% of the total samples collected for each study plan, for a total frequency of quality control samples of not less than 10% of the total samples collected. With the exception of bacteriological duplicate/replicate samples, the acceptable percent RPD will be based on the ratio of the sample concentration and detection limit (Ohio EPA, 2019): Acceptable % RPD = $[(0.9465X^{-0.344})*100] + 5$, where X = sample/detection limit ratio. For bacteriological samples, duplicate/replicate samples more than 5x apart from one another (%RPD > 133.3%) will be rejected in accordance with the Ohio EPA approved method for data validation of bacteriological samples outlined in Section F of the *Ohio 2022 Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA, 2022). Those RPDs that were higher than acceptable may indicate potential problems with sample collection and, as a result, the data will not be used for comparison to the water quality standards. Acid preservation of the samples, as specified in the NEORSD laboratory's standard operating procedure for each parameter, will occur in the field. Appendix B lists the analytical method, method detection limit and practical quantitation limit for each parameter analyzed. Field analyses include the use of either a YSI EXO1 sonde or YSI 600XL sonde to measure dissolved oxygen (DO), water temperature, conductivity and pH; and when necessary, a Hanna HI 98129 meter to measure pH and a

Hach HQ30d meter with LDO101 probe to measure DO. Field turbidity will be measured using a Hach 2100Q Turbidimeter. Specifications for these meters have been included in Appendix C.

Benthic and water column chlorophyll *a* samples may be collected if time and resources allow. Sampling methods will follow those detailed in the NEORSD *Chlorophyll a Sampling and Field Filtering Standard Operating Procedure* (SOP-EA001-02). A Chlorophyll *a* Sampling Field Sheet will be completed for each site where benthic chlorophyll *a* samples are collected (Appendix D). Water chemistry grab samples will be collected at the same time using the methods discussed previously and will be analyzed for nutrients, turbidity, alkalinity and suspended solids. Additionally, in the Cuyahoga River, approximately 24-hours prior to each chlorophyll *a* sampling event, YSI EXO2 data sondes may be deployed at sampling locations. If installed, each data sonde will record, at fifteen-minute intervals, dissolved oxygen concentration, pH, temperature, and conductivity from the time the data sonde is deployed until the time it is retrieved. These data sondes will be placed in the stream by inserting each one into a 4.5-inch PVC pipe with holes drilled into the sides of the lower third of the pipe to allow water to pass through it. The data sondes will remain in the river for approximately 24-hours or longer following collection of the chlorophyll *a* samples.

Where possible, data assessment will include an analysis of temporal and spatial trends in the collected data. Species assemblages and individual metrics will be analyzed. Graphs that show current and historic QHEI, L-QHEI, IBI, LIBI, MIwb, ICI, and LICI 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. It will also be used to determine any relationships among individual parameters and chlorophyll *a* concentrations. 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) Stream Flow Measurement

Stream flow will be recorded for all locations during each electrofishing pass utilizing data from the United States Geological Survey (USGS) gauge station nearest the stream location, if applicable.

Stream flow will be measured with a HACH FH950 Flow Meter or Ott MF Pro Meter, which measure flow in feet per second, when HD samplers are installed and retrieved. The specifications for the flow meters can be found in Appendix C.

(7) Schedule

One to three electrofishing surveys will be conducted at each site between June 15 and October 15, 2023. Surveys will be conducted at least three weeks apart. Specific dates

have not been scheduled. River flow and weather conditions will be assessed weekly to determine when each electrofishing pass will be conducted.

Artificial substrate samplers will be installed at stream locations between June 15 and August 19, 2023, and retrieved six weeks later. Qualitative macroinvertebrate sampling will be conducted one time at all sites. Specific dates have not been scheduled. River flow and weather conditions will be assessed weekly to determine when the HD sampler installations and retrievals and qualitative sampling will be conducted.

QHEI, and, if necessary, L-QHEI habitat evaluations will be conducted one time between June 15 and October 15, 2023. QHEI evaluations will be conducted around the same time as one of the electrofishing surveys.

Water chemistry samples will be collected a minimum of three times from stream locations between June 15 and October 15, 2023.

Benthic and water column chlorophyll *a* samples may be collected at least one time from stream locations between June 15 and October 15, 2023. These samples will be collected under low-flow conditions.

(8) 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* (1987a) and *III* (1987b), *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006), draft *Biological Criteria for the Protection of Aquatic Life: Volume IV: Fish and Macroinvertebrate Indicies for Ohio's Lake Erie Nearshore Waters, Harbors, and Lacustuaries* (1997) and *Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1)* (2010)

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 collect data. Proper steps will be taken to correct any problems as soon as possible, whether by repairing in the field, at the NEORSD Environmental & Maintenance Services Center, or by contacting the supplier or an appropriate service company.

Fish species difficult to identify will be brought back to the laboratory for verification by Level 3 Fish QDC's, 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.

All macroinvertebrate community assemblages from stream locations, except for any replicate samples, will be collected and shipped to an external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification for identification and enumeration. All specimens will be identified to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b). All macroinvertebrate specimens will be returned to NEORSD. At least two voucher specimens of each species, when available, will be separated into individual vials and kept 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 the Environmental & Maintenance Services Center for a period not less than ten years.

Water samples obtained for chemical analyses will be collected, preserved (see Section 4), 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 field logbook 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 provided in Appendix I. Updates, revisions and any information on document control will be sent to Ohio EPA as needed.

For benthic and water column chlorophyll *a* sampling, three filtrations will be performed for each sample. A field filtration blank will be submitted for every 20 samples.

Calibration of YSI 600XL, EXO1, and EXO2 data sondes will be done according to the YSI Environmental Operations Manual. The conductivity will be calibrated first using a 1.413 mS/cm standard. Second, the pH will be calibrated using two different buffers (7 and 10 s.u.). The DO will be calibrated last with an acceptable error of 0.2 mg/L.

If EXO2 sondes are installed in the Cuyahoga River, once they are removed, the accuracy of the data that has been collected will be checked by comparing readings taken by the sondes to known standards. If the measurements taken at this time meet quality control goals, all of the data collected since the last calibration will be considered accurate. The acceptable differences for pH and conductivity will be $\pm$0.3 with pH 7 buffer and $\pm$ 10% of the conductivity standard, respectively (EPA New England- Region 1, 2005). The acceptable difference for DO will be $\pm$0.2 mg/L. If the measurements do not meet quality control goals, best professional judgment will be used to decide if any of the data collected during that period may still be accurate. For example, the data collected from the four locations may be plotted on the same graph, and if it appears that the data points are

following similar trends, they may be considered accurate. If any data that do not meet quality control goals are used, a rationale for their inclusion will be provided when the data are submitted.

(9) Work Products

Within one year of completion of the project, fish data (species, numbers, weights, pollution tolerances, the incidence of DELT anomalies, IBI or LIBI, MIwb scores), macroinvertebrate data (types and numbers of macroinvertebrates collected and ICI or LICI scores), habitat data (QHEI or L-QHEI raw data and scores) and water chemistry results will be submitted to the Ohio EPA or an Ohio EPA approved data warehouse. Additionally, reports summarizing, interpreting, graphically presenting and discussing the IBI (LIBI, where applicable), MIwb, ICI (LICI, where applicable) and QHEI (L-QHEI, where applicable) scores, chlorophyll *a* results, and any excursions from water quality standards may be prepared for internal use.

(10) 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)
Seth Hothem[1]	4747 East 49th Street Cuyahoga Hts., Ohio 44125	hothems@neorsd.org	216-641-6000	QDC - 00010 CWQA/FCB/SHA /BMB
Jillian Knittle	4747 East 49th Street Cuyahoga Hts., Ohio 44125	knittlej@neorsd.org	216-641-6000	QDC – 00512 CWQA/BMB
Ron Maichle	4747 East 49th Street Cuyahoga Hts., Ohio 44125	maichler@neorsd.org	216-641-6000	QDC - 00145 CWQA/BMB
Mark Matteson	4747 East 49th Street Cuyahoga Hts., Ohio 44125	mattesonm@neorsd.org	216-641-6000	QDC – 01020 CWQA/FCB/SHA
Denise Phillips	4747 East 49th Street Cuyahoga Hts., Ohio 44125	phillipsd@neorsd.org	216-641-6000	QDC – 01203 CWQA
Francisco Rivera[2]	4747 East 49th Street Cuyahoga Hts., Ohio 44125	riveraf@neorsd.org	216-641-6000	QDC - 00262 CWQA
Eric Soehnlen	4747 East 49th Street Cuyahoga Hts., Ohio 44125	soehnlene@neorsd.org	216-641-6000	QDC – 01030 CWQA/BMB
Justin Telep	4747 East 49th Street Cuyahoga Hts., Ohio 44125	telepj@neorsd.org	216-641-6000	QDC – 01304 CWQA/FCB/SHA
John Rhoades	4747 East 49th Street Cuyahoga Hts., Ohio 44125	rhoadesj@neorsd.org	216-641-6000	QDC - 00008 CWQA
Kelsey Amidon[2]	4747 East 49th Street Cuyahoga Hts., Ohio 44125	amidonk@neorsd.org	216-641-6000	QDC – 01091 CWQA

[1] NEORSD Lead Project Manager

[2] See acknowledgement letter for conducting water chemistry sampling (Appendix F)

The following is a list of persons not qualified as Level 3 QDCs who may be involved in the project. Prior to the start of sampling, the project managers 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
Chris Abraham	4747 East 49th Street Cuyahoga Hts., Ohio 44125	abrahamc@neorsd.org	216-641-6000
Laurel Cope	4747 East 49th Street Cuyahoga Hts., Ohio 44125	copel@neorsd.org	216-641-6000
Brittany Dalton	4747 East 49th Street Cuyahoga Hts., Ohio 44125	daltonb@neorsd.org	216-641-6000
Laura Ferguson	4747 East 49th Street Cuyahoga Hts., Ohio 44125	fergusonl@neorsd.org	216-641-6000
Rae Grant	4747 East 49th Street Cuyahoga Hts., Ohio 44125	grantr@neorsd.org	216-641-6000
Jeff Harrison	4747 East 49th Street Cuyahoga Hts., Ohio 44125	harrisonj@neorsd.org	216-641-6000
Margaret Hodgkiss-Lilly	4747 East 49th Street Cuyahoga Hts., Ohio 44125	hodgkiss-lillym@neorsd.org	216-641-6000
Matthew Johnson	4747 East 49th Street Cuyahoga Hts., Ohio 44125	johnsonmatthew@neorsd.org	216-641-6000
Ryan Parrish	4747 East 49th Street Cuyahoga Hts., Ohio 44125	parrishr@neorsd.org	216-641-6000
Shawn Robinson	4747 East 49th Street Cuyahoga Hts., Ohio 44125	robinsons@neorsd.org	216-641-6000
Emma Routh	4747 East 49th Street Cuyahoga Hts., Ohio 44125	routhe@neorsd.org	216-641-6000
Brandon Saner	4747 East 49th Street Cuyahoga Hts., Ohio 44125	sanerb@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
Jack King	4747 East 49th Street Cuyahoga Hts., Ohio 44125	kingjack@neorsd.org	216-641-6000
Tyler Sagi	4747 East 49th Street Cuyahoga Hts., Ohio 44125	sagit@neorsd.org	216-641-6000
Paraprofessional Intern (TBD)	4747 East 49th Street Cuyahoga Hts., Ohio 44125	_____@neorsd.org	216-641-6000
Paraprofessional Intern (TBD)	4747 East 49th Street Cuyahoga Hts., Ohio 44125	_____@neorsd.org	216-641-6000

(11) Contract laboratory contact information

All bacteriological and/or chemical sample analysis will be completed by NEORSD's Analytical Services Division. Evidence of NEORSD's Analytical Services current accreditation and method dates can be found in Appendix E. The contact information for NEORSD's Analytical Service Division is:

NEORSD Analytical Services
Cheryl Soltis-Muth, Manager
4747 E. 49th Street
Cuyahoga Heights, Ohio 44056
soltis-muthc@neorsd.org
216-641-6000

Any fish that is not positively identified in the field, or at NEORSD, 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.

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 for stream locations will be completed by an external Level 3 Qualified Data Collector for Benthic Macroinvertebrate Biology Identification [3]. Benthic macroinvertebrates will be identified to the lowest practical level as recommended by Ohio EPA (1987b). Contact information for this contractor will be submitted once the contract is awarded.

(12) Copy of ODNR collector's permit

See Appendix G.

(13) Digital 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: Seth Hothem/ Seth Hothem Date: 3/28/23

[3] A letter of acknowledgement of the macroinvertebrate identification responsibilities will be added as an addendum to this study plan, in Appendix F, upon finalization of the macroinvertebrate identification contract.

(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: Seth Hothem/ Seth Hothem Date: 3/28/23

(15) Sample Location Statement

I attest that I will make available any and all sampling location information, including but not limited to; the name of the water body sampled, sampling location latitude and longitude, sampling location river mile where possible, general location information, the U.S. geological survey HUC 8 number and name, and the purpose for data collection at each sampling location.

Print/Signature: Seth Hothem/ Seth Hothem Date: 3/28/23

(16) Additional L3 Data Collector Statement

The Lead Project Manager for all stream locations is approved for all project data types.

Print/Signature: Seth Hothem/ Seth Hothem Date: 3/28/23

(17) 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: Seth Hothem/ Seth Hothem Date: 3/28/23

Print/Signature: Jillian Knittle/ Jill Knittle Date: 3/28/23

Print/Signature: Ron Maichle/ R. Maichle Date: 4-5-23

Print/Signature: Mark Matteson/ Mark Matteson Date: 3/28/23

Print/Signature: Denise Phillips/ Denise Phillips Date: 4/24/23

Print/Signature: John Rhoades/ John Rhoades Date: 03/28/23

Print/Signature: Eric Soehnlen/ Eric Soehnlen Date: 03/28/23

Print/Signature: Justin Telep/ Justin Telep Date: 3/29/23

Appendix A. Field Forms

OhioEPA **FISH DATA SHEET**

Sheet ID For Office Use Only

New Station (requires lat/long & county) ☐ **Mix Zone** ☐ **Page____of ____**

Station ID_____ **River Code**_____ **RM**_____ **Date**_____ **Time**_____

Stream_____ **Location**_____

Comments_____

Lat_____ **Long**_____ **County**_____ **ALP**_____ **Time Fished**_____

Crew_____ **Netter**_____ **Others**_____ **Sampler Type**_____

Distance_____ **Flow**_____ **Temp. C**_____ **Secchi**_____ **Source**_____ **Project**_____

DELT ANOMALIES
Deformities, **E**rosions, **L**esions, **T**umors
Multiple DELTs on one fish

	Fins Code	Number Weighed	Total Counted	Total Weight	Weights	Counts	D	E	L	T	M	*
1												
	V	10x										
2												
	V	10x										
3												
	V	10x										
4												
	V	10x										
5												
	V	10x										
6												
	V	10x										
7												
	V	10x										
8												
	V	10x										
9												
	V	10x										

* A-anchor worm; B-black spot; C-leeches; F-fungus; N-blind; P-parasites; S-emaciated, W-swirled scales Y-popeye; Z-other

	Fins Code	Number Weighed	Total Counted	Total Weight	Weights Counts											
10								D	E	L	T	M	*
	V	10x														
11								D	E	L	T	M	*
	V	10x														
12								D	E	L	T	M	*
	V	10x														
13								D	E	L	T	M	*
	V	10x														
14								D	E	L	T	M	*
	V	10x														
15								D	E	L	T	M	*
	V	10x														
16								D	E	L	T	M	*
	V	10x														
17								D	E	L	T	M	*
	V	10x														
18								D	E	L	T	M	*
	V	10x														
19								D	E	L	T	M	*
	V	10x														
20								D	E	L	T	M	*
	V	10x														
21								D	E	L	T	M	*
	V	10x														

NEORSD Macroinvertebrate Field Sheet

Stream: _____ River Mile: _____ Year: _____

Location: _____ Project: _____

River Code: _____ Station ID: _____

Drainage Area (mi^2): _____ Latitude (ºN)/Longitude (ºW): _____

Site Type: WWH EWH Coldwater Lacustuary Other: _____ *Eco-Region:* _____

Hester-Dendy Deployment Information

Install Date: _____ Crew (QDC Circled): _____

Current at HD (fps): _____ Depth (cm): _____ Pictures Obtained: Yes No

Replicate/Reinstall Date: _____ Crew (QDC Circled): _____

Current (fps): _____ Depth (cm): _____ Reason: _____

Sampling/Retrieval Information

Sampling Method: Hester-Dendy Dipnet Ekman (6x6) Other: _____

Sampling Date: _____ Crew (QDC Circled): _____

OEPA Comment Field Codes: _____ Water Temp: _____ °C / °F

HD Condition- *Current (fps):* _____ *Depth (cm):* _____ *Comments:* _____

Number of HD Blocks Obtained: _____ _____

Disturbed: Yes No *Debris:* Yes No _____

Silt/Solids: None Slight Moderate Heavy *Sample ID:* _____

Replicate: *Current (fps):* _____ *Depth (cm):* _____ *Comments:* _____

Number of HD Blocks Obtained: _____ _____

Disturbed: Yes No *Debris:* Yes No _____

Silt/Solids: None Slight Moderate Heavy *Sample ID:* _____

Dipnet- Time Sampled (min): _____ *X* *Number of Crew:* _____ = Total (min): _____

Start Time: _____ *End Time:* _____ *Sample ID:* _____

Habitats Sampled: Pool Riffle Run Margin Backwater

River Sampling Conditions

Weather:	Clear	Partly Cloudy	Overcast	Light Rain	Other:	_____
Canopy (over HD):	Open	75 %	50 %	25 %	Closed	
Flow Condition:	Dry	Intermittent	Interstitial	Low	Normal	Above Normal Flood
Current Velocity:	Non-detect	Slow	Moderate	Fast		
Channel Morphology:	Natural	Channelized	Channelized (Recovered)	Impounded		
Bank Erosion:	None	Slight	Moderate	Extensive		
Water Clarity:	Clear	Muddy	Tea	Milky	Other:	_____
Water Color:	None	Green	Brown	Grey	Other:	_____

Evidence of Pollution: _____

Potential Pollution Sources: _____

Comment Section: _____

_____

_____

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

Company/Entity: _____

NEORSD Macroinvertebrate Field Sheet

Physical Characteristics

Substrate Characteristics

Cobble is up to 10 in

Coarse Gravel

Fine Gravel

sand

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

Predominant Land Use (Indicate *Left*, *Right* or *Both*)

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

Predominant Riparian Vegetation

Left	*Right*	*Type*
		Large Trees
		Small Trees
		Shrubs
		Grass/Weeds
		None
		Riparian Width

Riffle Habitat

Embedded: Yes No

Development:

	Extensive
	Moderate
	Sparse
	Absent

Quality: Good Fair Poor

Margin Habitat

Margin Quality: Good Fair Poor _____ %

Types Present:

Root Mats	Undercut Banks	Rip Rap
Tree Roots	Shallows	Bulkhead
Woody Debris	Soft Clay	
Macrophytes/Grass	Other _____	

Biological Characteristics

Overall Collection

Est. Amt (V= >151; A= 150-101; C= 100-11; R= 10-1)	
/	Porifera, Bryozoa
/ /	Turbellaria, Oligochaeta, Hirudinea
/	Isopoda, Amphipoda
/	Decapoda, Hydracarina
	Ephemeroptera
	Baetidae
/ /	Heptageniidae, Leptohyphidae, Caenidae
	Other _____
/	Zygoptera, Anisoptera
	Plecoptera
	Hemiptera
/	Megaloptera, Neuroptera
	Trichoptera
	Hydropsychidae
/	Hydroptilidae, Leptoceridae
	Other _____
	Coleoptera
	Elimidae
	Other _____
	Diptera
	Chironomidae
/	Tipulidae, Simuliidae
	Other _____
/	Gastropoda, Bivalvia
	Other _____

V= Very Abundant; A= Abundant; C= Common; R= Rare

Habitat Specific Organisms

Riffle: _____ %
Predominant Organism: _____
Other Common Organisms: _____
Density: High Moderate Low
Diversity: High Moderate Low

Run: _____ %
Predominant Organism: _____
Other Common Organisms: _____
Density: High Moderate Low
Diversity: High Moderate Low

Pool: _____ %
Predominant Organism: _____
Other Common Organisms: _____
Density: High Moderate Low
Diversity: High Moderate Low

Margin:
Predominant Organism: _____
Other Common Organisms: _____
Density: High Moderate Low
Diversity: High Moderate Low

Other Notable Collections: _____

Field Narrative Rating: E VG G MG F P VP

NEORSD Macroinvertebrate Field Sheet

Field Sketch

Stream: _____ River Mile: _____ Year: _____

River Code: _____ Station ID: _____ Date: _____

Can place a copy of the sketch from your Field Notebook or the QHEI sketch (indicating HD) on page.

Comment Section (2): _____

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

OhioEPA

QHEI Score: ____

Stream & Location: _____ *RM:* _ _._ _ *Date:* _ _/ _ _/ _ _

Scorers Full Name & Affiliation: Northeast Ohio Regional Sewer District

River Code: _ _ _-_ _ _-_ _ _ *STORET #:* _ _ _ _ _ _ _ *Lat./ Long.:* (NAD 83 - decimal °) _ _ . _ _ _ _ _ /8_ . _ _ _ _ _ *Office verified location* ☐

1] *SUBSTRATE* Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*Or 2 & average*)

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐ ☐ BLDR /SLABS [10]	____	____	☐ ☐ HARDPAN [4]	____	____
☐ ☐ BOULDER [9]	____	____	☐ ☐ DETRITUS [3]	____	____
☐ ☐ COBBLE [8]	____	____	☐ ☐ MUCK [2]	____	____
☐ ☐ GRAVEL [7]	____	____	☐ ☐ SILT [2]	____	____
☐ ☐ SAND [6]	____	____	☐ ☐ ARTIFICIAL [0]	____	____
☐ ☐ BEDROCK [5]	____	____			

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☐ 3 or less [0]

ORIGIN		QUALITY	
☐ LIMESTONE [1]	SILT	☐ HEAVY [-2]	
☐ TILLS [1]		☐ MODERATE [-1]	
☐ WETLANDS [0]		☐ NORMAL [0]	
☐ HARDPAN [0]		☐ FREE [1]	
☐ SANDSTONE [0]	EMBEDDEDNESS	☐ EXTENSIVE [-2]	
☐ RIP/RAP [0]		☐ MODERATE [-1]	
☐ LACUSTURINE [0]		☐ NORMAL [0]	
☐ SHALE [-1]		☐ NONE [1]	
☐ COAL FINES [-2]			

Substrate ____ *Maximum 20*

Comments

2] *INSTREAM COVER* Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

____ UNDERCUT BANKS [1]	____ POOLS > 70cm [2]	____ OXBOWS, BACKWATERS [1]
____ OVERHANGING VEGETATION [1]	____ ROOTWADS [1]	____ AQUATIC MACROPHYTES [1]
____ SHALLOWS (IN SLOW WATER) [1]	____ BOULDERS [1]	____ LOGS OR WOODY DEBRIS [1]
____ ROOTMATS [1]		

AMOUNT

Check ONE (*Or 2 & average*)

☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Comments

Cover Maximum 20 ____

3] *CHANNEL MORPHOLOGY* Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Comments

Channel Maximum 20 ____

4] *BANK EROSION AND RIPARIAN ZONE* Check **ONE** in each category for *EACH BANK* (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
☐ ☐ NONE / LITTLE [3]	☐ ☐ WIDE > 50m [4]	☐ ☐ FOREST, SWAMP [3]	☐ ☐ CONSERVATION TILLAGE [1]
☐ ☐ MODERATE [2]	☐ ☐ MODERATE 10-50m [3]	☐ ☐ SHRUB OR OLD FIELD [2]	☐ ☐ URBAN OR INDUSTRIAL [0]
☐ ☐ HEAVY / SEVERE [1]	☐ ☐ NARROW 5-10m [2]	☐ ☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐ ☐ MINING / CONSTRUCTION [0]
	☐ ☐ VERY NARROW < 5m [1]	☐ ☐ FENCED PASTURE [1]	
	☐ ☐ NONE [0]	☐ ☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Comments

Riparian Maximum 10 ____

5] *POOL / GLIDE AND RIFFLE / RUN QUALITY*

MAXIMUM DEPTH Check **ONE** (*ONLY!*)

☐ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☐ 0.2-<0.4m [1]
☐ < 0.2m [0]

CHANNEL WIDTH Check ONE (*Or 2 & average*)

☐ POOL WIDTH > RIFFLE WIDTH [2]
☐ POOL WIDTH = RIFFLE WIDTH [1]
☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply

☐ TORRENTIAL [-1]
☐ VERY FAST [1]
☐ FAST [1]
☐ MODERATE [1]
☐ SLOW [1]
☐ INTERSTITIAL [-1]
☐ INTERMITTENT [-2]
☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Comments

Pool / Current Maximum 12 ____

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (*Or 2 & average*). ☐ **NO RIFFLE [metric=0]**

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Comments

Riffle / Run Maximum 8 ____

6] *GRADIENT* (ft/mi)

DRAINAGE AREA (mi^2)

☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ____ **%GLIDE:** ____
%RUN: ____ **%RIFFLE:** ____

Gradient Maximum 10 ____

A] SAMPLED REACH

Check ALL that apply

METHOD

- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☐ OTHER

STAGE

1st -sample pass- 2nd	
☐ HIGH	☐
☐ UP	☐
☐ NORMAL	☐
☐ LOW	☐
☐ DRY	☐

DISTANCE

- ☐ 0.5 Km
- ☐ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

_____ meters

CLARITY

1st --sample pass-- 2nd	
☐ < 20 cm	☐
☐ 20-<40 cm	☐
☐ 40-70 cm	☐
☐ > 70 cm/ CTB	☐
☐ SECCHI DEPTH	☐

CANOPY

- ☐ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

pass 1st _____ cm

pass 2nd _____ cm

C] RECREATION

POOL: ☐ >100ft² ☐ >3ft (AREA / DEPTH)

Comment RE: Reach consistency/ Is reach typical of steam?*, Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

B] AESTHETICS

- ☐ NUISANCE ALGAE
- ☐ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☐ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

D] MAINTENANCE

Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_20 / TILE / H_20 TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

- $\bar{x}$ width
- $\bar{x}$ depth
- max. depth
- $\bar{x}$ bankfull width
- bankfull $\bar{x}$ depth
- W/D ratio
- bankfull max. depth
- floodprone x^2 width
- entrench. ratio

Legacy Tree:

Stream Drawing:

Lake / Lacustuary (Lentic) QHEI Field Sheet

Ohio Environmental Protection Agency

QHEI Score: ☐

RIVERCODE_____ RIVERMILE _____ WATERBODY _____ DISTANCE ASSESSED (m): _____
DATE _____ LOCATION _____
SCORER_____ LAT. _____ LONG. _____ COMMENT _____

1] SUBSTRATE (Check *ONLY* Two Substrate TYPE BOXES; Estimate % or note every type present); LAKE:_____ LACUSTUARY:_____

TYPE	SHORE	BOTTOM		SHORE	BOTTOM
☐☐-BLDR/SLABS [7]			☐☐-HARDPAN [4]		
☐☐- BOULDER [10]			☐☐- BEDROCK [3]		
☐☐- COBBLE [8]			☐☐- DETRITUS [3]		
☐☐- GRAVEL [7]			☐☐- SILT [2]		
☐☐- SAND [6]			☐☐- MUCK [2]		

SUBSTRATE ORIGIN Check ONE (or 2 & *AVERAGE*)
☐-LIMESTONE [1]
☐-TILLS [1]
☐-WETLANDS [1]
☐-LACUSTUARINE [1]
☐-SANDSTONE [1]
☐-RIP/RAP [1]
☐-HARDPAN [0]
☐-SHALE [-1]
☐-COAL/ORE [-2]

SILT ORIGIN:

SUBSTRATE QUALITY Check ONE (or 2 & *AVERAGE*)
☐-SILT HEAVY [-2]
☐-SILT MODERATE [-1]
☐-SILT NORMAL [0]
☐-SILT FREE [1]
☐-CLAY [-2]
☐-INDUSTRIAL [-1]
☐-ORGANIC [1]
☐-NONE [1]

Substrate ☐ Max 20

NOTE: Ignore sludge that originates from point-sources, score on natural substrates
NUMBER OF SUBSTRATE TYPES ☐- 5 or More [2] ☐- 4 or Less [0]

COMMENTS: _____

2] COVER TYPES **TYPE:** (Check *All* That Apply) **AMOUNT**: (Check *ONLY* One or check2 and AVERAGE)

☐-OFF-SHORE SAND BARS [4]	☐-DEEPWATER > 1 M [1]	☐-WETLAND POOLS [1]
☐-OVERHANGING VEGETATION [1]	☐-ROOTWADS [1]	☐-SUBMERGED AQUATIC VEG. [4]
☐-SHALLOWS (ON BEACH) [1]	☐-BOULDERS [1]	☐-LOGS OR WOODY DEBRIS [1]
☐-ROOTMATS [1]	☐-SAND BEACH [1]	☐-GRAVEL BEACH [1]

☐-EXTENSIVE > 75% [9]
☐-MODERATE 25-75% [7]
☐-SPARSE 5-25% [3]
☐-NEARLY ABSENT < 5% [1]

Cover ☐ Max 20

COMMENTS: _____

3] SHORELINE MORPHOLOGY (Check *ONLY* one PER category or check 2 and *AVERAGE*)

SHORE SINUOSITY
☐-HIGH [2]
☐-MODERATE [4]
☐-LOW [3]
☐-NONE [1]

DEVELOPMENT
☐-EXCELLENT [6]
☐-GOOD [5]
☐-FAIR [3]
☐-POOR [1]

MODIFICATION
☐-NONE [7]
☐-RECOVERED [5]
☐-RECOVERING [3]
☐-RECENT OR NO RECOVERY [1]

STABILITY
☐-HIGH [3]
☐-MODERATE [2]
☐-LOW [1]

SHORE to BOTTOM SLOPE MORPHOLOGIES
☐-SLOPE < 15 deg. [0] ☐- SLOPE > 45 deg. [2]
☐-SLOPE < 25 deg. [1] ☐-SLOPE 90 deg. [0]
☐-SLOPE > 25 deg. [3]

AVERAGE DEPTH (of 5 measures)
☐- < 50 cm [0] ☐- > 400 – 500 cm [4]
☐- 50 - <100 cm [1] ☐- > 500 - 900 cm [2]
☐- ≥100 - 200 cm [2] ☐- >900 cm [1]
☐- >200-4 00 cm [3]

MODIFICATIONS OF SAMPLED SHORELINE
☐- CEMENTED [-1] ☐- STEEL BULKHEADS [-2]
☐-RIP RAPPED [1] ☐-ISLANDS [1]
☐-RAILROAD TIES [-1] ☐-DIKES [-1]
☐-DREDGED [-1] ☐-BANK SHAPING [-1]
☐-TWO SIDE CHANNEL MODIFICATIONS [-1] ☐-WOOD PILINGS [1]
☐-SHIP CHANNEL [-2]

Shore Line ☐ Max 20

COMMENTS: _____

★ Shore Right Looking East or South on Lake ★
★ Shore Right Looking Toward Lake in Lacustuary ★

4] RIPARIAN ZONE AND BANK EROSION (Check *ONE* box PER bank or 2 and *AVERAGE*)

RIPARIAN WIDTH L R (Per Bank)
☐☐-WIDE > 50 m [4]
☐☐-MODERATE 10-50 m [3]
☐☐-NARROW 5-10 m [2]
☐☐-VERY NARROW < 5 m [1]
☐☐-NONE [0]

SHORE LINE QUALITY (PAST 100 FOOT RIPARIAN) L R (Most Predominant Per Bank)
☐☐-FOREST, WETLAND, LAKE [3]
☐☐- SHRUB OR OLD FIELD [2]
☐☐-VINEYARD, ORCHARD [2]
☐☐-FENCED PASTURE [1]
☐☐-RESIDENTIAL, PARK, NEW FIELD [1]

L R
☐☐-CONSERVATION TILLIAGE [1]
☐☐-URBAN OR INDUSTRIAL [0]
☐☐-OPEN PASUTRE, ROWCROP [0]
☐☐-MINING/CONSTRUCTION [0]
☐☐- DIKED WETLAND [0]

BANK EROSION L R (Per Bank)
☐☐-NONE/LITTLE [3]
☐☐-MODERATE [-1]
☐☐-HEAVY/SEVERE [-3]

Riparian ☐ Max 10

COMMENTS: _____

5] AQUATIC VEGETATION QUALITY: PLANT SPECIES OBSERVED (Sum All Scores)
(Score all for observed abundance: ABUNDANT = [3]; COMMON = [5]; FEW = [1]; UNCOMMON = [0]) _____NO AQUATIC VEGETATION = 0

____-Pond Lilies (NYMPHAEA) ____-Sedge (CYPERACEAE) ____-Wild Celery (VALLISNERIA)
____-Pond Weed (POTAMOGETON) ____-Bulrush (SCIRPUS) ____-Waterweed (ELODEA) ____-Wild Rice (ZIZANIA)

(Score all for observed abundance: ABUNDANT = [-2]; COMMON = [-1]; FEW = [0])

____-Purple Loosestrife ____-Reed Grass ____-Eurasian Milfoil ____-Cattails ____-Algae (mats) ____-Algae (planktonic)

Vegetation ☐ Max 30

COMMENTS: _____

Is the Sampling Reach Representative of Area Habitat? (Y/N)____ If Not, Explain: _____

Depth measures: | | | | | | |

Zebra Mussel/Quagga Mussel Coverage ☐ - >60% ☐ - 60 - >25% ☐ - 25 - >10% ☐ - <10 - >1% ☐ - 1 – 0%

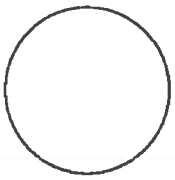
	Gear	Distance	Water Clarity	Wave Height
First Sampling Pass:	_____	_____	_____	_____
Second Sampling Pass:	_____	_____	_____	_____
Third Sampling Pass:	_____	_____	_____	_____

Subjective Rating (1 – 10) ☐ Aesthetic Rating (1 – 10) ☐

Photos: _____

WATERBODY MEASUREMENTS: AVERAGE WIDTH: _____ AVERAGE DEPTH: _____ Maximum Depth: _____

DRAWING OF SITE:

North Arrow: 

NEORSD Surface Water Condition Sampling Field Data Form

Stream: _____ Date: _____ Collectors: _____

Gage Station and ID: _____ Daily Mean Discharge: _____ ft^3/sec

Was this sample taken during or following a wet weather event? YES / NO

Water Quality Meters Used: _____

Sample ID:

Time (hrs): _____ River Mile (Site): _____

Weather: Clear Partly Cloudy Overcast Light Rain/Showers Heavy Rain
Steady Rain Heavy Snow Melt Other: _____

Flow: Dry Intermittent Minimal Baseline/Normal Elevated Flood

HD Status: OK Other: _____

Color: Clear Muddy Tea Milky Other: _____

Odor: Normal Petroleum Anaerobic Sewage Chemical Other: _____

Surface Coating: None Foam Oily Scum Other: _____

Field Parameters: Conductivity (µmhos/cm): _____ Sp. Cond. (µmhos/cm): _____

Dissolved Oxygen (mg/L): _____ D.O. (%): _____

Temperature (°C): _____ pH (s.u.): _____

Turbidity 1 (NTU): _____ Turbidity 2 (NTU): _____ Average (NTU): _____

General Comments: _____

Reporting sig figs: (Cond and DO% - 1) (pH, DO mg/L, and Chlor/BGA-PC - 0.1) (Temp- 0.01)

Sample ID:

Time (hrs): _____ River Mile (Site): _____

Weather: Clear Partly Cloudy Overcast Light Rain/Showers Heavy Rain
Steady Rain Heavy Snow Melt Other: _____

Flow: Dry Intermittent Minimal Baseline/Normal Elevated Flood

HD Status: OK Other: _____

Color: Clear Muddy Tea Milky Other: _____

Odor: Normal Petroleum Anaerobic Sewage Chemical Other: _____

Surface Coating: None Foam Oily Scum Other: _____

Field Parameters: Conductivity (µmhos/cm): _____ Sp. Cond. (µmhos/cm): _____

Dissolved Oxygen (mg/L): _____ D.O. (%): _____

Temperature (°C): _____ pH (s.u.): _____

Turbidity 1 (NTU): _____ Turbidity 2 (NTU): _____ Average (NTU): _____

General Comments: _____

Appendix B. Parameter Information

Parameter	Additional Name	Test	Unit	2023 Minimum Detection Limit	2023 Practical Quantitation Limit
Alkalinity	Alkalinity	EPA 310.2	mg/L	16	5.076
Mercury	Hg	EPA 245.1	µg/L	0.020	0.05
Ammonia [1]	NH_3	EPA 350.1	mg/L	0.01	0.05
Nitrite	NO2	EPA 353.2	mg/L	0.005	0.04
		ASTM D7781-14	mg/L	TBD	0.04
Nitrite + Nitrate	$NO_2 + NO_3$	EPA 353.2	mg/L	0.02	0.04
		ASTM D7781	mg/L	0.02	0.04
Total Kjeldahl Nitrogen	TKN	EPA 351.2	mg/L	0.276	0.75
Dissolved Reactive Phosphorus	DRP	EPA 365.1	mg/L	0.0113	0.025
Low Level Dissolved Reactive Phosphorus	LLDRP	EPA 365.1	µg/L	2.51	7.5
Total Phosphorus	Total-P	EPA 365.1	mg/L	0.0156	0.03125
Chloride	Chloride by IC	EPA 300.0	mg/L	2.27	5
Sulfate	Sulfate by IC	EPA 300.0	mg/L	1.89	5
Silver	Ag	EPA 200.8 [3]	µg/L	0.0239	0.25
		EPA 200.8 [4]	µg/L	0.0196	0.5
Aluminum	Al	EPA 200.8 [3]	µg/L	1.71	10
		EPA 200.8 [4]	µg/L	15.8	50
Arsenic	As	EPA 200.8 [3]	µg/L	0.311	1
		EPA 200.8 [4]	µg/L	0.12	1
Barium	Ba	EPA 200.8 [3]	µg/L	0.102	0.25
		EPA 200.8 [4]	µg/L	0.0243	0.5
Beryllium	Be	EPA 200.8 [3]	µg/L	0.0257	0.25
		EPA 200.8 [4]	µg/L	0.0375	0.5
Calcium	Ca	EPA 200.8 [3]	µg/L	21.5	125
		EPA 200.8 [4]	µg/L	58.7	500
Cadmium	Cd	EPA 200.8 [3]	µg/L	0.0282	0.25
		EPA 200.8 [4]	µg/L	0.0416	0.5
Cobalt	Co	EPA 200.8 [3]	µg/L	0.009	0.25
		EPA 200.8 [4]	µg/L	0.0251	0.5
Chromium	Cr	EPA 200.8 [3]	µg/L	0.469	1.25
		EPA 200.8 [4]	µg/L	1.65	5
Copper	Cu	EPA 200.8 [3]	µg/L	0.177	0.5
		EPA 200.8 [4]	µg/L	0.203	1.5
Iron	Fe	EPA 200.8 [3]	µg/L	3.175	12.5
		EPA 200.8 [4]	µg/L	53.5	150

Parameter	Additional Name	Test	Unit	2023 Minimum Detection Limit	2023 Practical Quantitation Limit
Potassium	K	EPA 200.8 [3]	µg/L	28.75	125
		EPA 200.8 [4]	µg/L	161	1250
Magnesium	Mg	EPA 200.8 [3]	µg/L	4.095	62.5
		EPA 200.8 [4]	µg/L	9.94	100
Manganese	Mn	EPA 200.8 [3]	µg/L	0.705	2.5
		EPA 200.8 [4]	µg/L	0.147	5
Molybdenum	Mo	EPA 200.8 [3]	µg/L	0.119	0.25
		EPA 200.8 [4]	µg/L	0.0619	0.5
Sodium	Na	EPA 200.8 [3]	µg/L	27.25	125
		EPA 200.8 [4]	µg/L	36.7	250
Nickel	Ni	EPA 200.8 [3]	µg/L	0.0745	1
		EPA 200.8 [4]	µg/L	0.0579	0.5
Lead	Pb	EPA 200.8 [3]	µg/L	0.139	0.5
		EPA 200.8 [4]	µg/L	0.0302	0.5
Antimony	Sb	EPA 200.8 [3]	µg/L	0.109	2.5
		EPA 200.8 [4]	µg/L	0.0442	0.5
Selenium	Se	EPA 200.8 [3]	µg/L	0.307	1
		EPA 200.8 [4]	µg/L	0.165	2
Tin	Sn	EPA 200.8 [3]	µg/L	5	20
		EPA 200.8 [4]	µg/L	0.824	2
Strontium	Sr	EPA 200.8 [3]	µg/L	0.0466	0.5
		EPA 200.8 [4]	µg/L	0.0324	0.5
Titanium	Ti	EPA 200.8 [3]	µg/L	0.059	1
		EPA 200.8 [4]	µg/L	0.233	1
Thallium	Tl	EPA 200.8 [3]	µg/L	0.0545	0.25
		EPA 200.8 [4]	µg/L	0.888	5
Vanadium	V	EPA 200.8 [3]	µg/L	0.258	2.5
		EPA 200.8 [4]	µg/L	1.96	10
Zinc	Zn	EPA 200.8 [3]	µg/L	2.48	5
		EPA 200.8 [4]	µg/L	1.07	5
Hardness	Hardness (calc.)	SM 2340B [2]	mg/L	CaCO3 mg/L = (2.497*Ca mg/L)+(4.118*Mg mg/L)	
Escherichia coli	*E. coli*	SM9223 Colilert QT (18 & 24 Hour)	MPN/100mL	1 MPN	1 MPN
Chlorophyll *a*	Chlorophyll *a*	EPA 445.0	µg/L	0.02	1
Chemical Oxygen Demand	COD	EPA 410.4	mg/L	8.4	20

Parameter	Additional Name	Test	Unit	2023 Minimum Detection Limit	2023 Practical Quantitation Limit
Biological Oxygen Demand	BOD	SM 5210 [2]	mg/L	2	N/A
Total Solids	TS	SM 2540 B [2]	mg/L	5	10
Total Suspended Solids	TSS	SM 2540 D [2]	mg/L	0.86	2
Total Dissolved Solids	TDS	SM 2540 C [2]	mg/L	0.86	2
Turbidity **		EPA 180.1	NTU	0.2	1
Field Parameter	**Additional Name**	**Test**	**(Value Reported in)**		
pH		SM 4500 H+B	s.u.		
Conductivity		SM 2510A [2]	µs/cm		
Specific Conductivity		SM 2510B [2]	µs/cm		
Dissolved Oxygen	DO	SM 4500-0 G [2]	mg/L		
Temperature	Temp	EPA 1701.1 [2]	°C		
Turbidity **		EPA 180.1	NTU		

[1] Listed MDL/PQL is for undistilled samples. Any samples that require distillation will have a MDL = 0.065 mg/L, PQL = 0.150 mg/L

[2] Standard Methods for the Examination of Water and Wastewater, Method approved by Standard Methods Committee, 1997. Editorial revisions, 2011.

[3] MDLs and PQLs specific to ICP-MS Xseries instrument

[4] MDLs and PQLs specific to ICP-MS qNOVA instrument

** Turbidity will either be completed in the field or at the laboratory.

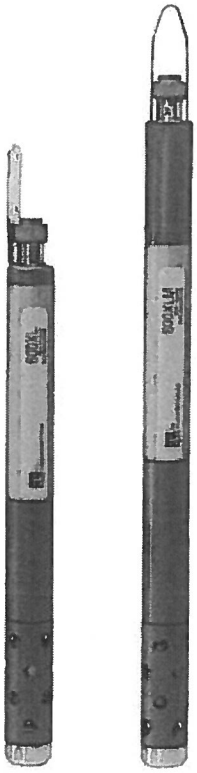
Appendix C. Meter Specifications

YSI 600XL and 600XLM Sondes

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)



The YSI 600XL and 600XLM

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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800 897 4151 (US)
www.ysi.com

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inquiry@sontek.com

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YSI Nanotech (Japan)
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Fax +81 44 221 1102
nanotech@ysi.com

ISO 9001
ISO 14001
Yellow Springs, Ohio Facility

CE

*Sensors with listed with the ETV logo were submitted to the ETV program on the Xylem 6000XLM. Information on the performance characteristics of YSI water quality sensors can be found at www.ysi.com, ysi.com/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?

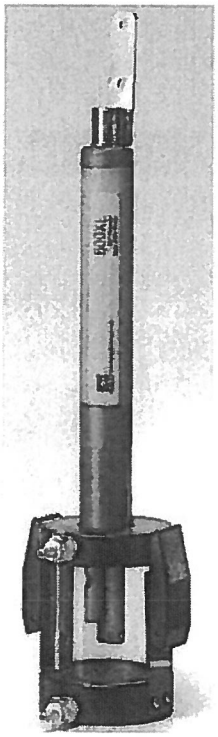
YSI 600XL & 600XLM Sensor Specifications

		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	0 to 200 ft, 61 m	0.001 ft, 0.001 m	±0.4 ft, ±0.12 m
	Shallow	0 to 30 ft, 9.1 m	0.001 ft, 0.001 m	±0.06 ft, ±0.02 m
	Vented Level	0 to 30 ft, 9.1 m	0.001 ft, 0.001 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	-5 to +50°C
	Storage	-10 to +60°C
Communications		RS-232, SDI-12
Software		EcoWatch®
Dimensions 600XL | 600XLM	Diameter	1.65 in, 4.19 cm | 1.65 in, 4.9 cm
	Length	16 in, 40.6 cm | 21.3 in, 54.1 cm
	Weight	1.3 lbs, 0.59 kg | 1.5 lbs, 0.69 kg
Power	External	12 V DC
	Internal (600XLM only)	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.)

HQ30d Portable pH, Conductivity, Dissolved Oxygen (DO), ORP, and ISE Multi-Parameter Meter

Product #: HQ30D53000000 Quantity
USD Price: $792.00

★★★★★ 5/5
Read 1 review Write a review Follow this product

Portable meter measures critical water quality parameters - without the need for multiple instruments
Single input channel for flexible measurement of pH, Conductivity, Dissolved Oxygen (DO), BOD, ORP, Ammonia, Ammonium, Fluoride, Chloride, Sodium, and temperature - any intelliCAL™ smart probe

Intuitive user interface for simple operation and accurate results
Guided calibration and check standard routines reduce calibration errors. Stabilization alerts and visual measurement lock ensure that you can trust the accuracy of the results

Trust your measurements - intelliCAL™ smart probes store all calibrations in the probe
Calibration history allows quick and easy change out of probes without re-calibrating. The HQd™ smart system records serial numbers, current calibration data, user ID, sample ID, time, and date automatically in the data log for complete GLP traceability

Designed for demanding conditions
Rugged, waterproof (IP67) meter provides worry-free, reliable operation in lab or field environments

Convenient kit includes everything you need to start testing
Meter kit includes, 4 AA batteries, quick-start guide, user manual, and documentation CD

Specifications

AC and USB Operation	optional
Automatic Buffer Recognition	Color-coded: 4.01, 7.00, 10.01 pH IUPAC: 1.679, 4.005, 7.000, 10.012, 12.45 DIN: 1.09, 4.65, 9.23 User-defined custom buffer sets
Barometric Pressure Measurement	For automatic compensation of DO when using an LDO or LBOD probe
Battery Requirements	4, AA
Benchtop	with stand
BOD5/CBOD resolution	Available when used with Hach WIMS BOD Manager software
Cable resistance correction	Digital - not needed
Calibration curves display	Calibration summary data logged and displayed
Calibration Intervals/Alerts/Reminder	2 hours to 7 days
Compliance	CE, WEEE
Conductivity Accuracy	± 0.5 % from (1µS/cm - 200 mS/cm)
Conductivity measurement	5 different stability modes
Conductivity Measurement Range	0.01 µS/cm to 200 mS/cm
Conductivity resolution	0.01 µS/cm with 2 digits
Custom Calibration Standards	User-defined standard sets
Data Export	Download via USB connection to PC or flash stick. Automatically transfer entire data log or as readings are taken
Data Memory	500 results
Digital (intelligent) electrode inputs	2
Dimensions (H x W x D)	7.8 in. x 3.7 in. x 1.4 in. (197 mm x 95 mm x 36 mm)
Display	Display readings from one or two probes Simultaneous readings from two probes (HQ40d only) pH: pH, mV, temperature Conductivity: Conductivity, TDS, salinity, resistivity, temperature LDO: dissolved oxygen, pressure, temperature LBOD: dissolved oxygen, pressure, temperature ORP/Redox: mV, temperature Sodium: Sodium, mV, temperature
Display Lock Function	Continuous measurement or press to read mode available with averaging function for LDO measurement.
Display Type	240 x 160 pixel Display readings from one or two probes pH: pH, mV, temperature Conductivity: Conductivity, TDS, salinity, resistivity, temperature LDO: dissolved oxygen, pressure, temperature ORP/Redox: mV, temperature Sodium: Sodium, mV, temperature
DO Measurement Range	0.01 to 20 mg/L (0 to 200%)
DO Resolution	0.01 mg/L
Fixed Buffer Selection	IUPAC standards (DIN 19266) or Technical buffer (DIN 19267) or 4-7-10 series or user defined
Inputs	M12 digital (1) for intelliCAL probes
Interface Languages	13**
Internal Data Storage	500
IP Rating	IP67
Languages:	English, French, German, Italian, Spanish, Danish, Dutch, Polish, Portuguese, Turkish, Swedish, Czech, Russian
mV Accuracy	± 0.1 mV
mV Measurement at Stable Reading	5 (auto) stabilization settings
mV Resolution	0.1 mV
Operating Error Messages	Text messages displayed
Operating Humidity	90 % relative humidity (non-condensing)
Operating Interface	Keypad
Operating Temperature	5 to 45 °C
ORP Electrode Calibration	Predefined ORP standards (including Zobell's solution)
Outputs	USB to PC / flash stick
PC Data Transfer Software	Included
pH Measurement at stable reading	5 stabilization settings
Printer	Optional accessory
Salinity Resolution	0.01 ppt
Warranty	3 years
Water Resistance	Meter Casing: 1 meter submersion for 30 minutes (IP67)
Weight	0.74 lbs. (0.335 kg)

2100P and 2100P IS Portable Turbidimeter

The Hach 2100P and 2100P IS Portable Turbidimeters bring laboratory-level performance on-site, offering fast, accurate results and the ease-of-use analysts demand in the field. With a measurement range of 0 to 1000 NTU and a resolution of 0.01 NTU, the 2100P turbidimeter is ideal for regulatory monitoring, process control or field studies.

Features and Benefits

Laboratory Quality in a Portable Unit

The Hach 2100P and 2100P IS Portable Turbidimeters offer a level of performance previously possible only with laboratory instruments. Microprocessor-controlled operation and Hach's unique Ratio™ optics bring great accuracy, sensitivity, and reliability to field and in-plant testing.

Two Models for Specific Requirements

- **2100P Turbidimeter**—*Get fast, accurate turbidity testing in the field or the lab, over a wide range of samples. Compliant with USEPA Method 180.1 design criteria.*
- **2100P IS Turbidimeter**—*Designed to meet international standards that mandate measurement using an LED light source.*

Two-detector Optical System

The two-detector optical system compensates for color in the sample, light fluctuation, and stray light, enabling analysts to achieve laboratory-grade performance on a wide range of samples, even under difficult, onsite conditions.

Specifications*

	2100P	2100P IS
Measurement Method	Nephelometric Ratio	
Regulatory	Meets EPA Method 180.1	Meets EN ISO 7027
Light Source	Tungsten lamp	Light-emitting diode (LED) @ 860 nm
Range		
Automatic Range Mode	0 to 1000 NTU	0 to 1000 FNU
Manual Range Selection	0 to 9.99, 0 to 99.9 and 0 to 1000 NTU	0 to 9.99, 0 to 99.9 and 0 to 1000 FNU
Accuracy	±2% of reading plus stray light	
Repeatability	±1% of reading, or 0.01 NTU, whichever is greater	±1% of reading, or 0.01 FNU, whichever is greater
Resolution	0.01 on lowest range	
Signal Averaging	Selectable on/off	
Power Requirement	4 AA alkaline batteries or optional battery eliminator	
Battery Life, Typical	300 tests with signal average mode off 180 tests with signal average mode on	
Operating Temperature	0 to 50°C (32 to 122°F)	
Sample Required	15 mL (0.5 oz.)	
Sample Cells	60 x 25 mm (2.36 x 1 in.) borosilicate glass with screw caps	
Dimensions	22.2 x 9.5 x 7.9 cm (8.75 x 3.75 x 3.12 in.)	
Weight	0.5 kg (1.1 lb.); shipping weight 2.7 kg (6 lb.)	
Warranty	2 years	

**Specifications subject to change without notice.*

DW = drinking water WW = wastewater municipal PW = pure water / power
IW = industrial water E = environmental C = collections FB = food and beverage

HACH®

Be Right™

2100Q and 2100Q *is* Portable Turbidimeter

The Hach 2100Q and 2100Q is Portable Turbidimeters offer unsurpassed ease of use and accuracy in turbidity measurement. Only Hach offers this unique combination of advanced features, such as assisted calibration and simplified data transfer, and measurement innovation, giving you accurate results every time.

Features and Benefits

Easy Calibration and Verification

Hach 2100Q and 2100Q *is* Portable Turbidimeters provide confidence your measurements are right every time. On-screen assisted calibration and verification save you time and ensure accuracy. With an easy-to-follow interface, complicated manuals are not needed to perform routine calibrations. Single-standard RapidCal™ calibration offers a simplified solution for low level measurements.

Simple Data Transfer

Data transfer with the optional USB + Power Module is simple, flexible, and doesn't require additional software. All data can be transferred to the module and easily downloaded to your computer with a USB connection, providing superior data integrity and availability. With two different module options, you can customize connectivity and power to meet your unique needs.

Accurate for Rapidly Settling Samples

The Hach 2100Q Portable Turbidimeter incorporates an innovative Rapidly Settling Turbidity™ mode to provide accurate, repeatable measurements for difficult to measure, rapidly settling samples. An exclusive algorithm that calculates turbidity based on a series of automatic readings eliminates redundant measurements and estimating.

Convenient Data Logging

Up to 500 measurements are automatically stored in the instrument for easy access and backup. Stored information includes: date and time, operator ID, reading mode, sample ID, sample number, units, calibration time, calibration status, error messages and the result.

Optical System for Precision in the Field

The two-detector optical system compensates for color in the sample, light fluctuation, and stray light, enabling analysts to achieve laboratory-grade performance on a wide range of samples, even under difficult site conditions.

Two Models for Specific Requirements

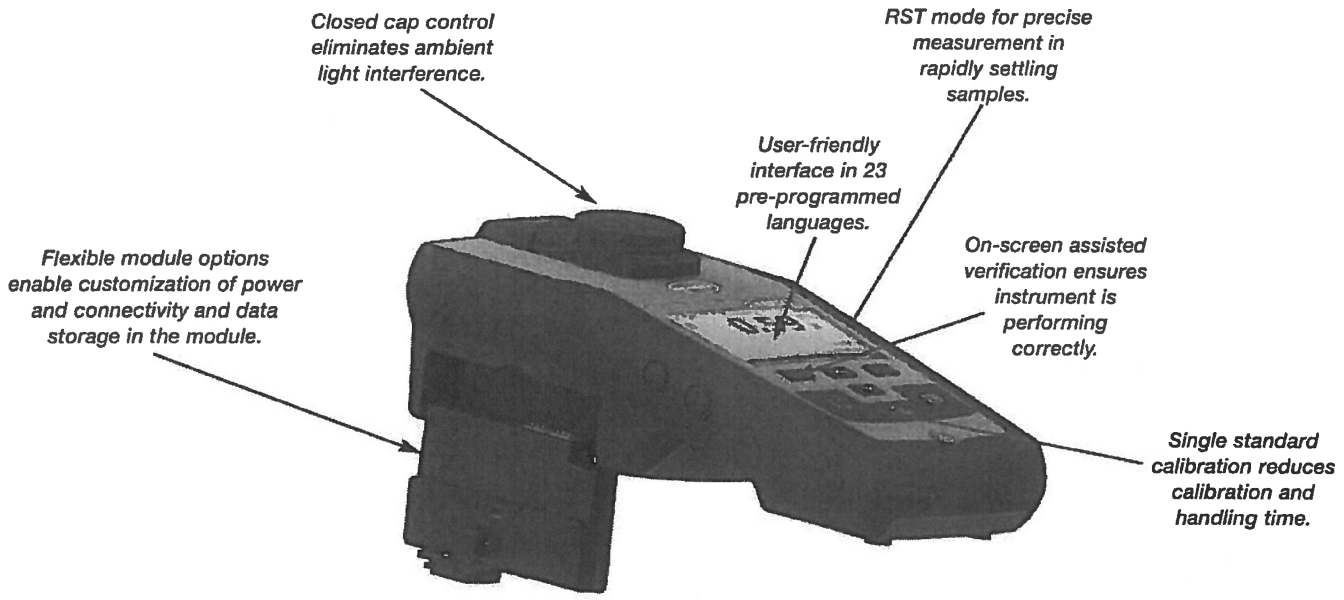
- **2100Q Turbidimeter**—*Compliant with USEPA Method 180.1 design criteria.*
- **2100Q *is* Turbidimeter**—*Compliant with ISO 7027 design criteria.*

DW = drinking water WW = wastewater municipal PW = pure water / power
IW = industrial water E = environmental C = collections FB = food and beverage

HACH®

Be Right™

Key Features



Specifications*

Measurement Method
Ratio turbidimetric determination using a primary nephelometric light scatter signal (90°) to the transmitted light scatter signal.

Regulatory
2100Q: Meets EPA Method 180.1
2100Q *is:* Meets ISO 7027

Light Source
2100Q: Tungsten filament lamp
2100Q *is:* Light-emitting diode (LED) @ 860 nm

Range
0 to 1000 NTU (FNU)

Accuracy
±2% of reading plus stray light from 0 to 1000 NTU

Repeatability
±1% of reading, or 0.01 NTU (FNU), whichever is greater

Resolution
0.01 NTU on lowest range

Stray Light
<0.02 NTU (FNU)

Signal Averaging
Selectable on/off

Detector
Silicon photovoltaic

Reading Modes (user selectable)
Normal (Push to Read)
Signal Averaging
Rapidly Settling Turbidity

Data Logger
500 records

Power Requirement
110-230 Vac, 50/60 Hz (with Power or USB+Power Module)
4 AA alkaline batteries
Rechargeable NiMH (for use with USB+Power Module)

Operating Conditions
Temperature: 0 to 50°C (32 to 122°F)
Relative Humidity: 0 to 90% @ 30°C,
0 to 80% @ 40°C, 0 to 70% @ 50°C, noncondensing

Storage Conditions
-40 to 60°C (-40 to 140°F), instrument only

Languages
English, French, German, Italian, Spanish, Portuguese (BR), Portuguese (PT), Bulgarian, Chinese, Czech, Danish, Dutch, Finnish, Greek, Hungarian, Japanese, Korean, Polish, Romanian, Russian, Slovenian, Swedish, Turkish

Interface
Optional USB

Instrument Enclosure Rating
IP67 (closed lid, battery compartment excluded)

Protection Class
Power Supply: Class II

Certification
CE certified

Sample Required
15 mL (0.3 oz.)

Sample Cells
60 x 25 mm (2.36 x 1 in.) borosilicate glass with screw cap

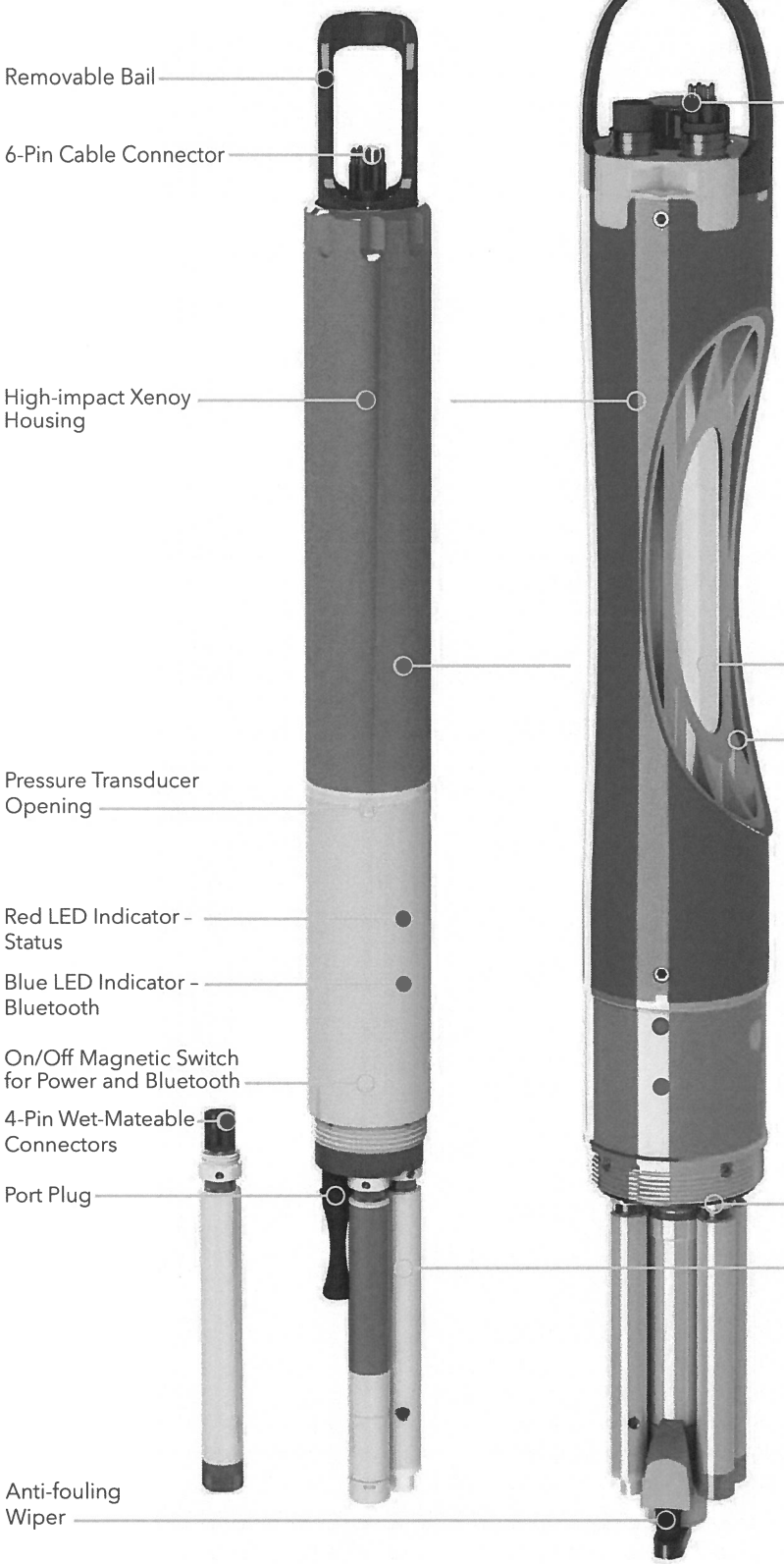
Dimensions
22.9 x 10.7 x 7.7 cm (9.0 x4.2 x 3.0 in.)

Weight
527 g (1.16 lb) without batteries
618 g (1.36 lb) with four AA alkaline batteries

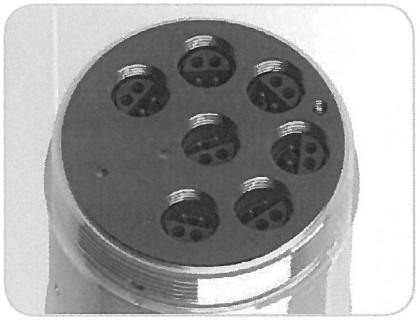
Warranty
1 year

**Specifications subject to change without notice.*

Sondes: EXO1 EXO2



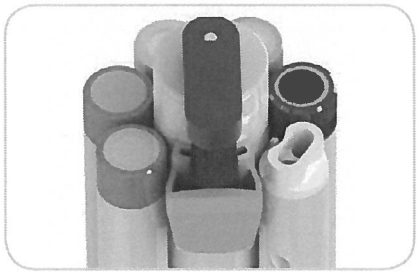
Cable connector, battery valve, and expansion port for an additional sensor



EXO2 sonde contains 6 universal sensor ports plus a central port for an anti-fouling wiper

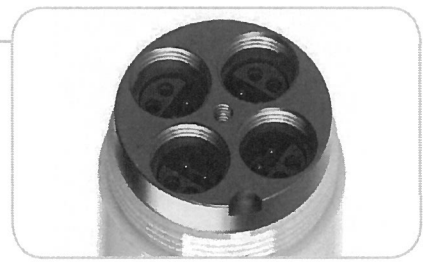
Battery Compartment

Cutaway: Reinforced internal structure



Anti-fouling wiper keeps sensors clear of biofouling and lengthens deployment times by 25%

Welded Titanium Housing



EXO1 sonde contains 4 universal sensor ports

Instrument Specifications*

EXO1 Sonde		
Ports	4 sensor ports Peripheral port: 1 power communication port	
Size	Diameter: 4.70 cm (1.85 in) Length: 64.77 cm (25.50 in)	
Weight	1.42 kg (3.15 lbs) with 4 probes, guard and batteries installed	
EXO2 Sonde		
Ports	7 sensor ports (6 ports available when central wiper used) Peripheral ports: 1 power communication port; 1 auxiliary expansion port	
Size	Diameter: 7.62 cm (3.00 in) Length: 71.10 cm (28.00 in)	
Weight	3.60 kg (7.90 lbs) with 5 probes, guard and batteries installed	
Sondes		
Operating Temperature	-5 to 50°C	
Storage Temperature	-20 to 80°C (except 0 to 60°C for pH and pH/ORP sensors)	
Depth Rating	0 to 250 m (0 to 820 ft)	
Communications	Computer Interface: Bluetooth wireless technology, RS-485, USB Output Options: USB with signal output adapter (SOA); RS-232 & SDI-12 with DCP-SOA	
Sample Rate	Up to 4 Hz	
Battery Life	90 days**	
Data Memory	512 MB total memory; >1,000,000 logged readings	
Sensors		**Calculated Parameters**
Ammonium	ORP	Salinity
Chloride	pH	Specific Conductance
Conductivity	Temperature	Total Dissolved Solids
Depth	Total Algae (Chlorophyll + BGA-PC or PE)	Total Suspended Solids
Dissolved Oxygen	Turbidity	
Fluorescent Dissolved Organic Matter (fDOM)	Vented Level	
Nitrate		
EXO Handheld		
Size	Width: 12.00 cm (4.72 in) Height: 25.00 cm (9.84 in)	
Weight	0.71 kg (1.56 lbs) without batteries	
Operating System	Windows CE 5.0	
Operating Temperature	-10 to 50°C	
Storage Temperature	-20 to 80°C	
IP Rating	IP-67	
Data Memory	2 GB total memory; >2,000,000 data sets	
Accessories		
Cables (vented and non-vented)	Flow cells	Sonde/sensor guard
Carrying case	KOR software	Calibration cup
DCP Signal Output Adapter	USB Signal Output Adapter	Anti-fouling components
Warranty		
3 months	Replaceable reagent modules for ammonium, chloride, and nitrate	
1 Year	Optical DO membranes and replaceable reagent moldules for pH and pH/ORP	
2 Years	Cables; sonde bulkheads; handheld; conductivity, temperature, depth, and optical sensors; electronics base for pH, pH/ORP, ammonium, chloride, and nitrate sensors; and accessories	

* Specifications indicate typical performance and are subject to change. Please check EXOwater.com for up-to-date information.

** Typically 90 days at 20°C at 15-minute logging interval; temperature/conductivity, pH/ORP, DO, and turbidity sensors installed on EXO1; or temperature/conductivity, pH/ORP, DO, total algae, and turbidity sensors installed with central wiper that rotates once per logging interval on EXO2. Battery life is heavily dependent on sensor configuration.

EXO Bluetooth modules comply with Part 15C of FCC Rules and have FCC, CE Mark and C-tick approval. Bluetooth-type approvals and regulations can be country specific. Check local laws and regulations to insure that the use of wireless products purchased from Xylem are in full compliance.

Sensor Specifications*

Sensor	Range	Accuracy*	Response	Resolution
Ammonium [11] (ammonia with pH sensor)	0 to 200 mg/L [1]	±10% of reading or 2 mg/L-N, w.i.g.	-	0.01 mg/L
Barometer	375 to 825 mmHg	±1.5 mmHg from 0 to 50°C	-	0.1 mmHg
Blue-green Algae Phycocyanin (PC) (part of Total Algae sensor)	0 to 100 RFU; 0 to 100 µg/L PC	Linearity: $R^2 > 0.999$ for serial dilution of Rhodamine WT solution from 0 to 100 µg/mL PC equivalents	T63<2 sec	0.01 RFU; 0.01 µg/L PC
Blue-green Algae Phycoerythrin (PE) (part of Total Algae sensor)	0 to 100 RFU; 0 to 280 µg/L PE	Linearity: $R^2 > 0.999$ for serial dilution of Rhodamine WT solution from 0 to 280 µg/mL PE equivalents	T63<2 sec	0.01 RFU; 0.01 µg/L PE
Chloride [11]	0 to 1000 mg/L-Cl [2]	±15% of reading or 5 mg/L-Cl, w.i.g.	-	0.01 mg/L
Chlorophyll (part of Total Algae sensor)	0 to 400 µg/L Chl; 0 to 100 RFU	Linearity: $R^2 > 0.999$ for serial dilution of Rhodamine WT solution from 0 to 400 µg/L Chl equivalents	T63<2 sec	0.01 µg/L Chl; 0.01 RFU
Conductivity [3]	0 to 200 mS/cm	0 to 100: ±0.5% of reading or 0.001 mS/cm, w.i.g.; 100 to 200: ±1% of reading	T63<2 sec	0.0001 to 0.01 mS/cm (range dependent)
Depth [4] (non-vented)	0 to 10 m (0 to 33 ft)	±0.04% FS (±0.004 m or ±0.013 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
	0 to 100 m (0 to 328 ft)	±0.04% FS (±0.04 m or ±0.13 ft)		
	0 to 250 m (0 to 820 ft)	±0.04% FS (±0.10 m or ±0.33 ft)		
Vented Level	0 to 10 m (0 to 33 ft)	±0.03% FS (±0.003 m or ±0.010 ft)		
Dissolved Oxygen Optical	0 to 500% air saturation	0 to 200%: ±1% of reading or 1% saturation, w.i.g.; 200 to 500%: ±5% of reading [5]	T63<5 sec [6]	0.1% air saturation
	0 to 50 mg/L	0 to 20 mg/L: ±0.1 mg/L or 1% of reading, w.i.g.; 20 to 50 mg/L: ±5% of reading [5]		0.01 mg/L
fDOM	0 to 300 ppb Quinine Sulfate equivalents (QSE)	Linearity: $R^2 > 0.999$ for serial dilution of 300 ppb QS solution Detection Limit: 0.07 ppb QSE	T63<2 sec	0.01 ppb QSE
Nitrate [11]	0 to 200 mg/L-N [1]	±10% of reading or 2 mg/L-N, w.i.g.	-	0.01 mg/L
ORP	-999 to 999 mV	±20 mV in Redox standard solutions	T63<5 sec [7]	0.1 mV
pH	0 to 14 units	±0.1 pH units within ±10°C of calibration temp; ±0.2 pH units for entire temp range [8]	T63<3 sec [9]	0.01 units
Salinity (Calculated from Conductivity and Temperature)	0 to 70 ppt	±1.0% of reading or 0.1 ppt, w.i.g.	T63<2 sec	0.01 ppt
Specific Conductance (Calculated from Cond. and Temp.)	0 to 200 mS/cm	±0.5% of reading or .001 mS/cm, w.i.g.	-	0.001, 0.01, 0.1 mS/cm (auto-scaling)
Temperature	-5 to 50°C	-5 to 35°C: ±0.01°C [10] 35 to 50°C: ±0.05°C [10]	T63<1 sec	0.001 °C
Total Dissolved Solids (TDS) (Calculated from Conductivity and Temperature)	0 to 100,000 g/L Cal constant range 0.30 to 1.00 (0.64 default)	Not Specified	-	variable
Total Suspended Solids (TSS) (Calculated from Turbidity and user reference samples)	0 to 1500 mg/L	Not Specified	T63<2 sec	variable
Turbidity [11]	0 to 4000 FNU	0 to 999 FNU: 0.3 FNU or ±2% of reading, w.i.g.; 1000 to 4000 FNU: ±5% of reading [12]	T63<2 sec	0 to 999 FNU: 0.01 FNU; 1000 to 4000 FNU: 0.1 FNU

All sensors have a depth rating to 250 m (820 ft), except shallow and medium depth sensors and ISEs. EXO sensors are not backward compatible with 6-Series sondes.

* Specifications indicate typical performance and are subject to change. Please check EXOwater.com for up-to-date information.
Accuracy specification is attained immediately following calibration under controlled and stable environmental conditions. Performance in the natural environment may vary from quoted specification.

[1] 0-30°C [2] 0-40°C w.i.g. = whichever is greater

[3] Outputs of specific conductance (conductivity corrected to 25°C) and total dissolved solids are also provided. The values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (Ed. 1989).

[4] Accuracy specifications apply to conductivity levels of 0 to 100,000 µS/cm.

[5] Relative to calibration gases

[6] When transferred from air-saturated water to stirred deaerated water

[7] When transferred from water-saturated air to Zobell solution

[8] Within the environmental pH range of pH 4 to pH 10

[9] On transfer from water-saturated air to rapidly stirred air-saturated water at a specific conductance of 800 µS/cm at 20°C; T63<5 seconds on transfer from water-saturated air to slowly-stirred air-saturated water.

[10] Temperature accuracy traceable to NIST standards

[11] Calibration: 1-, 2-, or 3-point, user-selectable

[12] Specification is defined in AMCO-AEPA Standards

FH950 Portable Velocity Meter with 20' Cable

Product #: FH950.10020 Quantity
USD Price: $4,585.00
Ships within 2 weeks

Reduce manhours 50%
The step-by-step user interface simplifies programming, delivers real-time data, and downloads directly to PC allowing a single person to take the readings and eliminating post site visit manual data transfer from logbook to PC

Automatically calculates total discharge based on USGS and ISO methods
Reduces time to manually calculate and likelihood of errors

Real-time velocity graphed on color display
Visualize velocity trends quickly

Lowest maintenance solution on the market
Electromagnetic velocity sensor with no moving parts never requires mechanical maintenance

Lightweight, rugged portable meter
Only 1.5 pounds

What's in the box

FH950.1 System Includes:
- Portable Velocity Meter
- Electromagnetic Sensor with 20' cable
- Fabric Carrying Case
- Adjustable Meter Rod Mount
- Universal Sensor Mount
- Battery Charger with Domestic/International Plug Adapters
- USB Cable
- Lanyard
- Sensor Screw Kit
- Absorbent Wipe

Specifications

Accuracy 2:	± 2% of reading ± 0.05 ft/s (± 0.015 m/s) through the range of 0 to 10 ft/s (0 to 3.04 ms/s); ± 4% of reading from 10 to 16 ft/s (3.04 to 4.87 m/s)
Battery Life:	heavy typical day use; 68°F (20°C)
Display: LCD:	Color, LCD 3.5 QVGA transflective (readable in direct sunlight)
Keypad:	Alpha-numerica
Operating Temperature Range:	-20 to 55 °C
Range:	to ft/s
Resolution:	Measurement Resolution - <10: 0.001; <100: 0.01; >100: 0.1
Storage Conditions:	-20 °C to 60 °C

Appendix D. Chlorophyll *a* Field Form

NEORSD Chlorophyll *a* Sampling Field Sheet

Stream:_____ Collectors:_____
Location:_____ Date:_____
RM:_____ Time:_____
Lat/Long:_____

Number of Rocks:_____ Total Area Scraped:_____cm^2

Diameter of individual scrape	Area of individual scrape
1_____	1_____
2_____	2_____
3_____	3_____
4_____	4_____
5_____	5_____
6_____	6_____
7_____	7_____
8_____	8_____
9_____	9_____
10_____	10_____
11_____	11_____
12_____	12_____
13_____	13_____
14_____	14_____
15_____	15_____
16_____	16_____
17_____	17_____
18_____	18_____
19_____	19_____
20_____	20_____
21_____	21_____
22_____	22_____
23_____	23_____
24_____	24_____
25_____	25_____
	Total:_____

Diameter to Area Conversion

Diameter (cm)	Area (cm2)
1.6	2.011
1.7	2.27
1.8	2.545
1.9	2.835
2.0	3.142
2.1	3.464
2.2	3.801
2.3	4.155

Total Sample Volume_____ml

Filter 1 LABLynx ID_____
Vol _____ml

Filter 2 LABLynx ID_____
Vol _____ml

Filter 3 LABLynx ID_____
Vol _____ml

Water Column Chlorophyll Sample

Filter 1 LABLynx ID_____
Vol _____ml

Filter 2 LABLynx ID_____
Vol _____ml

Filter 3 LABLynx ID_____
Vol _____ml

Flow: None Low Normal Elevated High

Turbidity: Clear Low Moderate* High*

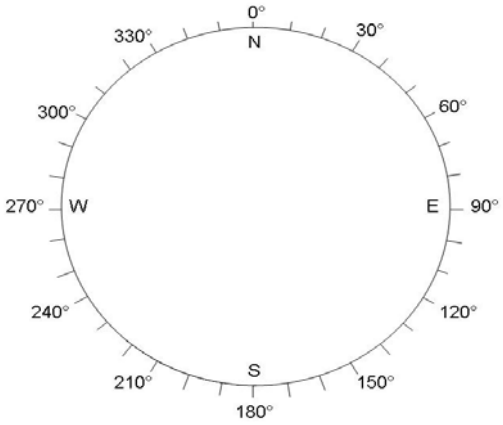
*Explain_____

Sky: Overcast Cloudy Partly Cloudy Mostly Clear Clear

Canopy: Open Mostly Open Partly Closed Closed

Riparian None Narrow L R Moderate L R Wide L R

Downstream Channel Direction



Clinometer

Left Bank _____°
Right Bank _____°

Left Bank _____°
Right Bank _____°

Left Bank _____°
Right Bank _____°

Stream Widths

_____m _____m _____m

Record two most predominate substrates with an X, and check all present.

	Riffle	Run	Reach
Boulder/Slabs	_____	_____	_____
Bedrock	_____	_____	_____
Boulder/Slabs	_____	_____	_____
Cobble	_____	_____	_____
Gravel	_____	_____	_____
Sand	_____	_____	_____
Silt	_____	_____	_____
Hardpan	_____	_____	_____
Detritus	_____	_____	_____
Artificial	_____	_____	_____

Substrate Origin

____Limestone ____Tills ____Rip-rap
____Sandstone ____Shale ____Wetlands
____Lacustrine ____Hardpan ____Coal Fines

Silt

____Heavy ____Moderate ____Normal ____None

Embeddedness

____Extensive ____Moderate ____Normal ____None

Notes:_____

_____

Length of Reach: _____m

Stream Drawing