Quality System Standard Operating Procedure for DIATOM STREAM SURVEYS

DISCLAIMER: This document is policy only and does not create legal rights or obligations. It is intended to provide division staff guidance on how to apply decisions, procedures and practices pertaining to the internal operation or actions of the division. Decisions affecting the public, including the regulated community, in any particular case will be made applying applicable laws and regulations to the specific facts. Mention of trade names or commercial products does not constitute an endorsement or recommendation for use.

1) EFFECTIVE DATE: October 15, 2023

2) SIGNATURES:

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Date: 2023.10.04 08:09:34 -05'00'

Robert S. Wilkinson, TDEC Quality Assurance Manager, Reviewer

This SOP is an intra-departmental document intended to govern the internal management of the Tennessee Department of Environment and Conservation and to meet requirements of the U.S. Environmental Protection Agency for a quality system. It is not intended to affect rights, privileges, or procedures available to the public.

DIVISION OF WATER RESOURCES
QUALITY SYSTEMS STANDARD OPERATING PROCEDURES
FOR DIATOM STREAM SURVEYS

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DOCUMENT TITLE	Quality System Standard Operating Procedure for Diatom Stream Surveys
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PLAN COVERAGE	General instructions for diatom surveys of surface waters in Tennessee by the Division of Water Resources.

Concurrences and Review of QSSOP Project 2023

As a part of the 2023 review process, the following individuals reviewed and/or provided comments used in this document.

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REVISIONS AND ANNUAL REVIEW PROCEDURE: QSSOP FOR DIATOM STREAM SURVEYS

1. This document shall be reviewed annually to reconfirm the suitability and effectiveness of the program components described in this document.

2. A report of the evaluation of effectiveness of this document shall be developed at the time of review and submitted to appropriate stakeholders. Peer reviews shall be conducted, if necessary and appropriate. It shall be reconfirmed that the document is suitable and effective. It shall include, if necessary, clarification of roles and responsibilities, response to problem areas and acknowledgement of successes. Progress toward meeting Tennessee Department of Environment and Conservation (TDEC) mission, program goals and objectives shall be documented. Plans shall be made for the upcoming cycle and communicated to appropriate stakeholders.

3. The record identified as "Revisions" shall be used to document all changes.

4. A copy of any document revisions made during the year shall be sent to all appropriate stakeholders. A report shall be made to the DWR director and Quality Assurance Manager of any changes that occur. Other stakeholders shall be notified, as appropriate and documented on the "Document Distribution" list.

EVALUATION PROCEDURE:
QSSOP FOR DIATOM STREAM SURVEYS

As this document is used, needed changes or improvements will be apparent. Specific recommendations for improvements or changes are solicited as well as information concerning typographical or formatting errors.

Send specific recommendations for improvements or changes to:
tdec.watershedplanning@tn.gov

QSSOP DOCUMENT DISTRIBUTION LIST

Copies of this document were distributed to the following individuals in TDEC and Tennessee Department of Health (TDH), see Table 1. The document is also available on the publication page of the division's website http://www.tn.gov/environment/article/wr-wq-water-quality-reports-publications and on SharePoint https://tennessee.sharepoint.com/sites/environment/DWR/PAS/SitePages/Home.aspx

Additional copies were distributed to non-TDEC agencies and individuals upon request (including other state and federal agencies, consultants, universities etc.).

The system for document distribution is described in TDEC Quality Management Plan, Chapters 5 and 10.

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PREFACE

The United States Environmental Protection Agency (U.S. EPA) requires that a centrally planned, directed, and coordinated quality assurance and quality control program be applied to efforts supported by them through grants, contracts, or other formalized agreements. 2CFR1500.11; 40CFR35 www.epa.gov/quality. This includes the implementation of a Quality Management Plan as written by the contract holder with Data Quality Objectives (DQOs) set in Quality Assurance Project Plans (QAPPs) for specific projects. The organization may elect to support portions of the QAPP through technical or administrative standard operating procedures (SOPs), as specified by the quality system. As a contract holder and through memoranda of agreement, the Tennessee Department of Environment and Conservation is required to maintain such a system.

This Quality System Standard Operating Procedure (QSSOP) was prepared, reviewed, and distributed in accordance with TDEC's Quality Management Plan and other quality system documents in response to U.S. EPA's requirements for a Quality Management Program. QSSOPs are integral parts of successful quality systems as they provide staff with the information to perform a job properly and facilitate consistency in the quality and integrity of the process.

This QSSOP is specific to the Division of Water Resources, is intended to assist the division in maintaining their quality control and quality assurance processes. It provides specific operational direction for the division's Quality Assurance Project Plan for Diatom Stream Surveys. The procedures are only mandatory for TDEC staff and their contractors.

This document will be reviewed annually and revised as needed. Always use the most recent version.

I. PROCEDURES

I.A. Scope, Applicability and Regulatory Requirements

The purpose of this Quality Systems Standard Operating Procedure (QSSOP) is to support the Quality Assurance Program. The document provides a consolidated reference document for use in training and orientation of employees. This guide will also be a reference tool for more experienced employees. It establishes an approach that can be recommended to sister agencies that monitor Tennessee water or stipulated to members of the regulated community given monitoring requirements in receiving streams. This SOP describes the diatom stream survey process and will delineate all steps in the process, including field collections, sample analysis, data reduction and reporting. This SOP is only intended to describe routine conditions encountered during a diatom stream survey.

The purpose of this SOP is not to supersede professional judgment, but rather is intended to ensure that appropriate sampling methods and quality assurance procedures are employed. Discuss any deviations from the protocols outlined in this SOP with the in-house EFO Quality Control (QC) officer for biological sampling or the central office QC coordinator. Document any departure from this protocol.

Federal Statutory Authority

Federal Water Pollution Control Act (amended through P.L. 106-308, October 13,2000) as Amended by the Clean Water Act of 1977 enacted by Public Law 92-500, October 18, 1972, 86 Stat. 816; 33 U.S.C. 1251 et. seq.
Title III, Sec. 302: Water Quality Related Effluent Limitations
Title III, Sec. 303: Water Quality Standards and Implementation Plans
Title III, Sec. 304: Information and Guidelines
Title III, Sec. 305: Water Quality Inventory

Tennessee Statutory Authority

Tennessee Water Quality Control Act of 1977 (Acts 1971, ch. 164, § 1; 1977 ch. 366, § 1; T.C.A., § 69-3-101, et seq.).

Tennessee Regulatory Authority

General Water Quality Criteria and the Antidegradation Statement: Rule 0400-40-03 Use Classifications for Surface Waters: Rule 0400-40-04

I.B. Definitions and Acronyms

Biocriteria: Numerical values or narrative expressions that describe the reference biological condition of aquatic communities inhabiting waters of a given designated aquatic life use. Biocriteria are benchmarks for water resources evaluation and management decisions.

BioForm: Electronic workbook used by DWR and TDH staff for reporting field and biorecon data collected during biological stream surveys.

Biometric: A calculated value representing some aspect of the biological population's structure, function or other measurable characteristic that changes in a predictable way with increased human influence.

Cleansed Diatom Material: Subsample that has been through the digestion process.

Diatom: Silicified algae, functionally single cell but may appear as filaments chains or colonies. For the purpose of this document, diatoms only refer to benthic taxa.

Diatom Region: One of six regions consisting of Level IV ecoregions grouped for diatom index assessments.

Ecological Subregion (or subecoregion): A smaller area that has been delineated within an ecoregion that has even more homogenous characteristics than does the original ecoregion. There are 31 (Level IV) ecological subregions in Tennessee.

Ecoregion: A relatively homogenous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, and other ecologically relevant variables. There are eight (Level III) ecoregions in Tennessee.

Ecoregion Reference: Least impacted waters within an ecoregion monitored to establish a baseline to which alterations of other waters can be compared.

E-Forms: Electronic forms, including BioForm (DWR and TDH staff only), Field Survey-Habitat Sheets and Macroinvertebrate taxa report (SQSH).

Frustule: The silicate cell wall of a diatom. The frustule is composed of two valves.

Habitat: The instream and riparian features that influence the structure and function of the aquatic community in a stream.

Hydra: DWR Database for water chemistry, bacteriological, fish tissue, macroinvertebrate, diatom, habitat, and stream survey data.

Macroalgae: Long filamentous strands of algae such as *Cladophora* or *Spirogyra* spp.

Microalgae: Primarily single celled algae which coat the substrate and are generally composed of diatoms and soft algae such as blue-green algae

Moss: Member of the division Bryophyta

Periphyton: Algae attached to submerged substrate in aquatic environments.

Sample ID: Unique sample number assigned by the TDH laboratory. Synonymous with VII log number (TDH LIMS), PeriSampID (EDAS sample log) and BenSamp ID (EDAS invert taxa report).

Sampling Event: Biological/Chemical and/or Bacteriological samples collected at the same site on the same date and time by the same team. All should be assigned the same field log number. (Duplicates are assigned a separate number).

Stagnant: Streams that are backed up (not flowing) due to conditions such as beaver dams, bridge constructions, embayments etc. (Naturally sluggish streams in west Tennessee may appear stagnant but are sampleable if dissolved oxygen levels are above criteria.)

Tennessee Diatom Index (TDI): Multi-metric index comprised of 8 biometrics calibrated to assess stress in the benthic diatom community.

Valve: Half of a frustule.

Waterbody ID Segment: (Waterbody Identification Segment) Unique identification assigned to an assessment unit.

Watershed: The area that drains to a particular body of water or common point.

Acronyms and Abbreviations

%CEN	Percent of centric taxa
%LAND	Percent taxa tolerant to general land disturbance
%LTN	Percent of taxa indicating low total nitrogen
%NAV	Percent *Navicula* taxa
%O2	Percent taxa requiring 50% Dissolved Oxygen Saturation
%PTOL	Percent of taxa tolerant of high phosphorus
%SEN	Percent abundance of pollution sensitive taxa
%TOL	Percent abundance of tolerant taxa
ABS	Aquatic Biology Section
ARAP	Aquatic Resource Alteration Permit
ASTM	American Society for Testing and Materials
ATTAINS	Assessment and Total Maximum Daily Load Tracking and Implementation System
BSERT	Biological Survey Electronic Reporting Tutorial
^{o}C	Degrees Centigrade
cm	Centimeter
CHEFO	Chattanooga Environmental Field Office
CKEFO	Cookeville Environmental Field Office
CLEFO	Columbia Environmental Field Office
CO	Nashville Central office
COC	Chain of Custody
DI	Deionized
DMGR	Division of Mineral and Geological Resources
D.O.	Dissolved oxygen
D/S	Downstream
DWR	Division of Water Resources
ECO	Ecoregion reference stream
EDAS	Ecological Data Application System
EFO	Environmental Field Office
FECO	Headwater reference stream
GIS	Geographic Information System
GPS	Global Positioning System
Hg	Mercury
HW	Headwater
HUC	Hydrological Unit Code
JCEFO	Johnson City Environmental Field Office

JEFO	Jackson Environmental Field Office
KEFO	Knoxville Environmental Field Office
LAB	Laboratory
ml	Milliliter
mm	Millimeter
MPS	Multi-Habitat periphyton sample
MQO	Measurement Quality Objective
MS	Mining Section
NA	Not applicable
NEFO	Nashville Environmental Field Office
NHD	National Hydrology Dataset
NPDES	National Pollutant Discharge Elimination System
PDE	Percent Difference in Enumeration
PFD	Personal Flotation Device
ppm	Parts per million
PTC	Percent Taxonomic Completeness
PTD	Percent Taxonomic Disagreement
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSSOP	Quality System Standard Operating Procedure
RDB	Right descending bank
RM	River mile
RPS	Rapid Periphyton Survey
SDS	Safety Data Sheet (previously MSDS)
SEMN	Southeast Monitoring Network
SOP	Standard Operating Procedure (synonymous with QSSOP)
SPERT	Stream Parameter Electronic Reporting Tutorial
SQSH	Semi-Quantitative Single Habitat
STP	Sewage Treatment Plant
TDEC	Tennessee Department of Environment and Conservation
TDH	Tennessee Department of Health
TDI	Tennessee Diatom Index
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Loading
TMI	Tennessee Macroinvertebrate Index
TN	Tennessee
TOPO	Topographic map
TVA	Tennessee Valley Authority

TWRA	Tennessee Wildlife Resources Agency
uml	Micromilliliter
umhos/cm	Micromhos per centimeter
U.S. EPA	United States Environmental Protection Agency
U/S	Upstream
uS/cm	Microsiemen per centimeter
USGS	United States Geological Survey
ID	Identification
WPU	Watershed Planning Unit

I.C. Method Summary

This document describes procedures for performing diatom surveys approved by the Division of Water Resources for assessing biological integrity of streams. The entire procedure is described including protocols for field assessments, sample collection, sample analysis, data reduction and reporting.

Diatoms are used by the Division as secondary indicator organisms to determine if a stream supports fish and aquatic life use. They are primary producers with early response to nutrient enrichment.

Two protocols are described in this document. The first, Rapid Periphyton Survey (RPS), is an estimate of algal biomass found in the stream and will only be used for special projects including the Southeast Monitoring Network (SEMN) monitoring. The second, more intensive protocol involves collecting a benthic diatom sample for lab analysis and identifying the diatom community. Diatom samples will be collected in conjunction with monthly nutrient sampling for assessments. They are most useful in streams where nutrient impairment is suspected or known and macroinvertebrates have not demonstrated a response. Diatom samples will also be collected at all reference streams during the watershed cycle for index calibration.

Diatom Survey Quick Field Reference

(Minimum tasks to be completed at all diatom sampling sites)

1. Upon arrival at site, record latitude and longitude in decimal degrees, verify that sample location is correct.

2. Establish minimum 100-yard reach area (walk bank without disturbing stream).

3. Take field measurements near middle of reach area. At minimum measure Dissolved Oxygen (D.O), temperature. pH and conductivity. Record information on stream survey field sheet.

4. Collect chemicals (if needed) upstream of area disturbed during field measurements.

5. Collect diatom samples (make sure at least 40 ml).

6. Collect macroinvertebrate sample if required (Contact Tennessee Wildlife Resource Agency (TWRA) regional office prior to sampling and carry collection permit).

7. Measure flow and complete rapid periphyton survey if SEMN site.

8. Estimate average canopy of entire reach and record on stream survey form. Measure canopy using a densiometer in the middle of the reach and record on stream survey form. (If RPS is being completed, measure canopy at 5 transects and record on RPS form).

9. Complete BioForm (event, stream survey sheet, habitat assessment sheet (and biorecon if collected).

10. Take pictures of upstream/downstream sample reach, any habitat problems, unusual observations, and potential pollution sources. (This can be done any time during survey, but additional pictures should be taken after survey is complete if significant disturbance is noted such as pipes, severe erosion, livestock in creek etc.)

I.D Health and Safety Warnings

(Adopted from Klemm et al., 1990)

1. Employee safety is the most important principle when collecting samples. If conditions are not safe; reschedule sampling for another date and time.

2. Do not enter water during flood conditions.

3. Know how to swim and/or use a personal flotation device (PFD) when entering the water.

4. Always wear waders with a belt to prevent them from filling with water in case of a fall (do not wear in a boat or canoe). In high velocity and high flow streams it is advisable to wear a PFD, it is required in a boat. Do not enter water if conditions are unsafe.

5. Always secure equipment such as meters when working from a boat or canoe.

6. Follow Tennessee boating laws and regulations. Information is available through the Tennessee Wildlife Resources Agency. PFD are required when operating a boat. Staff born after January 1, 1989, must have a Tennessee Boater Education Certificate issued by TWRA. Annual boat safety training is recommended.

7. Be vigilant, especially in turbid streams, to avoid broken glass, beaver traps or other hazardous objects that may lie out of sight on the stream bottom. Heavy wading boots should be worn in these situations.

8. Keep first aid supplies in the office, lab, and field at all times. Training in basic first aid and cardio-pulmonary resuscitation is strongly recommended. Check any expiration dates and replenish first aid kit supplies yearly or more frequently if needed.

9. Any person allergic to bee stings or other insect bites should carry needed medications and instruct team mates on how to use in the event of an allergic reaction.

10. Always perform lab work involving ethanol or CMC-10 in a room containing a properly installed and operating hood.

11. Carry cell phone in the field in case of emergency.

12. Keep a file in the office that contains emergency contacts and physician's name for each employee. Carry a list of emergency contact numbers for the sample area. Know the location of hospitals and law enforcement stations in the area.

13. Consider all surface waters potential health hazards due to toxic substances or pathogens and minimize exposure as much as possible. Do not eat, drink, smoke, apply cosmetics or handle contact lenses while collecting samples. Avoid splashing face and clean exposed body parts (face, hands, and arms) immediately after contact with these waters. Carry soap and an adequate supply of clean water, disinfectant wipes and/or waterless sanitizer for this purpose.

14. If working in water known or suspected to contain human wastes, get immunized against tetanus, hepatitis, typhoid fever, and polio.

15. Try to avoid working alone in the field. Make sure the supervisor or their designee knows where you are and when you are expected to return. Check in periodically.

16. Safety Data Sheets (SDS) [previously Material Safety Data Sheets (MSDS)] for formalin (also nitric acid, toluene and Naphrax if lab processing) are to be kept in the lab or office. Everyone working with these agents should be familiar with the location and content of the SDS sheets. Ethanol must be stored in fire-proof cabinet and disposed of as a hazardous waste.

17. When traveling in a vehicle always wear a seat belt and follow all Tennessee Department of Safety and Motor Vehicle Management rules. Do not text and drive. Do not use visual navigation aids (maps or electronic) while operating a vehicle.

18. In the event of a life-threatening emergency, go the nearest hospital. Call for emergency assistance if moving the injured person is likely to inflict further injury. Report all injuries at work, report to supervisor and follow guidelines found at https://www.tn.gov/workforce/injuries-at-work/employers/employers/reporting-a-claim.html

21. Be aware of potentially volatile situations. When entering or crossing private property, try to obtain permission from the landowner beforehand in order to avoid confrontation. Have business cards available to leave at residences when appropriate. If approached by someone representing law enforcement, show them a state I.D. and ask to see their I.D. or badge. The Tennessee Highway Patrol can be reached by dialing *THP (*847) from a mobile phone. The phone numbers for the THP district headquarters are listed below.

Knoxville:	(865) 594-5800	Chattanooga:	(423) 634-6898
Nashville:	(615) 741-2060	Memphis:	(901) 543-6256
Fall Branch:	(423) 348-6144	Cookeville:	(931) 528-8496
Lawrenceburg:	(931) 766-1425	Jackson:	(731) 423-6630

I.E Cautions

1. Avoid cross contamination of samples. Use new disposable pipettes at each site (or duplicate) and rinse jar used to combine aliquots thoroughly. Clean hands thoroughly between samples to remove diatoms. Only use clean bottles for collections.

2. Avoid sampling bias by following these procedures exactly. Document any deviation.

3. Take care not to under sample. At least 40 mls need to be collected at each site (more can be collected if needed to insure sufficient number of diatoms in sample). If habitat is limited, collect multiple aliquots at available habitat to achieve 40 mls. (Reach length may be extended if necessary, as long as no tributaries or other additional sources of contamination are present in the extended area.)

4. Use the standardized station ID naming protocol for all samples. Check the Division of Water Resource (DWR) online assessment map and/or stations table in Hydra to make sure a station has not already been established with a different station ID. Notify the Watershed Planning Unit (WPU) of any discrepancies. Make sure the station ID is included on all paperwork associated with the sample.

5. Measure river mile from mouth to headwaters. For embayments, start measuring from confluence with the original channel of the main stem. Use GIS (Geographic Position System) layer, TDEC on-line assessment map https://tdeconline.tn.gov/dwr/ or USGS Streamstats https://streamstats.usgs.gov/ss/ at the 1:2400 (7.5 minute) scale to measure stream miles. Do not use the Reach File Index or the National Hydrology Dataset (NHD) flowline layer which measures in straight lines.

6. To avoid errors, calibrate all meters following Protocol C. Ideally all meters should be calibrated daily. Dissolved oxygen must be calibrated daily. Minimally temperature, conductivity and pH must be calibrated once a week; more often if questionable readings are encountered, perform a drift check at the end of each day (or on return if overnight travel is required). If the meter calibration is off by more than 0.2 units for pH, temperature or D.O. when measured in mg/L or by more than 10% for conductivity or D.O when measured in % saturation do not report/upload readings for that parameter from any site collected since the last calibration. Make a note under meter problems on stream survey sheet and/or field parameter data forms.

7. Express all time on a 24-hour (military) clock format without colon.

8. Write all dates in mm/dd/yyyy format.

9. Express all distance measurements in English measurements (inches/feet/yard/miles).

10. Make sure to use appropriate units for all field measurements as indicated protocol C (field parameters) and E (stream survey sheet).

11. Use GPS to confirm location at site. Record latitude and longitude in decimal degrees.

12. If an error is made in any written or printed documentation, draw a single line through the error, so that it is readable and write the correction above. Date and initial the correction.

13. Take care that additional stream information recorded on the stream survey field sheet (or data form) does not contradict information provided on the

habitat field sheet (or data form). This is especially important for sediment and riparian information.

14. Document any deviations to protocol on the stream survey form.

15. Do not collect sample if flow is reduced to isolated pools, flooded or stagnant (such as impounded by beavers or bridge obstruction). Wait a minimum of 2 weeks after water returns to normal flow.

16. Check Hydra stations table before assigning station names to make sure a name has not already been assigned to the site by another sampling team or agency. Unless the sites are located upstream and downstream of a point source discharge, tributary confluence or some other factor that would affect the stream, stations collected within 200 yards of each other are considered the same site. Check station Ids to verify names follow logical progression from downstream to upstream. Upload new stations to Hydra. (See Protocol B).

I.F. Interferences

1. Document all deviations from protocol.

2. Make sure a minimum of 40 mls are collected at each site.

3. Collect samples in opaque brown bottles and avoid exposure to light.

4. Sampling should be conducted between March and November (preferably between April and October) when periphyton growth is highest and rainfall runoff is generally lower. High flow levels and scouring may be greater in the winter and spring.

5. Avoid areas of deep canopy unless entire reach is shaded.

6. Avoid sampling in flooded conditions or immediately after a flood.

7. Do not sample if stream is reduced to isolated pools. Only sample if there has been flow for longer than 2 weeks.

8. Do not sample if water is stagnant (backed up by log jams, beavers etc.). Move site outside of interference.

9. Do not sample near spring origin or in streams with < 0.01 square mile drainage.

10. To avoid errors, calibrate all meters following Protocol C. (Ideally all meters should be calibrated daily but minimally must follow schedule in Protocol C). Dissolved oxygen must be calibrated daily. Minimally temperature, conductivity and pH must be calibrated once a week, more often if questionable readings are encountered. Perform a drift check at the end of each day (or on return if overnight travel is required). If the meter calibration is off by more than 0.2 units for pH, temperature or D.O. when measured in mg/L or by more than 10% for conductivity or D.O when measured in % saturation do not report readings for that parameter from any site collected since the last calibration. Note under meter problems on stream survey sheet and/or field parameter data forms.

11. Use nomenclature consistent with United States Geological Survey (USGS) biodata https://my.usgs.gov/confluence/display/biodata/BioData+Taxonomy+Downloads

12. Sampling stations should be located in areas where the benthic community is not influenced by atypical conditions, such as those created by bridges or dams, unless judging the effects of atypical conditions is a component of the study objectives.

I.G. Personnel Qualifications and Training

Field Collections

At least one biologist on a sampling team must meet the following requirements. Trained staff with some coursework in biology and/or specific training and experience may assist in collections.

Minimum Education Requirements: B.S. in a biological science. Coursework in stream ecology and phycology is desirable. Advanced degree in stream ecology, aquatic biology, phycology, or similar field is preferable.

Professional credentials must be submitted to WPU and maintained on file in SharePoint:

https://tennessee.sharepoint.com/sites/environment/DWR/PAS/SitePages/Home.aspx and at the local office. See form Appendix B.

Field staff must successfully pass QC requirements (Section II-B).

Additional expertise:

- Proficiency in use of electronic forms including field devices,
- Use of standard water quality monitoring meters,
- Habitat evaluations
- Familiarity with Tennessee Water Quality Standards
- Stream ecology in Tennessee

Training:

- Protocols outlined in this SOP
- Habitat Assessments
- Physical-Chemical Field Parameters
- Electronic data recording, transmittal, and retrieval Quality System Requirements
- Quality Assurance Project Plan for 106 monitoring

Taxonomic Expertise:

All samples will be identified by the state lab or their contractor by a diatom taxonomist who has successfully completed QC requirements (Section II-E).

In addition, diatom taxonomists must pass Level 2 Society for Freshwater Science (SFS) https://diatoms.org/practitioners/diatom-taxonomic-certification or be a recognized expert in diatom taxonomy meeting at least four of the following criteria (adapted from the Taxonomic Certification program established in 2004 by the North American Benthological Society).

1. Author/coauthor of two or more peer-reviewed publications in diatom taxonomy or, has prepared and presented two or more papers at professional meetings focusing on the diatom taxonomy/systematics.
2. MS/PhD related to the field of diatom taxonomy.
3. Has worked in a professional capacity as a diatom taxonomist.

4. History of performing taxonomic identification / verification services for diatoms.
5. Has organized, prepared, and successfully presented one or more diatom taxonomic training workshops.
6. Has served / currently is serving as a peer-reviewer for one or more manuscripts received from a journal editor prior to its publication in the primary literature, with focus on diatoms.
7. Has received research funds that support taxonomic/systematic diatom studies.

I.H. Equipment and Supplies

Prior to any sampling trip, gather and inspect all necessary gear. Replace or repair any damaged equipment. Calibrate D.O. the morning of the sampling trip and make sure all other meters have been calibrated within the week (daily preferable) and have drift check since the last use. Upon return from a trip, do a drift check on all meters, take care of any equipment repairs or replacements immediately. Necessary equipment will vary per project, but the following is a standardized list.

Field Equipment/Supplies

- TWRA collection permit (if collecting macroinvertebrates at the same time)
- Natural Area collection permit if collecting in state park/natural area.
- National Park Permit if collecting in National Park
- State ID and business cards
- Waders
- Backpack
- Toughbook (or similar portable electronic device) with biological forms loaded (paper field forms may be used and transferred to electronic workbooks if Toughbook is not available.)
    - Bioevent
    - Habitat Assessment Field Sheet (High gradient and/or Low gradient)
    - Stream Survey Field Sheet
    - Biological Analysis Request Form (for Chain of Custody and/or samples sent to lab)
    - RPS
    - SEMN (If southeast monitoring network site)

- Calibrated GPS unit or Toughbook
- Calibrated dissolved oxygen meter (air calibration on site or at EFO)
- Calibrated pH meter
- Calibrated conductivity meter
- Calibrated temperature meter or thermometer in ^{o}C
- Spare batteries for all electronic equipment
- Digital camera or Toughbook
- External sample tags
- Disposable pipettes (single squeeze approximately 2 ml)
- Preservative (buffered formalin)
- 500 ml wide mouth sample jar (approx. 9-cm inner diameter), marked at the 100 ml fill point.
- 125 ml opaque brown plastic jar to hold final sample.
- Small ruler if completing RPS.
- Waterproof marking pens (Sharpies), pencils and black ballpoint ink pens (not rollerball or gel pens)
- Flashlights
- Duct Tape
- First Aid Kit
- Time keeping device.
- Spherical densiometer (for canopy measurements)
- Cell phone

Laboratory Equipment/Supplies

Nitric Acid Digestion

- Nitric Acid UN2031
- Potassium Dichromate UN3086
- 100 ml (250 ml, 500 ml) graduated cylinder (Class A)
- Greased pencil or marker (Sharpie).
- Fume Hood
- 250 ml (50 ml, 500 ml) glass beaker
- Hotplate
- Deionized water
- Vacuum pump (suction device with small diameter fitting)
- 20 ml glass vial with screw cap PVC lined closure or scintillation vials
- Wash bottle with deionized water

- Full face respirator 700 3M series (current Respirator Fit test card)
- Lab coat
- 5 ml pipette with disposable/glass tip
- Aluminum foil
- pH or litmus paper
- Scoopula
- Acid resistant gloves
- Safety Data Sheets for all reagents

Diatom Slide Mounting and taxonomy

- Coverslip (number 1 thickness, 20x20 mm)
- Kimwipes
- 2-inch square white tile (1 per sample)
- Beaker of DI water
- Hotplate
- High quality microscope slides
- 10-100 microliter pipette with disposable tips or glass type A
- Scalpels or razor blades
- Slide labels
- Toluene UN1294
- High refractive index resin (Naphrax diatom mountant© or equivalent), prepared per manufacturer's instructions
- Brightfield and phase contrast microscopes with magnification up to 1000x
- Camera with a graticule calibrated and set to the proper objective on the image software so scale bar is correct
- Safety Data Sheets for all reagents
- Taxonomic Bench Sheets
- Species level Taxonomic Keys

Sample Container and Formalin Acquisition

Sample containers and buffered formalin for DWR staff are obtained through the Tennessee Department of Health Environmental Laboratory, Aquatic Section in Nashville Contact Carrie.Perry@tn.gov 615-262-6330.Supplies must be requested at least 30 days in advance. Please specify the amount of the item needed.

Item

- 125 ml opaque brown plastic bottle
- Buffered Formalin

Collection Permits

A TWRA permit is not necessary when collecting diatoms (if also collecting macroinvertebrates or fish, a permit is necessary see macroinvertebrate QSSOP)

https://www.tn.gov/content/dam/tn/environment/water/policy-and-guidance/DWR-PAS-P-01-Quality_System_SOP_for_Macroinvertebrate_Stream_Surveys-122821.pdf

State Park/Natural Area Collection

A collection permit must be obtained when sampling in state parks or natural areas. DWR staff are included under one permit which is renewed annually.

All others will need to submit an application to the TDEC Division of Natural Areas https://www.tn.gov/environment/permit-permits/permit-natural-resources/tennessee-state-parks-scientific-research-and-collecting-permit.html

National Park Collection

A National Park permit will need to be obtained when sampling on National Park Lands. https://www.nps.gov/nature/request-a-permit.htm

I.I. Procedures

Diatom Survey Quick Field Reference

(Minimum tasks to be completed at all diatom sampling sites)

1. Upon arrival at site, record latitude/longitude in decimal degrees, verify that sample location is correct.

2. Establish minimum 100-yard reach area (walk bank without disturbing stream).

3. Take field measurements near middle of reach area (at minimum measure D.O., temperature, pH and conductivity). Record on stream survey field sheet.

4. Collect chemicals (if needed) upstream of area disturbed during field measurements.

5. Collect macroinvertebrate sample if required (this can be done at same time as diatom sampling). Note TWRA regional office must be contacted prior to sampling if macroinvertebrates are collected, and a copy of the collection permit must accompany at least one team member.

6. Collect diatom samples (make sure at least 40 ml).

7. Measure flow and complete rapid periphyton survey if SEMN site.

8. Estimate average canopy of entire reach and record on stream survey form. Measure canopy using a densiometer in the middle of the reach and record on stream survey form. (If RPS is being completed, measure canopy at 5 transects and record on RPS form).

9. Complete BioForm (event, stream survey sheet, habitat assessment sheet (and biorecon if collected).

10. Take pictures of upstream/downstream sample reach, any habitat problems, unusual observations, and potential pollution sources. (This can be done any time during survey, but additional pictures should be taken after survey is complete if significant disturbance is noted such as pipes, severe erosion, livestock in creek etc.)

Protocol A – Selection of Survey Type, Station Location and Sample Period

> Except at SEMN sites which are sampled in April, diatoms are sampled once during the growing season, April to October. Shoulder months of March and November can be sampled if necessary and if algal growth is present.

1. Determine biological sampling needs.

   The Watershed Planning Unit will coordinate biological sampling needs with the environmental field offices and state laboratory. The location and type of scheduled biological assessments will be included in the annual water quality monitoring workplan. Additional biological assessments may be conducted as needed.

   Biological sampling will generally follow the watershed cycle. When developing the monitoring workplan within the targeted watershed, diatom samples should be collected with the following priority:

   a. Southeast Monitoring Network Sites (SEMN)

      Established SEMN sites are monitored for diatoms once in April (or within 2 weeks of initial spring sample) unless high flows necessitate May sampling.

   b. Ecoregion Reference Streams

      Established ecoregion or headwater reference stations are monitored according to the watershed approach schedule.

   c. Sites where nutrient samples are being collected, especially if macroinvertebrates have not shown a response and/or semi-quantitative single habitat (SQSH) macroinvertebrate samples cannot be collected due to unavailability of targeted habitat.

   d. Streams known or expected to be impaired by nutrients. (Used as a screening tool to see if nutrient samples should be collected to confirm impairment).

2. Select Sites

Site selection is dependent on the study objectives. After determining the specific objectives of the study and clearly defining what information is needed, select sampling sites on specific reaches of the stream. Reconnaissance of the waterway is very important. Note possible sources of pollution, access points, substrate types, habitat, flow characteristics, and other physical characteristics that will need to be considered in selecting the sampling sites. Although the number and location of sampling stations will vary with each individual study, the following basic rules should be applied:

a. For watershed screenings, locate sites near the mouth of each tributary. If impairment is observed, locate additional sites upstream of the impaired stream reach to try to define how far the impairment extends and locate potential sources.

b. For monitoring point source pollution, establish a station downstream of the source of pollution depending on type of discharge and stream size to capture the potential area of impact. If possible, establish stations at various distances downstream from the discharge. Space the collecting stations exponentially farther apart going downstream from the pollution source to determine the extent of the recovery zone.

   For nutrient and dissolved oxygen, the impaired area (sag) may be far downstream of the source. If determining the effect of potential toxins, stations should be located closer to the discharge point. For intermittent discharges, sampling should be within thirty days of last discharge.

c. Unless the stream is small or extremely turbulent, an in-flow discharge will usually hug the stream bank for some distance. This may result in two very different biological populations and an inaccurate assessment of stream conditions. Make sure sample location is within the area influenced by the discharge.

d. Sampling stations for diatoms should be located within the same reach as macroinvertebrates. When possible, it should also be the same reach as chemical monitoring (or nearest access point with habitat). If the diatoms are collected more than 200 yards from the chemical sampling, consider it a separate station and assign it a different station ID number unless there are no tributaries, discharges, construction, agriculture, road crossings or other activities that would influence the stream between the chemical and biological sampling points.

e. Sampling stations should be located in areas where the benthic community is not influenced by atypical conditions, such as those created by bridges or dams unless judging the effects of atypical conditions is a component of the study objectives.

f. Ecoregion reference sites may be relocated upstream if localized disturbance is observed during sampling (for example beaver activity, riparian disturbance, 4-wheel activity, dredging etc.) Always communicate with WPU when relocating a reference stream.

g. Stream must have had flow for a minimum of 14 days prior to sampling. Wait 3 weeks if severe scouring has occurred. Avoid habitats that may not have been submerged for 2 weeks, isolated pools or stagnant water.

h. Do not sample near spring origin or in streams with < 0.01 square mile drainage.

3. Site Reconnaissance

When it is necessary to establish a new monitoring site or move an existing site, reconnaissance is needed to find a safe, accessible, and representative station. It is also recommended that reconnaissance be performed prior to the beginning of the monitoring year to determine if established sites are still accessible or need to be relocated.

a. New site reconnaissance

1) Consult aerial maps o identify potential access points that are representative and meet the needs of the study.

2) Drive to each potential monitoring point. Find a safe parking area near the access point. Park the car and walk to the creek. (If the access is through private property obtain permission before crossing.)

3) Make sure the creek is accessible and wadeable by entering the creek.

4) Make sure suitable diatom habitat is available.

5) Record latitude/longitude and information concerning access. Complete the new station form and upload to Hydra. Provide any unusual access information in the comment section.

b. Moving an established site.

1) If an established site becomes inaccessible, it may be necessary to relocate the site to another location. The new site should be located to meet the original objectives. This should be in the same waterbody ID segment (exceptions may be when needing to relocate a station downstream of a discharge.).

2) Ambient monitoring stations should never be moved.

Protocol B – Assigning DWR Station ID

A list of existing stations is available as a drop-down on the event tab of e-Forms, Appendix A, the station reference table on Hydra and the TDEC Data Viewer. If a station does not exist, a new station can be assigned using the new stations section on the form. However, before creating a new station ID, always check Hydra station reference table to make sure a station has not already been created at that location (the e-Forms are updated annually and may not have all the established stations in the drop-down list).

Even if the site has not been collected before by the EFO, a station ID may have already been assigned based on other agency data (NPDES instream sampling, ARAP, special projects, TVA etc.). Do not assume that a station does not exist because it has not been collected by the EFO or is not in the e-Form drop down list. It is very important that all data from a single location be given the same station ID to facilitate assessments based on all available information. **Contact the Watershed Planning Unit if there is any question or if there are naming errors associated with existing stations.**

It is very important that station IDs are assigned consistently with the same location always given the same ID regardless of the sample collection type, purpose, samplers, or year.

If new stations are created, they should be uploaded to the stations staging table in Hydra as soon after the sample collection as possible. They must be uploaded before samples are analyzed by the lab. An e-Form (see Appendix B) has been developed for submitting new stations. The form and biological survey electronic reporting tutorial (BSERT) are available on the DWR publications page or by contacting WPU QC staff.

DWR station IDs are created using the following protocol. The station ID is used to identify the sample and must be included on all associated paperwork, electronic datasheets, results, tags, etc. This number is to be used to identify this site every time it is sampled for any parameter (benthic, fish, periphyton, bacteria, and chemical).

Unless the sites are located upstream and downstream of a point source discharge, tributary confluence or some other factor that would affect the stream, stations collected within 200 yards of each other are considered the same site. (So, if chemical samples were taken off the bridge and biological samples were collected up to 200 yards upstream or downstream, they are still the same station.)

Chemical and biological stations collected more than 200 yards apart can still be considered the same station if there are no tributaries, discharges, construction, agriculture, road crossing or other activities that would influence the stream between sampling points. **It is very important for biological and chemical samplers to coordinate naming of station locations to avoid confusion.**

The official waterbody name is the one published on the USGS 1:24,000 scale (7.5 minute) USGS topographical map or equivalent GIS layer. Do not use other sources such as gazetteer, bridge signs or local names, which may differ.

It is also important that river miles used in the station ID are measured as accurately as possible using the USGS 1: 24,000 scale (7.5 minute) USGS topographical map and correspond to the latitude and longitude for easy comparison between multiple stations on the same waterbody. There are several options that can be used for measuring river miles:

(1) TDEC online Assessment map http://tdeconline.tn.gov/dwr/. Use the USA topographic map or USGS topographic map base map. Do not use the topographic base map which is not as high resolution and does not have some smaller tributaries. Do not use the assessment layers which follow flow lines and sometime cut off meanders.

(2) USGS Streamstats https://streamstats.usgs.gov/ss/. Use the National Map Base Layer. Do not use the National Geographic layer which uses flow lines which may cut off meanders and not all small tributaries are visible. This application measures distance in feet and will need to be converted to miles.

(3) ArcGIS Map Service. Use a USGS topographic base map at the 1:24,000 scale and do not use the NHD flowline layer or Reach File Index which are straight lines and cut off meanders.

For larger rivers, measure from the river mile if identified on the map layer.

When measuring river miles for streams that enter an embayment, begin measurement from the confluence with the original channel of the main stem (not from where the stream becomes an embayment). For example, in Figure 1, river mile 0 for Bearden Creek would start at the confluence with the original channel of the Clinch River as marked on the topographic map within Melton Hill Lake. Follow the original stream channel line if marked on the map (do not use “poly lines”). If the original stream channel is not marked on the topographic map, straight lines may be used through the embayment area.

If there are other stations located on the same stream, make sure the assigned river miles are appropriately upstream or downstream of existing stations. If errors are discovered on existing stations, contact WPU to have the stations reassigned.

Figure 1: Start of River Mile for Measuring Creeks Within Embayment Areas.

The only exception to the naming scheme is sites that have been designated as Ecoregion or headwater reference sites. These sites are always identified with their ECO or FECO designation no matter what the purpose of sampling. If new ecoregion reference sites are added, contact the WPU QC biologists to determine the appropriate station name.

1. Named streams/rivers

If a number does not already exist for the site, create an identification number. All letters in the station name are capitalized.

a. The first five digits will be the first five letters of the stream name (capitalized). If the stream name has more than one word, use the first letter of each word finishing out the five letters with the last word. For example, South Fork Forked

Deer River would be SFFDE. Do not use the words River, Creek Branch etc. (Fork is only used if the stream is also designated river, creek, branch etc.) For example, Dry Fork would be DRY but Dry Fork Creek would be DFORK. **The stream name will be one designated on the 1:24,000 scale (7.5 minute) USGS topographical map or GIS layer. (Do not use the Gazetteer, local name, bridge signs etc.).**

b. The next five characters designate the river mile. This is recorded as three whole numbers, a decimal and a tenth space. For example, river mile 1.2 would be 001.2. Do not add zeros to make a short stream name longer. It is very important that the river mile be determined as accurately as possible (see number 3 above). Measure the river miles from the confluence with the next waterbody downstream to the sampling location.

c. The last two characters designate the county (or state if not in Tennessee). Use the County Identification table in Appendix E to determine the appropriate county designation. The county is expressed with two-letters; do not use the numeric state code. If the station is in another state, add an underscore __ before the two-letter state abbreviation.

Example 1: A station located at river mile 2.0 on Puncheoncamp Creek in Cumberland County would be PUNCH002.0CU.

Example 2: A station located at river mile 25 on the North Fork Forked Deer River in Gibson County would be NFFDE025.0GI.

Example 3: A station that is located in Kentucky at river mile 15.2 of Spring Creek would be SPRIN015.2_KY.

If necessary, samples may be collected in a cross-section to isolate effects of contaminants or disturbance. In such instances, the station ID should identify the location of the sample by using the following designations at the end of the ID.

-RDB Right descending bank
-LDB Left descending bank
-MC Mid channel.

For example, for 3 sites on the Cumberland River at mile 102.5:

CUMBE102.5ST-RDB
CUMBE102.5ST-LDB
CUMBE102.5ST-MC

If the stream has both a natural channel and a canal, the canal should be designated with 1C after the first five letters and before the river mile. For example:

LOOSA010.1SH = Loosahatchie River at river mile 10.1 in the natural river channel.
LOOSA1C40.5FA = Loosahatchie River Canal at river mile 40.5

2. Unnamed Streams/Tributaries.

Check a 24k scale topographic map (hardcopy or GIS) layer to see if the unnamed stream is within a named geographical feature such as a cove, hollow, gulf, gulch, or valley.

a. For streams that are not within a named geographical feature:

(1) Use the first five letters of the receiving stream the tributary enters.

(2) Use a 3-5-character stream mile to indicate where the tributary enters the main stem (whole number, decimal and tenth for example river mile 0.1, 2.3, 10.9, 114.6).

(3) Use the letter T to indicate a tributary.

(4) Use the 3-digit river mile of the unnamed tributary where the station is located unless greater than 9.9 in which case use 4 digits. For example, 0.1, 2.1 or 10.3.

(5) Use the two-letter county abbreviation from Appendix E. If the station is in another state, add an underscore _ before the two-letter state abbreviation.

Example 1: A station located at river mile 0.2 on an unnamed tributary that entered the Harpeth River at river mile 114.6 in Williamson County would be HARPE114.6T0.2WI.

Example 2: A second station at river mile 0.3 on the same tributary would be HARPE114.6T0.3WI.

Example 3: A station located at river mile 5.5 on a different unnamed tributary which entered the Harpeth River at mile 115.0 in Williamson County would be HARPE115.0T5.5WI.

(6) When naming an unnamed tributary to an unnamed tributary, start at the named stream (mainstem) and work upstream to the sampling point.

(a) Record the first five letters of the mainstem (named stream).
(b) Record the river mile where the first unnamed tributary enters the main stem followed by a T.
(c) Record the river mile where the second unnamed tributary enters the first one, followed by a T.
(d) Record the river mile where the station is located, followed by the county designation.

Example: A station at river mile 0.2 on an unnamed tributary that flows into a second unnamed tributary at river mile 0.1 which, in turn flows into Cosby Creek at river mile 6.9 in Cocke County would be COSBY6.9T0.1T0.2CO (Figure 2).

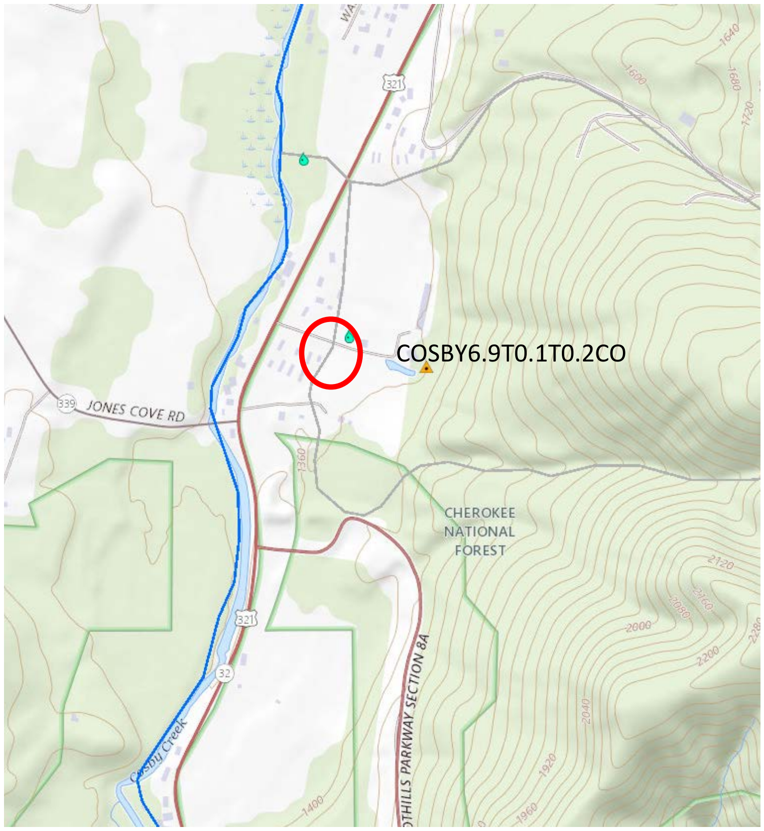

Figure 2: Naming Scheme for Stations Located on Unnamed Tributaries to Unnamed Tributaries. Station ID COSBY6.9T0.1T0.2CO.

b. **For streams that are within a named geographical feature:**

(1) The first five digits will be the first five letters of the name of the geographical feature (capitalized). If the feature name has more than one word, use the first letter of each word finishing out the five letters with the last word. Do not use the words Cove, Hollow, Gulch, Gulf, or Valley. If the feature name has fewer than five letters use the entire name.

(2) Add the underscore _G to indicate that the station is named after a geographical feature and not a named stream. Streams with "_G" will be the main branch running through the feature.

(3) The next three characters designate the miles upstream from the nearest named stream or waterbody. This will be written as one whole number, a decimal and a tenth space. For example, river mile 1.2 would be written as 1.2. If the stream is an unnamed tributary to the main branch (_G streams), the miles will be measured upstream from the main branch instead of the nearest named stream or waterbody (see example 3).

(4) Use the two-letter county or state abbreviation from Appendix E. If the station is not in Tennessee, add an underscore _ before the two-letter state abbreviation.

Example 1: A station that is in Shingle Mill Hollow in Marion County and is 0.3 miles upstream from Nickajack Reservoir, which is the closest named waterbody would be SMILL_G0.3MI.

Example 2: A station that is located on an unnamed main branch in Cave Cove in Marion County that is 0.4 miles upstream of the nearest named stream would be CAVE_G0.4MI.

Example 3: A station at river mile 0.2 on an unnamed tributary that enters main branch in Cave Cove at river mile 1.0 would be CAVE1.0G0.2MI.

3. Wetlands

a. For named wetlands

(1) Use the first five letters of the wetland name if one word – if more than one word, use the first letter of each word plus as many letters are needed in the last word to get five total letters (see 2.a).

(2) Add underscore _W.

(3) Use a 3-character stream mile including one whole number, the decimal and a tenth space. For example, river mile 1.2 would be written as 1.2.

(4) Use the two-letter county or state abbreviation from Appendix E. If the station is in another state, add an underscore _ before the two-letter state abbreviation.

Example 1: A station located at DUCK wetland would be DUCK_W1.2CH.

Example 2: A station located at BLACK HORSE wetland would be BHORS_W1.2CH.

b. For unnamed wetlands with an associated stream

(1) Use the first five letters of the stream associated with the wetland if one word – if more than one word, use the first letter of each word up to five letters (see 2. A.).Add underscore _W

(2) Use a 3-character stream mile including one whole number, the decimal and a tenth space. For example, river mile 1.2 would be written as 1.2.

(3) Use the two-letter county or state abbreviation from Appendix E. If the station is in another state, add an underscore _ before the two-letter state abbreviation.

Example: A wetland associated with a stream Clear Creek would be CLEAR_W1.2SM.

3. For isolated unnamed wetlands with no stream associated with it, use the name associated with the ARAP permit request.

(1) Use the first five letters of the company associated with the wetland, - if more than one word, use the first letter of each word up to five letters.

(2) Add underscore _W.

(3) Use a 3-character stream mile including one whole number, the decimal and a tenth space. For example, river mile 1.2 would be written 1.2.

(4) Use the two-letter county or state abbreviation from Appendix E. If the station is in another state, add an underscore _ before the two-letter state abbreviation.

Example: Company name Boones Farm BFARM_W1.2CO

4. **Sinking streams (with no clear channel or surface flow to main stem – use standard naming scheme for streams with clear channel or that resurface)**

   a. Use the first five letters of the stream name if one word – if more than one word, use the first letter of each word up to five letters. For unnamed sinking streams or if the receiving stream is unclear use the first five letters of the closest mapped feature.

   b. Add underscore _S.

   c. Use a 3-character stream mile including one whole number, the decimal and a tenth space (use additional characters as needed if the stream mile is greater than 9.9). Start mileage from the point where the stream disappears (if the stream resurfaces downstream and it is clearly the same stream, estimate the distance between surface points).

   d. Use the two-letter county or state abbreviation from Appendix E. If the station is in another state, add an underscore _ before the two-letter state abbreviation.

   Example 1. A station located at river mile 1.2 on Dry Creek would be DRY_S1.2CU.

   Example 2. A station located at river mile 11.2 on Stinky Cow Creek would be SCOW_S11.2CU.

   Example 3. An unnamed sinking stream station located on Crane Top Ridge with no clear flow pattern would be CTOP_S1.2FR.

5. **Reservoirs (man-made lakes)**

   a. Assign the first 5 letters of the impounded stream, river (or embayment).

   b. Use a 5-character stream mile if the sample is collected near the river channel. If the sample is collected near the right or left bank (such as at a boat dock) use a 4-character stream mile and the letters RDB or LDB to designate the right or left descending shore.

c. Use the appropriate two-letter county or state abbreviation from Appendix E. Add an underscore _ before the two-letter state abbreviation for stations in another state. For example, a station that was collected from a boat on Fishing Lake which dams Otter Creek in Anderson County would be OTTER012.3AN. If the station was collected off a dock near the left descending shore the station ID would be OTTER012.3AN-LDB'

In the station location include the reservoir name as well as location for clarification (for example Otter Lake near boat dock).

6. Natural Lakes

a. Use the first 5 digits of the lake's name.

b. Using an S to designate station and a two-digit whole number, assign the next available station ID. For example, if station IDs 1 through 4 already exist on that lake from previous studies (check Hydra) then use station ID 5. This would be designated S05.

c. Use the appropriate two-letter county or state abbreviation from Appendix E. Add an underscore _ before the two-letter state abbreviation for stations in another state.

For example, a new station located on Reelfoot Lake in Obion County would be REELFS05OB.

Protocol C – Field Parameters

Adapted from U.S. Environmental Protection Agency. 2002

Dissolved Oxygen (D.O.), pH, temperature and conductivity measurements are to be recorded at each biological monitoring station every time the site is sampled. Field parameters are to be entered on the field parameter data e-form and uploaded to Hydra (Protocol E). The stream parameter electronic reporting tutorial (SPERT) is available on the TDEC publications page for specific instructions on upload procedure. Multi-probe or individual meters meeting specifications in Table 2 can be used.

Table 2: Water Quality Probe Minimum Specifications

Parameter	Range	Accuracy	Resolution
Temperature	-5 °C to 45 °C	+/- 0.20 °C	0.1 °C
Specific Conductivity	0 to 100,000 umhos/cm	+/- 1% of reading	4 digits
pH	2 to 12 units	+/- 0.2 units	0.01 units
Dissolved Oxygen	0 to 20 mg/L	+/- 0.2 mg/L	0.01 mg/L

Label all meters as property of the State of Tennessee, Department of Environment and Conservation. Assign each meter a distinct identifying designation, (i.e., letter or a portion of the serial number) for calibration, maintenance, and deployment records. Mark each meter with this designation. Record the meter's ID number on the field parameter data sheet.

Beyond following the instructions in this SOP for calibrating, maintenance, and logging procedures, it is also recommended to refer to manufacturer's instructions.

1. Calibrate Meter(s)

If probes are factory calibrated, check readings against the appropriate standards to ensure the calibration is still accurate. Maintain calibration SOPs for each type and/or brand of meter. Keep all calibration records in a backed up digital format (preferred) or bound logbook (Figure 3). Include the date, meter designation, project name/number, initials of calibrator, parameter, standards used, meter reading, and adjustments.

Also, record routine maintenance and repairs in the logbook as well as upload to Waterlog Production's Equipment and Assets Inventory. Some probes must be sent to the manufacturer for calibration. Other probes must be replaced when they no longer maintain their calibration. In these cases, refer to manufacturer's instructions.

Meters should be calibrated in the following order: Conductivity, Dissolved Oxygen, pH.

Date	Meter	Project	Init.	Parameter	Standard	Reading	Adj	Comments
08/01/21	YSI-A	ARAP	LEE	Conductivity	142	120	142	Cleaned contacts
08/01/21	YSI-A	ARAP	LEE	Conductivity	142	140	NA	Drift Check

Figure 3: Meter Calibration Log

a. **Frequency: To ensure the most accurate data, it is desirable that meters be calibrated each morning before use (or the afternoon during drift check for the next day).** It is necessary to calibrate D.O. probes each morning of use and at each site where necessary (see # 2). Daily calibration is preferred for the most defensible data, but, when necessary, conductivity and pH probes can be calibrated weekly with a drift check performed daily upon return (or at the end of the sampling period if overnight travel is involved). The drift check can be performed the next morning if time is a factor. The probes must be recalibrated when the drift check is out of the acceptable range before the next use. A drift check should be performed weekly for temperature. Drift checks for D.O. probes are not necessary if the meter was recalibrated in the field.

b. **Conductivity:** Calibrate at 0 and the highest expected conductivity value. When using meters where zero is assumed, a higher standard is used for the calibration. For the MS5 or other meters where 0 is not assumed, the flow-through cell must be dried and placed in a dry calibration cup for the zero standard. Then a higher standard is used to calibrate the upper range.

c. **Dissolved Oxygen (D.O.):** The probe must be calibrated using air calibration (% saturation) each morning prior to use. Most probes automatically compensate for temperature changes. Some probes also automatically compensate for pressure changes. An American Society for Testing and Materials (ASTM) calibrated thermometer and/or a handheld barometer must be carried in the field if the probe does not compensate for temperature and/or pressure changes. It is only necessary to recalibrate the probe at sites where there is a significant elevation, pressure or temperature change and the meter does not automatically compensate. A significant change in elevation is 1000 feet. A significant change in pressure is ±20 mm Hg (higher or lower) or when a storm front comes through the area. A significant change in temperature includes any ±5°C change in temperature (higher or lower). If the D.O. probe is air calibrated, changes in pressure do affect concentration readings. Record the air calibration at the site in a calibration log in the field to the specified resolution in Table 2.

d. **pH**: To calibrate pH, use buffers that will bracket the anticipated sample pH value. If the streams in a particular area are between 7 and 4 pH range, then a 2-point calibration would be sufficient. The same would be true for an anticipated sample value in the 7 and 10 pH range. However, a 3-point calibration should be used for streams and runs where the pH range is unknown. When in doubt do a 3-point calibration. Depending on the type of meter either electrolyte or potassium chloride (KCL) pellets should be replaced monthly in most cases, every week in low ionic strength environments. pH electrode should not be submerged during storage.

If conductivity measures < 100 umhos/cm3 and pH < 6, a pH sample should be collected for lab analysis to validate pH measurement. These should be collected in a non-preserved 250 ml bottle with no air space and preserved on ice. Holding time is 72 hours. Place an X next to pH on the lab request sheet and label the bottle as a pH sample. On field form, record field measurement and indicate in the comment that a lab pH was also collected. Load to Hydra with the other field parameter.

e. **Temperature:** To check the calibration of the temperature probe place an American Society for Testing and Materials (ASTM) thermometer in a container of room temperature water large enough to submerge the temperature probe. Place the meter in the water bath and allow it to equilibrate then compare the probe's reading to the thermometer's reading and mathematically adjust the probe's temperature as necessary. Coordinate with TDH laboratory to include the ASTM thermometer in their annual thermometer calibration check against the ASTM certified thermometer. Record this information in the calibration log.

2. **Probe Placement:**

Ideally, measure water parameters after collecting chemical and bacteriological samples and before measuring flow or collecting other samples (i.e., macroinvertebrate, diatoms). Turn on the meter(s) and if there is a D.O. stirrer, be sure it is activated. Carefully place the meter(s) in the thalweg upstream of the chemical and bacteriological sampling area. Suspend the probe(s) in the water column so it does not touch the bottom. If the water is too shallow to suspend the meter(s), carefully lay it on its side, perpendicular to the direction of flowon a firm substrate (preferably rock). Do not allow the probe(s) to sink into soft substrate or leaves. The probe should be placed in an area of smooth flow (run) not in a pool, backwash, or turbulent area.

Stand downstream of the probe, being careful not to disturb the substrate around the probe(s). **Allow enough time for each reading to stabilize before it is recorded.** Depending on the meter, it may take a couple of minutes for dissolved oxygen to equilibrate. Record initial readings on the stream survey field sheet e-form (Appendix B) to the specified resolution (Table 2).

If D.O. readings are erratic or D.O. is less than 5 mg/l, check the membrane for wrinkles or bubbles or tears. If it is a Luminescent D.O. meter, check to see if the meter is scratched or sitting in bright sunshine. If sunshine is the problem, shade the probe (for example with your notebook). Erratic readings can also be caused by turbulence or failure to fully submerge the probe. In this case move it.

If D.O. continues to be erratic, field calibrate. If measurements are less than 5 mg/l, determine potential environmental causes such as algae, chemical spills, stagnant water, lots of organic matter, groundwater connection (springs) or wetlands. Document observance on stream survey data sheet. If the D.O. is below 5 mg/l and the post calibration is within 0.2 mg/l then check validated on the field parameter datasheet. If post calibration fails, reading should not be recorded on field parameter datasheet or uploaded to Hydra. Indicate calibration failure under meter problems on the datasheet.

If pH measurements are below 6 or above 9 and post calibration is acceptable, indicate validated under status ID on the field parameter datasheet. If post calibration is off, do not upload results to Hydra. Indicate potential environmental causes of low or high pH in meter problems.

Make sure the meter readings have stabilized before recording measurements. This may take several minutes especially in cold weather, very low flows, when oxygen levels are low or other unusual conditions.

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3. Duplicate Readings:

Take duplicate measurements at each site. If time is a constraint (short sample holding times or daylight), duplicate readings may be reduced to first and last site each day. To take a duplicate measurement, lift the probe completely out of the water, wait for the readings to change then return it to the original location or slightly upstream if the sediment was disturbed. Allow the meter to equilibrate before recording readings. If the readings are off by more than 0.2 units for pH, temperature, and D.O. in mg/L or off by more than 10% for specific conductivity, repeat the procedure until reproducible results are obtained. Record the 2 measurements that are within acceptable limits on the stream survey data sheet (BioForm) All results are to be recorded to the resolution specified in Table 2. Rinse the probes with clean water after use at each site to avoid contamination.

4. Record Field Parameters:

Document the field measurements on the electronic stream survey form included in the BioForm workbook. Specific conductivity must be measured in umhos/cm or uS/cm, dissolved oxygen in ppm (mg/l), and temperature in ^{o}C. If measurement is outside of criteria, there are no meter problems and drift check is OK, mark validated in the appropriate box on the field form.

5. Drift Check:

Without post-calibration checks, the accuracy of the water parameter measurements cannot be demonstrated. At the EFO lab, perform a drift check on each meter at the end of the day (or at the end of the trip on multiple night trips) and record results in the logbook (Figure 3). Drift checks can be done in the field if you have the proper equipment.

To check that the probes have maintained their calibration for pH and conductivity, compare the probe's readings against the appropriate pH, and conductivity standards. Adjust calibration if the probe is going to be used again that week. If the meter's calibration is off by more than 0.2 for pH or more than 10% for conductivity, all readings between the initial calibration and the drift check should be discarded. To check that the probes have maintained their calibration for temperature, compare the probe's readings against a standard ASTM thermometer. If the meter's calibration is off by more than 0.2, all the readings between the initial calibration and the drift check should be discarded.

When the D.O. probe has been air calibrated in the field due to pressure, elevation or temperature changes, a drift check is unnecessary at the end of the day. If the D.O. probe was not re-calibrated since leaving the base office, a drift check should be performed at the end of the day. If the meter's calibration is off by more than 0.2 mg/L (Winkler) or 10% (air), all readings between the initial calibration and the drift check are questionable.

If measurements are criteria violations and the data have been validated, be sure to indicate in the comments section for that parameter that the drift check passed.

If drift check fails for any parameter, do not upload parameter that failed. Upload parameters that pass with a note about the failing parameter. Indicate on electronic stream survey sheet that there was a

6. Other Parameters:

Some multi-parameter probes contain sensors for other water quality parameters such as turbidity or suspended solids. If these parameters are also measured, they should be calibrated following manufacturer's specifications prior to use with drift checks performed at the end of each day. It is recommended that turbidity be measured in the field instead of collecting a sample for lab analysis if a calibrated meter is available. Duplicate measurements should be taken at each site and recorded on the stream survey sheet.

Header Information for Field Forms (Protocols D-E-F)

Habitat and Stream Survey Forms must be completed with every biological sampling event. The DWR electronic e-forms are the required method for submitting data. See Biological Survey Electronic Reporting Tutorial (BSERT) or for details on using e-Forms and uploading to Hydra.

Most of the header information for the field forms will be populated from the BioEvent tab on the e-form. The following are details on the header information in the BioEvent.

1. **DWR Station ID**: If the station ID is not already on the drop-down list in the BioForm, check current stations table in Hydra or the assessment data viewer to see if a station ID has already been assigned to this location. (Do not rely on memory or assume no-one else has ever collected any type of sample at this location. Another agency or a permit holder may already have established a station). If a station has not already been assigned, use standard station naming procedure, protocol B. When assigning new stations, make sure the river miles are in line with existing stations (for example river mile 1 should be upstream of river mile 0.5) or notify WPU biological QC staff if existing stations are named inappropriately. Complete the new station information in the BioEvent tab on the BioForm. DWR staff will upload the new station information from the Hydra tab into the station staging table in Hydra (see BSERT).

2. **Date**: Enter date of assessment (MM/DD/YYYY)

3. **Time**: Enter time (24 hour clock no colons)

4. **Samplers:** Include names of all samplers at the event.

5. **Organization**: Environmental field office or other sampling agency. Use code found organization table in Hydra (unless it is a new organization it will be in the drop- down list on the BioForm). If it is a new organization, contact WPU.

6. **Monitoring Location Name**: If it is an existing station, this will be auto populated from the station ID on the BioEvent. If it is a new station, the waterbody name should match USGS topographic map layer on the DWR assessment map viewer or use unnamed tributary to named receiving stream. Do not use local names (or gazetteer names) that are not on this layer.

7. **Monitoring Location**: This is the point on the waterbody that is being sampled. If it is an existing station, it will be auto populated on the BioForm and will match the location in stations table in Hydra. If it is a new station, use road names or features identifiable on topographic map layer if possible. Do not put directions to the site under location. This can be added to comment field if site is hard to find. Unacceptable location descriptions include:

    a. Downstream Sewage Treatment Plant (STP) -Specify what STP and how far downstream).

    b. Stinky STP – Specify upstream or downstream, how far, and which outfall if there is more than one.

    c. Behind Mr. Jones House. – Mr. Jones may move, or next sampler may not know where Mr. Jones lives, use 123 Penny Lane Instead.

    d. Playground (camp site, church, landfill, park etc.) – Use name of playground and road location or another map feature.

    e. Off Highway 123 – Roads are long, add another landmark (for example off Hwy 123 approx. 0.5 mile upstream of intersection with Bumpass Rd).

    f. Highway 123 Bridge – Specify upstream or downstream and how far. (If the road crosses the creek multiple times add additional location information such as 500 yards upstream of Hwy 123 Bridge Crossing near intersection with First Street.)

    g. Farm Road: There are a lot of farms, be more specific.

8. **Drainage area**: Square-mile drainage upstream of sampling location (will be auto populated if using DWR electronic datasheet at an existing station.) Drainage area can be determined using the interactive map at https://streamstats.usgs.gov/ss/ .

9. **Ecoregion**: Specify ecoregion of stream reach (If using DWR electronic datasheets, ecoregion will be auto populated for existing stations.) For new station check station location at http://tdeconline.tn.gov/dwr/ .

10. **U/S ecoregion**: If the upstream drainage is in another ecoregion record this in U/S ECO. In comment field note if station characteristics are more similar to the upstream ecoregion. Leave blank if the upstream ecoregion is the same as the ecoregion at the sampling location.

11. **County** is the county name where the station is located (even if most of drainage is in another county). If using the BioForm, county will be auto populated for existing stations. For new stations use the county abbreviations in appendix E. For streams which form county boundaries, be consistent with other stations located on the stream.

12. **Latitude and Longitude** are always in decimal degrees. If you are using the BioForm, verify coordinates to make sure you are in the right collection. (Otherwise check latitude/longitude on map viewer). If discrepancies are discovered, notify WPU of need to correct database information once you have confirmed the correct location and GPS reading are accurate.

13. **When establishing new stations,** the latitude and longitude should be recorded mid-stream in the middle of the sampling reach with a calibrated GPS. Always check latitude and longitude against the database for existing stations to verify location.

14. **HUC**: is the 8-digit USGS +-Hydrologic Unit Code. The BioForm will auto populate the HUC for existing stations. For new stations use the mapviewer to assign the specific 8- digit HUC number.

15. **WS Group** is the watershed assessment group and will be auto populated by the BioForm for existing stations. For new stations the online assessment

mapviewer can be used except in split watersheds (06010102, 06010201 and 06020001). Contact WPU if you are uncertain of the appropriate watershed group.

16. **WBID#**: When possible, use Water Body ID Number (WBID#) assigned for the stream segment. The Water Body ID for each segment can be found using the online assessment database http://tdeconline.tn.gov/dwr/.

17. **Field Log Number**

    a. Samples must be assigned a field log number to allow complete reconstruction, from initial field records, through data storage, sample analysis and system retrieval. This includes biorecons that are identified in the field with no vouchers. If using DWR electronic forms, this number will be automatically assigned. Otherwise, the same field log number should be assigned to all samples collected at that site that day (Biorecon, SQSH, Diatoms, Chemicals). Even if different team members are collecting each sample type, one person is considered the primary assessor for the field log number. Use the format (Primary assessor initials followed by date with no separations (MMDDYYYY) and then a 2-digit running number for each site throughout the day. (If it is a duplicate, the second sample is given the next number in line.)

        i. KJL0131202201 would be all of the samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by KJL on 01-31-22 at the first site of the day.

        ii. KJL0131202202 would be the duplicate samples collected or assessed by KJL on 01-31-22 at the first site of the day.

        iii. KJL0131202203 would be all of the samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by KJL on 01-31-22 at the second site of the day.

        iv. KJL0201202201 would be all of the samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by KJL on 02-01-22 at the first site of the day.

18. **Project Name**: If using BioForm, select project name associated with the project purpose. which are included on the form as a drop-down list (watershed, 303(d), Antideg, ECO, FECO). Use project codes found in Appendix E or Hydra Reference table if possible. If a new project needs to be added contact WPU.

19. **Project ID**: Indicate project ID associated with the project name. The project ID for DWR surface water samples will always begin with TNPR. The ID will be automatically completed if using the e-Form. Otherwise, use project codes found in Appendix E or Hydra Reference table. If a new project needs to be added contact WPU.

20. **Activity Type**: Indicate the type of activity as listed in Table 3.

Table 3: Stream Survey Activity Types

Activity Type (Official Code)	Sample Type	Description
Sample-Routine	Diatom + Habitat Assessment	Diatom sample collected, no QC.
Quality Control Sample-Field Replicate	Diatom Field Duplicate	Diatom Field duplicate may or may not include habitat QC

21. **Sample Information**

    a. **Sample Status**. Indicate the status of the sample using the drop-down list on the e-form. If the sample could not be collected indicate if another attempt will be made to collect the sample when conditions improve by marking the revisit box.

    b. **Flow Conditions**: Indicate flow conditions at time of site visit. Do not collect samples if dry, isolated pools, stagnant, bankfull or flooding.

    c. Indicate all **sample types** collected at the site. (SQSH, biorecon, periphyton, nutrients, metals, E *coli*, organics, etc.).

Protocol D – Habitat Assessment

Habitat assessments must be completed each time a site is sampled for biology (diatoms and/or macroinvertebrates). The habitat assessment should be completed using the electronic e-Forms. E-Forms are available on the DWR website publications page or by contacting WPU. E-forms. can be completed directly in field (if tablets are available) or transferred from worksheets found in Appendix B to e-Form upon return to office. Datasheets should be uploaded to Hydra within one week and before sending samples to the lab.

Habitat assessments are primarily used to determine whether various components of the habitat are factors in fish and aquatic life impairment. A qualitative approach is used to minimize field time while still establishing a standardized assessment procedure that can be used for comparison to ecoregion guidelines. Because of the qualitative nature, the habitat assessment is not considered a cause of impairment without a measured biological response. By close adherence to these assessment guidelines and standardized training, a consistent habitat assessment approach can be achieved.

Conduct a habitat assessment every time a diatom sample is collected. This assessment must be conducted on the same day the biological sample is collected. Although generally only macroinvertebrate and/or diatoms samples are collected, it is important to consider both macroinvertebrates and fish when evaluating habitat. The macroinvertebrate sample is used as an indicator while the habitat assessment is used as a cause of impairment to both fish and aquatic life. It is necessary to walk the entire reach while assessing habitat. It is advisable that two staff members collaborate on the assessment to reduce subjectivity.

Two different habitat assessment e-forms or field sheets will be used dependent on the Level IV ecoregion and/or stream type at the sampling location (Appendix B). These field sheets are modified from *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Barbour et. al., 1999). Habitat guidelines for each ecoregion are provided in Table 4. Guidelines for individual parameters can be found in Appendix A. In ecoregions 65j, 66d, 66e, 66f, 66g, 66i, 66j, 66k, 67f, 67g, 67h, 67i, 68a, 68b, 68c, 68d, 69d, 69e, 71e, 71f, 71g, 71h, and 74a as well as moderate gradient streams in 71i, use the High Gradient Stream assessment field sheet to evaluate habitat.

In ecoregions 65a, 65b, 65e, 65i, 73a, 73b and 74b as well as low gradient non-riffle steams in 71i, use the Low Gradient assessment field sheet. Low gradient assessments may also be appropriate in some lower reaches of larger streams in other ecoregions. Copies of these field sheets are located in Appendix B and will be available for upload to field tablets (recommended).

Ecoregions designation based on sample point latitude and longitude can be found at https://tdeconline.tn.gov/dwr/. The Watersheds Planning Unit should be contacted if there is uncertainty about what ecoregion a stream is located in.

Evaluate all ten habitat parameters with 20 being the highest attainable score for each parameter (some are scored independently by bank with a scale of 0 -10). Scores are divided into four categories (Optimal, Suboptimal, Marginal and Poor) with a range of scores possible in each category.

The habitat assessment is based on the entire stream reach (typically 100 yards) and encompass all biological samples. If a longer sampling reach was used to collect biological samples (typically in larger streams or when habitat is scarce) or when collecting fish, the entire sampling reach is used for the habitat assessment. The assessment is an average of the conditions within this reach.

Because this assessment is qualitative, it is essential that assessors follow standardized protocols for scoring especially when assigning categories of Optimal, Sub-optimal, Marginal and Poor. This will enable comparison to ecoregion reference streams that have been assessed following the same standardized procedure.

Two steps are used to assign a habitat score for each parameter. The first step is assigning the parameter a condition category of Optimal, Suboptimal, Marginal, or Poor. **Assessors must be careful not to focus on the category names, they are meaningless in the state assessment. Scores are calibrated to pass/fail based on the median reference condition for each ecoregion.** The four broad categories are just a convenient tool to quadrisect the various habitat parameters before ranking. These categories are generally based on quantity of the specified parameter. The second step is assigning a numeric score (rank within that category). This is generally based on the quality of the parameter.

It is important that the assessor does not pre-calibrate the site based on reference expectations while in the field (For example thinking that streams in a certain area should score Optimal because that is as good as it gets, even if they do not meet the description). Scores will be adjusted to ecoregion reference conditions during analysis (Table 4). The best streams in some ecoregions may never fall in the "Optimal" category but will be considered fully supporting based on comparison to reference condition.

The guidelines on the field sheet and in this document should be followed as closely as possible. If the stream does not fit the descriptions, professional judgment should be used with the comment field used to explain scoring. A comment line is available at the bottom of each parameter. Comments can be used to provide additional descriptions, clarify difficult calls, explain atypical stream conditions, specify what characteristic resulted in the score when there are multiple interpretations, describe any factors that should be taken into consideration when interpreting the score or any other information that would help explain the assessment to a reviewer who has not been to the site.

Header

When using e-Forms, most of the header information will already be populated from the BioEvent, with the exception of the following:

<u>Habitat Assessed By</u>: Include initials of staff member(s) who scored the habitat assessment. Do not include any team members who were not involved with habitat assessment.

<u>Time</u>: 24-hour clock no colons

Note: If this is a QC, two separate habitat field sheets should be completed independently. If using the e-Form unhide the individual parameter worksheets. Consensus scores are marked on the primary habitat assessment worksheet (differentiate between investigator and consensus). Only the consensus data are uploaded to Hydra.

Protocol D-1: Moderate to High Gradient Habitat Assessment Field Sheet

The moderate to high gradient habitat assessment BioForm or field sheet (Appendix B) will be suitable for most wadeable streams in middle Tennessee (except for some streams in the Inner Nashville Basin – 71i) and in east Tennessee (unless in low gradient areas such as the mouth of large streams where riffles do not naturally occur). It will also be used for two ecoregions in west Tennessee: the Transition Hills (65j) and Bluff Hills (74a).

If riffles are not present due to disturbances such as sedimentation, sludge deposits or channel alterations, but the slope is moderate to high gradient, these field sheets will still be used to evaluate the stream. Some moderate to high gradient streams naturally do not have riffles (steep mountain streams or moderate gradient bedrock streams) however they should still be evaluated with this field sheet. The only time a low gradient field sheet should be used in these ecoregions is if the stream is in a low gradient area (sometimes occurs near the mouth of large streams). Note that the ecoregion reference guidelines cannot be used in low gradient streams in these ecoregions or for non-wadeable streams. Therefore, a suitable upstream or watershed reference must be selected for comparison. In these cases, the test stream should score within 75% of the “reference” stream to have comparable habitat.

1. Epifaunal Substrate/Available Cover

When assessing this parameter, look at various types of natural structures available to macroinvertebrates and/or fish throughout the entire reach. Look for habitat that provides refugia, feeding, spawning or nursery functions. Only count productive habitats, which provide a niche for colonization by macroinvertebrates or fish. For example, do not count “newly fallen trees, leaf litter that is not decaying or unstable habitats that will be washed out. Also, do not include artificial habitat such as fish attractors, tires, appliances, riprap, etc.

Natural productive habitats typically found in moderate to high gradient streams include:

- Cobble riffles
- Gravel riffles
- Bedrock crevices

- Boulders (Fish cover)
- Pool rock
- Run Rock
- Submerged trees (not new fall)
- Snags
- Decaying leaf litter
- Rock overhangs (Fish cover)
- Undercut banks
- Submerged Roots
- Macrophyte beds
- Mossy rocks

To assign a condition category, first look at how much of the stream reach is covered by natural, stable, productive habitat. The numeric score (rank) within the condition category is assigned based on the variety and quality of habitat.

For example, in a very high gradient mountain stream, over 70% of the substrate may be available for colonization putting this in the Optimal category. Four or more habitats may be present but is dominated by boulder cover so it may only score a 16. Variations in habitat that provide niches for different faunal types should be considered as different habitat types. For example, cobble in flowing water and cobble in pools count as two types of habitat.

Habitat that is not of sufficient quantity to support faunal populations, does not show evidence of colonization (such as newly fallen leaves), is not productive (such as seamless bedrock) or is likely to wash out should not be included. Artificial or man-made structures such as riprap are also not included since the goal is to evaluate natural habitat.

Optimal – Over 70% of the stream reach has natural, stable habitat available for colonization by macroinvertebrates and/or fish. Four or more productive habitats are present. Deadfall, leaf litter, snags etc. are not new-fall but show evidence of decay. If less than four habitats are present drop to Suboptimal.

20	Cobble and/or smaller boulders (≤18”) riffle is the dominant habitat.
19	Cobble run is the dominant habitat. Cobble riffles are present.
18	Cobble run is the dominant habitat. Cobble riffles are not present.

17	Productive habitat other than cobble riffle or run is dominant. Cobble riffles or runs are available.
16	Productive habitat other than cobble riffle or run is dominant Cobble riffles and runs are absent.

Suboptimal – Natural, stable habitat covers 40 – 70% of stream reach. Three or more productive habitats present. If near 70% and more than three habitats are available go to Optimal.

15	Cobble and/or smaller boulders (≤18") riffle is the dominant habitat.
14	Cobble run is the dominant habitat. Cobble riffles are present.
13	Cobble run is the dominant habitat. Cobble riffles are not present.
12	Habitat other than cobble riffle or run is dominant. Cobble riffles or runs are available.
11	Habitat other than cobble riffle or run is dominant Cobble riffles and runs are absent.

Marginal – Natural stable habitat covers 20 - 40% of stream reach or only 1 or 2 productive habitats are available in sufficient quantity to support a population. If coverage nears 40% and three or more productive habitats are present, go to Suboptimal.

10	Cobble and/or smaller boulders (≤18") riffle is the dominant habitat.
9	Cobble run is the dominant habitat. Cobble riffles are present.
8	Cobble run is the dominant habitat. Cobble riffles are not present.
7	Habitat other than cobble riffle or run is dominant. Cobble riffles or runs are available.
6	Habitat other than cobble riffle or run is dominant Cobble riffles and runs are absent.

Poor – Less than 20% stable habitat regardless of number of habitats. Lack of habitat is obvious. Substrate unstable or lacking.

5	At least two natural, stable, productive habitats are present in limited amount including either cobble riffles or runs.
4	At least two natural, stable, productive habitats are present in limited amount. Cobble or riffle runs are absent.

3	Cobble riffle or runs is the only habitat.
2	Only one natural, stable, productive habitat is available. Cobble riffles or runs are absent.
1	There are no natural, stable, productive habitats within the reach.

Comments: Use comment line to indicate what habitats are noticeably missing and describe any additional factors which could affect interpretation of the score.

2. Embeddedness of riffles

Estimate the percent that rocks are covered or sunken into the silt, sand, or mud of the stream bottom. **Observations should be done in cobble riffle areas.** Ideally, riffles should have multiple layers of cobble loosely lying on each other providing niches for macroinvertebrates and fish between and under the rocks. **Gravel riffles or cobble/gravel runs may be substituted if necessary.** However, make sure riffles are not absent due to sedimentation (in which case the parameter should score 1).

In moderate to high gradient streams that naturally do not have cobble riffles (i.e., extremely high gradient boulder streams or some moderate gradient bedrock streams) the parameter would score lower due to lack of niche space even if embeddedness is not high). Two factors should be evaluated for this parameter.

To determine the condition category, estimate the amount to which the rock is surrounded by fine sediment or conglomerate. Fine sediments are silt, clay, sand, sludge etc. Niche space may also by compromised by manganese or other deposits that cement the rocks together. Discoloration on the bottom and sides of rocks is a good way to determine the percent of embeddedness. However, take care that additional cobble layers are not buried in sediment and are not visible.

To select the score within the category, examine the amount of niche space that is provided by layering of cobble (ideal). There should be lots of sediment free spaces between and under rocks for macroinvertebrates and small fish to live. If the stream type is not a cobble-riffle, other examples of riffle or run niches affected by embeddedness include the bottom area of round boulders where it curves into the substrate or the spaces between gravel in a bedrock fissure. In moderate gradient bedrock streams without gravel (for example those with bedrock shelves) examine loose rocks or slabs in areas of relatively fast flow. These are less productive and should be scored lower in the selected condition category.

Optimal: Gravel, cobble and boulders are 0 - 25% surrounded by fine sediment. If embeddedness is close to 25% use quality of niche space to differentiate between Optimal and Suboptimal condition categories. Optimal would be layered cobble. To determine the rank within this category, consider the available niche space.

20	Niche spaces are free of sediment. Multiple layers of cobble provide niche space for colonization.
19	Niche spaces are free of sediment, but natural substrate does not provide multiple layers or is not cobble.
18	Small amount of sediment (up to 10%) but niche spaces are not compromised. Multiple layers of cobble are available for colonization
17	Small amount of sediment (up to 10%) but niche spaces are not compromised. Natural substrate does not provide multiple layers.
16	Sediment is more pronounced affecting up to 25% of niche space. Multiple layers of cobble are available for colonization.

Suboptimal: Gravel, cobble and boulders are 25% - 50% surrounded by fine sediment. If embeddedness is close to 25% use quality of niche space to differentiate between Optimal and Suboptimal condition categories. Optimal would be layered cobble. Likewise, as number approaches 50% use quality of niche space to differentiate between Suboptimal and Marginal. Suboptimal would be layered cobble.

15	Approximately 25% of niche space is affected. Substrate is not layered cobble.
14	Approximately 30 - 35% of niche space affected. Substrate is layered cobble.
13	Approximately 40 - 45% of niche space affected. Substrate is layered cobble.
12	Approximately 30 - 45% of niche space affected. Substrate is not layered cobble
11	Approximately 50% niche space is affected. Substrate is layered cobble.

Marginal: Gravel, cobble and boulders are 50% - 75% surrounded by fine sediment. As amount approaches 50%, use quality of niche space to differentiate between Suboptimal and Marginal condition categories. Suboptimal would be layered cobble.

10	Approximately 50% of niche space affected. Substrate is not layered cobble.
9	Approximately 55 - 65% of niche space affected. Substrate is layered cobble.
8	Approximately 55 - 65% of niche space affected. Substrate is not layered cobble
7	Approximately 70 - 75% of niche space affected. Substrate is layered cobble.
6	Approximately 70 - 75% of niche space is affected. Substrate is not layered cobble.

Poor: Gravel, cobble and boulders are more than 75% surrounded by fine sediment.

5	Approximately 80 - 85% of niche space affected. Substrate is layered cobble.
4	Approximately 80 - 85% of niche space affected. Substrate is not layered cobble.
3	Approximately 90 - 95% of niche space affected. Substrate is layered cobble
2	Approximately 90 - 95% of niche space affected. Substrate is not layered cobble.
1	Niche space is completely filled in by sediment.

Comments: Use comment line to describe type of sediment (sand, silt, clay, sludge etc.) and to describe any additional factors that would affect scoring.

3. Velocity/Depth Regime

Determine the patterns of velocity and depth. The four basic patterns are slow-deep, slow-shallow, fast-deep, and fast-shallow. The most productive streams will have all four patterns present. Differentiation between regimes will vary depending on stream size. Focus on habitat function. For example, does the difference between fast-deep and fast-shallow in a small stream provide habitat for different taxa.

Condition Category is based on how many of the four regimes are present. Ranking is based on which ones are prevalent.

Optimal: All four velocity/depth regimes are present.

20	All four velocity/depth regimes are equally available.
19	Fast-shallow is the dominant regime.
18	Slow-shallow is the dominant regime.
17	Fast-deep is the dominant regime.
16	Slow-deep is the dominant regime.

Suboptimal: Only 3 of the 4 velocity/depth regimes are present.

15	Slow-deep is the only missing regime.
14	Fast-shallow is dominant.
13	Slow-shallow is dominant.
12	Fast-deep is dominant.
11	Slow deep is dominant.

Marginal: Only 2 of the 4 regimes are present. Both regimes are adequate to support aquatic population adapted to that habitat.

10	Fast-Shallow and Slow-Shallow are present.
9	Fast-Shallow and Fast-Deep are present.
8	Fast-Shallow and Slow-Deep are present.
7	Slow-Shallow and Fast-Deep are present.
6	Fast-Deep and Slow-Deep are present.

Poor: One of the 4 regimes dominates the reach (if another is present it is too small or infrequent to sustain an aquatic population adapted to that habitat.

5	Fast-Shallow is dominant a second regime may be present but is too infrequent to sustain a population.
4	Slow-Shallow is dominant a second regime may be present but is too infrequent to sustain a population.
3	Fast-Deep is dominant a second regime may be present but is too infrequent to sustain a population.
2	Slow-Deep is dominant a second regime is present but is too infrequent to sustain a population.
1	Slow-Deep is the only regime present.

Comments: Use the comment field to describe any additional factors that may affect scoring.

4. Sediment Deposition

This parameter is designed to measure the changes that have occurred to the stream bottom and flow patterns as a result of the deposition of small particles (gravel, sand, silt). It differs from embeddedness which is designed to measure loss of niche space.

Select condition category by estimating the percent of the stream bottom that is affected by sediment deposition. **Areas of deposition occur in pools, bends, natural or man-made constrictions and other areas of slower flow.** Deposition is also observable through the formation of islands, point bars (areas of increased deposition at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals. Only areas of new, un-vegetated deposition on bars and islands should be considered when scoring.
If pools are too turbid to see bottom and too deep to reach down to feel the deposition, use alternate methods for estimating the bottom deposition. These include observing the amount of deposition in the shallower edges of the pool or probing the bottom with the handle of the net.

Rank within each category is determined by the areas most affected by sediment deposition. Sediment deposition in pools or slow areas will score higher than sediment deposition on point bars and islands. Note sediment deposition includes small particles (sand, silt, gravel etc.).

Optimal: Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.

20	No islands or point bars. No sediment in pools or slow areas.
19	No new deposition on stable islands or point bars. No sediment in pools or slow areas.
18	No new deposition on islands or point bars. Small amount of sediment in pools or slow areas.
17	Slight amount of new deposition on islands or point bars. No sediment in pools or slow areas.

16	Slight amount of new deposition on islands or point bars. Small amount of sediment in pools or slow areas. Almost 5% of bottom area affected.

Suboptimal: Sediment deposition affects 5 – 30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars.

15	Sediment deposition affects 5 – 15% of the bottom substrate. Most of the deposition is in pools or bends with little new accumulation on islands or point bars.
14	Sediment deposition affects 5 - 15% of the bottom substrate. Deposition occurs in both pool areas and as new accumulation on bars and islands.
13	Sediment deposition affects 20 – 25% of the bottom substrate. Most of the deposition is in pools or bends with little new accumulation on islands or point bars.
12	Sediment deposition affects 20 – 25% of the bottom substrate. Deposition occurs in both pool areas and as new accumulation on bars and islands.
11	Sediment deposition affects 30% of the bottom substrate. The majority of deposition is in pools or bends with little new build-up of islands or point bars. Move to Marginal if build-up of islands and point bars approaches 30%.

Marginal: Sediment deposition affects 30 – 50% of stream bottom. Sediment deposits at obstructions, constrictions, and bends. Moderate deposition of pools.

10	Sediment deposition affects 30% of stream bottom. Sediment deposits on bars and islands as well as pools and bends.
9	Sediment deposition affects 35 – 45% of stream bottom. Most of deposition is in pools rather than build-up of bars and islands.
8	Sediment deposition affects 35 – 45% of stream bottom. Moderate deposition of pools as well as new deposition on bars and islands.
7	Sediment deposition affects almost half of the stream bottom. Most of deposition is in pools rather than new deposition on bars and islands.
6	Sediment deposition affects almost half of the stream bottom. New sediment accumulation on bars and islands as well as in pools.

Poor: Heavy deposits of fine material. Increased bar development. More than 50% of the stream bottom changing frequently. Pools almost absent due to substantial sediment deposition.

5	Approximately 50% of the bottom substrate is affected by sediment deposition.
4	Approximately 60% of the bottom substrate is affected by sediment deposition.
3	Approximately 70% of the bottom substrate is affected by sediment deposition.
2	Approximately 80% of the bottom substrate is affected by sediment deposition.
1	Sediment blankets stream bottom pools absent due to sediment deposition.

Comment: Use comment field if needed to describe other factors related to score.

5. Channel Flow Status

Condition category will be selected based on the amount of the streambed covered by water. Rank within the category will be determined by how much productive habitat is exposed. **If water has been backed up by obstructions (such as beaver dam, log jams, debris plugs) move assessment reach above or below the affected area**. If this is not possible, determine whether sampling is appropriate or should be postponed until conditions are more representative of actual stream conditions. Use comment field to explain if necessary. Assess flow status based on what is submerged during normal flow conditions, for example naturally exposed gravel beds do not indicate exposed habitat. Use comment field to note if flow is reduced due to natural low flow conditions, drought, irrigation, municipal water withdrawal, impoundment etc.

Optimal: Water reaches base of both lower banks and streambed is covered by water throughout the reach. Minimal amount of productive habitat is exposed. Riffle areas are fully submerged.

20	Water is above the base of each bank. No productive habitats are exposed.
19	Productive habitats such as tree roots and riffles are submerged but some undercut areas may be above water. Riffle areas are fully submerged.

18	Some habitats such as tree roots are exposed but there is plenty of submerged habitat available. Riffle areas are fully submerged.
17	If rooted bank habitat is present, some tree roots are exposed but there is plenty of submerged root habitat available. Small areas of riffles may be minimally affected due to shallow water depth, but riffle habitat is not compromised
16	Water reaches base of both banks and water still covers streambed. Root, riffle, or other habitat is compromised due to water depth although is still available for colonization.

Suboptimal: Water covers more than 75% of the streambed but is less than 100% **or** 25% of productive habitat is exposed.

15	One or more habitats may be absent due to water depth, but riffle areas are not affected. (If productive riffle habitat is naturally not present score 11).
14	Water depth in riffles is reduced but this has not affected size or frequency of riffles.
13	Some riffle areas have become limited in size, but none are totally exposed.
12	A few smaller riffles have become exposed.
11	Up to 25% of small riffles have become exposed or productive riffle habitat is not naturally available.

Marginal: Water covers 25% - 75% of the streambed, **and/or** stable habitat is mostly exposed.

10	Waters covers 75% of channel. Most small riffles are exposed. (If productive riffle habitat is naturally not present score 11).
9	Water covers 60 – 70% of streambed. All smaller riffles are exposed. Large riffles do not have significant exposed areas.
8	Water covers about 50% of the streambed. Larger riffles are still present but are reduced in size.
7	Water covers 30 – 40% of the streambed. Majority of riffle areas are exposed although small areas of largest riffles are still submerged.
6	Water covers about 25% of streambed. Riffle areas are exposed although other rock habitat is available in run areas.

Poor: Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.

5	All riffles exposed. Runs extremely reduced. Very limited rock habitat available in running water.
4	All riffles exposed. Runs reduced to trickles. No rock habitat available in running water.
3	All riffles and runs exposed. Long stretches of pooled water provide some productive habitat. Stream may be flowing below surface between pools.
2	Stream reduced to isolated pools with no productive habitat.
1	Stream is dry.

Comment: Use comment field to explain factors affecting the amount of water in the stream including natural (beaver activity, karst, drought etc.) and unnatural (dams, log jams at bridges, water withdrawal etc.).

6. Channel Alteration

Determine how much, if at all, the stream reach has been altered by man-made activities (not beavers). Channel alteration is the presence of artificial embankments, riprap, and other forms of artificial bank stabilization or structures; when the stream is very straight for significant distances; when dams, culverts or bridges are present; when dredging or gravel/rock removal is evident, when snags/deadfall is removed, off-road vehicle activity or livestock access has altered the bottom contours/compressed riffles and when other such artificial changes have occurred. Bridges, dams, or other man-made structures upstream or downstream of the assessed reach should be considered if they affect flow patterns in the targeted reach.

Optimal: Channelization, gravel dredging, rock removal and off-road vehicle activity (past or present) absent or minimal. Stream has natural meander pattern. Shoring structures including riprap are absent. Artificial structures are not present in stream reach. Bridges, culverts, dams, or other structures upstream or downstream are not affecting the stream reach.

20	Stream has never been channelized and there are no artificial structures in stream reach or within impact area of reach. There is no evidence of past or present gravel dredging or rock removal. There is no evidence of off-road vehicle activity or livestock entry. Stream has normal meander pattern.
19	Stream has never been channelized and there are no artificial structures in stream reach or within impact area of reach. Evidence of past rock removal is minimal. There is no evidence of gravel/sand dredging, 4-wheel activity or livestock access. Stream flow pattern and habitat not affected.
18	Stream has never been channelized and there are no artificial structures in stream reach or within impact area of reach. Evidence of past gravel/sand dredging is minimal. There is no evidence of 4-wheel activity or livestock access. Stream flow pattern and habitat not affected.
17	Past channel alteration in small area (less than 5% of reach). Stream flow pattern not affected. Modification is stable, well vegetated with natural vegetation, no erosion potential. There are no artificial structures in stream reach or within impact area. There is no evidence of 4-wheel activity or livestock access
16	Evidence of past 4-wheel vehicle activity or livestock access. Riffle and run areas intact, stream contours not affected. Artificial structures may be present outside of the reach but are not affecting the flow patterns, habitat, or stream contours within reach.

Suboptimal: Evidence of channelization, dredging and/or 4-wheel activity or livestock access up to 40%. (May be longer reach if channelization is historic). Channel has stabilized and altered flow pattern does not affect colonization. Bridges, culverts, shoring or other artificial structures either within or outside of reach have not affected natural flow patterns.

15	Historic channelization has stabilized (May also include pre-civil war rock walls.) Modification is stable, well vegetated with natural vegetation and no erosion potential.
14	Bridge, culverts, shoring or artificial structures may be present but do not affect natural flow patterns in reach. (Includes structures upstream or downstream as well as within reach).
13	Recent off-road vehicle activity or significant livestock access in stream. Riffle or run areas slightly disturbed. Natural stabilization and re-colonization expected.

12	Evidence of recent rock removal or gravel/sand dredging has had slight impact on reach. Natural stabilization and re-colonization are expected.
11	New channelization up to 40% of reach. Modification is stable, well vegetated with natural vegetation, no erosion potential. (If not stable score 10).

Marginal: Channelization, dredging or 4-wheel activity or livestock access 40 to 80% or less amount of channelization that has not stabilized or Bridges, culverts, shoring or other artificial structures either within or outside of reach may have slightly affected natural flow patterns.

10	Less than 40% of reach altered but has not stabilized.
9	40 - 80% of reach has been channelized but is stable with natural vegetation.
8	Bridge, culverts, shoring, or artificial structures have slight effect on natural flow patterns in reach. (Includes structures upstream or downstream as well as within reach).
7	Dredging, rock removal, 4-wheeling, livestock access or other in-stream activity has impacted habitat in 40 - 80% of reach.
6	6 – 40 - 80% of reach has been altered and has not stabilized.

Poor: Over 80% of the stream reach channelized, dredged, or affected by off-road vehicles or livestock activity, instream habitat greatly altered or removed entirely or artificial structures within reach or upstream/downstream of reach have greatly affected natural flow patterns.

5	Over 80% of the stream reach is channelized and has not stabilized.
4	Over 80% of the stream reach is channelized and has been stabilized with artificial shoring.
3	Over 80% of the stream reach is channelized and has not stabilized.
2	Impoundment, bridge, or other artificial structure has a high level of impact on normal stream flow and/or channel pattern. Include upstream or downstream structures that have seriously affected the sample reach.
1	At least part of stream reach is in concrete or other artificial channel (including culverts).

Comment: Use comment field to indicate type of channel alteration (channelization, man-made dams, 4-wheel activity, construction vehicles). Also make note if beaver activity has altered stream (this is a natural condition so would score 20 if there are no artificial modifications but needs to be noted).

7. Frequency of Riffles, Bends or Other Re-Oxygenation Zones

Determine the pattern of stream morphology by estimating the sequencing of riffles. This is the only parameter where the hydrologic (not biological) definition of riffle will apply. Any swift moving re-oxygenation zones count, including bedrock riffles, large boulders, and bends. These areas provide diversity of habitat, control flow and provide refugia during storm events as well as re-oxygenate the water. To score this parameter, a longer segment may need to be incorporated into the evaluation if there are not at least 3 re-oxygenation areas within the sample reach. It may be necessary to pace off or measure distances. In larger streams where bends are the only re-oxygenation areas, maps/aerial photos may be used to determine frequency. Frequency will determine the condition category. Quality of habitat provided will determine the rank within the category.

Optimal: Occurrence of re-oxygenation zones relatively frequent. Distance between areas divided by average width of the stream <7:1.

20	Re-oxygenation areas are high quality cobble small boulder riffles.
19	Re-oxygenation areas are high quality gravel riffles
18	Re-oxygenation areas are not high-quality cobble/gravel riffle but provide productive habitat (may include cobble runs or lower quality cobble riffles).
17	Re-oxygenation areas are primarily bedrock, large boulder, or other relatively unproductive habitat.
16	Re-oxygenation areas are bends.

Suboptimal: Occurrence of re-oxygenation zones infrequent; distance between areas divided by average width of the stream is from 7 to 15.

15	Re-oxygenation areas are high quality cobble/small boulder riffles.
14	Re-oxygenation areas are high quality gravel riffles.
13	Re-oxygenation areas are not high-quality cobble/gravel riffle but provide productive habitat (may include cobble runs or lower quality cobble riffles).
12	Re-oxygenation areas are primarily bedrock, large boulder, or other relatively unproductive habitat.
11	Re-oxygenation areas are bends.

Marginal: Occasional re-oxygenation area. Distance between areas divided by average width of the stream is over 15 and up to 25.

10	Re-oxygenation areas are high quality cobble/small boulder riffles.
9	Re-oxygenation areas are high quality gravel riffles.
8	Re-oxygenation areas are not high-quality cobble/gravel riffle but provide productive habitat (may include cobble runs or lower quality cobble riffles).
7	Re-oxygenation areas are primarily bedrock, large boulder, or other relatively unproductive habitat.
6	Re-oxygenation areas are bends.

Poor: Generally, all flat water or flat bedrock. Little opportunity for re-oxygenation. Distance between areas divided by average width of the stream is over 25.

5	Re-oxygenation areas are high quality cobble/small boulder riffles.
4	Re-oxygenation areas are gravel riffles.
3	Re-oxygenation areas are not high-quality cobble/gravel riffle but provide productive habitat (may include cobble runs or lower quality cobble riffles).
2	Re-oxygenation areas are primarily bedrock, large boulder, or other relatively unproductive habitat.
1	Re-oxygenation areas are bends.

Comments: Use comment field to describe other factors affecting the score if needed such as atypical reoxygenation areas or poor-quality riffles.

8. Bank Stability

Determine whether the stream banks are eroded or have the potential for erosion. Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered less stable. Signs of instability include crumbling, unvegetated banks, exposed tree roots, slumping and/or exposed soil.

Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. Left and right banks are determined by facing downstream. Bank stability is evaluated as bankfull height. Erosion potential in terraces may lower scores if affecting stream.

Optimal: Banks stable, evidence of erosion or bank failure absent or minimal; little potential for future problems, < 5% of the bank affected. Terrace erosion not affecting stream and no healed-over erosion.

10	No signs of instability evident. Banks sloping. Little erosion potential
9	Steep banks or some potential for erosion.

Suboptimal: Moderately stable, infrequent, small areas of erosion. 5 – 30% of bank in reach has areas of erosion or other signs of instability. Little or no erosion on terraces. May have healed over erosion.

8	More than 5% healed over erosion and no active erosion.
7	5 - 15% of bank has areas of erosion or other signs of instability. Some are not healed over.
6	20 - 30% of bank has areas of erosion or other signs of instability. If approaching 30%, score Marginal if banks are steep or if eroding areas on terrace is affecting stream.

Marginal: Moderately unstable; 30-60% of bank in reach has areas of erosion or other signs of instability; high erosion potential during floods. Eroding terrace may be affecting stream.

5	30 - 40% of bank has areas of erosion or other signs of instability. If approaching 40 score lower if banks are steep or eroding terrace is affecting stream.
4	40 - 50% of bank has areas of erosion or other signs of instability. If approaching 50%, score lower if banks are steep or eroding terrace is affecting stream.
3	50 - 60% of bank has areas of erosion or other signs of instability If approaching 60%, score lower if banks are steep or sloughing or eroding terrace is affecting stream.

Poor: Unstable: many eroded areas; raw areas frequent along straight sections and bends; active bank sloughing; Over 60% of banks has areas of erosion or other signs of instability.

2	60 - 75% of bank has areas of erosion or other signs of instability.
1	80 - 90% of bank has areas of erosion or other signs of instability.

0	There are no stable areas on bank.

Comment: Use comment field if needed to describe additional factors affecting scoring.

9. Bank Vegetative Protection

Determine the type and quality of vegetation on the stream bank. This is the area from the base of the bank to the top of the bank. The object is to determine the ability of the bank to resist erosion as well as the ability of the plants to uptake nutrients, control instream scouring, supply food to shredders and provide stream shading. Streams that have various classes of native vegetation providing full natural plant growth including groundcover, shrubs, understory trees and mature trees will score highest.

In some regions, the introduction of exotics, such as kudzu, privet, multi-flora rose or honeysuckle, has virtually replaced all native vegetation. Although exotics may provide erosion control, they do not provide ideal food and habitat to stream organisms that have evolved to utilize native species. Banks that are dominated by non-native vegetation should score lower. A list of commonly encountered non-native species can be found in Appendix B. Species information, county distribution and pictures can be found at the Tennessee Invasive Plant Control website: http://www.tnipc.org/invasive-plants/

Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. Left and right banks are determined by facing downstream.

Condition category is determined by estimating the amount of bank covered by **undisturbed native vegetation**. Rank is determined by complexity of vegetation type.

Optimal: More than 90% of the streambank surfaces and immediate riparian zone covered by undisturbed vegetation. All four classes (mature trees, understory trees, shrubs, groundcover) are represented. All plants allowed to grow naturally. All plants are native.

10	No disruption. All classes of vegetation (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally.
9	Minimal disruption affecting less than 10% of stream bank. All classes of vegetation are represented and allowed to grow naturally.

Suboptimal: The majority (70 - 90%) of the bank is covered by undisturbed native vegetation. One class may not be well represented. Disruption evident but not affecting full plant growth. Non-native vegetation may be present but rare (< 30%).

8	Over 90% of bank area covered by native vegetation but one class not well represented.
7	70-90% of bank area covered by native vegetation. All classes of vegetation (mature trees, understory trees, shrubs, groundcover) are well represented and allowed to grow to full height.
6	70 - 90% of bank area covered by native vegetation but one class not well represented. Other classes allowed to grow to full height.

Marginal: 50 - 70% of the bank covered by undisturbed vegetation. Non-native vegetation may be common (30 - 50%). Two classes of vegetation may not be well represented.

5	All classes of vegetation (mature trees, understory trees, shrubs, groundcover) are represented. If approaching 70% score Suboptimal 7 if all vegetation allowed to grow to full height.
4	One class of vegetation not well represented or not allowed to grow to full height. If approaching 70% score Suboptimal 6 if all vegetation is native and allowed to grow to full height.
3	Two classes of vegetation not well represented or not allowed to grow to full height or non-native vegetation is common.

Poor: Less than 50% of the bank is covered by undisturbed vegetation or more than two classes of vegetation are not well represented, or most vegetation has been cropped. Non-native vegetation may be dominant (> 50%).

2	Vegetation that is present is mostly native and allowed to grow to full height.
1	Most vegetation is not allowed to grow to full height or is non-native.
0	Bank vegetation is absent or too sparse to provide bank protection or habitat.

Comment: Use the comment field to describe what class of plants are missing and/or describe exotic plants.

10. Riparian Vegetative Zone Width

Estimate the width of natural vegetation from the top of the stream bank out through the riparian zone (approximately 18 yards). Disturbance to the riparian zone occurs when there are roads, parking lots, fields, row crops, lawns, parks, bare soil, buildings, logging, campgrounds, golf courses or other human activity.

Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. Left and right banks are determined by facing downstream.

Condition category is determined by estimating the width of the riparian zone from the top of the stream bank, outward. Generally, the riparian ends at first indication of human disturbance with the exception of un-paved footpaths or trails in an otherwise undisturbed riparian.

Scoring within the category should be based on the level of impact the disturbance has. For example, un-grazed fields would score higher than active fields. Lawns would score higher than paved areas.

Paths, and walkways in an otherwise undisturbed riparian zone may be judged to be minimal disturbance if they are narrow, unpaved and show no evidence of erosion. They should not affect condition category but should lower score one point within category.

Optimal: Average width of riparian > 18 yards throughout reach.

10	There is no human disturbance.
9	Human disturbance minimal, for example, an un-paved footpath.

Suboptimal: Average width of riparian 12 – 18 yards throughout reach.

8	Human disturbance, after 12 yards of undisturbed riparian is minimal, for example an un-grazed hay field or areas of riparian that are less than 18 yards are small.

7	Human disturbance, after 12 yards is vegetated but has frequent use or is close cropped. For example, lawns, golf-courses, row crops, active pasture.
6	Human disturbance, after 12 yards is not vegetated, for example paved or gravel lots, roads, bare dirt.

Marginal: Average width of riparian 6 – 11 yards throughout reach.

5	Human disturbance, after 6 yards of undisturbed riparian is minimal, for example an un-grazed field, or areas that are less than 12 yards are small.
4	Human disturbance, after 6 yards is vegetated but has frequent use or is close cropped. For example, lawns, golf-courses, row crops, active pasture.
3	Human disturbance, after 6 yards is not vegetated, for example paved or gravel lots, roads, bare dirt.

Poor: Average width of riparian < 6 yards throughout reach.

2	Human disturbance is minimal, for example an un-grazed field or areas that are less than 6 yards are small.
1	Human disturbance is vegetated but has frequent use or is close cropped. For example, lawns, golf-courses, row crops, active pasture.
0	Human disturbance has removed all vegetation, for example paved or gravel lots, roads, bare dirt.

Comment field: Indicate type of disturbance and any additional factors affecting score.

Protocol D-2: Low Gradient Habitat Assessment Field Sheet

The low gradient habitat field sheet (Appendix B) is used for low gradient streams. This will include streams in ecoregions 65abei, 73ab and 74b in west Tennessee as well as some streams in ecoregion 71i in middle Tennessee. This assessment may also be appropriate in lower reaches of larger streams in other ecoregions.

1. Epifaunal Substrate/Available Cover

When assessing this parameter, look at various types of natural structures available to macroinvertebrates and/or fish throughout the entire reach. Only count productive habitats which are those that provide a niche for colonization by macroinvertebrates or fish. Look for habitat that provides refugia, feeding, spawning or nursery functions. Do not count newly fallen trees, leaf litter that is not decaying or unstable habitats that will be washed out. Also do not include artificial habitat such as fish attractors, tires, appliances, riprap etc.

Habitats that are generally found in low gradient streams include:

- Undercut banks
- Submerged roots
- Macrophyte beds
- Submerged trees (not new fall)
- Snags
- Decaying leaf litter
- Run rocks
- Pool Rocks
- Gravel riffles
- Sediment
- Bedrock fissures

To assign a condition category, first look at how much of the stream reach is covered by natural, stable, productive habitat. The numeric score (rank) within the condition category is assigned based on the variety and quality of the habitat. Variations in habitat that provide niches for different faunal types should be considered as different habitat types. For example, undercut banks with submerged tree roots should be considered separate from undercut banks with fine grassy roots.

Habitat that is not of sufficient quantity to provide faunal populations, does not show evidence of colonization (such as newly fallen leaves), is not productive (such as shifting sand) or is likely to wash out should not be included. Artificial structures such as riprap are also not included since the goal is to evaluate natural habitat.

Optimal – Over 50% of the stream reach has natural, stable habitat available for colonization by macroinvertebrates and/or fish. Three or more productive habitats are present. Deadfall, leaf litter, snags etc. are not new-fall but show evidence of decay. If less than three habitats are present drop to Suboptimal.

20	Deadfall and snags are the dominant habitat. At least two other habitats are available.
19	Rooted banks are the dominant habitat. At least two other habitats are available.
18	Macrophyte beds are the dominant habitat. At least two other habitats are available.
17	Leaf litter is the dominant habitat. At least two other habitats are available.
16	Another habitat is dominant. At least two other habitats are available.

Suboptimal – Natural stable habitat covers 30 - 50% of stream reach or less than three habitats are present. If nearing 30% and only one habitat is present, drop to Marginal.

15	Deadfall and snags are the dominant habitat.
14	Rooted banks are the dominant habitat.
13	Macrophyte beds are the dominant habitat.
12	Leaf litter is the dominant habitat.
11	Another habitat is dominant.

Marginal – Natural stable habitat covers 10 – 30% of the stream reach. Availability less than desirable, substrate frequently disturbed or removed. Habitat diversity is reduced. If nearing 10% and only one habitat is available, drop to Poor.

10	Deadfall and snags are the dominant habitat.
9	Rooted banks are the dominant habitat.
8	Macrophyte beds are the dominant habitat.
7	Leaf litter is the dominant habitat.
6	Another habitat is dominant.

Poor – Less than 10% stable habitat or 10% and only one habitat available. Lack of habitat is obvious; substrate unstable or lacking.

5	Rooted banks are the dominant habitat.
4	Deadfall and snags are the dominant habitat.
3	Macrophyte beds are the dominant habitat.
2	Leaf litter or another habitat is dominant.
1	Habitat is lacking.

Comments: Use comment line to indicate what habitats are noticeably missing or describe any additional factors which could affect interpretation of the score.

2. Channel Substrate Characterization (replaces Pool Substrate Characterization)

Evaluate the type and condition of the bottom substrate in the channel. Firmer sediment such as gravel, firm sand, and rooted aquatic plants support a wider variety of organisms and should be scored higher than a substrate dominated by soft sand, mud, or bedrock with no plants. In addition, a stream that has a uniform substrate will support fewer types of organisms and should score lower than a stream that has a variety of substrate type. Root mats for this parameter are those anchored in the bottom substrate of the channel and should not be confused with rooted undercut banks with grass or trailing tree roots. Firm sand is desirable while soft sand will score lower. Fissured bedrock with crevices and rock shelves will score higher than smooth bedrock.

The type of substrate will determine the condition category. Rank within the category will be based on the ratio of substrate type.

Optimal – Good mixture of substrate materials with gravel and firm sand prevalent. Root mats and submerged vegetation are common.

20	Even mix of gravel and firm sand. Both root mats and submerged vegetation are common.
19	Mixture of substrate including firm sand. Gravel is dominant. Both root mats and submerged vegetation are common.
18	Mixture of substrate including firm sand. Gravel is dominant. Either root mats or submerged vegetation is missing.

17	Mixture of substrate including gravel. Firm sand is dominant. Both root mats and submerged vegetation are common.
16	Mixture of substrate including gravel. Firm sand is dominant. Either root mats or submerged vegetation is missing.

Suboptimal - Mixture of soft sand, mud, or clay. Substrate may also be fissured bedrock. Some root mats and submerged vegetation present.

15	Mixture of soft sand, mud, and clay. No substrate dominant. Both root mats and submerged vegetation present.
14	Mixture of soft sand, mud and clay, mud dominant. Both root mats and submerged vegetation present.
13	Mixture of soft sand and mud, mud dominant. Either root mats or submerged vegetation is missing.
12	Mixture of soft sand and clay or substrate is fissured bedrock with frequent fissures and shelves. Some root mats and submerged vegetation present.
11	Mixture of soft sand and clay or substrate is fissured bedrock with frequent fissures and shelves. Either root mats or submerged vegetation is missing.

Marginal – All mud, clay, or soft sand bottom; substrate may also be fissured bedrock; little or no root mat; no submerged vegetation present.

10	Mud bottom, some root mat present.
9	Soft Sand bottom, some root mat present.
8	Clay bottom, some root mat present.
7	Mud or fissured bedrock bottom, no root mat present.
6	Soft sand or clay bottom, no root mat present.

Poor – Hard-pan clay, conglomerate or flat bedrock, no root mat or vegetation.

5	Predominantly flat bedrock, other non-bedrock substrate available.
4	Predominantly flat bedrock, infrequent crevices and/or shelves provide some habitat.
3	Predominantly conglomerate substrate.
2	Predominantly flat bedrock substrate.
1	Predominantly hard-pan clay substrate.

Comments: Use comment field if needed to clarify scoring or describe substrate.

3. Pool Variability

Rate the overall mixture of pool types found in the stream, according to size and depth (this will vary depending on the size of the stream). The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream having many different pool types will support a wider variety of aquatic species and should score higher. The variety of pool types will determine condition category. The quality of these pools will determine rank within the category. If a continuous run, look for bar formation or other natural features that break up the flow.

Optimal: Even mix of large-shallow, large–deep, small-shallow, small-deep pools present.

20	Some pools are at least 1 yard deep and are of sufficient length to support fish populations.
19	Large-deep pools are less than 1 yard but are of sufficient size and depth to support fish populations.
18	Large-deep pools are at least 1 yard providing distinct habitat but are of insufficient length to support fish populations.
17	Smaller stream, deep pools provide distinct benthic habitat from shallow pools but are not of sufficient depth to support fish populations.
16	Although all 4 pool types are available, some may not provide distinct faunal habitat due to small stream size.

Suboptimal: Majority of pools large-deep; very few shallow.

15	Some pools are at least 1 yard deep and are of sufficient length to support fish populations.
14	Large-deep pools are less than 1 yard but are of sufficient size and depth to support fish populations.
13	Large-deep pools are at least 1 yard providing distinct benthic habitat but are of insufficient length to support fish populations.
12	Smaller stream, deep pools provide distinct benthic habitat but are not of sufficient depth to support fish populations.
11	Smaller stream, deep pools though present may not provide distinct habitat.

Marginal: Shallow pools much more prevalent than deep pools.

10	Some pools are at least 1 yard deep and are of sufficient length to support fish populations.
9	Large-deep pools are less than 1 yard deep but are of sufficient size and depth to support fish populations.
8	Large-deep pools are at least 1 yard deep providing distinct habitat but are of insufficient length to support fish populations.
7	Smaller stream, deep pools are less than 1 yard deep and are of insufficient size to support fish populations but do provide distinct benthic habitat from shallow pools.
6	Smaller stream, deep pools though present may not be frequent enough or of sufficient size to provide distinct benthic habitat from shallow pools.

Poor: Majority of pools small-shallow or pools absent. Bar formations or other natural features may create changes in flow regimes.

5	Both large-shallow and small-shallow pools present.
4	Only small-shallow pools present.
3	Pools absent, although slow current areas are present.
2	Pools absent, although there are depth changes within channel.
1	Channel is a continuous run with little or no changes in velocity or depth.

Comments: Use the comment field if needed for clarification or to describe atypical characteristics affecting scoring.

4. Sediment deposition

This parameter is designed to measure the changes that have occurred to the stream bottom and flow patterns as a result of the deposition of small particles (gravel, sand, silt). Bar formation indicates more bedload than the stream can carry.

Select condition category by estimating the percent of the stream bottom that is affected by sediment deposition. Areas of deposition occur in pools, bends, natural or man-made constrictions and other areas of slower flow. A naturally shifting sand substrate should not be confused with sediment deposition. A change in particle size is considered deposition (for example silt instead of sand if sand is the natural bed material). Deposition is also observable through the formation of islands, point bars (areas of increased deposition at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals.

Only areas of new, unvegetated deposition on bars and islands should be considered when scoring. Established bars will have vegetation that remains after high flow events. Deposition in shifting sand streams is usually most evident in bar formations (not pool deposition). Estimate the area of unvegetated sediment bars and look for slugs of excess sand bedload (which occurs in sand bottom streams that are unable to transport and process a heavy bedload of sand material). Sediment bars may be masked if water levels are high. If pools are naturally not present, consider deposition in slower areas.

Rank within each category is determined by the areas most affected by sediment deposition. Sediment in pools or slow areas will score higher than sediment on point bars and islands.

Optimal: Sediment deposition affects less than 20% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.

20	No islands or point bars. No sediment in pools or slow areas.
19	No new deposition on stable islands or point bars. No sediment in pools or slow areas.
18	No new deposition on islands or point bars. Small amount of sediment in pools or slow areas.
17	Small amount of new deposition on islands or point bars. No sediment in pools or slow areas.
16	Small amount of new deposition on islands or point bars. Small amount of sediment in pools or slow areas. Up to 20% of bottom area affected. (As deposition approaches 20% if most of deposition is an increase in island or bars drop to Suboptimal.)

Suboptimal: Some new increase in bar formation, mostly from gravel, sand, or fine sediment (20 - 50%) of the bottom affected and/or slight deposition in pools or slow areas.

15	Sediment deposition affects 20 - 30% of the bottom substrate. Most of the deposition occurs in pools and slow areas.

14	Sediment deposition affects 20 - 30% of the bottom substrate. Most increase in bar formation possibly slight deposition in pools.
13	Sediment deposition affects 35 - 45% of the bottom substrate. Most of the deposition occurs as in pools and slow areas.
12	Sediment deposition affects 35 - 45% of the bottom substrate. Most increase in bar formation possibly slight deposition in pools.
11	Sediment deposition affects 50% of the bottom substrate. Deposition occurs primarily on pool or slow areas. If new accumulation is primarily bars and islands, drop to Marginal.

Marginal: Moderate deposition of new gravel, sand, or fine sediment on old and new bars 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; and/or moderate deposition of pools or slow areas prevalent.

10	Sediment deposition affects 50% of stream bottom. Sediment deposition on bars and islands as well as in pools or slow areas.
9	Sediment deposition affects 55 – 65% of stream bottom. Most of deposition is in pools or slow areas.
8	Sediment deposition affects 55 – 65% of stream bottom. Most deposition in bars and islands.
7	Sediment deposition affects 70 - 80% of the stream bottom. Most of deposition is in pools or slow areas.
6	Sediment deposition affects 70 - 80% of the stream bottom. Most sediment accumulation on bars and islands.

Poor: Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools may be almost absent due to substantial sediment deposition.

5	Approximately 85 - 90% of the bottom substrate is affected by sediment deposition. Pools heavily affected but still present or pools naturally absent.
4	Approximately 85- 90% of the bottom substrate is affected by sediment deposition. Pools absent due to sediment deposition.
3	Approximately 95% of the bottom substrate is affected by sediment deposition. Pools heavily affected but still present or pools naturally absent.
2	Approximately 95% of the bottom substrate is affected by sediment deposition. Pools absent due to sediment deposition.

1	Sediment blankets 100% of stream bottom.

Comments: Use the comment field if needed for clarification or to describe atypical characteristics affecting scoring.

5. Channel Flow Status

Estimate the degree to which the channel is filled with water. Condition category will be selected based on amount of streambed covered. Rank within the category will be determined by how much productive habitat is exposed. If the stream has no habitat, score lowest rank within condition category, and explain in comments. If water has been backed up by obstructions (such as beaver dam, log jams, bedrock during low flow) move assessment reach above or below the affected area or consider postponing sampling until an accurate assessment of stream conditions can be achieved.

Assess flow status based on what is submerged during normal flow conditions, for example naturally exposed gravel beds do not indicate exposed habitat. Evidence of frequent submersion may be change in color of substrate, shelves, or eroded areas. Use comment field to note if flow is reduced due to natural low flow conditions, drought, irrigation, municipal water withdrawal, impoundment etc.

Optimal: Water reaches base of both lower banks throughout reach and covers stream bed. Minimal productive habitat is exposed.

20	Water is above the base of each bank and no productive habitats are exposed.
19	Roots are submerged but some undercut areas may be above water. Other productive habitats are not affected.
18	Some shallow roots are exposed but there is submerged root habitat available. Other habitats are not affected.
17	Most shallow roots are exposed, but of submerged root habitat. Other habitats are not affected.
16	Some deeper, rooted areas are partially exposed but there is plenty of submerged root habitat. Other productive habitats are not affected.

Suboptimal: Water covers more than 75% of the streambed and/or at least one productive habitat is fully submerged. If all habitat is mostly exposed, move to Marginal, if all habitat is exposed, move to poor.

15	Some submerged rooted areas are totally exposed although the habitat is still plentiful. Other productive habitats are present and not affected.
14	Most root habitat is exposed. Other productive habitats are available. If other habitats ae not available drop to Marginal.
13	All root habitat is exposed. Other productive habitats are available and are fully submerged.
12	Other near-shore habitat such as macrophyte beds is partially exposed. Mid channel habitats such as fallen trees are available for full colonization.
11	Other near shore habitat not available. Mid-channel habitats such as fallen trees are available for full colonization. If almost 25% of channel is exposed drop to Marginal.

Marginal: Water covers 25% - 75% of the streambed, and/or productive habitat is mostly exposed. All near-shore habitat is exposed.

10	Waters covers about 75% of streambed. Mid channel habitats are available and not affected. If mid-channel habitats are not present drop to poor.
9	Water covers 60 – 70% of streambed. Some mid channel habitat such as fallen trees and snags are compromised but still available for full colonization.
8	Water covers about 50% of streambed. Most mid channel habitat is partially exposed limiting colonization.
7	Water covers 30 – 40% of streambed. Most habitat is fully exposed, at least one productive habitat available for limited colonization.
6	Water covers about 25% of streambed. Isolated areas of productive habitat.

Poor: Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.

5	Very little flow evident. Isolated patches of productive habitat.
4	Very little flow evident. Remaining habitat is un-productive.
3	Water reduced to standing pools. Isolated patches of productive habitat.
2	Water reduced to standing pools. No productive habitat.
1	Stream is dry.

Comment: Use comment field to explain factors affecting the amount of water in the stream including natural (beaver activity, karst, drought etc.) and unnatural (man-made dams, log jams at bridges, water withdrawal etc.). Also, use comment field to indicate if there is naturally no productive habitat which would affect ranking within category.

6. Channel Alteration

Determine how much, if at all, the stream reach has been altered by man-made activities (not beavers). Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams, culverts or bridges are present; when dredging or gravel/rock removal is evident, when snags/deadfall is removed, 4-wheel activity or livestock access has altered the bottom contours/compressed riffles and when other such artificial changes have occurred. Bridges, dams, or other man-made structures upstream or downstream of the assessed reach should be considered if they affect flow patterns in the targeted reach.

Optimal: Channelization, dredging, 4-wheel activity or livestock access (past or present) absent or minimal. Stream has normal meander pattern. Shoring structures including riprap are absent. Artificial structures are not present in stream reach. Bridges, culverts, dams, or other structures upstream or downstream are not affecting the stream reach.

20	Stream has never been channelized and there are no artificial structures in stream reach or within impact area of reach. There is no evidence of past or present dredging or rock removal. There is no evidence of 4-wheel activity or livestock activity. Stream has normal meander pattern.
19	Stream has never been channelized and there are no artificial structures in stream reach or within impact area of reach. Evidence of past rock removal. There is no evidence of gravel/sand dredging, 4-wheel activity or livestock activity. Stream flow pattern and habitat not affected.
18	Stream has never been channelized and there are no artificial structures in stream reach or within impact area of reach. Evidence of past gravel or sand dredging. There is no evidence of 4-wheel activity or livestock activity. Stream flow pattern and habitat not affected.

17	Past channel alteration in small area (less than 5% of reach). Stream flow pattern not affected. Modification is stable, well vegetated with natural vegetation, no erosion potential. There are no artificial structures in stream reach or within impact area.
16	Evidence of recent 4-wheel activity or livestock access. In-stream habitat, stream contours and banks not affected. Artificial structures may be present outside of the reach but are not affecting the flow patterns, habitat, or stream contours within reach.

Suboptimal: Channelization, dredging 4-wheel activity or livestock activity up to 40%. May be longer reach if channelization is historic (older than 50 years). Channelization has stabilized and altered flow pattern does not affect colonization. Bridges, culverts, shoring or other artificial structures either within or outside of reach have not affected natural flow patterns.

15	Historic channelization has stabilized. Modification is stable, well vegetated with natural vegetation and no erosion potential.
14	Bridge, culverts, shoring or artificial structures may be present but do not affect natural flow patterns in reach. (Includes structures upstream or downstream as well as within reach).
13	Recent off-road vehicle or livestock activity in stream. Channel substrate slightly disturbed. Natural stabilization and re-colonization expected.
12	Evidence of recent rock removal or gravel/sand dredging has had slight impact on reach. Natural stabilization and re-colonization are expected.
11	New channelization in up to 40% of stream reach. Modification is stable, well vegetated with natural vegetation, no erosion potential. (If unstable, score 10.)

Marginal: Channelization, dredging livestock access or 4-wheel activity 40 - 80% or less amount of channelization that has not stabilized. Bridges, culverts, shoring or other artificial structures either within or outside of reach may have slightly affected natural flow patterns.

10	Less than 40% of reach altered but has not stabilized.
9	40 - 80% of reach has recently been channelized but is stable with natural vegetation.

8	Bridge, culverts, shoring, or artificial structures have slight effect on natural flow patterns in reach. (Includes structures upstream or downstream as well as within reach).
7	Dredging, rock removal, 4-wheeling, livestock, or other in-stream activity has impacted habitat in 40 - 80% of reach.
6	40 - 80% of reach has been altered and has not stabilized.

Poor: Over 80% of the stream reach channelized, dredged, or affected by 4-wheel activity or livestock. Instream habitat greatly altered or removed entirely or artificial structures within reach or upstream/downstream of reach have greatly affected natural flow patterns.

5	Over 80% of the stream reach has been channelized but is stable with natural vegetation.
4	Over 80% of the stream reach is channelized and has been stabilized with artificial shoring.
3	Over 80% of the stream reach is channelized and has not stabilized.
2	Impoundment, bridge, or other artificial structure has a high level of impact on normal stream flow and/or channel pattern. Include upstream or downstream structures that have substantially affected the sample reach.
1	At least part of stream reach is in concrete or other artificial channel (including culverts).

Comment: Use comment field to indicate type of channel alteration (channelization, man-made dams, 4-wheel activity, livestock access etc.) and to explain any score adjustments. Also make note if beaver activity has altered stream (this is a natural condition so would score 20 if there are no artificial modifications but needs to be noted).

7. Channel Sinuosity

Evaluate the meandering or sinuosity of the stream. This includes streams have created a new a meander pattern within an older channel. A high degree of sinuosity provides diverse habitat for macroinvertebrates and the stream is better able to handle surges when the flow fluctuates due to rain events. **To estimate this parameter, a longer segment or reach than that designated for the sampling should be incorporated into the evaluation. This will vary by site but should**

include at least 2 bends. Maps may be used to estimate the sinuosity of larger streams where field evaluations are not practical.

The amount the meanders increase stream length determines the condition category. The quality of the meander (whether additional macroinvertebrate or habitat is provided) determines the rank.

Optimal – The bends in the stream increase the stream length 3-4 times longer than if it was in a straight line.

20	Stream meander increases stream length more than 4 times longer than a straight line.
19	Stream meander increases stream length 4 times longer than a straight line.
18	Stream meander increases stream length 3.5 times longer than a straight line. Bends provide productive macroinvertebrate habitat.
17	Stream meander increases stream length 3.5 times longer than a straight line. Bends do not provide additional macroinvertebrate habitat.
16	Stream meander increases stream length 3 times longer than a straight line. Bends provide productive macroinvertebrate habitat.

Suboptimal - The bends in the stream increase the stream length 2-3 times longer than if it was in a straight line.

15	Stream meander increases stream length 3 times longer than a straight line. Bends do not provide additional macroinvertebrate habitat.
14	Stream meander increases stream length 2.5 times longer than a straight line. Bends provide productive macroinvertebrate habitat.
13	Stream meanders increase stream length 2.5 times longer than a straight line. Bends do not provide additional macroinvertebrate habitat.
12	Stream meander increases stream length 2 times longer than a straight line. Bends provide productive macroinvertebrate habitat.
11	Stream meander increases stream length 2 times longer than a straight line. Bends do not provide additional macroinvertebrate habitat.

Marginal – The bends in the stream increase the stream length 1-2 times longer than if it was in a straight line.

10	Stream meander increases stream length 2 times longer than a straight line. Bends provide additional macroinvertebrate habitat.
9	Stream meander increases stream length 1.5 times longer than a straight line. Bends provide productive macroinvertebrate habitat.
8	Stream meanders increase stream length 1.5 times longer than a straight line. Bends do not provide additional macroinvertebrate habitat.
7	Stream meander increases stream length 1 times longer than a straight line. Bends provide productive macroinvertebrate habitat.
6	Stream meander increases stream length 1 times longer than a straight line. Bends do not provide additional macroinvertebrate habitat.

Poor – Channel straight; waterway has been channelized for a long distance.

5	Straight channel offset by some slight curves which, not meanders, do serve to provide some habitat and some energy dissipation during surges.
4	Straight channel with more than one slight curve.
3	Straight channel with a single slight curve.
2	Straight channel with no curves but some bank indentations providing habitat. (Stable indentations not subject to erosion).
1	Channel completely straight with no curves or stable indentations.

Comments: Use comment field if necessary to describe any other factors that influenced scoring.

8. Bank Stability

Determine whether the stream banks are eroded or have the potential for erosion. Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered less stable. Signs of instability include crumbling, unvegetated banks, exposed tree roots, slumping and/or exposed soil.

Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. Left and right banks are determined by facing downstream. Bank stability is evaluated as bankfull height. Erosion potential in terraces may lower scores if affecting stream.

Optimal: Banks are stable, evidence of erosion or bank failure absent or minimal; little potential for future problems, < 5% of the bank affected. Terrace erosion not affecting stream and no healed-over erosion.

10	No signs of instability evident. Banks sloping. Little erosion potential.
9	Steep banks or some potential for erosion.

Suboptimal: Moderately stable, infrequent, small areas of erosion. 5 – 30% of bank in reach has areas of erosion or other signs of instability. Little or no erosion on terraces. May have healed over erosion.

8	More than 5% healed over erosion and no active erosion.
7	5 - 15% of bank has areas of erosion or other signs of instability. Some are not healed over.
6	20 - 30% of bank has areas of erosion or other signs of instability. If approaching 30%, score Marginal if banks are steep or if eroding areas on terrace is affecting stream.

Marginal: Moderately unstable; 30-60% of bank in reach has areas of erosion or other signs of instability; high erosion potential during floods. Eroding terrace may be affecting stream.

5	30 - 40% of bank has areas of erosion or other signs of instability. If approaching 40 score lower if banks are steep or eroding terrace is affecting stream.
4	40 - 50% of bank has areas of erosion or other signs of instability. If approaching 50%, score lower if banks are steep or eroding terrace is affecting stream.
3	50 - 60% of bank has areas of erosion or other signs of instability If approaching 60%, score lower if banks are steep or sloughing or eroding terrace is affecting stream.

Poor: Unstable: many eroded areas; raw areas frequent along straight sections and bends; active bank sloughing; Over 60% of banks has areas of erosion or other signs of instability.

2	60 - 75% of bank has areas of erosion or other signs of instability.
1	80 - 90% of bank has areas of erosion or other signs of instability.

0	There are no stable areas on bank.

Comment: Use comment field if needed to describe additional factors affecting scoring.

9. Bank Vegetative Protection

Determine the type and quality of vegetation on the stream bank. This is the area from the base of the bank to the top of the bank. The object is to determine the ability of the bank to resist erosion as well as the ability of the plants to uptake nutrients, control instream scouring, supply food to shredders and provide stream shading. Streams that have various classes of native vegetation providing full natural plant growth including groundcover, shrubs, understory trees and mature trees will score highest.

In some regions, the introduction of exotics, such as kudzu, privet, multi-flora rose or honeysuckle, has virtually replaced all native vegetation. Although exotics may provide erosion control, they do not provide ideal food and habitat to stream organisms that have evolved to utilize native species. Banks that are dominated by non-native vegetation should score lower. A list of commonly encountered non-native species can be found in Appendix B. Species information, county distribution and pictures can be found at the Tennessee Invasive Plant Control website: http://www.tnipc.org/invasive-plants/

Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. Left and right banks are determined by facing downstream.

Condition category is determined by estimating the amount of bank covered by **undisturbed native vegetation**. Rank is determined by complexity of vegetation type.

Optimal: More than 90% of the streambank surfaces and immediate riparian zone covered by undisturbed vegetation. All four classes (mature trees, understory trees, shrubs, groundcover) are represented. All plants allowed to grow naturally. All plants are native.

10	No disruption. All classes of vegetation (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally.
9	Minimal disruption affecting less than 10% of stream bank. All classes of vegetation are represented and allowed to grow naturally.

Suboptimal: The majority (70 - 90%) of the bank is covered by undisturbed native vegetation. One class may not be well represented. Disruption evident but not affecting full plant growth. Non-native vegetation may be present but rare (< 30%).

8	Over 90% of bank area covered by native vegetation but one class not well represented.
7	70-90% of bank area covered by native vegetation. All classes of vegetation (mature trees, understory trees, shrubs, groundcover) are well represented and allowed to grow to full height.
6	70 - 90% of bank area covered by native vegetation but one class not well represented. Other classes allowed to grow to full height.

Marginal: 50 - 70% of the bank covered by undisturbed vegetation. Non-native vegetation may be common (30 - 50%). Two classes of vegetation may not be well represented.

5	All classes of vegetation (mature trees, understory trees, shrubs, groundcover) are represented. If approaching 70% score Suboptimal 7 if all vegetation allowed to grow to full height.
4	One class of vegetation not well represented or not allowed to grow to full height. If approaching 70% score Suboptimal 6 if all vegetation is native and allowed to grow to full height.
3	Two classes of vegetation not well represented or not allowed to grow to full height or non-native vegetation is common.

Poor: Less than 50% of the bank is covered by undisturbed vegetation or more than two classes of vegetation are not well represented, or most vegetation has been cropped. Non-native vegetation may be dominant (> 50%).

2	Vegetation that is present is mostly native and allowed to grow to full height.
1	Most vegetation is not allowed to grow to full height or is non-native.
0	Bank vegetation is absent or too sparse to provide bank protection or habitat.

Comment: Use the comment field to describe what class of plants are missing and/or describe exotic plants.

10. Riparian Vegetative Zone Width

Estimate the width of natural vegetation from the top of the stream bank out through the riparian zone (approximately 18 yards). Disturbance to the riparian zone occurs when there are roads, parking lots, fields, row crops, lawns, parks, bare soil, buildings, logging, campgrounds, golf courses or other human activity.

Each bank is evaluated separately on a scale of 0 to 10 and the cumulative score of both banks is used for this parameter. Left and right banks are determined by facing downstream.

Condition category is determined by estimating the width of the riparian zone from the top of the stream bank, outward. Generally, the riparian ends at first indication of human disturbance with the exception of un-paved footpaths or trails in an otherwise undisturbed riparian.

Scoring within the category should be based on the level of impact the disturbance has. For example, un-grazed fields would score higher than active fields. Lawns would score higher than paved areas.

Paths, and walkways in an otherwise undisturbed riparian zone may be judged to be minimal disturbance if they are narrow, unpaved and show no evidence of erosion. They should not affect condition category but should lower score one point within category.

Optimal: Average width of riparian > 18 yards throughout reach.

10	There is no human disturbance.
9	Human disturbance minimal, for example, an un-paved footpath.

Suboptimal: Average width of riparian 12 – 18 yards throughout reach.

8	Human disturbance, after 12 yards of undisturbed riparian is minimal, for example an un-grazed hay field or areas of riparian that are less than 18 yards are small.

7	Human disturbance, after 12 yards is vegetated but has frequent use or is close cropped. For example, lawns, golf-courses, row crops, active pasture.
6	Human disturbance, after 12 yards is not vegetated, for example paved or gravel lots, roads, bare dirt.

Marginal: Average width of riparian 6 – 11 yards throughout reach.

5	Human disturbance, after 6 yards of undisturbed riparian is minimal, for example an un-grazed field, or areas that are less than 12 yards are small.
4	Human disturbance, after 6 yards is vegetated but has frequent use or is close cropped. For example, lawns, golf-courses, row crops, active pasture.
3	Human disturbance, after 6 yards is not vegetated, for example paved or gravel lots, roads, bare dirt.

Poor: Average width of riparian < 6 yards throughout reach.

2	Human disturbance is minimal, for example an un-grazed field or areas that are less than 6 yards are small.
1	Human disturbance is vegetated but has frequent use or is close cropped. For example, lawns, golf-courses, row crops, active pasture.
0	Human disturbance has removed all vegetation, for example paved or gravel lots, roads, bare dirt.

Comment field: Indicate type of disturbance and any additional factors affecting score.

Habitat Scoring

Total the 10 habitat parameters and compare the score to the appropriate season and drainage area in the Habitat Assessment Guidelines (Table 4) to determine whether the habitat is capable of supporting a healthy benthic community. If score is low indicate whether this is a result of natural conditions (such as drought or beaver activity) or is the result of human disturbance. Write a brief description in space provided. (If more room is needed attach another sheet).

Sometimes it may be useful to evaluate individual parameters in addition to the total habitat score. For example, even if the total habitat score meets regional guidelines, the individual parameters of embeddedness and sediment deposition may be low indicating a problem with sedimentation. Likewise, there may be a problem with riparian removal even though habitat scores meet regional guidelines. On the other hand, a low total score may not indicate a habitat problem if the channel flow status and velocity depth regime score low in a region where reference streams have extremely reduced flow during the summer and fall.

Appendix A provides ecoregion specific expectations for each parameter on the Habitat guidelines field sheet.

Never use words such as supporting or non-supporting on habitat or any other forms including comments. That is an assessment decision based on many factors, not score alone.

4: Habitat Assessment Guidelines

Values listed below are considered to meet regional guidelines. Guidelines are based on 75% of median reference value, adjusted up to lowest habitat score passing the Tennessee Macroinvertebrate Index (TMI) in each ecoregion (Table 4).

Table 4: Habitat Assessment Guidelines.

Ecoregion	Habitat Type	Streams > 2.5 sq. mile drainage		Headwater Streams ≤ 2.5 sq. mile drainage	
		Jan-June	July-Dec	Jan-June	July-Dec
65abei	Low Gradient	>109	≥ 98	>107	≥ 111
65j	High Gradient	≥ 148	≥ 169	≥ 152	≥ 157
66d	High Gradient	≥ 157	≥ 158	≥ 146	≥ 157
66e	High Gradient	≥ 158	≥ 152	≥ 143	≥ 148
66f	High Gradient	≥ 135	≥ 136	≥ 148	≥ 140
66g	High Gradient	≥ 140	≥ 140	≥ 150	≥ 124
66j	High Gradient	≥ 145	≥ 139	≥ 115	≥ 132
67f	High Gradient	≥ 131	≥ 128	≥ 133	≥ 123
67g	High Gradient	≥ 106	≥ 103	≥ 136	≥ 129
67h	High Gradient	≥ 156	≥ 148	≥ 125	≥ 146
67i	High Gradient	≥ 114	≥ 117	≥ 114	≥ 117
68a	High Gradient	≥ 135	≥ 145	≥ 139	≥ 128
68b	High Gradient	≥ 124	≥ 129	≥ 137	≥ 143
68c	High Gradient	≥ 131	≥ 124	≥ 163	≥ 155
69d	High Gradient	≥ 133	≥ 123	≥ 134	≥ 123
69e	High Gradient	≥ 127	≥ 122	≥ 151	≥ 136
71e	High Gradient	≥ 113	≥ 114	≥ 145	≥ 130
71f	High Gradient	≥ 126	≥ 123	≥ 129	≥ 126
71g	High Gradient	≥ 126	≥ 128	≥ 119	≥ 149
71h	High Gradient	≥ 115	≥ 114	≥ 132	≥ 123
71i	High Gradient	≥ 112	≥ 99	≥ 113	≥ 114
71i	Low Gradient	≥ 106	≥ 114	>100	NA
73a	Low Gradient	≥ 118	≥ 118	≥ 106	≥ 106
74a	High Gradient	≥ 124	≥ 122	≥ 108	≥ 116
74b	Low Gradient	≥ 108	≥ 108	≥ 134	≥ 113

Protocol E – Stream Survey Field Sheet

The stream survey field sheet must be completed every time a biological sample is collected. The field sheet is completed using the SS2 tab on electronic e-Forms (BioForm for DWR/TDH staff or Stream Survey and Habitat Sheet for other stakeholders). Form updates and instructions (BSERT) are sent to EFOs and lab biologists in July and updated on the DWR publications page at the beginning of each fiscal year. They are also accessible to staff on SharePoint PAS website in the electronic forms folder.
https://tennessee.sharepoint.com/sites/environment/DWR/PAS/PAS/

The BioForm will generate an Excel spreadsheet that should be uploaded to Hydra by EFO or TDH lab staff within 1 week of collection and before sending samples to lab. See BSERT for complete upload instructions.

A screen shot of the electronic form can be found in Appendix B of this document, but only electronic forms should be used.

Information on the field sheet is designed to help make assessment decisions and provide supplemental information for interpreting biological sample results. Additional information, not included on the field sheet, should be added as needed to fully document field conditions at the time of the site visit. Consult all personnel present during sampling for additional observations that may have been overlooked before leaving the site.

Header Information

Header information will be filled in from the Bioevent tab on the electronic BioForm (see Protocol C-1).

When Using BioForm, the header information is entered in the Bioevent tab (Protocol C-1).

1. Field Parameters

Use calibrated meters for all field measurements (Protocol C).

Designate the meter's using identifying name or number that was used to make readings. The measurements for each parameter (including duplicates) are recorded in the appropriate boxes. Record the measurements in the units specified on the field sheet.

If, after the drift check, the meter was found to be off by more than 0.2 units for pH, temperature, or dissolved oxygen (or more than 10% for conductivity or percent saturation), do not upload values to Hydra. Indicate meter problem on stream survey sheet.

Do not record values if the reading is suspect for any reason. Indicate in comment field if readings were not recorded for any reason (failing post-calibration, no meter available, air bubble, etc.).

If the value is a criteria violation, verify measurements are correct and check box that it is validated or indicate meter problem if reading is suspect (do not record value).

DWR and TDH staff will upload field parameters using Hydra tab on BioForm directly to the Hydra Chemistry staging table within 30 days.

2. Weather

Indicate the appropriate level of precipitation for the previous 48 hours. Record approximate air temperature in Fahrenheit.

3. Physical Characteristics and Light Penetration

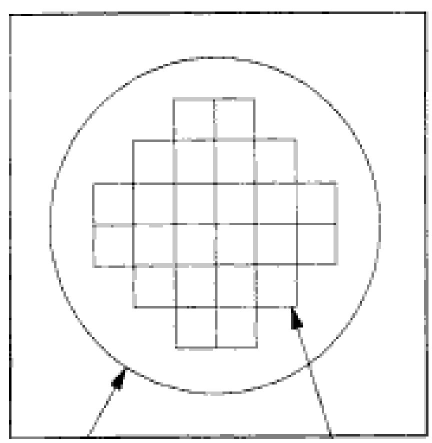
a. Indicate stream gradient in sample reach.
b. Estimate average stream width of reach area in yards. (This is wetted width)
c. Estimate stream at deepest point (usually pool) in yards.
d. Estimate average canopy for the entire reach and record value.
e. Measure canopy cover using a spherical densiometer mid-stream midway of the area(s) where biological samples were collected (mid-riffle if collecting one

riffle, midway between two riffles if collecting multiple riffles, mid-distance between most upstream and most downstream bank sample if collecting bank jabs or diatoms without associated macroinvertebrate sample). The densiometer is a convex mirror etched into 24 ¼-inch boxes (Figure 4). Each box is subdivided into four smaller squares, via an imaginary dot in the center of the box, to create a total of 96 smaller squares that can be counted within the entire densiometer.

Hold the densiometer one foot above the water surface. Holding the instrument at this level eliminates errors due to differing heights of samplers and different water depths and includes low overhanging vegetation more consistently than holding the densiometer at waist level. Take four measurements, facing upstream, downstream, the right descending bank, and the left descending bank. Hold the instrument far enough away from the body so that the operator's head is just outside the grid.

Count the number of small squares (out of a total of 96) that have tree canopy. Record this number (number of dots **WITH** canopy cover) on the field sheet. In order to get the overall percent canopy cover for that point, sum the four measurements and divide the total by 384 and multiply by 100%. Record this number in the measured field.

Photo provided by Joellyn Brazille, Memphis EFO



Cook et al. 1995

Figure 4: Spherical Densiometer

4. **Channel Characteristics**

   a. Estimate bank height and high-water mark in yards.
   b. Select best description of bank slope for each bank. Up to four may be selected if necessary.
   c. Indicate presence of any man-made modifications. Up to four may be selected.

5. **Stream characteristics:**

   a. Sediment deposits: Select only the one that best describes the reach. Please make sure this is consistent with score on sediment deposition on habitat assessment sheet.

      - Slight is generally a light layer over most of the slow areas that affect niche space.
      - Moderate is a slightly heavier layer over most of the slow areas and possibly in runs. or infrequent heavy deposits. Niche space is starting to be affected.
      - Excessive is a deeper layer over much of substrate that substantially reduces niche space.
      - Blanket is a deep layer coating all substrates (except possibly fast riffles). Niche space is compromised.

   b. Sediment Type: Indicate up to four types of sediment deposits that are affecting the reach.

   c. Turbidity: Indicate whether water is clear or select best description if turbid.

   d. Foam/Surface Sheen: Indicate whether a surface foam or sheen is present and type.

   e. Algae: Indicate level of algae through reach. Do not count moss.

      - Slight: Isolated pockets of algae, no effect on stream.
      - Moderate: Algae may have limited effect on benthic community (feeding groups and/or reduced niche space.). Diel dissolved oxygen patterns may not be affected.

- High: Algae frequent, possible nutrient loading, probably causing diel D.O. swings and/or has significant effect on benthic community (feeding groups and/or niche space).
- Choking: Algae covering most of stream, may form large mats or clumps. Excessive nutrient loading and significant diurnal D.O. swings indicated, Observable reduction of niche and probable change in biotic community structure.

f. Algae Type: Be careful not to include moss or duckweed. Pictural descriptions can be found at https://www.townofchapelhill.org/home/showdocument?id=28866.

- Diatoms: Generally slick coating on rocks and other hard substrate. Often brown in color.
- Green: Green algal clumps or mats that do not form long strands.
- Filamentous: Long green hair-like strands of algae attached to hard surface.
- Blue-Green: (Cyanobacteria) Appears slimy or oily. Often bright green or bluish green on or near surface of water. May be attached to rocks or other hard surfaces where it is generally darker in color.

g. Dominant Substrate**:** Select up to 4 substrate types (comprising more than 25% of stream) for each flow regime. (Note that for some monitoring projects which target stream disturbance such as Aquatic Resource Alteration Permits (ARAP), a pebble count may be desirable to provide a more concise measure of change in substrate.)

h. Surrounding Land Use: Select up to 4 surrounding land uses that affect the immediate stream reach. Describe any other land uses under stream information.

i. Observed Human Disturbance to Stream: Indicate level of disturbance types observed in area (Up to 4 may be selected for each of the following categories).

- Slight – Minimal effect on stream even during storm events.
- Moderate – Probable effect on stream, may be slight except during storm events.

- High - Definite effect on stream.

j. Other stream information and Additional Stressors

Describe any other conditions observed at the time of sampling. Include any changes observed from previous sampling efforts. Note anything special or unusual that would assist in assessments. Ask other team members for input. Take care not to contradict information provided on other parts of the sheet or on the habitat field sheet, for example sedimentation, erosion, and algae observations.
Examples of information that should be recorded:

- Any necessary deviations to standard sampling protocol (such as collecting more than 10 aliquots to ensure sufficient diatoms or collecting more than 2 aliquots from each habitat due to limited habitat availability).
- Physical changes from last sampling event.
- Low abundance of organisms, dominance of early instars.
- Recent evidence of scouring.
- Clarification of human disturbances already indicated such as cattle have full access to stream or fertilizer run-off from crops.
- Additional disturbances not on the drop-down list.
- Description of any outfalls, pipes, drainage ditches etc.
- Powerline/utility line crossings.
- Evidence of chemical impact such as bleaching or blackening of rocks.
- Presence of other stakeholders.
- Natural disturbances such as beaver activity.
- Gravel dredging.

Photographs

A digital photographic record is to be kept on each sampling station. Photographs of the general stream condition and potential pollution sources/disturbance should be taken during the original sample visit. Photographs of any changes are taken during subsequent sampling trips. Document the picture identification and a brief description on the field sheet.

Indicate photos on stream survey form with descriptions. When using e-Forms, embed photos in the stream survey sheet. Examples of photographs used for documentation should include (but not be limited to):

- Heavy algal growth
- Surface scum/foam/bacteriological growth
- Heavy or unusual sediment/iron precipitate
- Livestock in creek
- Heavy bank erosion
- Outfalls/pipes
- Runoff from fields/parking lots etc.
- Any disturbance that could affect the stream and would help with assessments.

Protocol F – Rapid Periphyton Survey (RPS)

The Rapid Periphyton Survey is a modification of the U.S. EPA's *Rapid Bioassessment for Use in Wadeable Streams and Rivers* (Barbour et. al., 1999).

The RPS field sheet is available in the BioForm workbook and is used to record all information and upload electronically to Hydra. Copies of all field forms are in Appendix B of this document. If a field tablet is not available, paper forms may be completed in field and transferred to the electronic workbook for upload. BioForms are available on SharePoint or by contacting WPU.

The top section (Diatom Sample Information, Figure 5) on the RPS field sheet is completed whenever diatom samples are collected (Protocol G). The second section (Rapid Periphyton Survey Data Sheet) includes field surveys along transects and is not required when collecting diatom samples. It does provide additional information on abundance of all algal types in the stream. It is required for the Southeast Monitoring Network sites (SEMN) and may be required for other projects.

Rapid Periphyton Survey:

1. Establish five transects across each stream reach. These do not need to be evenly spaced but should be representative of the reach. Target locations of likely algal growth (riffles and runs) if available. Avoid shaded areas if possible. Space transects to span full length of the reach.

2. Along each transect, observe 10 evenly spaced points. If the stream is not wide enough to observe 10 points (<1.5 m), observe as many points as possible and note the number of points observed and the reason in the comment field.

3. At each point on the transect, estimate moss cover, macroalgal cover and microalgal biofilm thickness using the classification system defined in Table 5. Record the coverage class (0-5) for moss and macroalgae and the biofilm thickness (0-5) in the appropriate column beside the selected point on the transect on the RPS.

4. Optimal substrate is defined as substrate with a diameter greater than 2 cm. Smaller substrate is not as suitable for the growth of a stable population of algae due to scouring and shifting. At each point on the transect, record if the substrate is of optimal size (Y/N). If the substrate is not optimal in size for a stable periphyton population, but moss, macroalgae, and/or microalgae are visible, score and record that information on the RPS sheet in the comments.

5. At the mid-point of each transect, take a canopy reading using a spherical densiometer (Protocol E Step 3).

Table 5. Percent Cover and Thickness Classes

Moss and Macroalgae Cover Classes						
Class Number	0	1	2	3	4	5
Coverage	0%	<5%	5% to 25%	26% to 50%	51% to 75%	>75%
Microalgal Thickness Class						
Class Number	0	1	2	3	4	5
Thickness	0 mm	<0.5 mm	0.5 to 1 mm	1 to 5 mm	5 to 20 mm	>20 mm
Characteristics	Rough	Slimy, no visible biofilm	Biofilm visible			

Protocol G – Diatom Sample Collection

1. Identify target substrates where benthic diatoms can be collected within arm's length (0.5 m) of the surface.

    a. Target substates include riffle/run rock, pool rock, leaf packs, woody debris/snags and removable portions of vascular plants or roots. Do not collect samples from sand or sediment.
    b. Substate should be "seasoned" (not recent or "new fall").
    c. Substrate should be exposed to sunlight during part of the day (avoid deep shade unless the entire reach has 100% canopy).
    d. Substrate should feel at least slightly slimy (biofilm).
    e. Substate should not be covered in filamentous or other types of macroalgae, moss or sediment which may impede diatom growth.
    f. Substrate needs to have been submerged at least 2 weeks and is not scoured.

2. Once habitats have been identified, determine proportion, and sample a total of 10 (4 ml) aliquots from the identified habitats. Proportion the number of samples from each habitat based on Table 6.

Table 6. Example of Aliquot Apportion Strategies (Each aliquot is 4 ml)

Number of different Substrate types available	Aliquot Apportion Strategy
1	10 aliquots from one substrate type
2	5 aliquots from each substrate type
3	4 aliquots from most abundant substrate 3 aliquots from remaining two substrates
4	3 aliquots from two most abundant substrates 2 aliquots from remaining two substrates
5	2 aliquots from each substrate

3. To collect each aliquot, first place 100 ml of creek water in 500 ml wide mouth plastic jar. The jar should be approximately 9 cm in diameter. (Measure and mark the 100 ml level with a sharpie prior to leaving the office – this jar can be re-used.)

4. Carefully remove the target habitat from the water.

5. Using fingers, rub substrate surface into the jar containing 100ml of stream water. (Do not use toothbrush or other tool that is difficult to clean and may cross-contaminate samples.) The amount of surface area rubbed should be approximately 9 cm in diameter. Use the mouth of the 500 ml jar to estimate. Rub the surface a minimum of three times to ensure algae removal.

6. Rinse fingers in jar and discard substrate.

7. Stir the jar well to homogenize the diatoms in the 100 ml slurry. Remove 2 ml of slurry by completely filling disposable pipetted and transfer to 150 ml opaque brown sample bottle. Stir the slurry again and remove a second 2 ml of sample with the pipette and transfer to sample bottle.

8. Repeat the process for a total of 10 targeted substrates and 40 ml of sample. The goal is to collect 40 ml of sample by collecting 4 ml aliquots from each of ten locations. However, if there are not enough rocks/roots/leaves etc. available, multiple aliquots may be collected from fewer sources. For example, if only five rocks are available in a stream, 8 mls from each rock should be collected. (In this example, 18 cm instead of 9 cm of surface area should be rubbed and 4 pipette-fulls collected from each rock.) Make sure at least 40 mls are collected, if there is any doubt, collect additional aliquots.

> In reference streams and other very clean reaches, during shoulder seasons or in deeply shaded streams, it may be necessary to collect from a larger surface area and/or additional aliquots to get enough diatoms. When in doubt about the diatom density (film is very light or few substrates have film) collect additional aliquots and/or include more surface area in aliquots. Record any deviations from standard protocol in the comment section of the stream survey worksheet.

9. Once 40 ml is collected, add 2 ml of (27%) buffered formalin to the sample bottle. See below for preparation or obtain from the aquatic biology section at the state lab. Do not continue to use buffered formalin that has begun to heavily precipitate.

10. Record the number of 4 ml aliquots collected from each habitat sampled on the top portion of RPS data sheet in the BioForm workbook (Figure 5). If completed

correctly, the total number of aliquots should equal 10. Also complete the Sampler information and any comments. The Station ID, date, EFO and field log number will be auto populated from the BioEvent tab in the workbook.

Diatom Sample Information			Revised 2/2/2023
DWR Station ID:		Date:	
Field Log Number:		Sample ID:	
Sampler:		EFO:	
Record aliquots for all RPS samples.		Hydra upload is below transects.	
Diatom Habitats Sampled (Specify number of aliquots - total 10)			SOP Link: RPS Collection
Riffle Rock:		Pool Rock:	
Leaf Packs:		Woody Debris:	
Aquatic Plants or Roots:		Comments:	Total aliquots= 0

Figure 5: Worksheet for reporting diatom sample collections (top half of RPS form in BioForm workbook).

Buffered Formalin Preparation

Use extreme caution when handling formalin. It is a very toxic chemical and can cause irritation to skin, eyes, and respiratory system. It is also highly flammable. A laboratory coat, latex or vinyl gloves, and eye protection are required when working with formalin. Avoid breathing vapors or exposing co-workers to them. Work in a well-ventilated area (preferably a laboratory hood or chemical ventilation system). Keep face away from open containers of formalin. Refer to the SDS for information and first aid measures.

1. Weigh out approximately 1 gram of sodium bicarbonate for each liter of formalin.
2. Gradually add the sodium bicarbonate to the container of formalin (37%). In general, one gram of sodium bicarbonate will buffer about one liter of formalin, but it is necessary to check the pH of the buffered solution, as individual batches of formalin may vary in pH. Close the container and shake vigorously after each addition.
3. Check the pH at each interval until reaching a pH between 7.5-8.0 S.U. The sodium bicarbonate may not all dissolve into the formaldehyde, as this is a supersaturated solution. The solution should not be milky white; this indicates that too much sodium bicarbonate was added.
4. Store the buffered formalin in a Nalgene plastic bottle and label "Buffered Formalin" with the date of preparation. Do not use buffered formalin if more than the initial precipitate is visible.

Protocol H - Sample Logging and Lab Transport

Samples must be assigned a field log number to allow complete reconstruction, from initial field records, through data storage, sample analysis and retrieval. If using DWR electronic forms, this number will be automatically assigned. If using paper forms the same field log number should be assigned to all samples collected at that site that day (biorecons, SQSH, diatoms, chemicals). A field log number can be created using the Primary assessor initials, followed by date (MMDDYYYY) with no separations, and then a 2-digit running number (i.e., 01) for each site throughout the day.

- JEB0131202201 would be all routine samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by JEB on 01-31-2022 at the first site of the day.

- JEB0131202202 would be all duplicate or replicate samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by JEB on 01-31-2022 at the first site of the day.

- JEB0131202203 would be all routine samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by JEB on 01-31-2022 at the second site of the day.

- JEB0201202201 would be all the routine samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by JEB on 02-01-2022 at the first site of the day.

- JEB0201202202 would be all samples (habitat, biorecon, SQSH, diatoms, etc.) collected or assessed by JEB on 02-01-2022 at the second site of the day.

A log is to be kept in the field office of all biological samples collected. Hydra can be used to generate this log (Figure 6). It is recommended that this be an electronic log. A back-up copy in a separate location must be kept of all logs. The log entry must include the field log number, DWR Station ID, date collected, time collected, collector's initials, monitoring location name, station location, type of sample, and date sent to the lab, date uploaded to Hydra for RPS, habitat and stream survey. A second log will be kept in the LIMs system at the TDH lab, which will also include sample identification and contracting information (Figure 7).

Transport to Lab

All diatom samples collected by DWR environmental field offices are to be delivered to the Nashville Environmental Laboratory (TDH) for identification within 30 days after collection. It is important that EFOs deliver samples to the lab as soon as possible (within 30 days of collection) to enable the lab to pace sample analysis and contracting throughout the year to meet TDEC reporting deadlines.

Samples containing formalin cannot be shipped. Contact the Aquatic Biology Section at 615-262-6330 to coordinate sample drop-off. A biological sample request form, including chain of custody must be completed and accompany all biological samples (page 112 and Appendix B).

Lab Sample Analysis Priorities:

Biological sample priorities are set by the Watershed Planning Unit who coordinates with the state lab. Before completing the "date needed" on the sample request form, contact WPU (Debbie.Arnwine@tn.gov) or designee if results are needed outside the following priority.

a. Non-priority samples (including TMDLs and ecoregion sites) are to be completed within one year of receipt by the laboratory. It is important that EFOs deliver samples to the lab as soon as possible (within 30 days of collection) to enable the lab to pace sample analysis and contracting throughout the year.

b. Anti-degradation samples within 30 days of receipt. (Samples should be delivered to lab within one week of collection.)

c. Special projects by agreed upon date as stipulated by grant. (SEMN samples completed 6 months after delivery to state lab. Samplers must deliver samplers to the lab within 30 days of collection.)

d. Priority samples (such as enforcement, complaints, spills) – contact Aquatic Biology Section, if lab receives too many priority requests, WPU will coordinate. Note that diatom processing takes a minimum of two weeks.

Field Log No.	SampleID	DWR Station ID	Monitoring Location Name	Location	Date Col.	Time Col.	Sampler	Type	EFO ID	EFO ID Date	Date uploaded Hydra	Date sent to Lab
NRG1117202 04	Assigned by Lab (V11 log number	COAHU45.4T0.4 T0.2BR	Coahulla Cr UT to UT	Trewhitt Rd	11/17/202	1300	NRG	Diatom	NA	NA	NA	12/01/2021

Figure 6: Diatom Sample Collection Log. Electronic log preferred- information can be generated through Hydra.

V11 log number	Field Log#	Ecoregion	Watershed grp	Station ID	Sample Type	Sampler	Sample Date	date received	Processing Initial/date	Taxonomist date complete	Contracted out /date	data Rec'd	Cost Code	Comments	Released from Starlims V11
N2008170-01	JIF07142020 2	66G	5	DUDLE000.2SV	MPS	JIF	07/14/2020		Processed MES 6/9/22		Enviro 6/22				

Figure 7: Diatom Sample ID Log (Lab)

Protocol I – Laboratory Analysis of Diatom Samples

All diatom samples are sent to the Aquatic Biology Section of the Tennessee Department of Health (TDH) Environmental Laboratory in Nashville for analysis. The TDH lab may subcontract the analysis to another qualified diatom laboratory.

Nitric Acid Digestion

The diatom cleaning steps remove both extracellular and intracellular organic material by digesting with nitric acid. After removing organic matter, all details of diatom structures essential to taxonomic identification should be clearly visible.

1. Shake sample vigorously for a minimum of 30 seconds to ensure material is suspended in water column. Using a clean glass pipette, draw 5 ml from middle of the water column and place in a labeled 250 ml beaker. After the sample draw, replace the lid and shake the bottle for another 30 seconds before drawing another 5 ml from the middle of the water column. Repeat this process for a total of four draws equaling 20 ml. Record total subsample volume. Retain the remaining sample for a minimum of five years.

2. Digestion must be performed inside a positive-draw hood wearing a lab coat and double gloves. A full-face respirator must be worn when actively boiling the sample.

3. Cover the countertop inside the fume hood with aluminum foil and white absorbent paper to help protect it from acid spills.

4. Set the sample under the hood making sure labels are visible. Add nitric acid slowly to each beaker in a 1:1 ratio, approximately 20 ml. Using a scoopula, add 4-5 grams of Potassium dichromatic to each beaker and gently swirl.

5. Place enough beakers to comfortably fit on a hotplate. Bring subsamples to a boil and continue boiling for 45 minutes – one hour. Using a timer, carefully swirl the beakers every ten minutes and place them back on the hotplate. Continue this action throughout the boiling process (for a total of three to four times) to ensure proper mixing of the sample. If the liquid level gets too low during the boiling process, carefully add more acid.

6. Remove beakers from hotplate. Allow to cool to ambient temperature.

7. Carefully add deionized water to the top rim of each beaker. This will neutralize the acid in the sample over time. Allow the samples to sit for a minimum of eight hours between water changes. This will allow the diatoms to settle to the bottom of the beaker.

8. After settling, being careful not to disturb the diatoms on the bottom of the beaker, slowly siphon water using a fine tip glass pipette (such as a Pasteur Pipette) from the top center of each beaker until 25-50 ml of sample remains. Be certain to avoid siphoning diatoms from the bottom. Watch for diatoms to move from the water surface, sides, or bottom of the beaker toward the pipette tip. Quickly remove the pipette from the water if clouds of suspended diatoms move toward the tip. Rinse off the glass pipette in between each beaker with DI water.

9. Repeat steps 7-8 for six more siphoning sessions. On the eighth day, use litmus/pH paper to check the pH. If the pH is not neutral (7), add additional DI water and repeat the siphoning process. When the pH is neutral, siphon water from each beaker until 15-20 ml of sample are left. Swirl beaker to remove diatoms on the bottom and pour into labeled glass vial. Pour a small amount of DI water into beaker to rinse off any remaining diatoms. Screw cap on vial.

10. Allow the vial to settle for eight hours. Carefully remove the extra water until approximately 10 ml are left without disturbing the diatoms on the bottom.

Diatom Mounting

1. Place a 2-inch square white tile next to the labeled vial for each subsample on a clean lab countertop. Place two 22x22 mm square coverslips on the tile in a diagonal position. Fill a beaker with DI water and use a glass pipette to draw 1 ml of the water. Carefully spread it over the coverslip making sure it does not spill over the slide onto the white tile. Repeat for the second coverslip.

2. Gently swirl the digested sample. Draw 100 uml (0.1 ml) of sample with a pipette. Place on the center bottom of the slide very slowly. Repeat this for the second coverslip. Allow the coverslips to dry overnight.

3. After drying overnight, place the coverslips on a clean dry slide and examine under a microscope with 40x view on each coverslip to ensure there are at least 15 diatoms per field of view working in all directions. If not, repeat step 2 until enough diatoms are visible for counting. (Target is 480-720 valves.)

4. Working under the fume hood with lab coat and double gloves, place one drop of prepared Naphrax (or equivalent) on the microscope slide. Gently flip the coverslip to sample side down on the Naphrax – there will be two slides per sample. Place the slide onto the hotplate and allow the Naphrax to boil for approximately one minute. Carefully remove the slide from the hotplate and gently press the coverslip down to remove any air bubbles and excess Naphrax. Let set overnight to harden. Carefully use a scalpel or razor to scrape the excess Naphrax from the sides of the coverslip. Label each slide with the lab log number, station ID, collection date and samplers initials.

Diatom Taxonomy and Enumeration

1. Identify and count diatom valves to the lowest possible taxonomic level, which should be species and perhaps variety level, under oil immersion at 1000x magnification. Only names consistent with those found in the master taxa table in Hydra may be used. https://apex.tdec.tn.gov:7777/apex/f?p=333:101:7360053809132::::: New taxon must be consistent with USGS biodata and approved by WPU. It is important to use this nomenclature which has been harmonized and calibrated for Tennessee Diatom Index comparison.

2. Target count is 600 valves (300 cells). (The count must be at least 480 valves, or an index value cannot be calculated.) Both valves of intact frustules should be counted separately. Do not count valves that are broken by more than 50% or are in poor condition. Count all diatoms in the last field of view when 600 is reached. Record numbers of valves observed for each taxon on the bench sheet.

3. Digital photographs should be taken of all unique taxa that have not been verified by an expert phycologist as documented in Hydra diatom master taxa list. These should be verified and uploaded to Hydra digital reference collection.

4. Completed diatom taxa lists and counts, will be uploaded by the TDH laboratory to the Ecological Data Application System (EDAS). If a taxon is not present in EDAS reference table, the diatom master taxa reference table in Hydra should be consulted for the correct final ID. https://apex.tdec.tn.gov:7777/apex/f?p=333:101:7360053809132:::::(Filter the table by the taxon name to see if there is an alternate final ID that is acceptable.) If it is there, add all the information for the species from Hydra to EDAS master taxa. If it is not in Hydra, notify the manager and the appropriate Watershed Planning Unit staff. WPU will send a crosswalk for the species or provide the needed information to be added into EDAS for the new species that was identified. New taxa must be verified by a recognized expert (Appendix D).

5. After taxonomic harmonization, the TDH laboratory will use EDAS to generate a taxonomic report and upload to the diatom taxa staging table in Hydra. Hydra will calculate the metrics. TDI (Tennessee Diatom Index) and determine diatom condition based on calibrated scores. The metrics and scoring information are described below for informational purposes. All calculations and scoring will be done through Hydra.

Protocol J - Tennessee Diatom Index (TDI)

The TDI is a multi-metric index comprised of eight metrics selected for the Southeast diatom index developed by Tetra Tech (Tetra Tech, 2022). The index was a collaborative effort between U.S. EPA, Tetra Tech, Alabama Department of Environmental Management, Georgia Department of Natural Resources, Kentucky Division of Water and TDEC to develop a nutrient sensitive index based on southeast diatom data.

Diatom data from over 1000 stations and 1500 samples across the 4-state area were processed. An extensive taxonomic harmonization effort resulted in a final set of operational taxonomic units for use in index development. Phycologists from USGS as well as Georgia College and State University provided assistance with harmonization.

More than 200 metrics using known diatom traits from a wide range of sources were generated. These metrics were combined into candidate indices using an all-possible model subsets routine. Top performing indices were selected based on overall discrimination, stressor sensitivity, and robust discrimination across ecoregions.

The final region-wide index is composed of eight metrics that reflected general disturbance sensitivity, tolerance, oxygen sensitivity, nutrient sensitivity, and motility (Table 7). The index has a discrimination efficiency around 70% and ecoregional discrimination efficiencies ranging from 50% to 100%. It is sensitive to nutrient gradients as well as general human disturbance measures.

Table 7: TDI Metric descriptions

Metric	Hydra Report	Description	Response to Stress
Bahls_3.pa	%SEN	Percent abundance of pollution sensitive taxa	Decrease
LTNtr	%LTN	Percent taxa indicating low total nitrogen conditions	Decrease
O_3.pt	% O2tr	Percent taxa requiring 50% dissolved oxygen saturation.	Increase
Wa_OptCat_L-1DisTot	%LAND	Percent taxa tolerant to general land disturbance including urbanization and agriculture.	Increase
Navicula.pt	%NAV	Percent Navicula taxa. (Motile taxa tolerant of fine sediment	)Increase
Centric.pt	%CEN	Percent of centric taxa – respond to effects of reservoir (lentic taxa) and tolerant of nutrients	Increase
High_P.pt	% PTOL	Percent taxa tolerant of TP > 0.1 mg/l.	Increase
BC_5.pa	%TOL	% abundance of highly tolerant taxa.	Increase

Tennessee further calibrated the index to Level IV ecoregions found in the state based on reference stream data to develop regional condition criteria for use in watershed assessments. The index is particularly effective in determining a biological response where nutrient levels are elevated but macroinvertebrates do not show a measurable response using the Tennessee Macroinvertebrate Index (TMI).

Metric values vary in scale depending on the units in the measurement and the ranges in the data sets. To give each metric equal weight in the index, metric values were converted to metric scores on a 100-point scale, using the effective range of each metric. The 5^{th} and 95^{th} percentile metric values from all sites were used as the effective ranges of metric variation in the samples. This recognized the possible range of metric values throughout the study area while discounting values that were unusually extreme and possibly outliers (Blocksom 2003).

For metrics that decreased with increasing stress, a metric score was calculated as follows:

$$\text{Decreaser metric score} = 100 * \frac{\text{Metric value} - \text{minimum}}{\text{95th percentile} - \text{minimum}}$$

For metrics that increase in increasing stress, a metric score was calculated as follows:

$$\text{Increaser metric score} = 100 * \frac{\text{Maximum} = \text{metric value}}{\text{maximum} - \text{5th perentile}}$$

Metric scores were truncated at 0 and 100. To calculate the index, the eight metrics scores are averaged. The target TDI score is based on the 25th percentile of index scores for each ecoregion (Table 8). TDI scores below the target are considered stressed.

Table 8: TDI target scores by Level IV ecoregion

Level IV ecoregion	TDI Target
73ab, 74a	40
67g, 71i, 74b	60
71eh	65
65abei, 67fhi, 71fg	70
65j, 66defijk, 68bc	75
66g, 68ad, 69de	80

Protocol K – Report Preparation

All field information and taxa lists associated with diatom surveys must be reported in the approved electronic format and uploaded to Hydra. E-forms should be used to record all stream survey and habitat information (as well as RPS information at SEMN sites). Sampler (if TDEC or TDH) staff will upload information directly to Hydra.

Note when using e-Forms (BioForm or Habitat and Stream Survey Form), the BioEvent Worksheet must be completed first (Appendix B) in order to populate header information on other forms. Instructions for completing e-forms and uploading to Hydra can be found in the BSERT on SharePoint or by contacting Kim.Laster@tn.gov or tdec.watershedplanning@tn.gov.

The TDH state laboratory is responsible for uploading diatom taxa lists to Hydra that are identified by them or their contractors. After sample completion and QC (by agreed due date) the lab will upload taxa lists using the diatom taxa staging Query in EDAS to the diatom taxa staging tables in Hydra and notify sampler that data are available.

Results should not be uploaded until QC is complete. However, data should not be held past due date. Instead, QC should be completed prior to completion of group of 10. If the last sample QC'ed fails, the next group of 10 should start after the failed sample. If the sample passes, additional QC does not need to be done until 10 samples are completed for that group.

In some cases, preliminary data may be requested by QPU before QC is complete. The state lab will load the taxa list to Hydra and add a comment to the record in the diatom metrics table that results are preliminary, and QC has not been completed. Once QC is done, the lab will update the taxa list in Hydra and remove the comment from the metrics table.

WPU (Debbie.Arnwine@tn.gov or designee) should be notified when new taxa (not already in Hydra master diatom taxa reference table) are found. After review, these will be added to the Hydra master taxa with verification pending. The state lab will send a digital image to an outside expert for verification. Results of the verification will be sent to WPU, and verification status in Hydra will be updated. The digital picture and associated meta-data will be uploaded by TDH to Hydra and will serve as the state reference collection.

Protocol L - Data and Records Management

All biological data and associated field information will be stored in the Hydra database.

Monitoring stations are established in Hydra. The Watershed Planning Unit is responsible for maintaining the stations' list. New stations should be uploaded by field staff to the staging table in Hydra using the new stations form included on the BioForm. WPU will be responsible for QC'ing the new stations, verifying that they are not an established station under another name, assigning a consecutive monitoring ID starting with TNW and uploading to the final table in Hydra.

Habitat sheets, field parameters and stream survey sheets will no longer be sent to the state laboratory with biological samples. The EFO will be responsible for uploading field information to Hydra within 30 days of field survey.

Diatom taxa lists are uploaded to Hydra by the Aquatic Biology Section, Lab Services, TDH on or before sample due date. An email will be sent to the TDEC field offices and Water Pollution Unit in the central office when new data have been uploaded.

Metrics are calculated and scored by Hydra. Scores are reported in the diatom metric tables using the most current SOP calibrations. For duplicates, one sample will be designated as primary by the WPU QC biologists and will be used for assessments. Generally, this will be the sample-routine unless the taxa list or field information indicate the duplicate sample is more representative. Examples include a high number of immature or damaged organisms identified to family and/or field notes indicating deviation from protocol or discrepancies between the two samples that would affect diatom populations.

Assessment information for each stream segment will be entered in ATTAINS (Assessment, TMDL Tracking and Implementation System) by the Watershed Planning Unit. WPU staff will meet with monitoring managers and biologists in each EFO before assessments are finalized. This database is linked to a GIS map and is accessible on the web for public access: http://tdeconline.tn.gov/dwr/

II. QUALITY CONTROL AND QUALITY ASSURANCE

The U.S. EPA requires that a centrally planned, directed, and coordinated quality assurance and quality control program be applied to efforts supported by them through grants, contracts, or other formalized agreements. This also applies to all monitoring activities reported to TDEC in support of the Clean Water Act. This time allocation is an essential component of biological sampling and analysis and will be included in annual work plans. This is not an optional or "as time allows" activity. The goal is to demonstrate the accuracy and precision of the biologists, as well as the reproducibility of the methodology, and to ensure unbiased treatment of all samples.

A. General Quality (QC) Practices

1. Quality Team Leader (QC Coordinator) - A centralized biological QC coordinator will be designated with the responsibility to ensure that all QC protocols are met. This person will be an experienced water quality biologist in the Watershed Panning Unit. Major responsibilities will include monitoring QC activities to determine conformance, distributing quality related information, training personnel on QC requirements and procedures, reviewing Quality Assurance/Quality Control plans for completeness, noting inconsistencies, and signing off on the Quality Assurance plan and reports.

2. Quality Team Member (EFO Biological QC officer) - One DWR staff member, qualified as a biologist, in each EFO will be designated as the Quality Team Member (in-house QC officer.) This person will be responsible for performing and/or ensuring that quality control is maintained and for coordinating activities with the central Quality Team Leader (QC coordinator).

   Areas of Responsibility

   1. Macroinvertebrate reference collection and vouchers
   2. 10% duplicate of biorecon collection, identification, and habitat assessment.
   3. 10% duplicate collection of SQSH and Diatom.
   4. Train new biological staff and those assisting biologists.
   5. Ensure habitat assessments, field parameters and stream survey forms are uploaded to Hydra in a timely manner weekly.

6. Ensure biorecons are analyzed within 30 days of collection (preferable) or within 30 days of end of sampling year and uploaded to Hydra.
7. Ensure samples are delivered to the laboratory within 30 days of collection following requirements for hazardous materials and that chain of custody is maintained.
8. Proper storage and disposal of ethanol.
9. Obtaining field and lab supplies and equipment.
10. Maintenance and repair of microscopes.
11. Maintenance and repair of sampling equipment.
12. Meter calibration, sampling/taxonomic and QC logs are maintained.
13. Maintain QSSOP updates and make sure all staff are aware of changes.

3. Training - Unless prohibited by budgetary or other travel restrictions, training will be conducted at least once a year through workshops, seminars and/or field demonstrations in an effort to maintain consistency, repeatability and precision between staff conducting diatom surveys. This will also be an opportunity for personnel to discuss problems they have encountered with the methodologies and to suggest SOP revisions prior to the annual SOP review. Note: topics of discussion should be submitted to the central Quality Team Leader (QC coordinator) before the meeting so that a planned agenda can be followed, thus making the best use of limited time.

B. Field Quality Control – Habitat Assessment and Biological Sampling Methodology

1. Habitat Assessments - At minimally 10% of sites, two trained biologists will complete habitat assessment field sheets independently. Scores are compared for each parameter with discrepancies arbitrated while in the field. See BSERT for complete instructions for how to unhide QC habitat forms, identify consensus habitat and upload to Hydra. Note only the consensus form is uploaded to Hydra.

2. Diatom Sample - A second diatom sample will be collected at 10% of the sites within 2 weeks of the original sample. (If rain or other factor compromises reproducibility, the second sample should not be collected). When possible, 2 different people should collect the original and duplicate sample. At least once a year, a team from another EFO or the state lab should collect the QC sample. New staff must successfully complete 2 consecutive QC before going to 10%.

> When collecting duplicate samples, indicate on lab sample request/COC forms for both he original sample and the duplicate that a duplicate was collected. This will help the lab compare the sample results.

3. If assessment results do not agree (both scores above or below target) the samplers will be contacted by the lab to determine if there was any discrepancy in habitat, location, environmental factors such as rain or collection methods. If so, the most representative sample will be used and uploaded as determined by the field office. This will not count as part of the required 10% duplicates.

   If there was no discrepancy in field conditions the taxa lists will be combined. A new Lab Sample ID will be generated for this sample that combines the original 2 Sample IDs. This will not count as a field QC sample.

Only the combined taxa list is loaded to Hydra using the original sample-routine field log number and activity type Quality Control Sample-Lab Duplicate. (The 2 original taxa lists should be deleted from Hydra). Hydra will statistically reduce the sample size to 300 valves before calculating metrics. The following comment should be entered in the comment field for the metrics record: Sample is a combination of sample routine and field replicate that failed field QC. TDI for sample-routine was "score" and TDI for field replicate was "score".

C. **Chain of Custody**

Chain of custody (COC) is required by the TDEC Office of General Counsel for samples that have the potential of being used in court, reviewed by state boards, or involved in state hearings. Since all samples have the potential to be used for these purposes, a completed form must accompany all samples. Chain of custody is the far right column of the biological analysis form (Appendix B). The entire form must be filled out completely.

The chain of custody follows the sample through collection, transfer, storage, taxonomic identification, quality assurance and disposal. The biologist who collected the sample must sign (not print) their name in full (not initial) in the Collected By space with the date and time (24-hour clock).

If the sample is given to anyone else before it is delivered to the lab, that person must put the receiver's name in the delivered to line with the date and time it is handed off. Then the person receiving the sample must sign their full name on the Received By space with the same date and time as in the delivered to line (if there are more people in the transfer of the sample than available lines, another COC can be stapled, just make sure to fill out the headings in case the sheets get separated). The person in the laboratory who receives the sample will sign they received the sample. The person who logs the sample in signs the last line.

D. Quality Control Log

A list of all samples prepped and/or identified by each taxonomist will be kept in a bound log or electronically with electronic backup on a separate system so that QC requirements and results can be documented (Figure 8). The QC log must contain the following information:

1. Sample log number
2. Field Log Number
3. Station ID
4. Sample Date
5. Taxonomist
6. Taxonomist Organization
7. ID date
8. QC taxonomist
9. QC taxonomist organization
10. QC Date
11. Results of QC (satisfactory/unsatisfactory)

Sample Log Number	Field Log Number	Station ID	Sample Date	Taxonomist	Taxonomist Org	ID date	QC taxonomist	QC Org	QC Date	S/U
N2010145-12	BTB1008202003	LICK003.8GE	10/08/20	BAB	Environ	03/14/21	MES	TDH	09/07/21	S
N2010145-10	BTB1007202001	LICK061.0GE	10/07/20	BAB	Environ	03/14/21				
N2010145-11	BTB1007202002	LICK052.3GE	10/07/20	BAB	Environ	03/14/21				
N2010120-01	BTB1005202001	FECO66E01	10/05/20	BAB	Environ	03/14/21				
N2010145-09	BTB1002202003	MEADO000.4GE	10/02/20	BAB	Environ	03/14/21				
N2010145-08	BTB1002202002	LMEAD000.1GE	10/02/20	BAB	Environ	03/14/21				
N2011037-02	LEE0730202004	CFORK003.8SC	07/30/20	BAB	Environ	05/15/21				
N2011025-01	LEE0730202001	DAVIS011.1CL	07/30/20	BAB	Environ	05/15/21				
N2011024-02	JIF0915202002	WPLPI015.8SV	09/15/20	BAB	Environ	07/10/21				
N2010122-01	BTB0728202001	SINKI000.5GE	07/28/20	BAB	Environ	07/10/21	MES		09/07/21	S

Figure 8: Diatom Taxonomic QC Log

E. Taxonomic Proficiency

Each new taxonomist, regardless of previous experience, will have every sample QC'ed by another taxonomist (who has successfully completed QC) until they have satisfactorily completed taxonomic QC based on the MQO (measurement quality objectives). A record of this is kept in the QC log.

Once a taxonomist has satisfactorily completed their QC requirements, 10% of identified samples will be randomly checked by another taxonomist. The sample to be QC'ed is randomly chosen by the QC'er after every 10^{th} sample is completed (or fewer depending on due date). The QC taxonomist will identify every organism in the sample without consulting the original taxonomist's list.

Once the second identification is complete, the two taxonomists will go over any discrepancies together. If QC fails, every sample prior to that one in the same group of 10 is re-id'd until a sample that meets QC is found. The next group of 10 starts after the unsatisfactory sample.

The QC coordinator calculates three precision estimates as data quality indicators adapted from the Society for Freshwater Science Taxonomic Certification Program. Quality Control Procedure for Sample-Based Taxonomic Data.

i. *Percent difference in enumeration* (PDE) quantifies the consistency of specimen counts in samples, and is determined by calculating a comparison of results from two independent laboratories or taxonomists using the formula:

$$PDE = [(n_1-n_2) / (n_1+n_2)] \times 100$$

Where n_1 is the number of organisms in a sample counted by T1, and n_2, by T2. Note that these numbers are from the counts of the taxonomists from their identification results, not from the sorting and subsampling procedures.

ii. *Percent taxonomic disagreement* (PTD) quantifies the sample-based precision of taxonomic identifications by comparing target level taxonomic results from two independent taxonomists, using the formula:

$$PTD = [1-(a/N)] \times 100$$

where *a* is the number of matches (agreements), and *N* is the total number of organisms in the larger of the two counts.

iii. *Percent taxonomic completeness* (PTC) is the percentage of individuals in a sample that are identified to the specified target level, calculated using the formula:

$$PTC = x/n \times 100$$

Where *x* is the number of specimens identified to target level, and *n* is the total number of specimens identified in the sample. Target level for each individual is determined by arbitration. Examples:

- If both taxonomists agree the organism can only be identified to species, target level is species.
- If first taxonomist identifies to species and 2nd to genus, but it is agreed that the lower identification is questionable, the target is genus.
- If first taxonomist identifies to genus and 2nd identifies to species and it is agreed that the lower identification is valid, the target is species.

i. It is also useful to calculate the absolute difference in PTC between T1 and T2 (PTC_{abs}).

Unless specified otherwise by project objectives, measurement quality objectives (MQO) are:

PDE ≤ 5
PTD ≤ 15
PTC ≥ 95
PTCabs ≤ 5

Round to tenths (0 – 4 round down, 5-9 round up).

1. Log results in the QC log.
2. All QC must be completed before the data are released to ensure accuracy of results. If, for any reason, a report is released prior to QC completion, an

addendum will be sent to all report recipients with any corrected information after QC is complete.

F. Reference Collections

1. A master collection of images of all taxa identified will uploaded to Hydra by the state laboratory. The images in the centralized master reference collection will be verified by outside experts recognized for expertise in a particular taxonomic group (Appendix D). The state laboratory will also indicate the initials of the outside expert who verified the image and date in the master diatom table.

2. The central laboratory reference collection will be catalogued with discrete collection numbers assigned to each taxon. Assign sequential numbers to specimens as they are added into the collection. For example, 0001 would be the first specimen in the collection. Maintain an accession catalog of all reference material in a permanently bound log and on disk. Each entry will be linked to the final ID in the Hydra master diatom taxa table and must contain the following information:

   Accession number (This must be unique for each group of organisms in each collection)
   Lab log number (Sample ID)
   Field log number
   Final ID (must match Hydra)
   Name of taxonomist
   Name of expert verifier and date verified

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IV. APPENDICES

APPENDIX A

ECOREGION REFERENCE INFORMATION

ECOREGION REFERENCE STREAMS
HEADWATER ECOREGION REFERENCE STREAMS
REGIONAL EXPECTATIONS FOR INDIVIDUAL HABITAT PARAMETERS

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO65E04	Active	Blunt Creek	06040005 TN Western Valley	RM 0.1 U/S McHee Levee Rd	Carroll	35.95916	-88.26805
ECO65E06	Active	Griffin Creek	08010204 N Fk Forked Deer	RM 5 U/S Stanford Lane Ford	Carroll	35.81861	-88.54055
ECO65E10	Active	Marshall Creek	08010208 Lower Hatchie	RM 2.2 Van Buren Rd	Hardeman	35.1619	-89.0694
ECO65E11	Active	West Fork Spring Creek	08010208 Lower Hatchie	RM 1.7 U/S Van Buren Rd	Hardeman	35.10194	-89.08194
ECO65E19	Active	Trace Creek	08010205 S FK Forked Deer	RM 1.3 U/S Liberty Road	Madison	35.66327	-88.66734
ECO65J04	Active	Pompeys Branch	06030005 TN Pickwick Lake	U/S Pompeys Branch Rd	Hardin	35.05388	-88.16805
ECO65J05	Active	Dry Creek	06030005 TN Pickwick Lake	RM 3.2 Dry Creek Rd	Hardin	35.035	-88.15222
ECO65J06	Active	Right Fork Whites Creek	06040001 TN Western Valley	RM 3.4 U/S Morris Lane	Hardin	35.05305	-88.04777
ECO66D03	Active	Laurel Fork	06010103 Watauga	RM 6.7 U/S Big Branch Off Dennis Cove Rd	Carter	36.2563	-82.10981
ECO66D05	Active	Doe River	06010103 Watauga	RM 26 U/S Picnic Area Roan Mtn State Park	Carter	36.15888	-82.10583
ECO66E04	Active	Gentry Creek	06010102 South Fork Holston	RM 2.1 Gentry Creek Rds end.	Johnson	36.5441	-81.7237
ECO66E09	Active	Clark Creek	06010108 Nolichucky	RM 1.8 National Forest property off Hwy 107 Clarks Creek Rd	Unicoi	36.14818	-82.52835
ECO66E11	Active	Lower Higgins Creek	06010108 Nolichucky	RM 1.7 Lower Higgins Cr Rd 1 mi NW Ernestville	Unicoi	36.08722	-82.52027

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO66E17	Active	Double Branch	06010201 Fort Loudoun Lake	RM 0.1 U/S Millers Cove Rd	Blount	35.74378	-83.76631
ECO66F06	Active	Abrams Creek	06010204 Little Tennessee	RM 18.3 West end of Cades Cove, 0.6 mi U/S Mill Creek	Blount	35.59305	-83.84694
ECO66F07	Active	Beaverdam Creek	06010102 S Fork Holston	RM 5, 1 mi SW Backbone Rock Park	Johnson	36.58638	-81.8275
ECO66F08	Active	Stony Creek	06010103 Watauga	RM 12.5 U/S SR 91	Carter	36.46811	-81.99569
ECO66G05	Active	Little River	06010201 Ft Loudoun/Little R	RM 50.7 U/S last house Little River Trail above Elkmont	Sevier	35.65333	-83.57727
ECO66G09	Active	North River	06010204 Little Tennessee	RM 3, 500 meters U/S campground on North River Rd	Monroe	35.32777	-84.14583
ECO66G12	Active	Sheeds Creek	03150101 Conasauga	RM 1.8, 0.25 mi U/S Sheeds Creek Rd	Polk	35.00305	-84.61222
ECO66G20	Active	Rough Creek	06020003 Ocoee	RM 1.5 National Forest Road 221 Stream Crossing	Polk	35.05386	-84.48031
ECO67F06	Active	Clear Creek	06010207 Lower Clinch	RM 1, U/S Norris Municipal Park Road	Anderson	36.21361	-84.05972
ECO67F13	Active	White Creek	06010205 Upper Clinch	RM 2, D/S old USGS gauging station next to White Creek Rd	Union	36.34361	-83.89166
ECO67F14	Active	Powell River	06010206 Powell	RM 106.5 McDowell Shoal D/S Fourmile Creek	Hancock	36.57764	-83.3659
ECO67F16	Active	Hardy Creek	06010206 Powell	RM 0.5, U/S SR 660 Powell Valley Rd	Lee County, VA	36.6499	-83.2496
ECO67F17	Active	Big War Creek	06010205 Upper Clinch	RM 0.6 Pawpaw Rd	Hancock	36.42626	-83.34663

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO67F23	Active	Martin Creek	06010206 Powell	RM 0.5 Powell Valley Rd just U/S Hopkins Rd	Hancock	36.59111	-83.335
ECO67F27	Active	Indian Creek	6010205 Clinch-Upper	Off Indian Creek Rd	Grainger	36.39519	-83.40339
ECO67G05	Active	Bent Creek	06010108 Nolichucky	RM 1.9 East of Hwy 340	Hamblen	36.18793	-83.16414
ECO67G10	Active	Flat Creek	06010107 Lower French Broad	RM 12 D/S Muddy Hollow Rd	Sevier	35.9157	-83.4515
ECO67G12	Active	Dry Creek	06020002 Hiwassee	RM 0.6 U/S of Bridge Crossing on Old Chattanooga Pike Sq	Bradley	35.11091	-84.96396
ECO67H06	Active	Laurel Creek	06010204 Little Tennessee	RM 0.8, D/S Laurel Creek Rd	Monroe	35.44829	-84.28833
ECO6701	Active	Big Creek	06010104 Holston	RM 9.8, D/S Fisher Creek West of Surgoinsville on Stanley Valley Rd	Hawkins	36.4778	-82.9387
ECO6702	Active	Fisher Creek	06010104 Holston	RM 0.6, U/S Bray Road	Hawkins	36.49	-82.94027
ECO6707	Probation	Possum Creek	06010102 South Fork Holston	RM 1.5, Weaver Pike Bridge, Bluff City	Sullivan	36.47964	-82.19932
ECO68A03	Active	Laurel Fork of Station Camp Cr	05130104 S Fork Cumberland	RM 4, Big South Fork NRA	Fentress/ Scott	36.51611	-84.69805
ECO68A08	Active	Clear Creek	06010208 Emory	RM 4, Genesis Rd (HWY 298)	Morgan	36.11916	-84.7425
ECO68A26	Active	Daddy's Creek	06010208 Emory	RM 2.3, U/S Hebbertsburg Rd, Catoosa	Cumberland	36.05861	-84.79138

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO68A27	Probation	Island Creek	06010208 Emory	RM 2.3, U/S Noah Hambrey Rd, Catoosa	Morgan	36.05138	-84.66805
ECO68B01	Active	Crystal Creek	06020004 Sequatchie	RM 1.2, Approx 0.25 mi D/S Lower East Valley Rd	Bledsoe	35.54083	-85.21694
ECO68B10	Active	Battle Creek	06030001 Guntersville	RM 17, D/S of Martin Spring Confluence	Marion	35.15628	-85.7894
ECO68C13	Active	Mud Creek	06030003 Upper Elk	RM 5.6, U/S E Roarks Cove Rd	Franklin	35.23055	-85.91722
ECO68C20	Active	Crow Creek	06030001 Guntersville Lake	RM 35, Off Ford Spring Rd upstream UT in Tom Pack Hollow	Franklin	35.1155	-85.9110
ECO69D03	Active	Flat Fork	06010208 Emory	RM 5, U/S Flat Fork Rd, U/S Rock Fork Branch	Morgan	36.1235	-84.5122
ECO69D05	Active	New River	05140104 S Fork Cumberland	RM 55.4, approx 0.5 mi U/S HWY 116, 0.3 mi U/S Morgan/Anderson Co. line	Morgan	36.12444	-84.43130
ECO69D06	Probation	Round Rock Creek	05130104 S Fork Cumberland	RM 1, U/S ford off Norma Rd	Campbell	36.24722	-84.28444
ECO69E04	Active	Stinking Creek	05130101 Upper Cumberland	RM 15.1, Approx 0.5 mi south of Stinking Creek Rd near power line	Campbell	36.4258	-84.2618
ECO71E14	Active	Passenger Creek	05130206 Red	RM 1.6, HWY 76	Montgomery	36.53444	-87.19583
ECO71E17	Active	Brush Creek	05130206 Red	Stroudville Rd	Robertson	36.481389	-87.089722
ECO71E18	Active	Santee Creek	05130206 Red	Sprouse Rd	Robertson	36.49778	-86.778333
ECO71E19	Active	Calebs Creek	05130206 Red	U/S Maxie/Carr Rd	Robertson	36.49237	-87.0066

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO71F19	Active	Brush Creek	06040004 Buffalo	RM 2.1, Paul Reed Rd, U/S Little Brush Creek	Lewis/Lawrence	35.41972	-87.53416
ECO71F27	Active	Swanegan Branch	06030005 Pickwick Lake	RM 0.5, Off Thomas Woodard Rd	Wayne	35.06916	-87.6375
ECO71F28	Active	Little Swan Creek	06040003 Lower Duck	RM 5.6, Meriwether Lewis National Monument	Lewis	35.52888	-87.45361
ECO71F29	Active	Hurricane Creek	06040003 Lower Duck	RM 6.6, Hwy 13	Humphreys	35.980556	-87.761389
ECO71G03	Active	Flat Creek	05130106 Upper Cumberland	RM 1.8, HWY 136	Putnam	36.35944	-85.43138
ECO71G04	Active	Spring Creek	05130106 Upper Cumberland	RM 16.2, Boatman Rd	Overton	36.27277	-85.42333
ECO71G10	Active	Hurricane Creek	06030003 Upper Elk	RM 9.4, Hurricane Creek Rd	Moore	35.32083	-86.29944
ECO71H03	Active	Flynn Creek	05130106 Upper Cumberland	RM 10.2, Flynn Creek Rd, 3 mi NE Nameless TN	Jackson	36.2792	-85.66444
ECO71H09	Active	Carson Fork	05130203 Stones	RM 4.2, Burt-Burgen Rd, 2 mi NE Bradyville	Cannon	35.76495	-86.13263
ECO71H17	Active	Clear Fork Creek	05130108 Caney Fork	RM 6.5, 100 Yds U/S of Cripps Lane (Old Metal Bridge)	Cannon	35.928651	-85.992117
ECO71I10	Probation	Flat Creek	06040002 Upper Duck	RM 6.4, U/S Hazelwood Rd	Marshall	35.68583	-86.80166
ECO71I12	Active	Cedar Creek	05130201 Cumberland	RM 4.6, Centerville Rd	Wilson	36.28425	-86.20339
ECO71I15	Active	Harpeth River	05130204 Harpeth	RM 105.7, D/S McDaniel Rd	Williamson	35.8325	-86.70019

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO73A02	Active	Middle Fork Forked Deer	08010100 Mississippi	RM 3.3, 0.5 miles upstream Watkins Rd	Lauderdale	35.81777	-89.65611
ECO73A03	Active	Cold Creek	08010100 Mississippi	RM 2.3, Approx 1.4 mi u/s Crutcher Lake Rd, U/S Adams Bayou	Lauderdale	35.66305	-89.81222
ECO73A04	Active	Bayou du Chien	08010202 Obion	RM 3.2, Approx 1.5 mi U/S boat ramp on Walnut Log Rd and 0.75 mi U/S last cabin	Lake	36.475	-89.30916
ECO74A06	Active	Sugar Creek	08010100 Mississippi	RM 2.3, U/S Copper Rd	Tipton	35.49944	-89.91914
ECO74A08	Active	Pawpaw Creek	08010202 Obion	RM 3.1, U/S Upper Crossing of Putnam Hill Rd	Obion	36.30527	-89.35666
ECO74B04	Active	Powell Creek	08010202 Obion	RM 2.2, McClains Levee Rd	Weakley	36.48027	-88.64

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
FECO65E03	Active	Dabbs Creek UT to UT	06040001 Tennessee Western Valley-Beech	RM 0.1, Natchez Trace State Park off Todd Trail	Henderson	35.79006	-88.30636
FECO65E04	Active	Cubb Creek UT	06040001 Tennessee Western Valley-Beech	RM 0.1, Natchez Trace State Park of Taylor Trail	Henderson	35.78489	-88.26502
FECO65E05	Active	Tuscumbia River UT	08010207 Hatchie-Lower	RM 0.6, Big Hill State Park at footbridge on Tuscumbia Trail bend	McNairy	35.05162	-88.74677
FECO65J01	Active	Haw Branch	06030005 Tennessee-Pickwick lake	RM 0.9, U/S Pickwick Embayment	Hardin	35.0852	-88.1916
FECO65J02	Active	Horse Creek UT	06040001 Tennessee Western Valley-Beech	RM 0.3, Sugar Camp Hollow	Hardin	35.15521	-88.19176
FECO66D01	Active	Black Branch	06010103 Watauga	RM 2.0, Above Hwy 231 near Elk Mills TN 195 Black Br Rd-West of US 321	Carter	36.2825	-82.0275
FECO66D06	Active	Tumbling Creek	06010108 Nolichucky	RM 1.5, Just U/S where tumbling Creek ends	Unicoi	36.0180	-82.48194
FECO66D07	Active	Little Stony Creek	06010103 Watauga	RM 2.0, Next to Little Stony Rd and 3.0 miles D/S conf with Goodwin Field Branch	Carter	36.2867	-82.0667
FECO66E01	Active	Clark Creek Unnamed Tributary In Hell Hollow	06010108 Nolichucky	In Hell Hollow off Hell Hollow Trail	Unicoi	36.13367	-82.53281

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
FECO66E03	Active	Birch Branch	06010102 South Fork Holston	RM 0.6, In Birch Branch Sanctuary Approximately 0.7 Mile Upstream Hwy 133 NW of Shady Valley	Johnson	36.555368	-81.869055
FECO66F01	Active	Laurel Creek Unnamed Tributary In Negro Grave Hollow	06010102 South Fork Holston	RM 0.3, Off Hwy 91 in Negro Grave Hollow	Johnson	36.57956	-81.75013
FECO66G01	Active	Indian Branch	06010204 Little Tennessee	RM 0.1, North River Rd	Monroe	35.33102	-84.06733
FECO66G02	Active	Texas Creek	06010107 French Broad-Lower	RM 0.1, Immediately U/S Hwy 321 border of GSMNP	Sevier	35.76229	-83.31250
FECO66G03	Active	Laurel Cove Creek	06010201 Ft Loudoun, Little River	RM 0.1; 100 Uds U/S of Laurel Creek Road GSMNP	Blount	35.61635	-83.73689
FECO66J01	Active	Negro Creek Unnamed Tributary	06020002 Hiwassee	RM 1.2; U/S of Bridge Crossing on Hwy 68 Near Stansbury Road From Negro Creek at RM 3.01	Polk	35.08725	-84.37862
FECO66J02	Active	Negro Creek Unnamed Tributary	06020002 Hiwassee	RM 0.9; U/S of Bridge Crossing on Hwy 68 just Before Cedar Spring Road at Negro Creek at RM 1.3	Polk	35.10821	-84.36329
FECO66J03	Active	Turtletown Creek Unnamed Tributary	06020002 Hiwassee	RM 1.6; Off Three Oaks Dr/ 150 Yards Past 107 Three Oaks Drive	Polk	35.08041	-84.34409
FECO67F02	Active	Mill Creek	06010207 Clinch-Lower	RM 1.1, Off Cave Rd	Roane	35.84999	-84.38210
FECO67F04	Active	Sutton Branch	06010206 Powell	RM 0.1, Off Rob Camp Church Rd	Claiborne	36.558	-83.422

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
FECO67F05	Active	Cave Spring Branch	06010201 Tennessee-Watts Bar	RM 0.1; U/S of Unimproved Road off Cate Road and Watts Bar Lake	Roane	35.7927	-84.44112
FECO67G05	Active	Happy Creek Unnamed Tributary	06010107 French Broad-Lower	RM 0.1, South of 1316 George Harrison Way 150 M U/S of Happy Creek	Sevier	35.86314	-83.70003
FECO67G11	Active	North Prong Fishdam Creek	06010102 Houlston-South Fork	RM 1.6 ,U/S SR 34 (2.0 miles from US 421)	Sullivan	36.5344	-82.0192
FECO67H01	Active	Taliaferro Branch	06020001 Tennessee	RM 2.4, Firetower Rd	Hamilton	35.16383	-85.01247
FECO67I12	Active	Mill Branch	06010207 Clinch-Lower	RM 1.2, Below the confluence of two tributaries just off Tuskegee Dr	Anderson	35.98833	-84.28888
FECO68A01	Active	Douglas Branch	06010208 Emory	RM 0.1, Barnett Bridge Rd	Morgan	36.14852	-84.77823
FECO68A03	Active	South Fork Elmore Creek	06010208 Emory	RM0.7; U/S Myatt Creek Road Catoosa WMA	Cumberland	36.083822	-84.955226
FECO68B04	Active	Daniel Creek	06020004 Sequatchie	RM1.4; U/S of Old Dunlap Road Bridge @ 5807 Dunlap Road	Marion	35.26088	-85.48222
FECO68C01	Active	Crow Creek Unnamed Tributary	06030001 Guntersville	U/S of Lost Cove Road	Franklin	35.10204	-85.92001
FECO68C02	Active	Coops Creek	06020004 Sequatchie	Rm 3.1; Mountain Review Road	Sequatchie	35.38127	-85.40402
FECO68C12	Active	Ellis Gap Branch	06020001 Tennessee	RM 0.4, 0.2 miles U/S Mullens Cove Rd in Prentice Cooper State Park	Marion	35.0492	-85.4728
FECO68C13	Active	Gilbreath Creek	06020001 Tennessee	RM 0.1; Cove Loop Lower Road Crossing	Rhea	35.47931	-85.07603

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
FECO69D01	Active	New RV 1 UT	05130104 Cumberland-South Fork	RM 0.1, U/S Hwy 116	Morgan	36.12090	-84.43214
FECO69D03	Active	Bear Branch	06010205 Clinch-Upper	RM 0.1, U/S Hwy 68	Campbell	36.39916	-84.30928
FECO69D04	Active	Wheeler Creek UT	05130104 Cumberland-South Fork	RM 0.6, Big Bruce Bridge	Campbell	36.30771	-84.27522
FECO69E01	Active	Titus Creek UT	06010205 Clinch-Upper	RM 1.9, U/S of Stinking Creek Rd	Campbell	36.41966	-84.29011
FECO71F02	Active	Wolfpen Branch	06040004 Buffalo	RM 0.1 U/S confluence Little Buffalo River (Laurel Hill WMA)	Lawrence	35.34597	-87.49881
FECO71F03	Active	Ethridge Hollow	06040003 Duck-Lower	RM 0.1, U/S Hwy 230	Humphreys	35.9407	-87.6530
FECO71F05	Active	Kelley Creek	05130204 Harpeth	RM 2.4, Off Taylor Cemetery Rd	Williamson	35.89778	-87.10004
FECO71F06	Active	Mark's Creek	05130202 Cumberland-Cheatham	HWY 12	Cheatham	36.28544	-87.07753
FECO71G01	Active	Flat Creek	05130106 Cumberland-Upper (Cordell Hull)	RM 8.3, Upper Hillman Rd	Overton	36.41239	-85.37442
FECO71G02	Active	Long Fork UT	05110002 Barren	RM 0.1, U/S Tanyard Rd	Macon	36.48909	-85.93973
FECO71H01	Active	Riley Creek UT	06040002 Duck-Upper	RM 0.6; U/S Holland Hill Lane	Coffee	35.49518	-86.22351
FECO71H02	Active	East Fork Stones River UT	05130203 Stones	RM 0.1; Stones River Road 0.8 Mi West of Hwy 146 Intersection	Cannon	35.84485	-85.95803

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
FECO71H03	Active	Haws Spring Fork	05130203 Stones	RM 2.7, Off Farm Rd off Jimtown Rd	Cannon	35.761291	-86.08854
FECO71H04	Active	Wilmouth Creek UT	05130108 Caney Fork	RM 0.1; Melton Hollow Road ~ 0.25 Miles U/S From Wilmouth Road Intersection	Cannon	35.8914	-85.9897
FECO71I02	Active	Young Branch	05130201 Cumberland-Old Hickory Lake	RM 1.6, U/S Hwy 70N	Wilson	36.24031	-86.16099
FECO71I03	Active	McKnight Branch UT	05130203 Stones	RM 2.4, U/S Ford off Elrod McElroy Rd	Rutherford	35.896901	-86.18094
FECO71I06	Active	Cedar Creek Unnamed Tributary	05130201 Cumberland-Old Hickory Lake	RM 0.3, 2280 Beckwith Road U/S TVA Substation	Wilson	36.20362	-86.46275
FECO73A01	Active	Bayou Duchien Unnamed Tributary	08010202 Obion	RM 0.1; U/S Walnut Log Road	Obion	36.46288	-89.32092
FECO74A04	Active	Barnishee Bayou UT	08010101 Mississippi	RM 0.89, U/S of Riddick Rd in Meeman Shelby State Park	Shelby	35.35198	-90.04863
FECO74A05	Active	Reelfoot Creek UT	08010202 Obion	RM 0.5; U/S Hwy 22	Lake	36.407306	-89.325336
FECO74B01	Active	North Fork Wolf River UT	08010210 Wolf	RM 0.2, Ames Plantation	Fayette	35.10770	-89.31641
FECO74B03	Active	North Fork Obion River UT	08010202 Obion	RM 2.3, U/S Terrapin Rd	Henry	36.48688	-88.48829
FECO74B04	Active	Bull Branch	08010209 Loosahatchie	RM 0.8; U/S Bethel Rd	Shelby	35.3915	-89.7998

Regional Expectations for Individual Habitat Parameters - streams > 2.5 sq mile drainage

(Values represent 75% of median reference score and may indicate impairment regardless of total habitat score)

ECO	Season *	Epifaunal Substrate	Embeddedness	Channel Substrate	Velocity Depth	Pool Variability	Sediment Deposition	Flow Status	Channel Alteration	Riffle Frequency	Channel Sinuosity	Bank Stability (either bank)	Vegetative Protection (either bank)	Riparian Vegetation (either bank)
65a	Spring	11	NA	8	NA	10	10	12	14	NA	9	5	7	7
65a	Fall	10	NA	8	NA	8	10	12	12	NA	8	5	6	7
65b	Spring	11	NA	8	NA	10	10	12	14	NA	9	6	7	7
65b	Fall	10	NA	8	NA	8	10	12	12	NA	8	5	6	7
65e	Spring	11	NA	8	NA	10	10	12	14	NA	9	5	7	7
65e	Fall	10	NA	8	NA	8	10	12	12	NA	8	5	6	7
65i	Spring	11	NA	8	NA	10	10	12	14	NA	NA	5	7	7
65i	Fall	10	NA	8	NA	8	10	12	12	NA	NA	5	6	7
65j	Spring	13	13	NA	11	NA	11	14	15	14	NA	7	6	8
65j	Fall	13	14	NA	12	NA	11	11	14	13	NA	7	8	8
66d	Spring	15	15	NA	15	NA	13	14	15	15	NA	8	8	8
66d	Fall	15	15	NA	14	NA	14	14	15	15	NA	8	8	8
66e	Spring	14	14	NA	14	NA	14	15	15	15	NA	8	8	8
66e	Fall	14	14	NA	14	NA	13	13	15	15	NA	8	8	8
66f	Spring	14	14	NA	12	NA	13	14	14	13	NA	8	8	8
66f	Fall	14	14	NA	13	NA	14	14	14	14	NA	8	8	8
66g	Spring	14	15	NA	14	NA	14	14	15	14	NA	8	8	8
66g	Fall	14	14	NA	14	NA	14	12	14	15	NA	8	8	8
67f	Spring	14	14	NA	13	NA	12	14	14	14	NA	7	7	7
67f	Fall	14	13	NA	12	NA	11	14	14	13	NA	7	7	7
67g	Spring	12	11	NA	11	NA	11	12	11	12	NA	4	4	2
67g	Fall	10	12	NA	11	NA	10	12	11	11	NA	5	4	2
67h	Spring	13	12	NA	12	NA	9	12	11	14	NA	6	7	7

ECO	Season *	Epifaunal Substrate	Embeddedness	Channel Substrate	Velocity Depth	Pool Variability	Sediment Deposition	Flow Status	Channel Alteration	Riffle Frequency	Channel Sinuosity	Bank Stability (either bank)	Vegetative Protection (either bank)	Riparian Vegetation (either bank)
67h	Fall	12	11	NA	11	NA	9	11	13	12	NA	6	6	7
67i	Spring	11	12	NA	11	NA	14	13	13	11	NA	6	7	6
67i	Fall	13	13	NA	12	NA	14	13	14	12	NA	6	7	6
68a	Spring	14	13	NA	14	NA	13	14	14	14	NA	8	5	8
68a	Fall	13	13	NA	12	NA	14	13	14	12	NA	8	5	8
68b	Spring	11	14	NA	13	NA	11	14	14	14	NA	6	7	7
68b	Fall	15	13	NA	14	NA	13	11	14	12	NA	7	7	5
68c	Spring	14	12	NA	13	NA	13	13	15	13	NA	7	8	8
68c	Fall	12	13	NA	13	NA	13	14	14	15	NA	7	8	8
69d	Spring	12	12	NA	14	NA	13	13	14	14	NA	7	8	8

Regional Expectations for Individual Habitat Parameters - streams > 2.5 sq mile drainage cont.

ECO	Season *	Epifaunal Substrate	Embeddedness	Channel Substrate	Velocity Depth	Pool Variability	Sediment Deposition	Flow Status	Channel Alteration	Riffle Frequency	Channel Sinuosity	Bank Stability (either bank)	Vegetative Protection (either bank)	Riparian Vegetation (either bank)
69d	Fall	12	12	NA	11	NA	12	10	14	13	NA	7	7	7
69e	Spring	12	12	NA	12	NA	10	12	14	14	NA	6	7	7
69e	Fall	13	13	NA	11	NA	10	7	14	14	NA	6	6	7
71e	Spring	12	11	NA	143	NA	11	14	12	13	NA	5	5	4
71e	Fall	11	10	NA	11	NA	10	13	12	12	NA	4	4	4
71f	Spring	12	14	NA	13	NA	10	12	14	12	NA	5	7	6
71f	Fall	13	13	NA	13	NA	11	13	14	13	NA	6	7	6
71g	Spring	12	13	NA	12	NA	12	13	13	13	NA	7	7	7
71g	Fall	11	13	NA	11	NA	13	12	14	13	NA	7	7	6
71h	Spring	12	13	NA	12	NA	12	13	11	13	NA	6	5	4
71h	Fall	12	11	NA	12	NA	12	12	12	13	NA	7	6	3
71i	Spring	11	11	11	11	10	10	13	13	11	9	6	7	4
71i	Fall	10	10	9	10	10	10	9	13	10	8	5	5	4
73a	Spring	8	NA	8	NA	10	8	12	13	NA	7	4	6	8
73a	Fall	8	NA	6	NA	9	8	13	13	NA	6	4	6	8
74a	Spring	9	6	NA	10	NA	6	6	11	12	NA	3	3	4
74a	Fall	8	8	NA	10	NA	6	6	12	11	NA	4	4	7
74b	Spring	9	NA	7	NA	6	8	11	13	NA	8	3	6	8
74b	Fall	8	NA	9	NA	6	8	9	11	NA	7	4	5	8

* Spring is January through June, Fall is July through December

Regional Habitat Expectations for Headwater Streams - ≤ 2.5 square mile drainage

(Values represent 75% of median reference score and may indicate impairment regardless of total habitat score)

ECO	Season *	Epifaunal Substrate	Embeddedness	Channel Substrate	Velocity Depth	Pool Variability	Sediment Deposition	Flow Status	Channel Alteration	Riffle Frequency	Channel Sinuosity	Bank Stability (either bank)	Vegetative Protection (either bank)	Riparian Vegetation (either bank)
65a	Spring	13	NA	8	NA	5	11	11	15	NA	9	5	6	8
65a	Fall	10	NA	8	NA	9	8	11	15	NA	13	6	6	8
65b	Spring	13	NA	8	NA	5	11	11	15	NA	9	5	6	8
65b	Fall	10	NA	8	NA	9	8	11	15	NA	13	6	6	8
65e	Spring	13	NA	8	NA	5	11	11	15	NA	9	5	6	8
65e	Fall	10	NA	8	NA	9	8	11	15	NA	13	6	6	8
65i	Spring	13	NA	8	NA	5	11	11	15	NA	9	5	6	8
65i	Fall	10	NA	8	NA	9	8	11	15	NA	13	6	6	8
65j	Spring	13	14	NA	10	NA	11	14	15	14	NA	6	6	8
65j	Fall	11	14	NA	10	NA	13	13	15	12	NA	6	7	8
66d	Spring	14	14	NA	14	NA	12	15	15	15	NA	8	8	8
66d	Fall	14	14	NA	13	NA	12	13	15	15	NA	8	8	8
66e	Spring	14	14	NA	12	NA	13	14	14	13	NA	6	8	8
66e	Fall	15	15	NA	12	NA	14	8	15	15	NA	8	8	8
66f	Spring	15	14	NA	14	NA	14	15	14	15	NA	7	6	6
66f	Fall	15	14	NA	14	NA	14	15	14	15	NA	7	6	6
66g	Spring	14	11	NA	11	NA	13	14	14	14	NA	8	8	7
66g	Fall	14	12	NA	9	NA	12	8	14	15	NA	8	7	8
66j	Spring	12	11	NA	14	NA	8	14	12	14	NA	6	4	6
66j	Fall	1	13	NA	10	NA	9	12	14	14	NA	6	5	5
67f	Spring	14	12	NA	11	NA	14	14	12	14	NA	7	8	8
67f	Fall	12	14	NA	10	NA	14	13	14	14	NA	7	6	7
67g	Spring	13	14	NA	10	NA	12	12	15	14	NA	8	8	8

ECO	Season *	Epifaunal Substrate	Embeddedness	Channel Substrate	Velocity Depth	Pool Variability	Sediment Deposition	Flow Status	Channel Alteration	Riffle Frequency	Channel Sinuosity	Bank Stability (either bank)	Vegetative Protection (either bank)	Riparian Vegetation (either bank)
67g	Fall	12	14	NA	9	NA	12	11	15	12	NA	8	8	8
67h	Spring	15	13	NA	10	NA	11	9	12	15	NA	5	7	8
67h	Fall	15	12	NA	14	NA	14	12	12	15	NA	6	5	7
67i	Spring	11	14	NA	11	NA	14	13	13	11	NA	6	7	6
67i	Fall	13	12	NA	12	NA	14	13	14	12	NA	6	7	6
68a	Spring	12	13	NA	12	NA	10	15	14	14	NA	7	7	7
68a	Fall	12	12	NA	10	NA	11	8	12	10	NA	6	6	7
68b	Spring	15	13	NA	13	NA	13	14	14	15	NA	7	4	2
68b	Fall	13	15	NA	9	NA	14	12	12	15	NA	7	2	2
68c	Spring	15	14	NA	12	NA	12	12	14	15	NA	6	7	8
68c	Fall	15	14	NA	14	NA	12	12	13	15	NA	6	7	8
69d	Spring	14	12	NA	8	NA	12	12	14	14	NA	8	8	8
69d	Fall	14	11	NA	8	NA	8	12	14	14	NA	7	7	7
69e	Spring	14	14	NA	10	NA	14	14	14	14	NA	7	8	7
69e	Fall	14	14	NA	10	NA	12	14	14	14	NA	7	7	7
71e	Spring	12	12	NA	12	NA	11	14	9	13	NA	6	6	6
71e	Fall	9	11	NA	8	NA	8	8	11	13	NA	4	6	6
71f	Spring	11	14	NA	11	NA	12	13	15	14	NA	6	8	8
71f	Fall	14	14	NA	10	NA	11	12	14	14	NA	6	7	8
71g	Spring	14	11	NA	12	NA	10	13	15	14	NA	6	6	3
71g	Fall	12	11	NA	11	NA	9	11	15	12	NA	6	6	4
71h	Spring	13	13	NA	11	NA	12	14	14	14	NA	7	7	7
71h	Fall	12	12	NA	8	NA	11	12	13	14	NA	6	8	6
71i^	Spring	13	12	NA	10	NA	10	13	11	13	NA	5	5	4
71I^	Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
73a	Spring	8	NA	9	NA	3	12	13	12	NA	6	7	7	8
73a	Fall	8	NA	9	NA	3	12	13	12	NA	6	7	7	8

ECO	Season *	Epifaunal Substrate	Embeddedness	Channel Substrate	Velocity Depth	Pool Variability	Sediment Deposition	Flow Status	Channel Alteration	Riffle Frequency	Channel Sinuosity	Bank Stability (either bank)	Vegetative Protection (either bank)	Riparian Vegetation (either bank)
74a	Spring	9	6	NA	9	NA	5	8	15	14	NA	3	4	8
74a	Fall	13	6	NA	10	NA	5	7	12	10	NA	3	4	8
74b	Spring	10	NA	4	NA	7	11	12	15	NA	11	6	7	8
74b	Fall	12	NA	5	NA	7	12	10	12	NA	7	7	8	8

* Spring is January through June, Fall is July through December
^71 I Headwater is high gradient form only

APPENDIX B

FORMS, FIELD SHEETS AND REPORTS

NEW STATION E-FORM
SAMPLING EVENT E-FORM
FIELD PARAMETER E-FORM
HABITAT ASSESSMENT FIELD SHEETS
STREAM SURVEY INFORMATION E-FORM
RAPID PERIPHYTON SURVEY E-FORM
DIATOM TAXA HYDRA UPLOAD FORMAT
BIOLOGICAL SAMPLE REQUEST INCLUDING CHAIN OF CUSTODY FORM

See SharePoint
https://tennessee.sharepoint.com/sites/environment/DWR/PAS/SitePages/Home.aspx
or contact WPU for copies of all e-Forms and guidance documents for completing e-forms and upload to Hydra (BSERT and SPERT).

New Station e-Form – Surface Water Stations Only

18	BSERT Link: New Stations	Stations last updated 6/24/2022. Add new stations below.	SOP Link: New Stations
19	**DWR Station ID:**		
20	Monitoring Location Name:		
21	Monitoring Location:		
22	County:		
23	River Mile:		
24	Latitude:		
25	Longitude:		
26	Ecoregion:		
27	u/s ECO:		
28	HUC:		
29	HUC Name:		
30	Waterbody ID:		
31	Watershed Group:		
32	Drainage Area:		
33	HUC 12:		
34	TDEC Environmental Field Office:		
35	State Name:		
36	Reservoir Name:		
37	Water Type:		
38	Comments:		
39			
40	Save		
41			

Sampling Event e-Form

	A	B	C	D	E
1	TDEC-DWR Sampling Event		BioForm 6.0 - Revised 6/30/2022		
2	**DWR Station ID:**		**Date:**		
3	**Today's sample sequence:**		**Time:**		
4	**Lead Sampler's Initials:**		**Organization:**		
5	**Samplers:**		**Index Period:**		Spring = Jan. - June Fall = July - Dec.
6	**Project Name:**		Project ID:		
7	**Activity Type:**				
8	Monitoring Location ID:		Field Log Number:		
9	Monitoring Location Name:		Watershed Group:		
10	Monitoring Location:				
11	County:		Drainage Area:		
12	Ecoregion:		u/s ECO:		
13	Latitude:		Longitude:		Verify Coordinates
14	HUC:		Waterbody ID:		
15	Save Button	Latitude at collection site:		Check location if lat/long is pink	
16		Longitude at collection site:			

Field Parameter e-Form

	A–C	D	E	F–K	L
16	**Field Parameters:** (Note: mg/L = ppm)			**Meters Used:**	
17		1st	2nd	☑ if Validated. Describe meter/reading problem below.	SOP Link: H_20 Field Para-meters
18	**pH (su):**			☐	
19	**Conductivity (umhos):**			☐	
20	**Temperature (C°):**			☐	
21	**Dissolved Oxygen** (mg/L):			☐	
22	Dissolved Oxygen %:				
23	Turbidity (NTU):				
24	TDS (mg/L):				
25	Flow (cfs):				
26	**Weather:**				
27	Previous 48 hours precipitation:			Approx. Air Temperature (F°):	

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		Habitat Assessment By:	
Monitoring Location Name:		Date:	Time:
Monitoring Location:		Field Log Number:	
HUC:	WS Group:	Ecoregion:	QC: ☐ Duplicate ☐ Consensus

	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.	Natural stable habitat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to Optimal.)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present. (If near 40% and more than 2 go to Suboptimal.)	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to Suboptimal if riffle not layered cobble.	Gravel, cobble, and boulders 25-50% surrounded by fine sediment. Niches in bottom layers of cobble compromised. If near 50% & riffles not layered cobble drop to Marginal.	Gravel, cobble, and boulder s are 50-75% surrounded by fine sediment. Niche space in middle layers of cobble is starting to fill with fine sediment.	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment. Niche space is reduced to a single layer or is absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime. Other regimes too small or infrequent to support aquatic populations.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to Marginal if build-up approaches 30%.	Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions, and bends. Moderate pool deposition.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
5. Channel Flow Status. .	Water reaches base of both lower banks and streambed is covered by water throughout reach. Minimal productive habitat is exposed.	Water covers > 75% of streambed or 25% of productive habitat is exposed.	Water covers 25-75% of streambed and/or productive habitat is mostly exposed.	Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)				
DWR Station ID_______________ Date______ Assessors______________				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization, dredging rock removal, 4-wheel, or livestock activity (past or present) absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging 4-wheel or livestock activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.	Channelization, dredging 4-wheel or livestock activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.	Over 80% of reach channelized, dredged, or affected by 4-wheelers or livestock. Instream habitat greatly altered or removed. Artificial structures have greatly affected flow pattern.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category. Rank by quality.	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7:1.	Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15.	Occasional re-oxygenation area. The distance between areas divided by average stream width is over 15 and up to 25.	Generally, all flat water or flat bedrock; little opportunity for re-oxygenation. Distance between areas divided by average stream width >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score Marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score Poor if banks steep.	Unstable; many eroded areas; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream.	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented, or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score ________ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW
If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance
Describe:

HABITAT ASSESSMENT FIELD SHEET- LOW GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		Habitat Assessment By:	
Monitoring Location Name:		Date:	Time:
Monitoring Location:		Field Log Number:	
HUC:	WS Group:	Ecoregion:	QC: ☐ Duplicate ☐ Consensus

	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Over 50% of reach has natural, stable habitat for colonization by macroinvertebrates and/or fish. Three or more productive habitats are present.	Natural stable habitat covers 30-50% of stream reach, or less than three habitats are present.	Natural stable habitat 10-30% of stream reach. Availability less than desirable, substrate frequently disturbed or removed. Habitat diversity is reduced.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
2. Channel Substrate Characterization	Good mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; or substrate is fissured bedrock, some root mats and submerged vegetation present.	All mud, clay, soft sand, or fissured bedrock bottom, little or no root mat, no submerged vegetation present.	Hard-pan clay, conglomerate, or predominantly flat bedrock; no root mat or submerged vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools are large-deep very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
4. Sediment Deposition	Sediment deposition affects less than 20% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 20-50% of bottom affected. Slight deposition in pools.	Moderate deposition of fine material on old and new bars, 50-80% of bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
5. Channel Flow Status. If water backed up by obstructions (beaver dam, log jams, bedrock during low flow) move assessment reach above or below affected area or consider postponing sampling until accurate assessment of stream can be achieved.	Water reaches base of both lower banks throughout reach. Streambed is covered. Minimal productive habitat is exposed.	Water covers > 75% of streambed and/or < 25% of productive habitat is exposed.	Water covers 25-75% of streambed and/or stable habitat is mostly exposed.	Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- LOW GRADIENT STREAMS (BACK)

DWR Station ID_________________________ Date___________ Assessor:____________				
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging 4-wheel, or livestock activity absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging, 4-wheel or livestock activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.	Channelization, dredging, 4-wheel or livestock activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.	Over 80% of reach channelized, dredged, or affected by 4-wheelers or livestock. Instream habitat greatly altered or removed. Artificial structures may have greatly affected flow pattern.
SCORE	20 19 18 17 6	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Channel Sinuosity (Entire meander sequence not limited to sampling reach)	The bends in the stream increase the stream length 3-4 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2-3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 6	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion 5-30% of bank eroded. If approaching 30% score Marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score Poor if banks steep.	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented, or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.
SCORE___(LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE___(RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score _______ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW
If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance
Describe:

STREAM SURVEY INFORMATION (see protocol E for detailed information and BSERT for Completing E-Form)

DWR Station ID:	**Samplers:**	
Monitoring Location Name:	**Date:**	**Time:**
Monitoring Location:	**Organization:**	Drainage Area:
County:	Ecoregion:	u/s ECO:
Latitude:	HUC:	WS Grp:
Longitude:	WBID:	Field Log #:

Project Name: ☐ Watershed ☐ 303(d) ☐ Antideg ☐ ECO ☐ FECO Other:

Project ID: TNPR

Activity Type: ☐ Sample ☐ QC Sample ☐ Habitat ☐ QC habitat ☐ QC ID

Sample Status: ☐Collected ☐Seasonally Dry ☐Frequently Dry ☐No Channel
☐Too Deep (Not Wadeable) ☐Too Deep (Temporary) ☐Permanent Barrier ☐Fenced
☐Landowner Denial: ☐Temporary Barrier ☐Posted Plan to revisit? ☐Yes ☐No

Flow Conditions: ☐Dry ☐Isolated Pools ☐Stagnant ☐Low ☐Moderate ☐High ☐Bankful ☐Flooding

Samples Collected
☐Biorecon ☐ SQKICK ☐ SQBANK ☐ Diatoms ☐ Chemical/Bacti ☐ Other Describe ____

Field Parameters: Meter(s) Used:

pH (su)			Dissolved Oxygen %		
Conductivity (umhos)			Turbidity (NTU)		
Temperature (C°)			TDS (mg/L)		
Dissolved Oxygen (ppm=mg/L)			Flow (cfs)		

Meter Problems?____

Photos Taken? ☐ No ☐Yes: Description: ______________________________

Previous 48 hours precipitation: ☐Unknown ☐None ☐Slight ☐Moderate ☐Heavy ☐Flooding
Air Temperature (°F) ______

Physical Characteristics & Light Penetration:

Gradient (sample reach): ☐Flat ☐Low ☐Moderate ☐High ☐Cascades
Average Stream Width: ☐Very Small (<1.5yd) ☐Small (1.5-3yd) ☐Med. (3-10yd) ☐Large (10-25yd) ☐Very Large (>25yd)
Maximum Stream Depth: ☐Shallow (<0.3yd) ☐Medium (0.3-0.6yd) ☐Deep (0.6 – 1yd) ☐Very Deep(>1yd)
% Canopy Cover Estimated for Reach: ____%
% Canopy Cover Measured (mid-reach): ____u/s + ____d/s + ____LDB + ____RDB = Total/384*100 __

Channel Characteristics:

Bank Height: _______ (yd.) High Water Mark: ______(yd.)
Bank Slope LDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope
Bank Slope RDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope
Manmade Modification: ☐None ☐Rip-Rap ☐Cement ☐Gabions ☐Channelized ☐Dam ☐Dredging ☐Bridge ☐ATV

Stream Characteristics:

Sediment Deposits: ☐None ☐Slight ☐Moderate ☐Excessive ☐Blanket
Sediment Type: ☐None ☐Sand ☐Silt ☐Mud ☐Clay ☐Sludge ☐Mn Precipitant ☐Orange Flocculent
Turbidity: ☐Clear ☐Slightly Turbid ☐Muddy ☐Milky ☐Tannic ☐Planktonic Algae ☐Dyed
Foam/Surface Sheen: ☐None ☐Nutrient ☐Surfactant ☐Bacteria
Algae: ☐None ☐Slight ☐Moderate ☐High ☐Choking Type: ☐Diatoms ☐Green ☐Filamentous ☐Blue-green

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID:	Date:	Assessors:

Dominate Substrate: (More than 25%) Select up to 4

Riffle	Run	Pool
☐ Boulders (>10")	☐ Boulders (>10")	☐ Boulders (>10")
☐ Cobble (2.5-10")	☐ Cobble (2.5-10")	☐ Cobble (2.5-10")
☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")
☐ Bedrock	☐ Bedrock	☐ Bedrock
☐ Sand	☐ Sand	☐ Sand
☐ Silt (not gritty)	☐ Silt (not gritty)	☐ Silt (not gritty)
☐ Clay (Slick)	☐ Clay (Slick)	☐ Clay (Slick)

Surrounding Land Uses (list additional land uses under comments)

☐ Forest	☐ Grazing	☐ Stormwater	☐ STP/WWTP	☐ Construction
☐ Wetland	☐ Row Crops	☐ Urban	☐ Industry	☐ Impoundment
☐ Park	☐ CAFO/Dairy	☐ Commercial	☐ Mining/Dredging	☐ ATV/OHV
☐ Hay/Fields	☐ Logging	☐ Residential	☐ Road/Hwy/RR	☐ Golf Course

Observed Human Disturbance to Stream: Blank (not observed) S (Slight) M (Moderate) H (High)

Riparian Loss		Logging		Industry		ATV/OHV	
Channelization		Urban		Mining/ Dredging		Golf Course	
Active Grazing		Commercial		Road/Hwy/RR		Garbage/Trash	
Row Crops		Residential		Construction		Landfill	
CAFO/Dairy		STP/WWTP		Impoundment		Water Withdrawal	

Other Stream Information and Stressors:

Stream Sketch: (include road name or landmark, flow direction, reach distance, distance from bridge or road, sampling points, tributaries, outfalls, livestock access, riparian, potential impacts, north arrow, immediate land use, buildings, etc.) Use additional sheet if necessary.

Rapid Periphyton Sample Data (all samples)

	A	B	C	D	E	F	G	H
1	Diatom Sample Information							Revised 2/2/2023
2	DWR Station ID:					Date:		
3	Field Log Number:					Sample ID:		
4	Sampler:					EFO:		
5	Record aliquots for all RPS samples.				Hydra upload is below transects.			
6	Diatom Habitats Sampled (Specify number of aliquots - total 10)						SOP Link: RPS Collection	
7		Riffle Rock:			Pool Rock:			
8		Leaf Packs:			Woody Debris:			
9		Aquatic Plants or Roots:		Comments:			Total aliquots=	0
10	Complete transects for SEMN sites. Transects optional for other algae samples.							
11	Coverage Class (Moss and Macro-Algae)							
12	0	1	2	3	4	5		

BioEvent | SS2 | HG_Hab | LG_Hab | BRFieldFamVer | Hydra | BRGenVer | BioAnalysis | inorg | tags | RPS | SEMN | SEMN-QHS | V ...

Rapid Periphyton Survey Data Sheet (SEMN only)

Complete transects for SEMN sites. Transects optional for other algae samples.

Coverage Class (Moss and Macro-Algae)					
0	1	2	3	4	5
0%	< 5%	5 to 25%	26 to 50%	51 to 75%	> 75%

Biofilm Thickness (Micro-Algae)					
0	1	2	3	4	5
0 mm	< 0.5 mm	0.5 to 1 mm	1 to 5 mm	5 to 20 mm	> 20 mm

Rapid Periphyton Survey Data Sheet

Transect Number	Point	Moss	Macro	Micro	Substrate >2cm (Y/N)
1	1				
1	2				
1	3				
1	4				
1	5*				
1	6				
1	7				
1	8				
1	9				
1	10				

Canopy Cover	Trans 1
u/s	
d/s	
RDB	
LDB	
% (Total/384)	

Transect Number	Point	Moss	Macro	Micro	Substrate >2cm (Y/N)
2	1				
2	2				
2	3				
2	4				
2	5*				
2	6				
2	7				
2	8				
2	9				
2	10				

Canopy Cover	Trans 2
u/s	
d/s	
RDB	
LDB	
% (Total/384)	

BioEvent | SS2 | HG_Hab | LG_Hab | BRFieldFamVer | Hydra | BRGenVer | BioAnalysis | inorg | tags | RPS | SEMN | SEMN-Q

Transect Number	Point	Moss	Macro	Micro	Substrate >2cm (Y/N)
3	1				
3	2				
3	3				
3	4				
3	5*				
3	6				
3	7				
3	8				
3	9				
3	10				

Canopy Cover	Trans 3
u/s	
d/s	
RDB	
LDB	
% (Total/384)	

Transect Number	Point	Moss	Macro	Micro	Substrate >2cm (Y/N)
4	1				
4	2				
4	3				
4	4				
4	5*				
4	6				
4	7				
4	8				
4	9				
4	10				

Canopy Cover	Trans 4
u/s	
d/s	
RDB	
LDB	
% (Total/384)	

Transect Number	Point	Moss	Macro	Micro	Substrate >2cm (Y/N)
5	1				
5	2				
5	3				
5	4				
5	5*				
5	6				
5	7				
5	8				
5	9				
5	10				

Canopy Cover	Trans 5
u/s	
d/s	
RDB	
LDB	
% (Total/384)	

Comments:

BioEvent | SS2 | HG_Hab | LG_Hab | BRFieldFamVer | Hydra | BRGenVer | BioAnalysis | inorg | tags | **RPS**

Diatom Taxa Upload Format

DWR_STATION_ID	PERISAMP ID	FIELD_LOG_NUMBER	ACTIVITY_START_DATE	PROJECT_NAME	ACTIVITY_TYPE	ORGANIZATION	SAMPLER	SAMPLE_COLLECTION_METHOD_ ID	FINAL ID	INDIVIDUALS	EXCLUDED_TAXA	COMMENTS	LAB_ORG	ID_BY

TDH Biological Sample Request Including Chain of Custody Form

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**STATE OF TENNESSEE - ENVIRONMENTAL LABORATORIES**									**Biological Analysis**			
2	**Please Print Legibly**								**Schedule must be Arranged in advance for all tests (615)262-6327				
3	Project/Site No.						**Screening Bioassays**		**Chronic Bioassays**	Branch Lab Number			
4	Project Name						(Cannot be used for permitting)		Chronic Cd	**Chain of Custody (sign full name)**			
5	Station No.			County			48 hr Static Screening Cd		Log Number	1. Collected by			
6	Description						Log Number		LC50 @ 24 hrs	Date		Time	
7	Stream Mile			Depth			LC50 @ 24 hrs		LC50 @ 48 hrs	Delivered to			
8	Collection Date			Time			LC50 @ 48 hrs		LC50 @ 72 hrs	Date		Time	
9	Sampler's Name (Print)						48 hr Static Screening Pp		LC50 @ 96 hrs	2. Received by			
10	Sampling Agency						Log Number		Survival	Date		Time	
11	Billing Code			Permit #:			LC50 @ 24 hrs		NOAEC	Delivered to			
12	If Priority, Date Needed			WS Grp:			LC50 @ 48 hrs		LOAEC	Date		Time	
13	Send Report to		R. Cochran & D. Arnwine, TDEC/DWR/WPU/CO						Reproduction	3. Received by			
14							48 hr Static Definitive Cd		NOAEC	Date		Time	
15	Field Log Number:						Log Number		LOAEC	Delivered to			
16	Contact Hazard		Unknown				LC50 @ 24 hrs		IC25	Date		Time	
17	Date Reported			By			LC50 @ 48 hrs		Chronic Pp	4. Rec'd in Lab by			
18	Reviewed By						NOAEC		Log Number	Date		Time	
19	Reviewed by						LOAEC		LC50 @ 24 hrs	Logged in by			
20		BIOLOGICAL SURVEYS					96 hr Static Definitive Pp		LC50 @ 48 hrs	Date		Time	
21		Macroinvertebrate Recon					Log Number		LC50 @ 72 hrs	**Additional Information**			
22		Rapid Bioassessment (State SOP)					LC50 @ 24 hrs		LC50 @ 96 hrs	1. Approx. volume of sample			
23		Intensive Survey - Surber					LC50 @ 48 hrs		LC50 @ 120 hrs	2. Nearest town or city			
24		Intensive Survey - Dendy					NOAEC		LC50 @ 144 hrs				
25		Fish Population Recon					LOAEC		LC50 @ 168 hrs	3. Others present at collection			
26		Fish Population Intensive					96 hr Static Definitive Cd		Survival				
27		Fish Tissue Collection					Log Number		NOAEC	4. Number of other samples collected at same			
28		Chlorophyll Analysis					LC50 @ 24 hrs		LOAEC	time at this point			
29		Log Number					LC50 @ 48 hrs		Growth				
30		Chlorophyll a					LC50 @ 72 hrs		NOAEC	5. Field collection procedure, handling and/or			
31		Pheophyton					LC50 @ 96 hrs		LOAEC	preservation of this sample.			**TDEC SOP**
32		***SPECIAL STUDIES***					NOAEC		IC25	Activity Type:			
33		(Please Specify)		**SEMN Qual**			LOAEC						
34		BR Family (Lab Log No:)			Bank		96 hr Static Definitive Pp		Chlorine Residual	6. Mode of transportation to lab			
35		BR Genera (Lab Log No:)			Macrophyte		Log Number						
36		SQKICK (Lab Log No:)			Slow Rock		LC50 @ 24 hrs		Lab Parameters	7. Sample/cooler sealed by			
37		SQBank (Lab Log No:)			Sediment		LC50 @ 48 hrs		pH				
38		Diatoms (Lab Log No:)			Leaf		LC50 @ 72 hrs		Cond.	8. Date sample/cooler sealed			
39		SEMN 500 SQKICK:			Woody		LC50 @ 96 hrs		D.O.	9. Remarks			
40		Other (Lab Log No:)					NOAEC		Temp.	**Biological EDD uploaded to Hydra.**			
41		Describe Other:					LOAEC						

BioEvent | SS2 | HG_Hab | LG_Hab | BRFieldFamVer | Hydra | BRGenVer | **BioAnalysis** | inorg | tags | RPS | SEMN | SEMN-QHS | Validation

APPENDIX C

TENNESSEE DIATOM TAXA LIST

(Final Id is acceptable reporting nomenclature)

Tennessee Taxa List

(Diatoms added after March 2023 can be found on Hydra Diatom Master Taxa Table)

Order	Family	Genus	Final Id
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes acares
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes coarctata
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes decipiens
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes inflata
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes minuscula
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes ricula
Achnanthales	Achnanthaceae	Achnanthes	Achnanthes subhudsonis var. kraeuselii
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis neodiminuta
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis neothumensis
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis pediculus
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis placentula
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis placentula var. euglypta
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis placentula var. lineata
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis pseudolineata
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis pseudothumensis
Achnanthales	Achnanthaceae	Cocconeis	Cocconeis scutellum
Achnanthales	Achnanthaceae	Karayevia	Karayevia clevei
Achnanthales	Achnanthaceae	Karayevia	Karayevia clevei var. rostrata
Achnanthales	Achnanthaceae	Karayevia	Karayevia laterostrata
Achnanthales	Achnanthaceae	Karayevia	Karayevia oblongella
Achnanthales	Achnanthaceae	Karayevia	Karayevia ploenensis
Achnanthales	Achnanthaceae	Karayevia	Karayevia suchlandtii
Achnanthales	Achnanthaceae	Lemnicola	Lemnicola hungarica
Achnanthales	Achnanthaceae	Planothidium	Planothidium
Achnanthales	Achnanthaceae	Planothidium	Planothidium apiculatum
Achnanthales	Achnanthaceae	Planothidium	Planothidium biporomum
Achnanthales	Achnanthaceae	Planothidium	Planothidium daui
Achnanthales	Achnanthaceae	Planothidium	Planothidium delicatulum
Achnanthales	Achnanthaceae	Planothidium	Planothidium dispar
Achnanthales	Achnanthaceae	Planothidium	Planothidium distinctum
Achnanthales	Achnanthaceae	Planothidium	Planothidium dubium
Achnanthales	Achnanthaceae	Planothidium	Planothidium ellipticum
Achnanthales	Achnanthaceae	Planothidium	Planothidium engelbrechtii

Order	Family	Genus	Final Id
Achnanthales	Achnanthaceae	Planothidium	Planothidium frequentissimum
Achnanthales	Achnanthaceae	Planothidium	Planothidium granum
Achnanthales	Achnanthaceae	Planothidium	Planothidium hauckianum
Achnanthales	Achnanthaceae	Planothidium	Planothidium haynaldii
Achnanthales	Achnanthaceae	Planothidium	Planothidium holstii
Achnanthales	Achnanthaceae	Planothidium	Planothidium joursacense
Achnanthales	Achnanthaceae	Planothidium	Planothidium lanceolatum
Achnanthales	Achnanthaceae	Planothidium	Planothidium minutissimum
Achnanthales	Achnanthaceae	Planothidium	Planothidium miotum
Achnanthales	Achnanthaceae	Planothidium	Planothidium oestrupii
Achnanthales	Achnanthaceae	Planothidium	Planothidium peragalli
Achnanthales	Achnanthaceae	Planothidium	Planothidium peragalli var. parvulum
Achnanthales	Achnanthaceae	Planothidium	Planothidium rostratum
Achnanthales	Achnanthaceae	Platessa	Platessa
Achnanthales	Achnanthaceae	Platessa	Platessa bahlsii
Achnanthales	Achnanthaceae	Platessa	Platessa conspicua
Achnanthales	Achnanthaceae	Platessa	Platessa holsatica
Achnanthales	Achnanthaceae	Platessa	Platessa hustedtii
Achnanthales	Achnanthaceae	Platessa	Platessa kingstonii
Achnanthales	Achnanthaceae	Platessa	Platessa lutheri
Achnanthales	Achnanthaceae	Platessa	Platessa montana
Achnanthales	Achnanthaceae	Platessa	Platessa rupestris
Achnanthales	Achnanthaceae	Platessa	Platessa stewartii
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium abundans fo. Rosenstockii
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium bioretii
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium chlidanos
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium curtissimum
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium daonense
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium grischunum
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium harveyi
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium helveticum
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium lacus-vulcani
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium lauenburgianum
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium levanderi
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium marginulatum
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium rechtensis

Order	Family	Genus	Final Id
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium scoticum
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium subatomoides
Achnanthales	Achnanthaceae	Psammothidium	Psammothidium ventralis
Achnanthales	Achnanthaceae	Rossithidium	Rossithidium duthii
Achnanthales	Achnanthaceae	Rossithidium	Rossithidium linearis
Achnanthales	Achnanthaceae	Rossithidium	Rossithidium nodosum
Achnanthales	Achnanthaceae	Rossithidium	Rossithidium petersennii
Achnanthales	Achnanthaceae	Rossithidium	Rossithidium pusillum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium affine
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium alpestre
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium altergracillima
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium atomus
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium caledonicum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium catenatum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium crassum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium deflexum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium delmontii
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium druartii
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium eutrophilum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium exiguum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium exiguum var. heterovalvum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium exilis
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium gracillimum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium jackii
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium kranzii
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium latecephalum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium macrocephalum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium microcephalum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium minutissimum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium pyrenaicum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium reimeri
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium rivulare
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium saprophilum
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium subhudsonis var. kraeuselii
Achnanthales	Achnanthidiaceae	Achnanthidium	Achnanthidium thienemannii
Achnanthales	Achnanthidiaceae	Eucocconeis	Eucocconeis flexella
Achnanthales	Achnanthidiaceae	Eucocconeis	Eucocconeis laevis

Order	Family	Genus	Final Id
Achnanthales	Achnanthidiaceae	Planothidium	Planothidium chilense
Acrochaetiales	Aulacoseiraceae	Aulacoseira	Aulacoseira granulata var. angustissima
Acrochaetiales	Aulacoseriaceae	Aulacoseira	Aulacoseira
Acrochaetiales	Aulacoseriaceae	Aulacoseira	Aulacoseira subarctica
Aulacoseirales	Aulacoseiraceae	Aulacoseira	Aulacoseira alpigena
Aulacoseirales	Aulacoseiraceae	Aulacoseira	Aulacoseira distans
Aulacoseirales	Aulacoseiraceae	Aulacoseira	Aulacoseira granulata
Aulacoseirales	Aulacoseiraceae	Aulacoseira	Aulacoseira italica
Aulacoseirales	Aulacoseiraceae	Aulacoseira	Aulacoseira muzzanensis
Aulacoseirales	Aulacoseiraceae	Aulacoseira	Aulacoseira pusilla
Aulacoseirales	Aulacoseiraceae	Aulacoseira	Aulacoseira tenella
Aulacoseirales	Aulacoseriaceae	Aulacoseira	Aulacoseira ambigua
Aulacoseirales	Aulacoseriaceae	Aulacoseira	Aulacoseira subborealis
Bacillariales	Bacillariaceae	Bacillaria	Bacillaria paradoxa
Bacillariales	Bacillariaceae	Cylindrotheca	Cylindrotheca closterium
Bacillariales	Bacillariaceae	Denticula	Denticula
Bacillariales	Bacillariaceae	Denticula	Denticula elegans
Bacillariales	Bacillariaceae	Denticula	Denticula kuetzingii
Bacillariales	Bacillariaceae	Denticula	Denticula subtilis
Bacillariales	Bacillariaceae	Denticula	Denticula tenuis
Bacillariales	Bacillariaceae	Hantzschia	Hantzschia amphioxys
Bacillariales	Bacillariaceae	Hantzschia	Hantzschia distinctepunctata
Bacillariales	Bacillariaceae	Hantzschia	Hantzschia elongata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia acicularioides
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia acicularis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia acidoclinata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia acula
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia aequorea
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia agnita
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia alpina
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia amphibia
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia amphibioides
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia angustata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia angustatula
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia bacillum
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia biacrula
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia bremensis

Order	Family	Genus	Final Id
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia brevissima
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia bulnheimiana
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia capitellata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia clausii
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia communis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia desertorum
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia dissipata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia dissipata var. media
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia dubia
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia elegantula
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia filiformis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia filiformis var. conferta
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia flexoides
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia fonticola
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia fossilis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia frustulum
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia gandersheimiensis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia gessneri
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia graciliformis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia gracilis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia hantzschiana
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia heufleriana
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia inconspicua
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia intermedia
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia lacuum
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia lanceolata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia liebetruthii
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia linearis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia linearis var. tenuis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia lorenziana
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia microcephala
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia nana
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia palea
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia palea var. debilis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia palea var. tenuirostris
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia paleacea
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia paleaeformis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia parvula
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia pellucida

Order	Family	Genus	Final Id
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia perminuta
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia pseudofonticola
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia pumila
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia pura
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia pusilla
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia radicula
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia rautenbachiae
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia recta
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia reversa
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia romana
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia rostellata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia sigma
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia sigmoidea
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia sinuata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia sinuata var. delognei
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia sinuata var. tabellaria
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia sociabilis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia solita
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia soratensis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia subacicularis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia subcapitellata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia sublinearis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia subtilis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia suchlandti
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia supralitorea
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia tenuis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia tropica
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia tubicola
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia umbonata
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia vermicularis
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia vitrea
Bacillariales	Bacillariaceae	Nitzschia	Nitzschia wuellerstorffii
Bacillariales	Bacillariaceae	Psammodictyon	Psammodictyon constrictum
Bacillariales	Bacillariaceae	Simonsenia	Simonsenia delognei
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella acuminata
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella aerophila
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella apiculata
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella calida

Order	Family	Genus	Final Id
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella coarctata
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella compressa
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella debilis
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella gracilis
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella hungarica
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella levidensis
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella littoralis
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella scalaris
Bacillariales	Bacillariaceae	Tryblionella	Tryblionella victoriae
Chaetophorales	Chaetophoracea	Stigeoclonium	Stigeoclonium lubricum
Coscinodiscales	Hemidiscaceae	Actinocyclus	Actinocyclus normanii
Cymbellales	Cymbellaceae	Cymbella	Cymbella
Cymbellales	Cymbellaceae	Cymbella	Cymbella affinis
Cymbellales	Cymbellaceae	Cymbella	Cymbella aspera
Cymbellales	Cymbellaceae	Cymbella	Cymbella cistula
Cymbellales	Cymbellaceae	Cymbella	Cymbella compacta
Cymbellales	Cymbellaceae	Cymbella	Cymbella cymbiformis
Cymbellales	Cymbellaceae	Cymbella	Cymbella ehrenbergii
Cymbellales	Cymbellaceae	Cymbella	Cymbella elginensis
Cymbellales	Cymbellaceae	Cymbella	Cymbella helvetica
Cymbellales	Cymbellaceae	Cymbella	Cymbella hustedtii
Cymbellales	Cymbellaceae	Cymbella	Cymbella laevis
Cymbellales	Cymbellaceae	Cymbella	Cymbella lanceolata
Cymbellales	Cymbellaceae	Cymbella	Cymbella leptoceros
Cymbellales	Cymbellaceae	Cymbella	Cymbella mexicana
Cymbellales	Cymbellaceae	Cymbella	Cymbella microcephala var. crassa
Cymbellales	Cymbellaceae	Cymbella	Cymbella neocistula
Cymbellales	Cymbellaceae	Cymbella	Cymbella obscura
Cymbellales	Cymbellaceae	Cymbella	Cymbella proxima
Cymbellales	Cymbellaceae	Cymbella	Cymbella subturgidula
Cymbellales	Cymbellaceae	Cymbella	Cymbella tumida
Cymbellales	Cymbellaceae	Cymbella	Cymbella tumidula
Cymbellales	Cymbellaceae	Cymbella	Cymbella turgida
Cymbellales	Cymbellaceae	Cymbella	Cymbella turgidula
Cymbellales	Cymbellaceae	Cymbellafalsa	Cymbellafalsa diluviana
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura amphicephala
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura hauckii
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura

Order	Family	Genus	Final Id
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura apiculata
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura cuspidata
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura incerta
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura lata
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura naviculiformis
Cymbellales	Cymbellaceae	Cymbopleura	Cymbopleura subaequalis
Cymbellales	Cymbellaceae	Delicata	Delicata delicatula
Cymbellales	Cymbellaceae	Didymosphenia	Didymosphenia geminata
Cymbellales	Cymbellaceae	Encyonema	Encyonema
Cymbellales	Cymbellaceae	Encyonema	Encyonema appalachianum
Cymbellales	Cymbellaceae	Encyonema	Encyonema auerswaldii
Cymbellales	Cymbellaceae	Encyonema	Encyonema brehmii
Cymbellales	Cymbellaceae	Encyonema	Encyonema cespitosum
Cymbellales	Cymbellaceae	Encyonema	Encyonema gaeumannii
Cymbellales	Cymbellaceae	Encyonema	Encyonema hamsherae
Cymbellales	Cymbellaceae	Encyonema	Encyonema hebridicum
Cymbellales	Cymbellaceae	Encyonema	Encyonema lacustre
Cymbellales	Cymbellaceae	Encyonema	Encyonema leibleinii
Cymbellales	Cymbellaceae	Encyonema	Encyonema lineolatum
Cymbellales	Cymbellaceae	Encyonema	Encyonema lunatum
Cymbellales	Cymbellaceae	Encyonema	Encyonema mesianum
Cymbellales	Cymbellaceae	Encyonema	Encyonema minuta var. pseudogracilis
Cymbellales	Cymbellaceae	Encyonema	Encyonema minutum
Cymbellales	Cymbellaceae	Encyonema	Encyonema neogracile
Cymbellales	Cymbellaceae	Encyonema	Encyonema pergracile
Cymbellales	Cymbellaceae	Encyonema	Encyonema perpusillum
Cymbellales	Cymbellaceae	Encyonema	Encyonema reichardtii
Cymbellales	Cymbellaceae	Encyonema	Encyonema silesiacum
Cymbellales	Cymbellaceae	Encyonema	Encyonema triangulum
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis cesatii
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis delicatissima
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis falaisensis
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis krammeri
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis microcephala
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis neoamphioxys
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis subminuta
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis vandamii

Order	Family	Genus	Final Id
Cymbellales	Cymbellaceae	Encyonopsis	Encyonopsis aequalis
Cymbellales	Cymbellaceae	Paraplaconeis	Paraplaconeis minor
Cymbellales	Cymbellaceae	Placoneis	Placoneis
Cymbellales	Cymbellaceae	Placoneis	Placoneis abiskoensis
Cymbellales	Cymbellaceae	Placoneis	Placoneis anglophila
Cymbellales	Cymbellaceae	Placoneis	Placoneis clementioides
Cymbellales	Cymbellaceae	Placoneis	Placoneis clementis
Cymbellales	Cymbellaceae	Placoneis	Placoneis elginensis
Cymbellales	Cymbellaceae	Placoneis	Placoneis exigua
Cymbellales	Cymbellaceae	Placoneis	Placoneis gastrum
Cymbellales	Cymbellaceae	Placoneis	Placoneis hambergi
Cymbellales	Cymbellaceae	Placoneis	Placoneis neglecta
Cymbellales	Cymbellaceae	Placoneis	Placoneis paraelginensis
Cymbellales	Cymbellaceae	Placoneis	Placoneis placentula
Cymbellales	Cymbellaceae	Placoneis	Placoneis pseudanglica
Cymbellales	Cymbellaceae	Placoneis	Placoneis symmetrica
Cymbellales	Gomphonemataceae	Gomphoneis	Gomphoneis minuta
Cymbellales	Gomphonemataceae	Gomphoneis	Gomphoneis olivaceum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema acidoclinatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema acuminatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema affine
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema amoenum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema angustatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema angustum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema apuncto
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema augur
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema caperatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema clavatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema drutelingense
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema elongatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema gracile
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema incognitum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema innocens
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema instabilis
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema intricatum var. vibrio
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema louisiananum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema manubrium

Order	Family	Genus	Final Id
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema mehleri
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema mexicanum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema minutum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema minutum fo. Syriacum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema parvulum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema parvulum fo. Saprophilum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema pseudoaugur
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema puiggarianum var. aequatorialis
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema pygmaeum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema tergestinum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema truncatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema sarcophagus
Cymbellales	Gomphonemataceae	Gomphoneis	Gomphoneis herculeana
Cymbellales	Gomphonemataceae	Gomphoneis	Gomphoneis herculeana var. loweii
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema americobtusatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema bipunctatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema brebissonii
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema celatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema coronatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema cymbelliclinum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema dichotomum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema exilissimum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema freesei
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema insigne
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema intricatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema kobayasii
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema lagenula
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema micropus
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema minutum fo. Curtum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema olivaceoides
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema olivaceum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema parvulius
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema productum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema pseudotenellum

Order	Family	Genus	Final Id
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema pumilum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema pumilum var. elegans
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema pumilum var. rigidum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema reimeri
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema rhombicum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema sierranum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema sphaerophorum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema stoermeri
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema subclavatum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema subtile
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema turgidum
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema turris
Cymbellales	Gomphonemataceae	Gomphonema	Gomphonema ventricosum
Cymbellales	Gomphonemataceae	Gomphosphenia	Gomphosphenia
Cymbellales	Gomphonemataceae	Gomphosphenia	Gomphosphenia grovei
Cymbellales	Gomphonemataceae	Gomphosphenia	Gomphosphenia grovei var. lingulata
Cymbellales	Gomphonemataceae	Gomphosphenia	Gomphosphenia lingulatiformis
Cymbellales	Gomphonemataceae	Gomphosphenia	Gomphosphenia tackei
Cymbellales	Gomphonemataceae	Reimeria	Reimeria sinuata
Cymbellales	Gomphonemataceae	Reimeria	Reimeria sinuata fo. Antiqua
Cymbellales	Gomphonemataceae	Reimeria	Reimeria uniseriata
Cymbellales	Rhoicospheniaceae	Rhoicosphenia	Rhoicosphenia abbreviata
Eunotiales	Eunotiaceae	Eunotia	Eunotia
Eunotiales	Eunotiaceae	Eunotia	Eunotia arcus
Eunotiales	Eunotiaceae	Eunotia	Eunotia bidentula
Eunotiales	Eunotiaceae	Eunotia	Eunotia bigibba
Eunotiales	Eunotiaceae	Eunotia	Eunotia bilunaris
Eunotiales	Eunotiaceae	Eunotia	Eunotia bilunaris var. linearis
Eunotiales	Eunotiaceae	Eunotia	Eunotia boomsma
Eunotiales	Eunotiaceae	Eunotia	Eunotia botuliformis
Eunotiales	Eunotiaceae	Eunotia	Eunotia braendlei
Eunotiales	Eunotiaceae	Eunotia	Eunotia camelus
Eunotiales	Eunotiaceae	Eunotia	Eunotia canicula
Eunotiales	Eunotiaceae	Eunotia	Eunotia carolina
Eunotiales	Eunotiaceae	Eunotia	Eunotia circumborealis
Eunotiales	Eunotiaceae	Eunotia	Eunotia cristagalli
Eunotiales	Eunotiaceae	Eunotia	Eunotia denticulata

Order	Family	Genus	Final Id
Eunotiales	Eunotiaceae	Eunotia	Eunotia diodon
Eunotiales	Eunotiaceae	Eunotia	Eunotia elegans
Eunotiales	Eunotiaceae	Eunotia	Eunotia eruca
Eunotiales	Eunotiaceae	Eunotia	Eunotia exigua
Eunotiales	Eunotiaceae	Eunotia	Eunotia exigua var. bidens
Eunotiales	Eunotiaceae	Eunotia	Eunotia exigua var. tridentula
Eunotiales	Eunotiaceae	Eunotia	Eunotia fallax
Eunotiales	Eunotiaceae	Eunotia	Eunotia flexuosa
Eunotiales	Eunotiaceae	Eunotia	Eunotia formica
Eunotiales	Eunotiaceae	Eunotia	Eunotia genuflexa
Eunotiales	Eunotiaceae	Eunotia	Eunotia glacialis
Eunotiales	Eunotiaceae	Eunotia	Eunotia groenlandica
Eunotiales	Eunotiaceae	Eunotia	Eunotia implicata
Eunotiales	Eunotiaceae	Eunotia	Eunotia incisa
Eunotiales	Eunotiaceae	Eunotia	Eunotia intermedia
Eunotiales	Eunotiaceae	Eunotia	Eunotia macroglossa
Eunotiales	Eunotiaceae	Eunotia	Eunotia maior
Eunotiales	Eunotiaceae	Eunotia	Eunotia meisteri
Eunotiales	Eunotiaceae	Eunotia	Eunotia metamonodon
Eunotiales	Eunotiaceae	Eunotia	Eunotia microcephala
Eunotiales	Eunotiaceae	Eunotia	Eunotia microcephala var. tridentata
Eunotiales	Eunotiaceae	Eunotia	Eunotia minor
Eunotiales	Eunotiaceae	Eunotia	Eunotia monodon
Eunotiales	Eunotiaceae	Eunotia	Eunotia monodon var. constricta
Eunotiales	Eunotiaceae	Eunotia	Eunotia montuosa
Eunotiales	Eunotiaceae	Eunotia	Eunotia mucophila
Eunotiales	Eunotiaceae	Eunotia	Eunotia muscicola
Eunotiales	Eunotiaceae	Eunotia	Eunotia muscicola var. tridentula
Eunotiales	Eunotiaceae	Eunotia	Eunotia naegelii
Eunotiales	Eunotiaceae	Eunotia	Eunotia nymanniana
Eunotiales	Eunotiaceae	Eunotia	Eunotia paludosa
Eunotiales	Eunotiaceae	Eunotia	Eunotia paludosa var. trinacria
Eunotiales	Eunotiaceae	Eunotia	Eunotia papilioforma
Eunotiales	Eunotiaceae	Eunotia	Eunotia parallela
Eunotiales	Eunotiaceae	Eunotia	Eunotia paratridentula
Eunotiales	Eunotiaceae	Eunotia	Eunotia pectinalis
Eunotiales	Eunotiaceae	Eunotia	Eunotia pectinalis var. undulata
Eunotiales	Eunotiaceae	Eunotia	Eunotia perminuta

Order	Family	Genus	Final Id
Eunotiales	Eunotiaceae	Eunotia	Eunotia perpusilla
Eunotiales	Eunotiaceae	Eunotia	Eunotia pirla
Eunotiales	Eunotiaceae	Eunotia	Eunotia praerupta
Eunotiales	Eunotiaceae	Eunotia	Eunotia praerupta var. bidens
Eunotiales	Eunotiaceae	Eunotia	Eunotia praerupta var. curta
Eunotiales	Eunotiaceae	Eunotia	Eunotia rhomboidea
Eunotiales	Eunotiaceae	Eunotia	Eunotia rushforthii
Eunotiales	Eunotiaceae	Eunotia	Eunotia septentrionalis
Eunotiales	Eunotiaceae	Eunotia	Eunotia serra
Eunotiales	Eunotiaceae	Eunotia	Eunotia serra var. diadema
Eunotiales	Eunotiaceae	Eunotia	Eunotia soleirolii
Eunotiales	Eunotiaceae	Eunotia	Eunotia subarcuatoides
Eunotiales	Eunotiaceae	Eunotia	Eunotia subherkiniensis
Eunotiales	Eunotiaceae	Eunotia	Eunotia sudetica
Eunotiales	Eunotiaceae	Eunotia	Eunotia tautoniensis
Eunotiales	Eunotiaceae	Eunotia	Eunotia tenella
Eunotiales	Eunotiaceae	Eunotia	Eunotia tridentula
Eunotiales	Eunotiaceae	Eunotia	Eunotia trinacria
Eunotiales	Eunotiaceae	Eunotia	Eunotia triodon
Eunotiales	Eunotiaceae	Eunotia	Eunotia valida
Eunotiales	Eunotiaceae	Eunotia	Eunotia vanheurckii var. intermedia
Eunotiales	Eunotiaceae	Eunotia	Eunotia varioundulata
Eunotiales	Eunotiaceae	Eunotia	Eunotia zasuminensis
Eunotiales	Eunotiaceae	Eunotia	Eunotia zygodon
Eunotiales	Peroniaceae	Peronia	Peronia fibula
Fragilariales	Diatomaceae	Fragilariforma	Fragilariforma
Fragilariales	Diatomaceae	Fragilariforma	Fragilariforma bicapitata
Fragilariales	Diatomaceae	Fragilariforma	Fragilariforma constricta
Fragilariales	Diatomaceae	Fragilariforma	Fragilariforma lata
Fragilariales	Diatomaceae	Fragilariforma	Fragilariforma virescens
Fragilariales	Diatomaceae	Fragilariforma	Fragilariforma virescens var. capitata
Fragilariales	Fragilariaceae	Asterionella	Asterionella formosa
Fragilariales	Fragilariaceae	Ctenophora	Ctenophora pulchella
Fragilariales	Fragilariaceae	Ctenophora	Ctenophora pulchella var. lacerata
Fragilariales	Fragilariaceae	Diatoma	Diatoma mesodon
Fragilariales	Fragilariaceae	Diatoma	Diatoma moniliformis
Fragilariales	Fragilariaceae	Diatoma	Diatoma tenuis

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Fragilariales	Fragilariaceae	Diatoma	Diatoma vulgaris
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria capucina
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria capucina var. fragilarioides
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria capucina var. gracilis
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria crotonensis
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria dilatata
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria grunowii
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria mesolepta
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria neoproducta
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria pararumpens
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria pectinalis
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria perminuta
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria radians
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria recapitellata
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria sepes
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria synegrotesca
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria tenera
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria vaucheriae
Fragilariales	Fragilariaceae	Fragilaria	Fragilaria vaucheriae var. capitellata
Fragilariales	Fragilariaceae	Hannaea	Hannaea arcus
Fragilariales	Fragilariaceae	Meridion	Meridion alansmithii
Fragilariales	Fragilariaceae	Meridion	Meridion circulare
Fragilariales	Fragilariaceae	Meridion	Meridion circulare var. constrictum
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira brevistriata
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira elliptica
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira parasitica
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira parasitica var. subconstricta
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira pseudoconstruens
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira trainorii
Fragilariales	Fragilariaceae	Pseudostaurosira	Pseudostaurosira zeilleri
Fragilariales	Fragilariaceae	Punctastriata	Punctastriata lancettula
Fragilariales	Fragilariaceae	Stauroforma	Stauroforma exiguiformis
Fragilariales	Fragilariaceae	Staurosira	Staurosira

Order	Family	Genus	Final Id
Fragilariales	Fragilariaceae	Staurosira	Staurosira construens
Fragilariales	Fragilariaceae	Staurosira	Staurosira construens var. binodis
Fragilariales	Fragilariaceae	Staurosira	Staurosira construens var. venter
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella berolinensis
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella confusa
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella lapponica
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella leptostauron
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella leptostauron var. dubia
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella martyi
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella pinnata
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella pinnata var. intercedens
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella rhomboides
Fragilariales	Fragilariaceae	Staurosirella	Staurosirella subcapitata
Fragilariales	Fragilariaceae	Synedra	Synedra
Fragilariales	Fragilariaceae	Synedra	Synedra famelica
Fragilariales	Fragilariaceae	Synedra	Synedra filiformis var. exilis
Fragilariales	Fragilariaceae	Synedra	Synedra goulardi
Fragilariales	Fragilariaceae	Synedra	Synedra mazamaensis
Fragilariales	Fragilariaceae	Synedra	Synedra pulchella var. flexella
Fragilariales	Fragilariaceae	Synedra	Synedra rumpens
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria acus
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria contracta
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria delicatissima
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria delicatissima var. angustissima
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria oxyrhyncus
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria ramesi
Fragilariales	Fragilariaceae	Ulnaria	Ulnaria ulna
Licmophorales	Licmophoraceae	Licmophora	Licmophora gracilis
Mastogloiales	Mastogloiaceae	Aneumastus	Aneumastus tuscula
Mastogloiales	Mastogloiaceae	Mastogloia	Mastogloia smithii
Melosirales	Melosiraceae	Melosira	Melosira varians
Naviculales	Amphipleuraceae	Amphipleura	Amphipleura pellucida
Naviculales	Amphipleuraceae	Frustulia	Frustulia

Order	Family	Genus	Final Id
Naviculales	Amphipleuraceae	Frustulia	Frustulia amphipleuroides
Naviculales	Amphipleuraceae	Frustulia	Frustulia crassinervia
Naviculales	Amphipleuraceae	Frustulia	Frustulia inculta
Naviculales	Amphipleuraceae	Frustulia	Frustulia krammeri
Naviculales	Amphipleuraceae	Frustulia	Frustulia latita
Naviculales	Amphipleuraceae	Frustulia	Frustulia rexii
Naviculales	Amphipleuraceae	Frustulia	Frustulia rhomboides
Naviculales	Amphipleuraceae	Frustulia	Frustulia rhomboides var. capitata
Naviculales	Amphipleuraceae	Frustulia	Frustulia saxonica
Naviculales	Amphipleuraceae	Frustulia	Frustulia spicula
Naviculales	Amphipleuraceae	Frustulia	Frustulia vulgaris
Naviculales	Amphipleuraceae	Frustulia	Frustulia weinholdii
Naviculales	Berkekeyaceae	Parlibellus	Parlibellus crucicula
Naviculales	Berkekeyaceae	Parlibellus	Parlibellus protracta
Naviculales	Berkekeyaceae	Parlibellus	Parlibellus protractoides
Naviculales	Brachysiraceae	Brachysira	Brachysira
Naviculales	Brachysiraceae	Brachysira	Brachysira apiculata
Naviculales	Brachysiraceae	Brachysira	Brachysira brebissonii
Naviculales	Brachysiraceae	Brachysira	Brachysira microcephala
Naviculales	Brachysiraceae	Brachysira	Brachysira ocalanensis
Naviculales	Brachysiraceae	Brachysira	Brachysira procera
Naviculales	Brachysiraceae	Brachysira	Brachysira serians
Naviculales	Brachysiraceae	Brachysira	Brachysira vitrea
Naviculales	Cavinulaceae	Cavinula	Cavinula
Naviculales	Cavinulaceae	Cavinula	Cavinula cocconeiformis
Naviculales	Cavinulaceae	Cavinula	Cavinula jaernefeltii
Naviculales	Cavinulaceae	Cavinula	Cavinula lacustris
Naviculales	Cavinulaceae	Cavinula	Cavinula lapidosa
Naviculales	Cavinulaceae	Cavinula	Cavinula pseudoscutiformis
Naviculales	Diadesmidaceae	Diadesmis	Diadesmis confervacea
Naviculales	Diadesmidaceae	Diadesmis	Diadesmis gallica
Naviculales	Diadesmidaceae	Diadesmis	Diadesmis laevissima
Naviculales	Diadesmidaceae	Humidophila	Humidophila contenta
Naviculales	Diadesmidaceae	Humidophila	Humidophila pantropica
Naviculales	Diadesmidaceae	Humidophila	Humidophila perpusilla
Naviculales	Diadesmidaceae	Luticola	Luticola
Naviculales	Diadesmidaceae	Luticola	Luticola cohnii
Naviculales	Diadesmidaceae	Luticola	Luticola goeppertiana

Order	Family	Genus	Final Id
Naviculales	Diadesmidaceae	Luticola	Luticola minor
Naviculales	Diadesmidaceae	Luticola	Luticola mutica
Naviculales	Diadesmidaceae	Luticola	Luticola nivalis
Naviculales	Diadesmidaceae	Luticola	Luticola saxophila
Naviculales	Diadesmidaceae	Luticola	Luticola stigma
Naviculales	Diadesmidaceae	Luticola	Luticola terminata
Naviculales	Diadesmidaceae	Luticola	Luticola ventricosa
Naviculales	Diploneidaceae	Diploneis	Diploneis
Naviculales	Diploneidaceae	Diploneis	Diploneis boldtiana
Naviculales	Diploneidaceae	Diploneis	Diploneis elliptica
Naviculales	Diploneidaceae	Diploneis	Diploneis finnica
Naviculales	Diploneidaceae	Diploneis	Diploneis marginestriata
Naviculales	Diploneidaceae	Diploneis	Diploneis oblongella
Naviculales	Diploneidaceae	Diploneis	Diploneis oculata
Naviculales	Diploneidaceae	Diploneis	Diploneis ovalis
Naviculales	Diploneidaceae	Diploneis	Diploneis parma
Naviculales	Diploneidaceae	Diploneis	Diploneis petersenii
Naviculales	Diploneidaceae	Diploneis	Diploneis pseudovalis
Naviculales	Diploneidaceae	Diploneis	Diploneis puella
Naviculales	Diploneidaceae	Diploneis	Diploneis smithii
Naviculales	Diploneidaceae	Diploneis	Diploneis smithii var. pumila
Naviculales	Diploneidaceae	Diploneis	Diploneis subovalis
Naviculales	Naviculaceae	Adlafia	Adlafia
Naviculales	Naviculaceae	Adlafia	Adlafia bryophila
Naviculales	Naviculaceae	Adlafia	Adlafia minuscula
Naviculales	Naviculaceae	Adlafia	Adlafia minuscula var. muralis
Naviculales	Naviculaceae	Adlafia	Adlafia multnomahii
Naviculales	Naviculaceae	Adlafia	Adlafia suchlandtii
Naviculales	Naviculaceae	Capartogramma	Capartogramma crucicula
Naviculales	Naviculaceae	Chamaepinnularia	Chamaepinnularia
Naviculales	Naviculaceae	Chamaepinnularia	Chamaepinnularia bremensis
Naviculales	Naviculaceae	Chamaepinnularia	Chamaepinnularia evanida
Naviculales	Naviculaceae	Chamaepinnularia	Chamaepinnularia hassiaca
Naviculales	Naviculaceae	Chamaepinnularia	Chamaepinnularia mediocris
Naviculales	Naviculaceae	Chamaepinnularia	Chamaepinnularia soehrensis
Naviculales	Naviculaceae	Chamaepinnularia	Chamaepinnularia submuscicola
Naviculales	Naviculaceae	Decussata	Decussata placenta
Naviculales	Naviculaceae	Eolimna	Eolimna minima
Naviculales	Naviculaceae	Eolimna	Eolimna subadnata

Order	Family	Genus	Final Id
Naviculales	Naviculaceae	Eolimna	Eolimna tantula
Naviculales	Naviculaceae	Fistulifera	Fistulifera
Naviculales	Naviculaceae	Fistulifera	Fistulifera pelliculosa
Naviculales	Naviculaceae	Geissleria	Geissleria acceptata
Naviculales	Naviculaceae	Geissleria	Geissleria decussis
Naviculales	Naviculaceae	Geissleria	Geissleria ignota
Naviculales	Naviculaceae	Geissleria	Geissleria kriegeri
Naviculales	Naviculaceae	Geissleria	Geissleria lateropunctata
Naviculales	Naviculaceae	Geissleria	Geissleria paludosa
Naviculales	Naviculaceae	Geissleria	Geissleria punctifera
Naviculales	Naviculaceae	Geissleria	Geissleria schoenfeldii
Naviculales	Naviculaceae	Hippodonta	Hippodonta capitata
Naviculales	Naviculaceae	Hippodonta	Hippodonta hungarica
Naviculales	Naviculaceae	Hippodonta	Hippodonta lueneburgensis
Naviculales	Naviculaceae	Mayamaea	Mayamaea
Naviculales	Naviculaceae	Mayamaea	Mayamaea agrestis
Naviculales	Naviculaceae	Mayamaea	Mayamaea atomus
Naviculales	Naviculaceae	Mayamaea	Mayamaea cahabaensis
Naviculales	Naviculaceae	Mayamaea	Mayamaea permitis
Naviculales	Naviculaceae	Microcostatus	Microcostatus krasskei
Naviculales	Naviculaceae	Microcostatus	Microcostatus maceria
Naviculales	Naviculaceae	Microcostatus	Microscostatus naumannii
Naviculales	Naviculaceae	Navicula	Navicula
Naviculales	Naviculaceae	Navicula	Navicula aboensis
Naviculales	Naviculaceae	Navicula	Navicula absoluta
Naviculales	Naviculaceae	Navicula	Navicula agnita
Naviculales	Naviculaceae	Navicula	Navicula angusta
Naviculales	Naviculaceae	Navicula	Navicula antonii
Naviculales	Naviculaceae	Navicula	Navicula aquaedurae
Naviculales	Naviculaceae	Navicula	Navicula arvensis
Naviculales	Naviculaceae	Navicula	Navicula canalis
Naviculales	Naviculaceae	Navicula	Navicula capitatoradiata
Naviculales	Naviculaceae	Navicula	Navicula capitellata
Naviculales	Naviculaceae	Navicula	Navicula cari
Naviculales	Naviculaceae	Navicula	Navicula caterva
Naviculales	Naviculaceae	Navicula	Navicula cincta
Naviculales	Naviculaceae	Navicula	Navicula concentrica
Naviculales	Naviculaceae	Navicula	Navicula contenta var. biceps
Naviculales	Naviculaceae	Navicula	Navicula cryptocephala

Order	Family	Genus	Final Id
Naviculales	Naviculaceae	Navicula	Navicula cryptofallax
Naviculales	Naviculaceae	Navicula	Navicula cryptotenella
Naviculales	Naviculaceae	Navicula	Navicula cryptotenelloides
Naviculales	Naviculaceae	Navicula	Navicula dealpina
Naviculales	Naviculaceae	Navicula	Navicula detenta
Naviculales	Naviculaceae	Navicula	Navicula dibola
Naviculales	Naviculaceae	Navicula	Navicula difficillima
Naviculales	Naviculaceae	Navicula	Navicula digitoradiata var. minima
Naviculales	Naviculaceae	Navicula	Navicula eileeniae
Naviculales	Naviculaceae	Navicula	Navicula elginensis var. rostrata
Naviculales	Naviculaceae	Navicula	Navicula erifuga
Naviculales	Naviculaceae	Navicula	Navicula escambia
Naviculales	Naviculaceae	Navicula	Navicula exigua var. capitata
Naviculales	Naviculaceae	Navicula	Navicula exigua var. signata
Naviculales	Naviculaceae	Navicula	Navicula exilis
Naviculales	Naviculaceae	Navicula	Navicula expecta
Naviculales	Naviculaceae	Navicula	Navicula festiva
Naviculales	Naviculaceae	Navicula	Navicula germainii
Naviculales	Naviculaceae	Navicula	Navicula geronimensis
Naviculales	Naviculaceae	Navicula	Navicula gibbosa
Naviculales	Naviculaceae	Navicula	Navicula globulifera
Naviculales	Naviculaceae	Navicula	Navicula gottlandica
Naviculales	Naviculaceae	Navicula	Navicula gregaria
Naviculales	Naviculaceae	Navicula	Navicula gysingensis
Naviculales	Naviculaceae	Navicula	Navicula harderi
Naviculales	Naviculaceae	Navicula	Navicula hasta
Naviculales	Naviculaceae	Navicula	Navicula incertata
Naviculales	Naviculaceae	Navicula	Navicula ingenua
Naviculales	Naviculaceae	Navicula	Navicula kotschyi
Naviculales	Naviculaceae	Navicula	Navicula lanceolata
Naviculales	Naviculaceae	Navicula	Navicula laterostrata
Naviculales	Naviculaceae	Navicula	Navicula libonensis
Naviculales	Naviculaceae	Navicula	Navicula longicephala
Naviculales	Naviculaceae	Navicula	Navicula mediocostata
Naviculales	Naviculaceae	Navicula	Navicula menisculus
Naviculales	Naviculaceae	Navicula	Navicula menisculus var. obtusa
Naviculales	Naviculaceae	Navicula	Navicula meniscus
Naviculales	Naviculaceae	Navicula	Navicula microcari

Order	Family	Genus	Final Id
Naviculales	Naviculaceae	Navicula	Navicula microcephala
Naviculales	Naviculaceae	Navicula	Navicula minima var. atomoides
Naviculales	Naviculaceae	Navicula	Navicula notha
Naviculales	Naviculaceae	Navicula	Navicula occulta
Naviculales	Naviculaceae	Navicula	Navicula paucivisitata
Naviculales	Naviculaceae	Navicula	Navicula perminuta
Naviculales	Naviculaceae	Navicula	Navicula phyllepta
Naviculales	Naviculaceae	Navicula	Navicula pseudolanceolata
Naviculales	Naviculaceae	Navicula	Navicula pseudoventralis
Naviculales	Naviculaceae	Navicula	Navicula radiosa
Naviculales	Naviculaceae	Navicula	Navicula radiosafallax
Naviculales	Naviculaceae	Navicula	Navicula recens
Naviculales	Naviculaceae	Navicula	Navicula reichardtiana
Naviculales	Naviculaceae	Navicula	Navicula rhynchocephala
Naviculales	Naviculaceae	Navicula	Navicula rostellata
Naviculales	Naviculaceae	Navicula	Navicula salinarum
Naviculales	Naviculaceae	Navicula	Navicula salinicola
Naviculales	Naviculaceae	Navicula	Navicula sanctaecrucis
Naviculales	Naviculaceae	Navicula	Navicula schmassmannii
Naviculales	Naviculaceae	Navicula	Navicula schroeteri
Naviculales	Naviculaceae	Navicula	Navicula stankovici
Naviculales	Naviculaceae	Navicula	Navicula subrotundata
Naviculales	Naviculaceae	Navicula	Navicula symmetrica
Naviculales	Naviculaceae	Navicula	Navicula tenelloides
Naviculales	Naviculaceae	Navicula	Navicula thienemanni
Naviculales	Naviculaceae	Navicula	Navicula tridentula
Naviculales	Naviculaceae	Navicula	Navicula trilatera
Naviculales	Naviculaceae	Navicula	Navicula tripunctata
Naviculales	Naviculaceae	Navicula	Navicula trivialis
Naviculales	Naviculaceae	Navicula	Navicula utermoehlii
Naviculales	Naviculaceae	Navicula	Navicula veneta
Naviculales	Naviculaceae	Navicula	Navicula vilaplanii
Naviculales	Naviculaceae	Navicula	Navicula viridula
Naviculales	Naviculaceae	Navicula	Navicula viridulacalcis
Naviculales	Naviculaceae	Navicula	Navicula wildii
Naviculales	Naviculaceae	Nupela	Nupela
Naviculales	Naviculaceae	Nupela	Nupela carolina
Naviculales	Naviculaceae	Nupela	Nupela clementis
Naviculales	Naviculaceae	Nupela	Nupela elegantula

Order	Family	Genus	Final Id
Naviculales	Naviculaceae	Nupela	Nupela fennica
Naviculales	Naviculaceae	Nupela	Nupela frezelii
Naviculales	Naviculaceae	Nupela	Nupela gracillima
Naviculales	Naviculaceae	Nupela	Nupela impexiformis
Naviculales	Naviculaceae	Nupela	Nupela lapidosa
Naviculales	Naviculaceae	Nupela	Nupela neglecta
Naviculales	Naviculaceae	Nupela	Nupela silvahercynia
Naviculales	Naviculaceae	Nupela	Nupela subrostrata
Naviculales	Naviculaceae	Nupela	Nupela vitiosa
Naviculales	Naviculaceae	Nupela	Nupela wellneri
Naviculales	Naviculales	Kobayasiella	Kobayasiella parasubtilissima
Naviculales	Naviculales	Kobayasiella	Kobayasiella subtilissima
Naviculales	Neidiaceae	Neidium	Neidium
Naviculales	Neidiaceae	Neidium	Neidium affine
Naviculales	Neidiaceae	Neidium	Neidium affine var. amphirhynchus
Naviculales	Neidiaceae	Neidium	Neidium affine var. longiceps
Naviculales	Neidiaceae	Neidium	Neidium affine var. undulatum
Naviculales	Neidiaceae	Neidium	Neidium alpinum
Naviculales	Neidiaceae	Neidium	Neidium ampliatum
Naviculales	Neidiaceae	Neidium	Neidium apiculatum
Naviculales	Neidiaceae	Neidium	Neidium binodeforme
Naviculales	Neidiaceae	Neidium	Neidium binodis
Naviculales	Neidiaceae	Neidium	Neidium bisulcatum
Naviculales	Neidiaceae	Neidium	Neidium bisulcatum var. baicalense
Naviculales	Neidiaceae	Neidium	Neidium bisulcatum var. subampliatum
Naviculales	Neidiaceae	Neidium	Neidium carterii
Naviculales	Neidiaceae	Neidium	Neidium densestriatum
Naviculales	Neidiaceae	Neidium	Neidium dubium
Naviculales	Neidiaceae	Neidium	Neidium iridis
Naviculales	Pinnulariaceae	Caloneis	Caloneis
Naviculales	Pinnulariaceae	Caloneis	Caloneis aerophila
Naviculales	Pinnulariaceae	Caloneis	Caloneis bacillum
Naviculales	Pinnulariaceae	Caloneis	Caloneis clevei
Naviculales	Pinnulariaceae	Caloneis	Caloneis hyalina
Naviculales	Pinnulariaceae	Caloneis	Caloneis lewisii
Naviculales	Pinnulariaceae	Caloneis	Caloneis schumanniana

Order	Family	Genus	Final Id
Naviculales	Pinnulariaceae	Caloneis	Caloneis schumanniana var. biconstricta
Naviculales	Pinnulariaceae	Caloneis	Caloneis silicula
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia abaujensis var. subundulata
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia acrosphaeria
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia appendiculata
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia biceps
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia borealis
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia borealis var. rectangularis
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia braunii
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia braunii var. amphicephala
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia brebissonii
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia divergens
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia erratica
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia gibba
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia grunowii
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia ignobilis
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia interrupta
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia legumen
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia lundii
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia macilenta
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia maior
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia mesogongyla
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia microstauron
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia nodosa
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia obscura
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia parvulissima
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia perirrorata
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia rupestris
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia ruttneri
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia saprophila
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia schoenfelderi
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia stomatophora
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia streptoraphe
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia subcapitata

Order	Family	Genus	Final Id
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia subcapitata var. paucistriata
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia subgibba
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia substomatophora
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia termitina
Naviculales	Pinnulariaceae	Pinnularia	Pinnularia viridis
Naviculales	Plagiotropidaceae	Plagiotropis	Plagiotropis lepidoptera var. proboscidea
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma acuminatum
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma attenuatum
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma obscurum
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma obtusatum
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma reimeri
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma scalproides
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma sciotoense
Naviculales	Pleurosigmataceae	Gyrosigma	Gyrosigma spencerii var. curvula
Naviculales	Pleurosigmataceae	Pleurosigma	Pleurosigma delicatulum
Naviculales	Sellaphoraceae	Fallacia	Fallacia
Naviculales	Sellaphoraceae	Fallacia	Fallacia auriculata
Naviculales	Sellaphoraceae	Fallacia	Fallacia enigmatica
Naviculales	Sellaphoraceae	Fallacia	Fallacia helensis
Naviculales	Sellaphoraceae	Fallacia	Fallacia indifferens
Naviculales	Sellaphoraceae	Fallacia	Fallacia insociabilis
Naviculales	Sellaphoraceae	Fallacia	Fallacia lenzii
Naviculales	Sellaphoraceae	Fallacia	Fallacia omissa
Naviculales	Sellaphoraceae	Fallacia	Fallacia pygmaea
Naviculales	Sellaphoraceae	Fallacia	Fallacia subhamulata
Naviculales	Sellaphoraceae	Fallacia	Fallacia vitrea
Naviculales	Sellaphoraceae	Pseudofallacia	Pseudofallacia monoculata
Naviculales	Sellaphoraceae	Pseudofallacia	Pseudofallacia tenera
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora atomoides
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora bacillum
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora crassulexigua
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora difficillima
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora disjuncta
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora elliptica
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora hustedtii
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora japonica

Order	Family	Genus	Final Id
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora joubaudii
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora laevissima
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora mutata
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora nigri
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora pseudopupula
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora pulchra
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora pupula
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora pupula var. capitata
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora rectangularis
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora rostrata
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora rugula
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora saugerresii
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora schadei
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora seminulum
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora stauroneioides
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora stroemii
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora vitabunda
Naviculales	Sellaphoraceae	Sellaphora	Sellaphora wallacei
Naviculales	Stauroneidaceae	Craticula	Craticula
Naviculales	Stauroneidaceae	Craticula	Craticula accomoda
Naviculales	Stauroneidaceae	Craticula	Craticula accomodiformis
Naviculales	Stauroneidaceae	Craticula	Craticula ambigua
Naviculales	Stauroneidaceae	Craticula	Craticula citrus
Naviculales	Stauroneidaceae	Craticula	Craticula cuspidata
Naviculales	Stauroneidaceae	Craticula	Craticula halophila
Naviculales	Stauroneidaceae	Craticula	Craticula halophilioides
Naviculales	Stauroneidaceae	Craticula	Craticula minusculoides
Naviculales	Stauroneidaceae	Craticula	Craticula molestiformis
Naviculales	Stauroneidaceae	Craticula	Craticula riparia
Naviculales	Stauroneidaceae	Craticula	Craticula subminuscula
Naviculales	Stauroneidaceae	Craticula	Craticula submolesta
Naviculales	Stauroneidaceae	Prestauroneis	Prestauroneis integra
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis agrestis
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis anceps
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis anceps fo. gracilis
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis gracilis
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis kriegeri
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis legumen

Order	Family	Genus	Final Id
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis limneticus
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis nobilis
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis obtusa
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis parathermicola
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis phoenicenteron
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis prominula
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis pseudosubobtusoides
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis reichardtii
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis smithii
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis smithii var. incisa
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis smithii var. sagitta
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis thermicola
Naviculales	Stauroneidaceae	Stauroneis	Stauroneis truncata
Orthoseirales	Orthoseiraceae	Orthoseira	Orthoseira
Orthoseirales	Orthoseiraceae	Orthoseira	Orthoseira roeseana
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia adnata
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia argus
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia argus var. protracta
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia goeppertiana
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia reichelti
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia smithii
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia sorex
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia turgida
Rhopalodiales	Rhopalodiaceae	Epithemia	Epithemia turgida var. granulata
Rhopalodiales	Rhopalodiaceae	Rhopalodia	Rhopalodia brebissonii
Rhopalodiales	Rhopalodiaceae	Rhopalodia	Rhopalodia gibba
Rhopalodiales	Rhopalodiaceae	Rhopalodia	Rhopalodia gibba var. ventricosa
Rhopalodiales	Rhopalodiaceae	Rhopalodia	Rhopalodia gibberula
Rhopalodiales	Rhopalodiaceae	Rhopalodia	Rhopalodia gibberula var. vanheurckii
Rhopalodiales	Rhopalodiaceae	Rhopalodia	Rhopalodia musculus
Surirellales	Entomoneidaceae	Entomoneis	Entomoneis alata
Surirellales	Entomoneidaceae	Entomoneis	Entomoneis ornata
Surirellales	Surirellaceae	Campylodiscus	Campylodiscus hibernicus
Surirellales	Surirellaceae	Cymatopleura	Cymatopleura elliptica
Surirellales	Surirellaceae	Cymatopleura	Cymatopleura solea
Surirellales	Surirellaceae	Cymatopleura	Cymatopleura solea var. apiculata

Order	Family	Genus	Final Id
Surirellales	Surirellaceae	Stenopterobia	Stenopterobia curvula
Surirellales	Surirellaceae	Stenopterobia	Stenopterobia delicatissima
Surirellales	Surirellaceae	Surirella	Surirella
Surirellales	Surirellaceae	Surirella	Surirella amphioxys
Surirellales	Surirellaceae	Surirella	Surirella angusta
Surirellales	Surirellaceae	Surirella	Surirella atomus
Surirellales	Surirellaceae	Surirella	Surirella brebissonii
Surirellales	Surirellaceae	Surirella	Surirella elegans
Surirellales	Surirellaceae	Surirella	Surirella gracilis
Surirellales	Surirellaceae	Surirella	Surirella helvetica
Surirellales	Surirellaceae	Surirella	Surirella lacrimula
Surirellales	Surirellaceae	Surirella	Surirella linearis
Surirellales	Surirellaceae	Surirella	Surirella linearis var. constricta
Surirellales	Surirellaceae	Surirella	Surirella minuta
Surirellales	Surirellaceae	Surirella	Surirella ovalis
Surirellales	Surirellaceae	Surirella	Surirella ovata var. salina
Surirellales	Surirellaceae	Surirella	Surirella patella
Surirellales	Surirellaceae	Surirella	Surirella peisonis
Surirellales	Surirellaceae	Surirella	Surirella roba
Surirellales	Surirellaceae	Surirella	Surirella robusta
Surirellales	Surirellaceae	Surirella	Surirella splendida
Surirellales	Surirellaceae	Surirella	Surirella stalagma
Surirellales	Surirellaceae	Surirella	Surirella suecica
Surirellales	Surirellaceae	Surirella	Surirella tenera
Surirellales	Surirellaceae	Surirella	Surirella tenera var. nervosa
Surirellales	Surirellaceae	Surirella	Surirella tenuis
Tabellariales	Tabellariaceae	Tabularia	Tabularia fasciculata
Tabellariales	Tabellariaceae	Tabellaria	Tabellaria fenestrata
Tabellariales	Tabellariaceae	Tabellaria	Tabellaria flocculosa
Tabellariales	Tabellariaceae	Tabellaria	Tabellaria quadriseptata
Tabellariales	Tabellariaceae	Tetracyclus	Tetracyclus glans
Tabellariales	Tabellariaceae	Tetracyclus	Tetracyclus rupestris
Thalassiophysales	Catenulaceae	Amphora	Amphora
Thalassiophysales	Catenulaceae	Amphora	Amphora bicapitata
Thalassiophysales	Catenulaceae	Amphora	Amphora copulata
Thalassiophysales	Catenulaceae	Amphora	Amphora indistincta
Thalassiophysales	Catenulaceae	Amphora	Amphora ovalis
Thalassiophysales	Catenulaceae	Amphora	Amphora pediculus
Thalassiophysales	Catenulaceae	Amphora	Amphora tumida

Order	Family	Genus	Final Id
Thalassiophysales	Catenulaceae	Halamphora	Halamphora montana
Thalassiophysales	Catenulaceae	Halamphora	Halamphora veneta
Thalassiosirales	Skeletonemaceae	Skeletonema	Skeletonema potamos
Thalassiosirales	Stephanodiscaceae	Cyclostephanos	Cyclostephanos dubius
Thalassiosirales	Stephanodiscaceae	Cyclostephanos	Cyclostephanos invisitatus
Thalassiosirales	Stephanodiscaceae	Cyclostephanos	Cyclostephanos tholiformis
Thalassiosirales	Stephanodiscaceae	Cyclotella	Cyclotella
Thalassiosirales	Stephanodiscaceae	Cyclotella	Cyclotella atomus
Thalassiosirales	Stephanodiscaceae	Cyclotella	Cyclotella cryptica
Thalassiosirales	Stephanodiscaceae	Cyclotella	Cyclotella meneghiniana
Thalassiosirales	Stephanodiscaceae	Cyclotella	Cyclotella striata
Thalassiosirales	Stephanodiscaceae	Lindavia	Lindavia ocellata
Thalassiosirales	Stephanodiscaceae	Stephanodiscus	Stephanodiscus
Thalassiosirales	Stephanodiscaceae	Stephanodiscus	Stephanodiscus alpinus
Thalassiosirales	Stephanodiscaceae	Stephanodiscus	Stephanodiscus hantzschii
Thalassiosirales	Stephanodiscaceae	Stephanodiscus	Stephanodiscus hantzschii f. tenuis
Thalassiosirales	Stephanodiscaceae	Stephanodiscus	Stephanodiscus medius
Thalassiosirales	Stephanodiscaceae	Stephanodiscus	Stephanodiscus minutulus
Thalassiosirales	Stephanodiscaceae	Stephanodiscus	Stephanodiscus niagarae
Thalassiosirales	Thalassiosiraceae	Discostella	Discostella asterocostata
Thalassiosirales	Thalassiosiraceae	Discostella	Discostella pseudostelligera
Thalassiosirales	Thalassiosiraceae	Discostella	Discostella stelligera
Thalassiosirales	Thalassiosiraceae	Thalassiosira	Thalassiosira
Thalassiosirales	Thalassiosiraceae	Thalassiosira	Thalassiosira lacustris
Thalassiosirales	Thalassiosiraceae	Thalassiosira	Thalassiosira pseudonana
Thalassiosirales	Thalassiosiraceae	Thalassiosira	Thalassiosira visurgis
Thalassiosirales	Thallassiosiraceae	Conticribra	Conticribra weissflogii
Triceratiales	Triceratiaceae	Pleurosira	Pleurosira laevis
Zygnematales	Desmidiaceae	Staurastrum	Staurastrum
Zygnematales	Desmidiaceae	Staurastrum	Staurastrum punctulatum

APPENDIX D

TAXONOMIC INFORMATION

REFERENCE LITERATURE
CRITERIA FOR TAXONOMIC EXPERTS
TAXONOMIC SPECIALISTS FOR REFERENCE VERIFICATION

Taxonomic References

(All final IDs must conform to TDEC Hydra database master taxa diatom table final ID or those found in USGS biodata
https://apex.tdec.tn.gov:7777/apex/f?p=333:101:13200111653422:::::

Bowling Green State University (Dr. Rex Lowe): Center for Algal Microscopy: https://www.bgsu.edu/arts-and-sciences/biological-sciences/facilities-and-resources/algal-microscopy-laboratory.html

Diatoms of North America. 2019. https://diatoms.org//

Houk, V., Klee, R. and Tanaka, H. (2010) Atlas of freshwater centric diatoms with a brief key and descriptions, Part III. Stephanodiscaceae A. Cyclotella, Tertiarius, Discostella Fottea 10 (Supplement): 1-498.

Krammer, K. & Lange-Bertalot, H. 1988. Bacillariophyceae. 2. Teil: Bacillariaceae, Epithemiaceae, Surirellaceae. In Ettl, H., Gerloff, H., Heynig, H. & Mollenhauer, D. (Eds.). Süsswasserflora von Mitteleuropa. 2(2): 1-596. Gustav Fisher Verlag, Stuttgart, Germany.

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New Zealand National Institute of Water and Atmospheric Research http://www.niwa.cri.nz/__data/assets/pdf_file/0011/38675/peri_complete.pdf

Smith, G.M., 1950. The freshwater algae of the United States. Second edition. McGraw-Hill Book Company. New York, New York.

University of Michigan (Dr. Eugene Stoermer) Great Lakes Diatoms:
http://www.umich.edu/~phytolab/GreatLakesDiatomHomePage/top.html

Criteria for Taxonomic Experts

(Adapted from the Taxonomic Certification Program established in 2004 by the North American Benthological Society.)

In order to be considered an expert an individual must meet **at least four** of the following criteria:

1. **Authorship.** Author/coauthor of two or more peer-reviewed publications in the group for which the applicant seeks recognition as a taxonomic/systematic expert. Or, has prepared and presented two or more papers at professional meetings focusing on the taxonomy/systematics of the group for which the applicant seeks recognition as a taxonomic expert.

2. **Academic Qualification**. Has been presented and earned a graduate degree (MS/PhD) related to the field of diatom taxonomy, with MS or PhD thesis focused on the taxonomy/systematics of group for which the applicant seeks recognition as a taxonomic expert. Post-doctoral employment/experience focusing on taxonomy/systematics of group for which the applicant seeks recognition as a taxonomic expert will fulfill this criterion.

3. **Employment**. Currently serves (or has previously served) in a professional capacity (e.g., at place of employment - institution, business, agency, department, company) as curator or manager of a diatom reference collection.

4. **Experience**. Has a history of / currently is performing taxonomic identification / verification services for individuals, businesses, agencies, companies, and/or organizations outside of primary place of employment in the group for which the applicant seeks recognition as a taxonomic/systematic expert.

5. **Teaching**. Has organized, prepared, and successfully presented one or more taxonomic training workshops focusing on the group for which expertise is sought; the workshop or course must have been inclusive of the group for which the applicant seeks recognition as a taxonomic/systematic expert. Or, has served as an individual or as a collaborative instructor in the teaching of one or more college or university courses focusing on the taxonomy of diatoms.

6. **Influence and Recognition.** Has served / currently is serving as a peer-reviewer for one or more manuscripts received from a journal editor prior to its publication in the primary literature, with focus of the manuscript(s) on the

group for which taxonomic expertise is sought. Service as a guest or assistant editor for a journal publishing peer-reviewed articles focusing on taxonomic / systematic issues shall satisfy this criterion.

7. **Research**. Has submitted (as PI, co-PI, or collaborating researcher) one or more proposals to (currently pending at time of request for recognition as expert) or has received research funds (grant/contract/gift) from provincial, federal, state, regional, and/or private sources that support taxonomic/systematic studies in the group for which the applicant seeks recognition as a taxonomic/systematic expert.

Taxonomic Specialists for Reference Verification

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APPENDIX E

SUPPLEMENTARY INFORMATION

PROJECT NAMES AND IDS
ORGANIZATIONS
COUNTY ABBREVIATIONS AND CODE NUMBERS
EXOTIC PLANTS IN TENNESSEE

Project Names and IDs
(Projects added after 01-13-2023 on projects reference table Hydra)

Project ID	Short Name	Project Name	Project Purpose
TNPR0080	303(d)	303(d)	The 303(d)/Impaired Waters List is a compilation of the streams and lakes in Tennessee that are water quality limited or are expected to exceed water quality standards in the next two years and need additional pollution controls. Water quality limited streams are those that have one or more properties that violate water quality standards. They are considered impaired by pollution and not fully meeting designated uses.
TNPR0029	71iPM	71iPM	In FY-08 90 probabilistic monitoring stations were established on wadeable streams across the 71i ecoregion.
TNPR0098	AG-303(d)	Agriculture on 303(d) list	319 grant for impaired sites where source is agriculture.
TNPR0084	AIR DEPOSITION	AIR DEPOSITION	Test air deposition model in predicting mercury and selenium bioaccumulation in fish.
TNPR0005	ARAP	ARAP	Streams are evaluated as needed generally in response to requests for new or expanded ARAP permits.
TNPR0082	ATV Park	ATV Park	Investigation of off road vehicle facility.
TNPR0002	Agriculture	Agriculture	Data collected in collaboration with the Department of Agriculture.
TNPR0003	Ambient	Ambient	For water quality trend analyses established sites are monitored. These sites include some of the original 23 ambient stations along with about 70 additional ambient sites. Chemical samples are collected, and field parameters are measured at least quarterly at each of these stations every year.

Project ID	Short Name	Project Name	Project Purpose
TNPR0004	Antidegrada-tion	Antidegrada-tion	Streams are evaluated for antidegradation status based on a standardized evaluation process which includes information on specialized recreation uses scenic values ecological consideration biological integrity and water quality.
TNPR0071	Auburn University	Auburn University	Samples collected for lake study conducted by Auburn University.
TNPR0089	Border State not TDEC	Border State not TDEC	Samples collected by a state bordering TN in a shared watershed.
TNPR0065	Clean Lakes Statewide Assessment	Clean Lakes Statewide Assessment	The Clean Lakes Statewide Assessment is part of the National Lakes Assessment (NLA).
TNPR0006	Coalfields	Coalfields	Special project to sample metals in fish tissue and water column in streams draining TN coalfields
TNPR0019	Complaint	Complaint	Sampling performed in response to citizen complaints.
TNPR0063	Compliance	Compliance	Sampling related to departmental compliance activities.
TNPR0043	Conductivity	Conductivity	Conductivity Study
TNPR0020	Construction	Construction	Sampling performed due to construction activities.
TNPR0044	Copperhill	Copperhill	The Tennessee Department of Health (TDH) Environmental Epidemiology Program (EEP) was asked on September 3, 2008 by the Tennessee Department of Environment and Conservation (TDEC) Division of Remediation (DoR) to provide guidance on the possibility of adverse health effects from iron in soil and sediment in the Davis Mill Surface Water - Sub OU 1-D Gypsum Pond Area (the Gypsum Pond Area).

Project ID	Short Name	Project Name	Project Purpose
TNPR0045	Corridor K	Corridor K	Corridor K is a route on the Appalachian Development Highway System which starts at I-75 near Cleveland Tennessee and ends near Dillsboro North Carolina. The portion of Corridor K lying within the project area follows US 64 and is part of the Ocoee Scenic Byway which was designated as the nation's first National Forest Scenic Byway. Sampling is being conducted as part of the Environmental Impact Statement.
TNPR0092	DEIDS	Determining Ecological Integrity and Developing Success Criteria for Streams	Geomorphological Reference Sites established by Natural Resource Section.
TNPR0007	DOR	DOR (previously DOE-O)	Data collected in collaboration with the Division of Remediation (previously Department of Energy Oversight).
TNPR0047	Dissolved Oxygen	Dissolved Oxygen	Sampling is conducted to investigate natural diurnal fluctuations in dissolved oxygen.
TNPR0046	Diurnal	Diurnal	The primary purpose of this study was to investigate natural diurnal fluctuations of dissolved oxygen levels in 15 major ecological subregions in Tennessee. Historic daylight readings were used to supplement this information and to evaluate dissolved oxygen patterns in the other 9 subregions. This study was funded in part by a FY 2002 104(b)(3) grant (CP-97449702-0).

Project ID	Short Name	Project Name	Project Purpose
TNPR0086	Drinking Water Lake Study	Drinking Water Lake Study	Drinking Water Lake Study
TNPR0008	EPA	EPA	Data collected in collaboration with the Federal Environmental Protection Agency.
TNPR0037	Ecoregion	Ecoregion	The data obtained from the ecoregion (ECO) delineation and reference site monitoring project will be used as a tool to implement the requirements of the Tennessee Water Quality Control Act.
TNPR0048	Elk River	Elk River	This project was designed to provide the information necessary to quantify nutrient-load reductions for development and implementation of nutrient TMDLs and for long-term management of nutrient loading in the Elk River watershed including potential watershed-based nutrient trading strategies.
TNPR0021	Enforcement	Enforcement	Sampling performed in response to enforcement activities.
TNPR0038	FECO	FECO	The data obtained from the first-order ecoregion (FECO) delineation and reference site monitoring project will be used as a tool to implement the requirements of the Tennessee Water Quality Control Act.
TNPR0088	Fish Kill	Fish Kill	Sampling conducted to identify the pollutants associated with a fish kill.
TNPR0061	Flood	Flood	Sampling associated with effects of major flood events.
TNPR0059	HRWA	HRWA	Data collected by the Harpeth River Watershed Association.
TNPR0090	Healthy Watersheds	Healthy Watersheds	Samples collected as part of Healthy Watersheds Initiative.

Project ID	Short Name	Project Name	Project Purpose
TNPR0030	ISP	Impounded Stream Project	In 2003 the Tennessee Department of Environment and Conservation Division of Water Pollution Control was awarded a 104(b)(3) grant to perform a probabilistic monitoring study of 75 streams below small impoundments. The study measured effects of the impoundments on aquatic life nutrients dissolved oxygen pH iron manganese habitat flow and periphyton in the downstream reaches.
TNPR0022	Inspection	Inspection	Sampling related to departmental inspection activities.
TNPR0024	Kingston	Kingston	Sampling performed in response to the December 22, 2008 dike failure at the TVA Kingston Fossil Plant in Roane County Tennessee.
TNPR0083	Landfill	Landfill	Landfill water quality investigation.
TNPR0027	MS4	MS4	Sampling performed by municipal separate storm sewer systems (MS4s) permitees to meet permit requirements.
TNPR0057	Mercury	Mercury	Mercury study of possible contamination caused by bridge degradation in Wayne and surrounding counties.
TNPR0064	Mercury Sediment Study	Mercury Sediment Study	Although it is not commonly done samples of the sediment at the bottom of a creek or lake can be collected to determine the presence of harmful amounts of metals or carcinogens.
TNPR0097	Mining Ambient	Mining Ambient	Annual quarterly chemical sampling collected by surface mining unit.
TNPR0096	Mitigation	Mitigation	Pre or post mitigation survey

Project ID	Short Name	Project Name	Project Purpose
TNPR0041	NLS	National Lakes Study	EPA National Lakes Assessment is designed to provide statistically valid regional and national estimates of the condition of lakes.
TNPR0053	NPDES Permit	NPDES Permit	Upstream and downstream sampling required by NPDES discharge permits.
TNPR0058	NRCS	NRCS	Sampling conducted by the Natural Resources Conservation Service
TNPR0009	NRDA	NRDA	Data collected in collaboration with the U.S. Department of the Interior's Natural Resource Damage Assessment and Restoration Program
TNPR0010	ORNL	ORNL	Data collected in collaboration with Oak Ridge National Laboratory
TNPR0094	PAA	Peracetic Acid	Study to determine the effects of PAA as substitute for Chlorine to instream macroinvertebrates.
TNPR0076	Periphyton Study	Periphyton Study	Periphyton sampling conducted in conjunction with other monitoring activities
TNPR0049	Post Flood	Post Flood	Sampling conducted following the May 2010 Nashville flood.
TNPR0077	Pre Excavation	Pre Excavation	Sampling performed before an excavation event for the purpose of establishing pre-excavation norms.
TNPR0035	QC	QC	Quality Assurance/Quality Control
TNPR0054	REFERENCE	REFERENCE	The data obtained from the ecoregion (ECO) delineation and reference site monitoring project will be used as a tool to implement the requirements of the Tennessee Water Quality Control Act.
TNPR0055	RESERVOIR	RESERVOIR	Reservoir sampling.
TNPR0068	Recreational Area	Recreational Area	Samples collected to measure the impacts of a recreational area
TNPR0095	Relocation	Relocation	Monitoring of relocated waterbodies.
TNPR0062	Restoration	Restoration	Samples collected to measure the effects of stream restoration projects.

Project ID	Short Name	Project Name	Project Purpose
TNPR0093	SE Comparability	Southeast Comparability Study	Test biological method comparability between U.S. EPA region IV states.
TNPR0039	SEMN	SEMN	A Southeast Region Monitoring Network (SEMN) was established by the southeastern states to develop a joint reference stream monitoring network.
TNPR0091	Special Studies Project	Special Studies Project	Samples collected for limited study.
TNPR0023	Spill	Spill	Potentially harmful spill investigation.
TNPR0060	Superfund - External	Superfund - External	Sampling conducted by consultant on Superfund sites.
TNPR0087	Superfund - TDEC	Superfund - TDEC	Sampling conducted by TDEC on Superfund sites.
TNPR0028	Surface Mining	Surface Mining	Sampling performed by TDEC Division of Water Resource's Mining Section and permitees in response to regulated mining activity.
TNPR0012	TDOT	TDOT	Data collected in collaboration with Tennessee Department of Transportation.
TNPR0001	TMDL	Total Maximum Daily Load	Waterbody monitoring is required to develop Total Maximum Daily Loads or TMDLs as a result of being placed on the 303(d) list.
TNPR0050	TN-KY	Tennessee-Kentucky Project	Joint project with Kentucky to sample shared watersheds.
TNPR0013	TVA	TVA	Data collected in collaboration with the Tennessee Valley Authority
TNPR0014	TWRA	TWRA	Data collected in collaboration with the Tennessee Wildlife Resources Agency.
TNPR0018	Tissue	Tissue	Fish tissue sampling.
TNPR0036	Training	Training	Samples collected as part of training exercises.

Project ID	Short Name	Project Name	Project Purpose
TNPR0056	UNIDENTIFIED	UNIDENTIFIED	UNIDENTIFIED
TNPR0078	URS Corporation	URS Corporation	Data collected by URS Corporation consulting firm.
TNPR0015	USACE	USACE	Data collected in collaboration with the United States Army Corps of Engineers.
TNPR0016	USGS	USGS	Data collected in collaboration with the United States Geological Survey.
TNPR0017	UTC	UTC	Data collected in collaboration with the University of Tennessee Chattanooga.
TNPR0085	WSA	WSA	The Wadeable Streams Assessment (WSA) establishes a national baseline that can be used to compare Tennessee's streams with other states' streams.
TNPR0031	WSA 2004	WSA 2004	The Wadeable Streams Assessment (WSA) establishes a national baseline that can be used to compare Tennessee's streams with other states' streams. This project number denotes the 2004-2005 sampling events.
TNPR0032	WSA 2008	WSA 2008	The Wadeable Streams Assessment (WSA) establishes a national baseline that can be used to compare Tennessee's streams with other states' streams. This project number denotes the 2008-2009 sampling events.
TNPR0033	WSA 2010	WSA 2010	The Wadeable Streams Assessment (WSA) establishes a national baseline that can be used to compare Tennessee's streams with other states' streams. This project number denotes the 2010-2011 sampling events.

Project ID	Short Name	Project Name	Project Purpose
TNPR0081	WSA-SE	WSA-SE	The Wadeable Streams Assessment (WSA) establishes a national baseline that can be used to compare Tennessee's streams with other states' streams. This project number denotes the 2007-2008 sampling events.
TNPR0051	Watershed	Watershed	Sampling to confirm continued support of designated uses and to increase the number of assessed waterbodies.
TNPR0066	Willamette Clearcutting Project	Willamette Clearcutting Project	Study to measure the effects of clearcutting.

Organization Codes

(Organizations added after 01-13-2023 available in organizations reference table Hydra)

Organization	Organization Full Name
A & L AL	A & L AL
ADVENT	Advent Consulting Group, LLC
AEDC	Arnold Engineering Development Center - U.S. Air Force
AIR	AIRL, INC
ANSDU	Academy of Natural Sciences of Drexel University
ARC	Aquatic Resource Center
ARCADIS	ARCADIS Consulting
ARI	ARI Environmental Inc.
ARM	Aquatic Resource Management
AST	AST Environmental
AUB	Auburn University
AquAeTer	AquAeTer, Inc
Barge	Barge Design Solutions
BCH	Beaver Creek Hydrology
BDY	BDY Environmental LLC
BHA	Brophy-Heinke & Associates, Inc
BNA	Nashville Airport
BOWATER	Bowater Paper Mill
BSC	Biological Systems Consultants
C&EC	Civil and Engineering Consultants Inc
CAS	Columbia Analytical Services
CEC	Copperhead Environmental Consulting Inc.
CGS	CG Services Corporation
CH2M	CH2M Hill Companies Ltd
CHSW	City of Chattanooga Storm Water
CHWWTP	City of Chattanooga Waste Water Treatment Plant
CLEVESW	Cleveland Stormwater
CRWA	Clinch River Watershed Association
Chattanooga EFO	TDEC Chattanooga Environmental Field Office
Columbia EFO	TDEC Columbia Environmental Field Office
Cookeville EFO	TDEC Cookeville Environmental Field Office

Organization	Organization Full Name
DAT	Data Analysis Technologies Inc
DBC	Dinkins Biological Consulting, LLC
DEPA	Development and Environmental Planning Association
DOE-O	TDEC Department of Energy Oversight
DOR	TDEC Division of Remediation
DOR-OR	Division of Remediation (Previously DOE-O)
DRAA	D.R. Allen and Associates
DWR	TDEC Division of Water Resources
EASTMAN	Eastman Chemical Company
ECOA	EcoAnalysts Inc.
ENSAFE	ENSAFE consulting
ENVIRON	Environ Environmental Corporation
ENVSCI	Enviroscience
EPA	United States Environmental Protection Agency
ESC	Environmental Science Corporation
ETC	Environmental Testing Laboratories
ETSU	East Tennessee State University
FLLA	Fort Loudoun Lake Association
G&M	Griggs & Maloney Incorporated
GEOS	GEOServices LLC
GEPD	Georgia Environmental Protection Division
GSH	Glenn Springs Holding, Inc.
HCWQ	Hamilton County Water Quality
HHNT	Hodges, Harbin, Newberry and Tribble, Inc.
HRA	HRA Environmental Services
HUC	Hiwassee Utilities Commission
JCWWTP	Johnson City Waste Water Treatment Plant
Jackson EFO	TDEC Jackson Environmental Field Office
Johnson City EFO	TDEC Johnson City Environmental Field Office
KCI	KCI Technologies
KDOW	Kentucky Division of Water
KMM	Kalina Manoylov Phycologist, Georgia College and State University
Knoxville EFO	TDEC Knoxville Environmental Field Office
MBEL	Moccasin Bend Environmental Lab

Organization	Organization Full Name
MDEQ	Mississippi Department of Environmental Quality
MEAD	Mead Paper
MRNA	Mitigation Resources of North America
Memphis EFO	TDEC Memphis Environmental Field Office
Metro Nash	Metro Nashville
Microbac	Microbac Laboratory
Mid M	Middlesboro Mining
Mining Section	TDEC Mining Section
MRW	MRW Environmental LLC
NAL	National Analytical Laboratories (aka NWA & NWALAB)
NASHVILLE ZOO	Nashville Zoo
NC	National Coal
NCDWQ	North Carolina Division of Water Quality
NCO	TDEC DWR Nashville Central Office
NEWFIELDS	Newfields Consulting
NORM	Normandeau Associates Inc.
NYRSTAR	NYRSTAR
Nashville EFO	TDEC Nashville Environmental Field Office
OCEAN	Oceana
OLIN	Olin Corporation
ORNL	Oak Ridge National Laboratory
PACE	Pace Analytical Services
PAI	Pennington and Associates Inc.
PAS	TDEC Planning and Standards Unit (now WPU)
PCC	Premium Coal Company
PFWD	Pigeon Forge Water Development
PFWD 03403	Pigeon Forge Water Development
RE	Ramboll Environ
RJS	Jan Stevenson, Phycologist Michigan State University
SBC	S. Bradford Cook Consultant
SHWWTP	Springhill Wastewater Treatment Plant
SLI	Skelly and Loy Consultants
SME	S&ME Inc.
SSG	Sevier Stormwater Group
Stantec	Stantec

Organization	Organization Full Name
TA	Test America
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment and Conservation
TDH ABS	Tennessee Department of Health Aquatic Biology Section
TDH LABS	Tennessee Department of Health Environmental Laboratory.
TDH Labs-Knox	TDH Labs-Knoxville
TDOT	Tennessee Department of Transportation
TEC	TEC Environmental Laboratories Inc
TLI	Technical Laboratories Inc
TRC	Third Rock Consultants, LLC
TRIAD	Triad Environmental Consultants
TSMP	Tennessee Stream Mitigation Program
TTU	Tennessee Tech University
TUB	Tullahoma Utility Board
TVA	Tennessee Valley Authority
TVR	Tennessee Valley Recycling
TWL	Technical Water Laboratories
TWRA	Tennessee Wildlife Resources Agency
UNION U	Union University
URS	URS Corporation
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UTC	University of Tennessee Chattanooga
UTK	University of Tennessee Knoxville
Unknown	Historical data - organization not recorded
VA	State of Virginia Environmental Program
VE	Vindicated Environmental
WATeR	Watershed Association for Tellico Reservoir
WLLC	Waypoint, LLC
WMS	TDEC Watershed Management Unit
Wood	Wood Environmental and Infrastructure Solutions
WP	Waypoint Analytical Inc
WP-J	Waypoint Analytical Inc

Organization	Organization Full Name
WP-M	Waypoint Analytical Inc
WPC	TDEC Water Pollution Control
WPU	Watershed Planning Unit

County Abbreviations and Code Numbers

COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS	COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS
ANDERSON	**AN**	01	001	LAUDERDALE	**LE**	49	097
BEDFORD	**BE**	02	003	LAWRENCE	**LW**	50	099
BENTON	**BN**	03	005	LEWIS	**LS**	51	101
BLEDSOE	**BL**	04	007	LINCOLN	**LI**	52	103
BLOUNT	**BT**	05	009	LOUDON	**LO**	53	105
BRADLEY	**BR**	06	011	MCMINN	**MM**	54	107
CAMPBELL	**CA**	07	013	MCNAIRY	**MC**	55	109
CANNON	**CN**	08	015	MACON	**MA**	56	111
CARROLL	**CR**	09	017	MADISON	**MN**	57	113
CARTER	**CT**	10	019	MARION	**MI**	58	115
CHEATHAM	**CH**	11	021	MARSHALL	**ML**	59	117
CHESTER	**CS**	12	023	MAURY	**MY**	60	119
CLAIBORNE	**CL**	13	025	MEIGS	**ME**	61	121
CLAY	**CY**	14	027	MONROE	**MO**	62	123
COCKE	**CO**	15	029	MONTGOMERY	**MT**	63	125
COFFEE	**CE**	16	031	MOORE	**MR**	64	127
CROCKETT	**CK**	17	033	MORGAN	**MG**	65	129
CUMBERLAND	**CU**	18	035	OBION	**OB**	66	131
DAVIDSON	**DA**	19	037	OVERTON	**OV**	67	133
DECATUR	**DE**	20	039	PERRY	**PE**	68	135
DE KALB	**DB**	21	041	PICKETT	**PI**	69	137
DICKSON	**DI**	22	043	POLK	**PO**	70	139
DYER	**DY**	23	045	PUTNAM	**PU**	71	141
FAYETTE	**FA**	24	047	RHEA	**RH**	72	143
FENTRESS	**FE**	25	049	ROANE	**RO**	73	145
FRANKLIN	**FR**	26	051	ROBERTSON	**RN**	74	147
GIBSON	**GI**	27	053	RUTHERFORD	**RU**	75	149
GILES	**GS**	28	055	SCOTT	**SC**	76	151
GRAINGER	**GR**	29	057	SEQUATCHIE	**SE**	77	153
GREENE	**GE**	30	059	SEVIER	**SV**	78	155
GRUNDY	**GY**	31	061	SHELBY	**SH**	79	157
HAMBLEN	**HA**	32	063	SMITH	**SM**	80	159

COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS	COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS
HAMILTON	**HM**	33	065	STEWART	**ST**	81	161
HANCOCK	**HK**	34	067	SULLIVAN	**SU**	82	163
HARDEMAN	**HR**	35	069	SUMNER	**SR**	83	165
HARDIN	**HD**	36	071	TIPTON	**TI**	84	167
HAWKINS	**HS**	37	073	TROUSDALE	**TR**	85	169
HAYWOOD	**HY**	38	075	UNICOI	**UC**	86	171
HENDERSON	**HE**	39	077	UNION	**UN**	87	173
HENRY	**HN**	40	079	VAN BUREN	**VA**	88	175
HICKMAN	**HI**	41	081	WARREN	**WA**	89	177
HOUSTON	**HO**	42	083	WASHINGTON	**WN**	90	179
HUMPHREYS	**HU**	43	085	WAYNE	**WE**	91	181
JACKSON	**JA**	44	087	WEAKLEY	**WY**	92	183
JEFFERSON	**JE**	45	089	WHITE	**WH**	93	185
JOHNSON	**JO**	46	091	WILLIAMSON	**WI**	94	187
KNOX	**KN**	47	093	WILSON	**WS**	95	189
LAKE	**LA**	48	095				

Exotic Plants in Tennessee

Compiled by the Tennessee Exotic Plant Pest Council. More information on these species including links to pictures can be found at: http://www.tnipc.org/invasive-plants/

Threat Level	Scientific Name	Common Names	Category
Established	*Ailanthus altissima* (Mill.) Swingle	Tree of Heaven	Tree
Established	*Albizia julibrissin* Durazz.	Mimosa Silktree Silky Acacia	Tree
Established	*Alliaria petiolata* (Bieb.) Cavara & Grande	Garlic Mustard	Forb/Herb
Established	*Alternanthera philoxeroides* (Mart.) Griseb.	Alligatorweed	Forb/Herb
Established	*Arthraxon hispidus* (Thunb.) Makino	Hairy Jointgrass Small Carpetgrass	Grass
Established	*Bromus inermis* Leyss.	Hungarian Brome Smooth Brome	Grass
Established	*Celastrus orbiculatus* Thunb.	Asian Bittersweet Oriental Bittersweet	Vine
Established	*Centaurea stobe* L. ssp. *micranthos* (S.G.Gmel. ex Gugler) Hayek.	Centaurea biebersteinii DC. Spotted Knapweed	Forb/Herb

Threat Level	Scientific Name	Common Names	Category
Established	*Clematis terniflora* DC.	Sweet Autumn Clematis	Vine
Established	*Dioscorea polystachya Turez.*	Chinese Yam Cinnamon Vine Dioscorea oppositifolia L.	Vine
Established	*Elaeagnus umbellata* var. *parviflora* (Wall. ex Royle) C.K.Schneid.	Autumn Olive	Shrub
Established	*Euonymus alatus* (Thunb.) Sieb.	Burning Bush Winged Euonymus	Shrub
Established	*Euonymus hederaceus Champ. & Benth.*	Euonymus fortunei (Turcz.) Hand.-Mazz. Winter Creeper	Vine
Established	*Fallopia japonica* (Houtt.) Ronse Decr.	Fleeceflower Japanese Knotweed Mexican Bamboo Polygonum cuspidatum Seib. & Zucc.	Forb/Herb
Established	*Hedera helix* L.	English Ivy	Vine
Established	*Hydrilla verticillata* (L.f.) Royle	Hydrilla Water Thyme	Aquatic

Threat Level	Scientific Name	Common Names	Category
Established	*Lespedeza bicolor* Turcz.	Bicolor Lespedeza Shrubby Bushclover Shrubby Lespedeza	Shrub
Established	*Lespedeza cuneata* (Dum.-Cours) G. Don	Chinese Lespedeza Sericea Lespedeza	Forb/Herb
Established	*Ligustrum sinense* Lour.	Chinese Privet	Shrub
Established	*Lonicera japonica* Thunb.	Japanese Honeysuckle	Vine
Established	*Lonicera maackii* (Rupr.) Herder.	Amur Bush Honeysuckle	Shrub
Established	*Lythrum salicaria* L.	Purple Loosestrife	Forb/Herb
Established	*Microstegium vimineum* (Trin.) A. Camus	Japanese Stiltgrass Nepalese Browntop Nepalgrass	Grass
Established	*Miscanthus sinensis* Anderss.	Chinese Silver Grass Eulalia Grass Maiden Grass Zebra Grass	Grass

Threat Level	Scientific Name	Common Names	Category
Established	*Murdannia keisak* (Hassk.) Hand.-Maz.	Asian spiderwort Marsh Dayflower	Forb/Herb
Established	*Myriophyllum aquaticum* (Vell.) Verdc.	Brazilian Watermilfoil Parrot Feather	Aquatic
Established	*Myriophyllum spicatum* L.	Eurasian Water-milfoil	Aquatic
Established	*Paulownia tomentosa* (Thunb.) Sieb. & Zucc. ex Steud.	Empress Tree Princess Tree Royal Paulownia	Tree
Established	*Perilla frutescens* (L.) Britton	Beefsteak Plant Chinese basil Perilla Perilla Mint	Forb/Herb
Established	*Phragmites australis* (Cav.) Trin. ex Steud.	Common Reed	Grass
Established	*Pueraria montana* var. *lobata* (Willd.) Maesen & S. Almeida	Kudzu	Vine
Established	*Pyrus calleryana* Dcne.	Bradford Pear Callery Pear	Tree
Established	*Rosa multiflora* Thunb. ex Murr.	Multiflora Rose	Shrub
Established	*Rubus phoenicolasius* Maxim.	Wine Raspberry Wineberry	Shrub

Threat Level	Scientific Name	Common Names	Category
Established	*Sorghum halepense* (L.) Pers.	Johnson Grass	Grass
Established	*Spiraea japonica* L.f.	Japanese Meadowsweet Japanese Spiraea	Shrub
Established	*Tussilago farfara* L.	Coltsfoot	Forb/Herb
Established	*Vinca minor* L.	Common Periwinkle	Vine
Established	*Wisteria sinensis* (Sims) DC.	Chinese Wisteria	Vine
Established	*Wisteria floribunda* (Willd.) DC.	Japanese Wisteria	Vine
Emerging	*Acroptilon repens* (L.) DC.	Centaurea repens (L.) Russian Knapweed	Forb/Herb
Emerging	*Akebia quinata* (Houtt.) Dcne.	Chocolate vine Five-leaf akebia	Vine

Threat Level	Scientific Name	Common Names	Category
Emerging	*Ampelopsis glandulosa* var. *brevipedunculata* (Maxim.) Momiy.	_Ampelopsis brevipedunculata_ (Maxim.) _Trautv_ _Ampelopsis heterophylla_ (Thunb.) Siebold & Zucc. Amur peppervine Creeper Porcelain berry Wild grape	Vine
Emerging	*Arundo donax* L.	Elephant Grass Giant Reed	Grass
Emerging	*Buddleja davidii* Franch.	Butterfly Bush	Shrub
Emerging	*Firmiana simplex* (L.) W. Wight	_Firmiana platanifolia_ (L. f.) Schott & Endl. _Sterculia platanifolia_ L. f.) Chinese Parasol Tree Phoenix Tree Varnish Tree	Tree
Emerging	*Heracleum mantegazzianum* Sommier & Levier	Giant cow parsnip Giant hogweed	Forb/Herb
Emerging	*Humulus japonicus* Siebold & Zucc.	Japanese Hops	Vine

Threat Level	Scientific Name	Common Names	Category
Emerging	*Imperata cylindrica* (L.) Beauv.	Cogongrass Japanese Bloodgrass	Grass
Emerging	*Liriope spicata* (Thunb.) Lour.	Creeping Lilyturf Creeping Liriope Lilyturf Monkey-grass	Forb/Herb
Emerging	*Lygodium japonicum* (Thunb. ex Murr.) Swartz	Japanese Climbing Fern	Forb/Herb
Emerging	*Mahonia bealei* (Fortune) Carr.	Beale's Barberry Leatherleaf Mahonia	Shrub
Emerging	*Melia azedarach* L.	Chinaberry	Tree
Emerging	*Nandina domestica* Thunb.	Heavenly Bamboo Nandina Sacred Bamboo	Shrub
Emerging	*Persicaria perfoliata* (L.) H. Gross	Asiatic Tearthumb Mile-a-minute Weed	Forb/Herb
Emerging	*Phyllostachys aurea Carr.* Ex A.& C. Rivère	Golden Bamboo	Grass
Emerging	*Ranunculus ficaria* L.	_Ficaria verna_ Huds. Fig Buttercup Lesser Celandine	Forb/Herb

Threat Level	Scientific Name	Common Names	Category
Emerging	*Rhamnus cathartica* L.	Common Buckthorn European Buckthorn Purging Buckthorn	Shrub
Emerging	*Rottboellia cochinchinensis* (Lour.) W.D. Clayton	Itchgrass	Grass
Emerging	*Salvinia molesta* Mitchell	Aquarium Water-moss Giant Salvinia	Aquatic
Emerging	*Solanum viarum* Dunal	Tropical Soda Apple	Shrub
Emerging	*Trapa natans* L.	Water Caltrop Water Chestnut	Aquatic
Emerging	*Triadica sebifera* (L.) Small	Chinese Tallowtree	Tree
Emerging	*Tribulus terrestris* L.		

APPENDIX F

TN PROTOCOLS
SOUTHEAST MONITORING NETWORK

SITE LIST AND MONITORING RESPONSIBILITY
MONITORING PROTOCOLS
DATA MANAGEMENT
TN SEMN FIELD SHEET

SEMN Site List and Monitoring Responsibility

Station ID	EFO	Stream Name	Location	Lat	Long	ECOIV	HUC
ECO66E09	JC	Clark Creek	Off Hwy 107 Clarks Creek Rd	36.14818	-82.52835	66e	06010108
ECO66G05	K	Little River	U/S Last house Little River Trail above Elkmont	35.65333	-83.5773	66g	06010201
ECO66G12	CH	Sheeds Creek	0.25 mi u/s Sheeds Creek Rd Crossing	35.00305	-84.61211	66g	03150101
ECO66G20	CH	Rough Creek	FR 221	35.05386	-84.48031	66g	06020003
ECO6702	JC	Fisher Creek	U/s Bray Rd. Crossing	36.49	-82.9403	67	06010204
ECO67F06	KEFO	Clear Creek	U/S Norris Municipal Park Rd	36.21361	-84.05972	67f	06010207
ECO67F13	KEFO	White Creek	D/S old USGS gaging station next to White Creek Rd	36.34361	-83.89166	67f	06010205
ECO68A03	MS	Laurel Fork Station Camp Creek	BSF NRRA RM4	36.51296	-84.71617	68a	05130104
ECO68C20	CH	Crow Creek	Off Ford Spring Rd U/S UT in Tom Pack Hollow	35.1155	-85.9111	68c	06030001
ECO71F19	CL	Brush Creek	Paul Reed Rd. just d/s Little Brush Creek	35.4217	-87.5355	67f	06040004

ECO71H17	CK	Clear Fork Creek	100 yds. u/s Cripps Ln. (Old Metal Bridge)	35.928651	-85.992117	71H	05130108
CITICO12.3MO	TVA	Citico Creek	Jack Best Campground	35.445524	-84.110308	66g	06010204
FIGHT000.6_GA	TVA	Fightingtown Creek	TN Ave/Mobile Rd Bridge Crossing just inside Georgia	34.9854	-84.3855	66d	06020003
WOLF002.7CO	TVA	Wolf Creek	Off Hwy 25/70 Near Wolf Creek Road	35.92242	-82.94656	66g	06010105

SEMN Monitoring Protocols

Sampling Frequency

April:

1. Collect SQKICK following TDEC protocols.
2. Collect qualitative habitats sample (QHS) using 3 jabs – field pick all unique species, keep in separate bottles (see below for more detail).
3. Complete and upload Habitat Assessment (BioForm).
4. Complete and upload Stream Survey Sheet (BioForm).
5. Complete and upload SEMN Field Sheet (BioForm)
6. Collect periphyton sample and complete Rapid Periphyton Survey Data Sheet (BioForm).
7. Measure canopy using densiometer at five transects.
8. Deploy Hobo continuous temperature/water depth loggers.
9. Take instantaneous measurements of D.O., temperature, conductivity, pH.
10. Measure flow along same transect where logger is deployed.
11. Collect water quality samples listed below.

July

1. Complete and upload Habitat Assessment (BioForm).
2. Complete and upload Stream Survey Sheet (BioForm).
3. Measure canopy using densiometer at one transect in the middle of the reach.
4. Download data from Hobo continuous temperature/water depth loggers.
5. Take instantaneous measurements of D.O., temperature, conductivity, pH.
6. Measure flow along same transect where logger is deployed.
7. Collect water quality samples listed below.

September

1. Collect SQKICK following TDEC protocols.
2. Collect qualitative habitats using 3 jabs – field pick all unique species, keep in separate bottles.
3. Complete and upload Habitat Assessment (BioForm).
4. Complete and upload Stream Survey Sheet (BioForm).
5. Complete and upload SEMN Field Sheet (BioForm).
6. Measure canopy using densiometer at one transect in the middle of the reach.
7. Download Hobo continuous temperature/water depth data.
8. Take instantaneous measurements of D.O., temperature, Conductivity, pH).
9. Measure flow along same transect where logger is deployed.
10. Collect water quality samples listed below.

January

1. Complete Stream Survey Sheet.
2. Complete Climate Change Field Sheet (BioForm).
3. Measure canopy using densiometer at one transect in the middle of the reach.
4. Download data from Hobo continuous temperature/water depth loggers.
5. Take instantaneous measurements of D.O., temperature, conductivity, pH.
6. Measure flow along same transect where logger is deployed.
7. Collect water quality samples listed below.

SEMN Sampling Methodology

The initial macroinvertebrate sample will be collected in April 2013. Subsequent samples will be collected annually within 2 weeks of the original collection. If flooding/high water prevents sample collection within the specified time period, samples will be taken as closely as reasonable to the target period.

500 micron mesh nets will be used for all sample collection.
The following samples will be collected within a 100 meter reach at each site:

A. Semi-quantitative Riffle Kick (SQKICK)

Approximate total area = 2 meters square. In larger streams, collect 2 riffles or upper or lower end of a large riffle. In smaller streams, multiple riffles may need to be collected to achieve the desired area. Follow TDEC DWR most recent QSSOP for Macroinvertebrate Stream Surveys Protocol.

Kicks will be composited and debris will be returned to laboratory for microscopic sub-sampling and species identification.

B. Qualitative Habitat Sampling (QHS)

Three "jabs" will be collected from all available habitats. Samples will be picked in the field targeting all unique taxa (it is recommended that all taxa be collected due to difficulty in differentiating species in field). Taxa from each habitat will be kept in a separate container with separate species lists generated for each habitat.

The following are examples of habitats that should be collected if present, other productive habitats such as moss can also be collected:

Habitat	Definition of 3 jabs (approximate)
Rooted undercut banks/tree roots	3 net widths
Macrophytes	3 net widths
Leaf Packs	3 handfuls
Woody Debris/Snags	3 net widths or 3 handfuls of loose material
Fine sediment	3 net widths approx. 4 cm deep
Pool Rock	6.cobble size (3 if approaching boulder)

C. Fish

Fish population samples will be collected in April- June of each year starting in 2013. Each agency will follow their own protocols. TVA will help coordinate sampling in states that need assistance. (TVA will collect all TN sites.)

D. Diatoms

The initial diatom sample will be collected in April 2013. Subsequent samples will be collected annually within 2 weeks of the original collection. If flooding/high water prevents sample collection within the specified time period, samples will be taken as closely as reasonable to the target period.

- Sampling protocols will follow U.S. EPA SPNBR or equivalent 9(TDEC protocols)..
- Subsample will consist of 600 valve (300 cell).
- Taxonomic level will be species (or lowest practical).

E. Field Documentation (Use BioForm and upload to Hydra)

- EPA Rapid Habitat Assessment Field Data Sheet for High Gradient Streams (1-200 scale).
- Canopy measurement midstream along 5 transects facing upstream/downstream/left bank and right bank using spherical densiometer held 12 inches above water surface.
- Digital photo documentation facing upstream and downstream as well as location of depth/temperature logger and any indications of human disturbance.
- Document dominant riparian vegetation type.
- Complete Field Observation Sheet (may substitute in-house form as long as all requested information is included.)

F. Temperature and Flow Loggers

- One continuous temperature logger will be deployed at each site with measurements taken every 30 minutes if a flow gauge is present.
- Two continuous water depth loggers will be deployed at each ungaged site (one in water and one in air) with measurements taken every 30 minutes. Water temperature should be measured at same depth/location as continuous monitoring sensor as QC check on each field visit. Instantaneous flow measurements should also be recorded along same transect during field visits for calibration.

G. Physical/chemical parameters

- Instantaneous measurements of flow, temperature, D.O., conductivity, and pH at each site visit.
- Minimal water quality samples:
    - Total Alkalinity
    - Ammonia Nitrogen
    - Arsenic
    - Cadmium
    - Chromium
    - Color (True and apparent)
    - Copper
    - Iron
    - Lead
    - Manganese
    - Nitrate+nitrite
    - Dissolved Residue
    - Suspended Residue
    - Selenium
    - Sulfates
    - Total Hardness

- Total Kjeldahl Nitrogen
- Total Organic Carbon
- Total Phosphorus
- Turbidity
- Zinc

Macroinvertebrate Sample Analysis:

All samples are to be sent to aquatic biology section for subcontracting. Contractor will identify all samples using keys agreed upon by monitoring network to ensure consistency. New taxon will be verified by outside expert and retained in reference collection. Sample and sorted debris will be retained a minimum of five years. Identified organisms will be retained for the life of the project.

A. Semi-quantitative Riffle Kick (SQKICK):

Subsample to 300 +/- 10% organisms following U.S. EPA 841-B-99-002 section 7.3 protocols.

Identify each organism in subsample to lowest possible taxon (usually species).
Taxa list should include count of each taxon in subsample.

B. Qualitative Habitat Sample (QHS)

Identify organisms in each habitat to lowest possible taxon (usually species).
Maintain separate taxa lists for each habitat including estimated abundance:

- Rare = 1-3
- Common = 4-9
- Abundant = 10-49
- Dominant = > 50

C. Quality Assurance

Each agency will follow approved Quality Assurance Project Plan (QAPP) for sorting and taxonomy. A voucher collection of each unique taxon will be housed by each agency and will be made available for verification or comparison to other identifications if needed. One riffle sample per year collected will be randomly selected from the 40 reference sites to be identified by all participating agencies.

D. Data Management

Continuous monitoring data will be downloaded by EFO and run through ConDataQC R Shiny app https://tetratech-wtr-wne.shinyapps.io/ContData QC/ by EFO. Both the original and QC'd file is saved on H:\TDEC Share\DWR Continuous Monitoring Data until TNCON development is complete. Macroinvertebrate and diatom data will be uploaded to Hydra and WQX every six months by the TDH Laboratory or WPU. SEMN Field Sheets will be uploaded to Hydra SEMN field staging table by EFO sampler.

TN SEMN Field Sheet
(See BSERT for BioForm instructions and upload).

	A	B	C	D	E	F	G	H	I	J
1	TN Southeast Monitoring Network (SEMN) Field Sheet									
2	**DWR Station ID:**		Samplers:				Organization:			
3	Monitoring Location ID:		Date:		**Time:**					
4	Monitoring Location			Location:						
5	Field Log Number:			Diatom Field Log #: (**April**)				Project:		
6	SOP Link: SEMN Protocol									
7	**Pre-Visit Check:**									
8	HoboWare Pro software updated?			Date:						
9	huttle batteries checked and synced with computer?			Date:						
10	**SEMN Biological Samples Collected**									
11	SEMN 500 SQKICK:									
12	**Qualitative Individual Habitats Sampled**									
13	**Habitat**	**Jab Definition**		**Sampled?**						
14	Rooted Bank	3 net widths								
15	Macrophytes	3 net widths								
16	Pool Rocks	6 cobbles or 3 boulders								
17	Fine Sediment	3 net widths ~4 cm deep								
18	Leaf Pack	3 handfuls								
19	Woody Debris/Snags	3 net widths or 3 handfuls								
20	Record chemical water samples and diatoms collected and physical parameters and flow measurements in Stream Survey tab (SS2).									
21										
22	**HOBO U20 Logger Information**									
23	Water temperature beside water probe:			°C						
24	Water depth from surface to HOBO sensor hole:			feet						
25	Any changes to probes or location?			If yes describe below in observed changes, such as probe move.						
26	Air Logger Downloaded/Re-deployed:		Time:		Battery Status:		Latitude:		Longitude:	
27	Describe any problems or changes to air sensor:		hornet nest							
28	Water Logger Downloaded/Re-deployed:		Time:		Battery Status:		Latitude:		Longitude:	
29	Describe any problems or changes to water sensor:									
30	**SEMN Stream Information:**									
31	Dominate streamside vegetation:									
32	Dominate composition of leaf packs:									
33	Describe any observed changes, such as probe moved, dewatered, buried in sediment, or fouled since last site visit:									
34	Describe any deviation from protocol:									
35	Describe any changes to the site such as beaver activity, logging, fire, agriculture, construction:									

BioEvent | SS2 | HG_Hab | LG_Hab | BRFieldFamVer | Hydra | BRGenVer | BioAnalysis | inorg | tags | RPS | **SEMN** | SEMN-QHS | Validation

Document Revision History

(Detailed revision for each document can be found on page 11)

Revision Number	Date	Brief Summary of Change
1	01-13-2023	Drop soft algae protocols Change document title from Periphyton to Diatom Incorporate Tennessee Diatom Index (TDI) Drop RPS requirements

NOTICE OF REVISIONS RECORD 2023

Date	Specific Section or Page	Revision Type	Revision Description
09-27-22	Title	Major	Replace Periphyton with Diatom in SOP title.
09-27-22	Throughout document	Minor	Replace Water Pollution Control (WPC) with Division of Water Resource (DWR)
09-27-22	Page 14	Minor	Updated distribution list
09-27-22	Pages 20-23	Minor	Updated definitions and acronyms
09-27-22	Pages 24-28	Minor	Updated Health, Safety, Cautions and Interferences
09-27-22	Page 30	Major	Clarified taxonomic expertise requirements.
09-27-22	Page 30	Minor	Updated field and lab equipment
09-27-22	Protocol F	Major	Removed of requirement for RPS for routine diatom collections.
09-27-22	Protocol G	Major	Removed protocol for collection of periphyton from sand/sediment.

Date	Specific Section or Page	Revision Type	Revision Description
09-27-22	Protocol G	Major	Added collection options for limited habitat sites.
09-27-22	Protocol I	Major	Removed soft algae lab analysis protocols. Updated diatom lab protocols and removed bio-volume analysis.
09-27-22	Protocol J	Major	Revised data reduction to incorporate Tennessee Diatom Index (TDI)
11-22-22	Protocol A	Major	Instructions for site reconnaissance added.
12-07-22	Protocol I	Major	Revised Diatom lab processing to incorporate TN Dept Health Environmental Labs SOP.
01-12-23	Appendix C	Major	Added current list of acceptable reporting nomenclature.
01-12-23	Protocol K and Appendix B	Major	Revised reporting format and forms
01-12-23	Section II-E	Minor	Updated reference image storing location.
01-12-23	Protocols C and E Appendix B	Major	Added information on completing revised field forms.
01-12-23	Protocol D	Major	Updated habitat assessment scoring protocols to match 2021 macroinvertebrate QSSOP.
01-13-23	Protocol L	Major	Updated Data and Records Management.
01-13-23	Section II	Minor	Added QC officer responsibilities.
01-13-23	Appendix E	Major	Biovolume calculation protocol removed.
01-23-23	Section II	Major	Replace % Community Similarity with Measurement Quality Objectives for Taxonomic Proficiency QC.
02-10-23	Appendix B	Minor	Updated E forms

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