



Division of Water Resources

Quality System Standard Operating Procedure

for

MACROINVERTEBRATE STREAM SURVEYS

Control Number DWR-PAS-P-01-QSSOP-081117

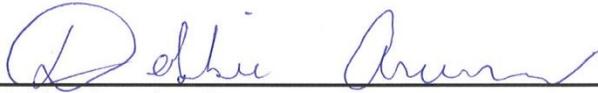
August 2017

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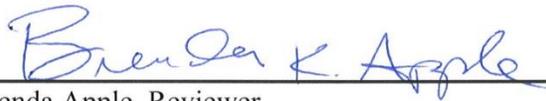
This revision has been reviewed and approved. It becomes effective on August 11, 2017



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Document Revision History

(Detailed revision record for each document can be found on page vii and in Appendix G)

Revision Number	Date	Brief Summary of Change
6	08-11-17	Taxonomic changes, biometric changes, updated field sheets, regional recalibrations, electronic reporting requirements.
5	07-01-2011	Decision making flowcharts, guidelines for headwater streams, updated field sheets, revised field sheets biometric changes, regional recalibrations.
4	October 1, 2006	Taxonomic changes, biometric changes, updated field sheets, regional recalibrations.
3	November 1, 2003	Clarified all protocols, added subsampling requirements.
2	March 1, 2002	First use of regional biocriteria guidelines
1	1996	Incorporated EPA Rapid Bioassessment Protocols.
0	1992	Initial SOP

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

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DIVISION OF WATER RESOURCES

**QUALITY SYSTEM STANDARD OPERATING PROCEDURE FOR
MACROINVERTEBRATE STREAM SURVEYS**

TITLE AND APPROVAL PAGE

DOCUMENT TITLE	Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys
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PLAN COVERAGE	General instructions for macroinvertebrate stream surveys in Tennessee

Concurrences and Review of QSSOP Project 2017

As a part of the 2017 review process, the following individuals reviewed and/or provided comments used in this document.

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REVISIONS AND ANNUAL REVIEW PROCEDURE: QS-SOP FOR MACROINVERTEBRATE 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 TDEC–BOE 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 Assistant Commissioner and Quality Assurance Manager of any changes that occur. Other stakeholders shall be notified, as appropriate and documented on the “Document Distribution” list.

NOTICE OF REVISIONS RECORD 2017 (Records of Previous Revision are in Appendix G)

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
07-01-17	Title	Minor	Updated division name.
07-01-17	Throughout document	Minor	Updated staff
07-01-17	Throughout document	Major	Changed headwater stream drainage from ≤ 2 square miles to ≤ 2.5 square miles.
07-01-17	Notice of Revisions 2006-11	Minor	Moved to Appendix
07-01-17	Equipment and Supplies	Major	Added requirements on obtaining TWRA collection permit.
07-01-17	Section 1D-F	Minor	Updated safety, cautions and interferences.
07-01-17	Protocol B	Minor	Clarified station naming scheme and added requirements for electronic reporting.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
07-01-17	Protocol C	Minor	Clarified pH calibration and DO measurements. Added requirements for electronic reporting.
07-01-17	Protocol D	Major	Refined habitat assessment protocols in response to statewide DWR regional QC workshops. Added requirements for electronic reporting.
07-01-17	Table 2	Major	Recalibrated habitat assessment guidelines. Split scoring by season.
07-01-17	Protocol G	Minor	Updated sampling priorities to match CALM.
07-01-17	Protocol G	Major	Clarified Personnel Qualifications, added credentials form.
07-01-17	Protocol E	Major	Revised Stream Survey Sheet. Added requirements for electronic reporting.
07-01-17	Protocols F and G	Major	Added information on Threatened and Endangered Species.
07-01-17	Protocol F	Minor	Clarified when to collect biorecons.
07-01-17	Protocol F	Major	Eliminated semi-aquatic taxa, collembolan and micro/meio-crustacea from biorecon metric counts. Combined Chironomidae for genus level.
07-01-17	Protocol F	Minor	Clarified descriptions for collection of various habitat types.
07-01-17	Protocol F	Minor	Clarified retention of vouchers.
07-01-17	Protocol F	Major	Added electronic reporting requirements.
07-01-17	Table 4	Major	Revised biometrics for biorecons in ecoregion 73. Replaced EPT with ETO and added CRMOL. Recalibrated metrics for all bioregions. Replace %Clingers with %Clingers-Cheumatopsyche. Split by stream size and season. Split ecoregion 74b from 65e. Revised language for scoring interpretation.
07-01-17	Protocol F	Major	Eliminated semi-aquatic taxa, collembolan and micro/meio-crustacea from SQSH biometric calculations.
07-01-17	Protocol F	Major	Added electronic reporting requirements.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
07-01-17	Protocol H	Minor	Revised field number reporting format for DWR samples.
07-01-17	Protocol J	Major	Eliminated semi-aquatic taxa, collembolan and micro/meio-crustacea from taxonomy. Added electronic reporting requirements..
07-01-17	Protocol K	Major	Added protocol for proportioning undetermined taxa. Replaced %Clingers with %Clingers-Cheumatopsyche. Added 2 metrics and revised target score for ecoregion 73. Added electronic reporting requirements.
07-01-17	Protocol L	Major	Added electronic reporting requirements.
07-01-17	Section I.J	Major	Added electronic reporting requirements for all data types for all samplers. Added Waterlog upload requirements for DWR staff.
07-01-17	Section II	Major	Defined responsibilities of In-house QC officer. Revised taxonomic QC requirements for SQSH samples.
07-01-17	Appendix A	Major	Revised SQSH Biocriteria Tables. Recalibrated all metrics. Split by stream size and season. Split 7b from bioregion 65abei. Added SQBANK criteria for bioregion 67fhi (Fall only/non-headwater only). Changed drainage area for headwater streams. Removed headwater stream cautions.
07-01-17	Appendix A	Minor	Updated ecoregion reference streams.
07-01-17	Appendix A	Major	Recalibrated regional expectations for individual habitat parameters. Split all ecoregions by season.
07-01-17	Appendix B	Major	Updated field worksheets and reporting forms. Added electronic reporting formats..
07-01-17	Appendix C	Major	Updated list of intolerant families for biorecons. Updated master taxa list
07-01-17	Appendix E	Major	Updated Exotic Plants List and moved to Appendix E. Moved county abbreviations to appendix E. Added reference tables for project names, organizations and activity types to appendix E.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
07-01-17	Appendix F	Major	Added protocols for Southeast Monitoring Network.

EVALUATION PROCEDURE: QS-SOP FOR MACROINVERTEBRATE 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.

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QSSOP DOCUMENT DISTRIBUTION LIST

Copies of this document were distributed to the following individuals in TDEC and TDH. 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.). An updated distribution list is maintained in the Planning and Standards Unit.

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PREFACE

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 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 technical Standard Operating Procedure (QS-SOP) 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. QS-SOPs 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 QS-SOP is specific to the Division of Water Resources and is intended to assist the division in maintaining their quality control and quality assurance processes and ensure compliance with government regulations. It provides specific operational direction for the division's Quality Assurance Project Plan for Macroinvertebrate Stream Surveys.

I. PROCEDURES

I.A SCOPE, APPLICABILITY AND REGULATORY REQUIREMENTS

The purpose of this Quality Systems Standard Operating Procedure (QS-SOP) 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 macroinvertebrate stream survey process and will delineate all steps in the process, including habitat assessments, field collections, sample analysis, data reduction and reporting. This SOP is only intended to describe routine conditions encountered during a macroinvertebrate stream survey.

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 Classification for Surface Waters: Rule 0400-40-04

I.B METHOD SUMMARY

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

Macroinvertebrates are used by the Division as indicator organisms to determine if a stream supports fish and aquatic life. Two types of surveys (biorecons and semi-quantitative single habitat) are used depending on the purpose of the survey.

Biorecons (BR) will be used as a screening or reconnaissance tool to provide a quick evaluation of the relative health of the biological community. The biorecon will be used primarily for general watershed assessments and for determining where more intensive monitoring is needed. This method is not comparable to biocriteria referenced in the Water Quality Standards.

Semi-quantitative single habitat surveys (SQKICK or SQBANK) will be conducted whenever a more defensible and/or definable assessment is needed. This method is directly comparable to biocriteria referenced in the Water Quality Standards. The semi-quantitative biological survey is also preferred in situations where the use attainment status of a stream is not obvious from the results of a biorecon. Antidegradation Policy evaluations, enforcement actions and TMDL studies are additional examples of occasions when biorecons may provide inadequate amounts of information and a semi-quantitative sample would be preferable. It is recommended that this method be used by any outside agency or private organization submitting biological data to the Division for review. The semi-quantitative method is required for any individual conducting macroinvertebrate surveys for permit compliance.

Habitat assessments (high gradient and low gradient) are also described in this document. Habitat assessments are to be conducted in conjunction with all types of biological surveys since habitat is often a limiting factor to the complexity of the benthic community. By following this assessment procedure, habitat can either be confirmed or eliminated as a cause of stress to the macroinvertebrate community.

Macroinvertebrate Survey Quick Field Reference
(Minimum tasks to be completed at all biological sampling sites)

1. Before leaving office, contact TWRA regional office to inform them of sample locations. Permit must be carried at all times.
2. Upon arrival at site, record lat/long in decimal degrees, verify that sample location is correct.
3. Establish minimum 100 yard reach area (walk bank without disturbing stream).
4. Take field measurements near middle of reach area (minimum DO, temp, pH and conductivity). Record on stream survey field sheet.
5. Collect chemicals (if needed) upstream of area disturbed during field measurements.
6. Collect macroinvertebrate sample (biorecon or SQSH).
7. If biorecon collected and score is ambiguous, collect SQSH if assessment cannot be made based on field observations or other information (see flow chart).
8. Collect periphyton samples if required.
9. Measure flow if SEMN site.
10. Measure canopy midstream in middle of riffle where macroinvertebrates are collected or in middle of stream reach if collecting SQBANK or multiple riffles. Estimate average of entire reach. If periphyton are collected at same time, measure midstream at 5 transects instead.
11. Complete stream survey field sheet including stream sketch.
12. Complete habitat assessment field sheet.
13. Take pictures of upstream/downstream sample reach, any habitat problems 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.C DEFINITIONS AND ACRONYMS

Benthic Community: Animals living on the bottom of the stream.

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.

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.

Bioregion: An ecological subregion, or group of ecological subregions, with similar aquatic macroinvertebrate communities that have been grouped for assessment purposes.

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.

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 25 (Level IV) ecological subregions in Tennessee.

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

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

Headwater stream: Streams with less than or equal to a 2.5square mile drainage area.

Macroinvertebrate: Animals without backbones that are large enough to be seen by the unaided eye and which can be retained by a U.S. Standard No. 30 sieve (28 meshes/inch, 0.595 mm).

Productive Habitats: Provide niche for colonization by macroinvertebrate or fish.

Reference database: Biological and chemical data from ecoregion reference sites.

Riparian Zone: An area that borders a waterbody (approximately 18 yards wide).

Stream Order: Strahler order as determined using 7.5 series topographic maps.

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

Acronyms

AB	Aquatic Biology Section
ADB	Assessment Database
BR	Biorecon
BOE	Bureau of Environment
BSERG	Biological Survey Electronic Reporting Guidance
CALM	Consolidate Assessment and Listing Methodology
Cfs	Cubic feet per second
CHEUM	Cheumatopsyche
CHEFO	Chattanooga Environmental Field Office
CKEFO	Cookeville Environmental Field Office
CLEFO	Columbia Environmental Field Office
CMERG	Continuous Monitoring Electronic Guidance
CO	Central Office
COC	Chain of Custody
CRMOL	Crustacea and Mollusca
DO	Dissolved Oxygen
DOR	Department of Remediation
D/S	Downstream
DWR	Division of Water Resources
EDAS	Ecological Data Application System
ECO	Ecoregion Reference Stream
EFO	Environmental Field Office
EPT	Ephemeroptera, Plecoptera, Trichoptera
EPT-Cheum	EPT abundance excluding <i>Cheumatopsyche</i> spp.
ES	Environmental Specialist
ETO	Ephemeroptera, Plecoptera, Odonata
ETW	Exceptional Tennessee Waters
FECO	Headwater Reference Stream
FWS	Society for Fresh Water Sciences
GIS	Geographic Information System
GPS	Global Positioning System
HW	Headwater
IT	Intolerant Taxa
JCEFO	Johnson City Environmental Field Office
JEFO	Jackson Environmental Field Office
KEFO	Knoxville Environmental Field Office
LDB	Left Descending Bank
LDO	Luminescent Dissolved Oxygen
LS	Lab Services
MC	Mid Channel
MEFO	Memphis Environmental Field Office
MS	Mining Section

MSDS	Material Safety Data Sheets
NEFO	Nashville Environmental Field Office
NCBI	North Carolina Biotic Index
OC	Oligochaeta and Chironomidae
PAS	Planning and Standards Unit
PFD	Personnel Flotation Device
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QSSOP	Quality System Standard Operating Procedure
RDB	Right Descending Bank
RM	River Mile
SDS	Safety Data Sheet (previously MSS)
SEMN	Southeast Monitoring Network
SPERG	Stream Parameter Reporting Guidance
SQBANK	Semi-Quantitative Bank Sample
SQKICK	Semi-Quantitative Kick Sample
SQSH	Semi-Quantitative Single Habitat Sample
TDEC	Tennessee Department of Environment and Conservation
TDH	Tennessee Department of Health
T&E	Threatened and Endangered
TMI	Tennessee Macroinvertebrate Index
TMDL	Total Maximum Daily Loading
TNUTOL	Tennessee Nutrient Tolerant Organisms
TOPO	Topographic Map
TR	Taxa Richness
TWRA	Tennessee Wildlife Resources Agency
U/S	Upstream
WPC	Water Pollution Control

I.D HEALTH AND SAFETY WARNINGS

(Adopted from Klemm et al., 1990)

1. Know how to swim and/or use a PFD when entering the water.
2. Always wear waders with a belt to prevent them from filling with water in case of a fall. In high velocity and high flow streams it is advisable to wear a PFD.
3. 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 they must have a Tennessee Boater Education Certificate issued by TWRA.
4. 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.
5. 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.
6. 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.
7. Always perform lab work involving ethanol or CMC-10 in a room containing a properly installed and operating hood.
8. Carry cell phone in the field in case of emergency.
9. Keep a file in the office that contains emergency contacts and physician's name for each employee.
10. 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.
11. If working in water known or suspected to contain human wastes, get immunized against tetanus, hepatitis, typhoid fever and polio.
12. Try to avoid working alone in the field. When working alone, make sure the supervisor or their designee knows where you are and when you are expected to return. Check in periodically.

13. Safety Data Sheets (SDS) [previously Material Safety Data Sheets (MSDS)] for ethanol and CMC-10 (if mounting slides) are to be kept in the lab or office. Everyone working with these agents should be familiar with the location and content of the MSDS sheets. Ethanol must be stored in fire-proof cabinet and disposed of as a hazardous waste.
14. Be aware of potentially volatile situations. If possible, obtain permission from land-owners before crossing private property. Have business cards available to leave at residences when appropriate. If approached by someone representing law enforcement, show them your state I.D. and ask to see their I.D. or badge. The Tennessee Highway Patrol can be reached by dialing *THP (*847) from your mobile phone.
15. 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.
16. 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. If a non-life threatening injury occurs on the job, seek medical assistance from the authorized state worker's compensation network. A current list of providers may be found on the State Treasurer's homepage under Workers Compensation Provider Directory at <https://www.tn.gov/workforce/section/injuries-at-work> . Always complete and file an accident report if medical assistance is provided for a work related injury.

I.E CAUTIONS

1. Avoid cross contamination of samples. Thoroughly rinse all nets and sieves and inspect for clinging organisms before leaving the sample site. Inspect nets and sieves again immediately before sampling the next site. Thoroughly rinse bottles and inspect before re-use.
2. Avoid sampling bias by following these procedures exactly. Document any deviation.
3. Take care not to over-sample, especially on biorecons. Sample only 4 habitats as defined in Protocol F. Only retain representative taxa for vouchers. Take care not to under sample (less than 160 organisms) on SQSH samples. Collect additional kicks (or banks) if needed to achieve minimal sample size.
4. Make sure sample site meets ecoregion, drainage area and sample method requirements before comparing to semi-quantitative or biorecon guidelines. Biocriteria metrics used to calculate the TMI can only be applied to SQKICK or SQBANK samples with a 160-240 subsample identified to genus level. Never calculate quantitative metrics or apply biocriteria to biorecons.
5. Use the standardized station ID naming protocol for all samples. Check the stations table in Waterlog to make sure a station has not already been established with a different station ID. Notify PAS of any discrepancies. Make sure the station ID is included on all paperwork associated with the sample.
6. Measure river mile from mouth to headwaters. When measuring embayments, start measuring from confluence with the original channel of the main stem. Use GIS (preferred) or map wheel at the 1:2400 (7.5 minute) scale to measure stream miles. When using GIS use the ArcView measuring tool, do not use the Reach File Index or the NHD flowline layer which measures in straight lines. Do not use TDEC on-line assessment map measuring tool as it is inaccurate due to rounding errors. The USGS stream stats site <https://streamstatsags.cr.usgs.gov/streamstats/> may be used.
7. Use the USGS stream stats site (see # 6 for link) to calculate drainage area.
8. 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. If discrepancies are noted, do not report 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.

9. Express all time on a 24-hour (military) clock format.
10. Write all dates in mm/dd/yyyy format.
11. Express all distance measurements in English measurements (inches/feet/yard/miles).
12. Make sure to use appropriate units for all field measurements as indicated protocol C (field parameters) and E (stream survey sheet).
13. Use GPS to confirm location at site. Record latitude and longitude in decimal degrees.
14. If an error is made in any written documentation, draw a single line through the error, so that it is readable and write the correction above. Date and initial the correction.
15. When possible, chemical and semi-quantitative (SQSH) macroinvertebrate samples should be collected on the same day (required for CADDIS analysis). If this is not possible, chemical and biological samples should not be separated by more than 4 weeks.
16. Make sure drainage area, sample method and ecoregion drainage are appropriate for comparison to biorecon guidelines or SQSH biocriteria.
17. Check waterlog 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. Check station Ids to make verify names follow logical progression from downstream to upstream.
18. Use caution when assessing headwater streams (≤ 2.5 square mile drainage) with biorecon guidelines and/or SQSH biocriteria tables. Guidelines are based on a limited number of samples within each bioregion.
19. 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.

I.F INTERFERENCES

1. Document all deviations from protocol.
2. Semi-quantitative bank samples collected in 65j, 66d, 66e, 66f, 66g, 68a, 68b, 68c, 69d, 71e, 71f, 71g, 71h, and 74a cannot be compared to biocriteria. If sampling in a non-riffle stream in these regions, an upstream or offsite reference must be collected.
3. Semi-quantitative kick samples collected in 65a, 65b, 65e, 65i, 73a and 74b cannot be compared to biocriteria. An upstream or offsite reference must be collected.
4. Additional samples (of the same habitat) should be collected if needed to ensure 200 organisms were found in the semi-quantitative sample collection (document).
5. Avoid sampling in flooded conditions or immediately after a flood.
6. Do not sample if stream is reduced to isolated pools. If stream channel naturally goes dry, only sample if there has been flow for longer than 30 days. Only compare to biocriteria or biorecon guidelines for those regions where reference streams routinely went dry (68b, 68c, 69d, and 71i).
7. Do not sample if water is stagnant (backed up by log jams, beavers etc.).
8. 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. If discrepancies are noted, do not report 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.
9. Organisms that are not included on the Tennessee taxa list (Appendix C) (or on macroinvertebrate master taxa table in waterlog) must be sent to the state lab for verification and inclusion in the statewide reference collection. After in-house confirmation, the state lab will send any new taxon to a qualified expert for verification (Appendix D).
10. 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.
11. Do not retain threatened and endangered species. Document occurrence and release. Samplers should check data view for records and be able to field ID potential T%E species in sample reach.

I.G PERSONNEL QUALIFICATIONS

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 macroinvertebrate taxonomy is desirable. Advanced degree in stream ecology, aquatic biology or similar field is preferable.

Professional credentials must be submitted and maintained on file in SharePoint: <https://tennessee.sharepoint.com/sites/environment/DWR/PAS/SitePages/Home.aspx> and at the local office. Credentials must include Name, Education (school and degree), specific experience and publications related to macroinvertebrate stream surveys and taxonomy including any certifications. See form Appendix B.

Minimum experience:

(QC requirements are described in Section II)

Biorecon Field collections

Must shadow an experienced biologist for a minimum of one year and successfully pass 10 biorecon field duplicates. Specific class-work involving biological stream surveys and macroinvertebrate taxonomy can be substituted for experience, but not QC requirements. Before biorecon training and QC is completed, biologists may collect SQSH samples.

SQSH Field Collections

Must demonstrate knowledge of stream types including hydrology and macroinvertebrate habitat for various stream classes in each bioregion in collection area. Must pass 2 SQSH Field Duplicates.

Taxonomic Expertise:

Biorecon

Must be proficient in identification at target level (family or genus excluding chironomids or oligochaetes). Proficiency is demonstrated by passing a minimum of 10 biorecon duplicate samples that have been identified by a second taxonomist who has already passed QC requirements. The samples must represent a variety of stream types and bioregions and include, most commonly encountered taxa within the biologist's area of responsibility.

SQSH (Semi-Quantitative Single Habitat)

- Must be proficient in identification at genus level including chironomids and oligochaetes. Proficiency is demonstrated by passing a minimum of 10 SQSH samples that have been identified by a second taxonomist who has already passed QC requirements. (May be reduced to 2 samples if taxonomist meets 1 or more requirements as taxonomic expert in appendix D)
- Experience in southeast U.S. taxa preferable.
- Society for Fresh Water Science (FWS) or equivalent taxonomic certification is desirable.
- Must show proficiency in sorting (see protocol I) by passing a minimum of 10 samples.

Additional expertise:

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

Training:

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

Additional requirements for non-DWR/TDH staff.

- Must successfully complete at least one sample collection in accordance with TDEC QSSOP in the presence of a DWR/TDH biologist.
- Must submit and pass QC requirements on one sample submitted to state laboratory for sorting efficiency and taxonomic verification (at permittee's expense). Once QC is passed, internal QC is acceptable.

I.H. EQUIPMENT AND SUPPLIES

Prior to any sampling trip, gather and inspect all necessary gear. Replace or repair any damaged equipment. Calibrate DO the morning of the sampling trip and make sure all other meters have been calibrated within the week 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

- TWRA collection permit
- Waders
- Forceps
- Ethanol
- External sample tags
- Internal sample tags
- Toughbook with biological forms loaded (once available).
- Habitat Assessment Field Sheet (High gradient for riffles, Low gradient for glide-pool)
- Stream Survey Field Sheet
- Biorecon Field Sheet (Biorecons only)
- Biological Analysis Request Form (for Chain of Custody and/or samples sent to lab)
- Rapid periphyton assessment sheet
- ½ gallon wide mouth plastic sample bottles for Semi-Quantitative samples
- Small wide mouth plastic bottles for biorecons
- Calibrated GPS unit or Toughbook
- Calibrated Dissolved Oxygen meter and replacement membrane kit
- Calibrated pH meter
- Calibrated conductivity meter
- Calibrated temperature meter or thermometer in °C
- Spare batteries for all electronic equipment
- Camera (preferably digital) with memory cards or film or Toughbook
- Triangular dip net with 500-micron mesh (Biorecons and SQBANK samples only)
- One meter square kick net with 500 micron mesh (SQKICK samples only)
- Rectangular net (18") with 500 micron mesh (SQKICK in small streams only)
- Sieve bucket with 500 micron mesh
- White enamel or plastic pans for sorting debris (biorecons only)
- Waterproof marking pens (Sharpies), pencils and black ballpoint ink pens (not roller-ball or gel pens)
- Flashlights
- Duct Tape
- First Aid Kit
- Time keeping device
- Spherical densiometer (for canopy measurements)

- GIS capability (to calculate stream miles to assign station ID in field if needed)
- Cell phone

Optional Equipment

- Topographic maps (USGS quadrangle maps) may also be referred to as topos or quads
- Tennessee Atlas and Gazetteer
- Magnifying lens

Laboratory Equipment

Biorecons (EFO)

- Dissecting Microscope
- Jewelers Forceps
- Petri dish
- Ethanol
- Glass vials with rubber or Teflon line lid for reference specimens
- Taxonomic Bench Sheet
- Transfer pipette (or equivalent suction device)

Additional equipment needed for SQSH (state lab or consultant)

- Microscope slides
- Round 12 mm coverslips
- Square 22 mm coverslips
- Gridded Tray with subsampling insert
- Small Gridded dish (36 grids)
- CMC-10 or equivalent permanent mounting media
- Random number jar
- Turkey baster (or equivalent suction device)
- Slide storage box

Sample container and Ethanol Acquisition

Sample containers and ethanol for DWR staff are obtained through the Tennessee Department of Health Environmental Laboratory in Nashville.

Supplies must be requested at least two weeks prior to the anticipated date they will be needed (preferably one month).

Item	Edison Number	Check
• SQSH Jar 1/2 gal	1000109388	
• 1 oz wm bottle (Biorecon collection)	1000109082	
• Alcohol Ethyl	1000109487	

Contact: Dr Bob Read, Director, TDH Environmental Lab
 (615) 262-6302
Bob.Read@tn.gov

TWRA Collection Permits

All individuals collecting macroinvertebrate samples must obtain a collection permit from TWRA which is renewed annually. Permit must be carried at all time when collecting. TWRA regional office must be contacted before sampling.

DWR and TDH biological staff are under one permit. Please contact Debbie Arnwine, 615-532-0703 Debbie.Arnwine@tn.gov to be added to permit.

Others should contact Rusty Boles with TWRA. 615-934-7505. Rusty.boles@tn.gov.

TWRA CONTACTS FOR DISPATCH NOTIFICATION

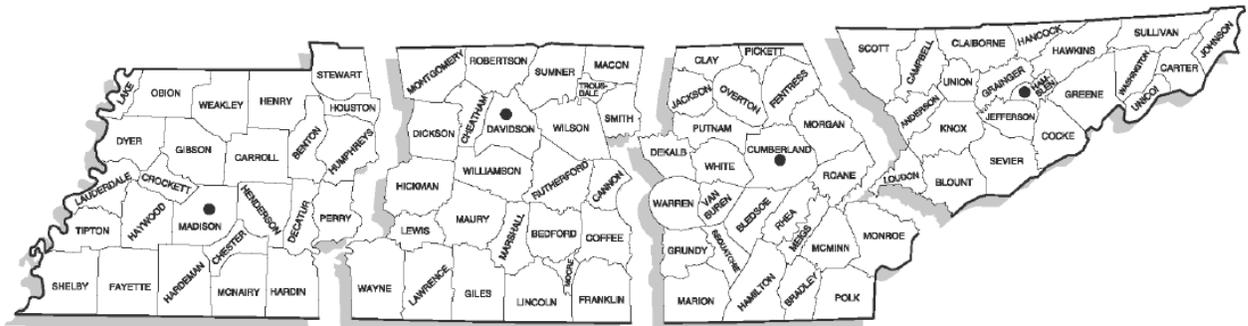
IT IS REQUIRED THAT YOU NOTIFY TWRA PRIOR TO COLLECTING IN THE FIELD.

FAILURE TO REPORT MAY RESULT IN LOSS OF PERMIT.

If you are unable to contact the regional dispatchers via the numbers listed below, you may send an e-mail to satisfy the reporting requirement. Your et mail should contain the following information: Permit Number, Name of Permit Holder, Date of collection, Location of Collection (name of body of water, cave, wma, mile marker, ect), Collection Methods/equipment, and names of personnel that will be in the field collecting specimens. If you have a change, you must notify the region of the change.

You may reach the dispatchers by using the following e-mail addresses:

- Region I: twra.dispatchregion1@tn.gov
- Region II: twra.dispatchregion2@tn.gov
- Region III: twra.dispatchregion3@tn.gov
- Region IV: twra.dispatchregion4@tn.gov



Region I
 Jackson, TN
 1-800-372-3928
 731-423-5725

Region II
 Nashville, TN
 1-800-624-7406
 615-781-6622

Region III
 Crossville, TN
 1-800-262-6704
 931-484-9571

Region IV
 Morristown, TN
 1-800-332-0900
 423-587-7037

I.I PROCEDURES

Protocol A - Selection of Survey Type and Station Location

1. Determine biological sampling needs.

The central office will coordinate biological sampling needs with the environmental field offices. 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, macroinvertebrate samples should be collected with the following priority

a. Antidegradation Monitoring:

- If the waterbody does not have SQSH data from the last five years and there is a possibility that the stream has exceptional biology a SQSH should be collected to determine ETW status.
- If this is a new or expanded permit on a segment that is not currently assessed, a SQSH should be conducted so it can be determined whether a stream meets biocriteria guidelines. Note this will not be considered an assessment of use-support until the 305(b)/303(d) review.

b. Southeast Monitoring Network Sites (SEMN)

Established SEMN sites are monitored for macroinvertebrates (SQSH and individual habitats following SEMN protocols) in spring (April) and fall (September) of each monitoring year (Appendix F). A biorecon is also collected in spring and fall during the watershed cycle.

c. Ecoregion Reference Streams,

Established ecoregion or headwater reference stations are monitored according to the watershed approach schedule. Each station is sampled quarterly for chemical quality and pathogens as well as in spring and fall for macroinvertebrates and habitat. Periphyton is sampled once during the growing season (April – October). Both semi-quantitative and biorecon benthic samples are collected to provide data for both biocriteria and biorecon guidelines. If watershed screening efforts indicate a potential new reference site, more intensive reference stream monitoring protocols are used to determine potential inclusion in the reference database.

e. Sites on the 303(d) list for Fish and Aquatic Life

Macroinvertebrate should be collected for impaired sites listed for physical alteration in streamside or littoral vegetation, siltation, metals, abandoned mining, nutrients (SQSH only), Follow flow chart 3 to determine whether a biorecon or SQSH needed. Sampling downstream of Major Dischargers and CAFO's:

During each monitoring cycle, the major dischargers are identified. Stations are established at those waterbodies, if the facility does not currently have in-stream monitoring requirements built into their permit. The pollutant of concern and the effect it would have on the receiving stream may determine the location of the station. (Note: stations may not be required for dischargers into very large waterways such as the Mississippi River or large reservoirs.) Stations downstream of STPs or industries that discharge nutrients should include a SQSH, plus monthly nutrient monitoring.

Stations should also be established downstream of CAFOs with individual permits or others in which water quality based public complaints have been received. The emphasis should be on monitoring biointegrity (SQSH survey if the stream is wadeable or in a region in which SQBANK surveys can be done) and monthly nutrient and pathogen sampling.

Location of point source discharges can be found on the water quality assessments data viewer. <http://tdeconline.tn.gov/dwr/>. Permit requirements can be accessed through Waterlog. To download a spreadsheet by watershed go to the WPC reports, permits by watershed cycle, interactive format.

- f. TMDL: Monitoring for scheduled TMDLs in the watershed group is coordinated between the Watershed Management Unit (WMU) manager and the EFOs to meet objectives for each TMDL. The frequency and parameters monitored for TMDL monitoring depends on the specific TMDL.
- g. Special Project Monitoring: Occasionally, the division is given the opportunity to compete for special EPA grant resources for monitoring and other water quality research projects. If awarded, activities related to these grants become a high priority because the division is under contract to achieve the milestone set out in the workplan.
- h. Watershed Monitoring: In addition to the previous priorities, each EFO should monitor additional stations to confirm continued support of designated uses and to increase the number of assessed waterbodies. Macroinvertebrate biorecons, habitat assessments, and field measurements of DO, specific conductance, pH and temperature are conducted at the majority of these sites. These priorities include:
- Previously assessed segments, particularly large ones, that would likely revert to Category 3 unassessed status. (Note that a single site per assessed segment is generally adequate if assessment was supporting and no changes are evident).

- Sites below ARAP activities or extensive nonpoint source impacts in wadeable streams where biological impairment is suspected. Examples might be unpermitted activities, violations of permit conditions, failure to install or maintain BMPs, large-scale development, clusters of stormwater permits, dredging, stream relocations, impoundments, road construction, golf courses or a dramatic increase in impervious surfaces.
- Unassessed reaches especially in third order or larger streams or in disturbed headwaters.
- Sites where the last biological sample was ambiguous (collect SQSH at these).
- Pre-restoration or BMP monitoring. In most cases this sampling would be to document improvements, but might also be needed to confirm that the stream is a good candidate for such a project. This protects against the possibility that a good stream could be harmed by unnecessary restoration. The Natural Resource Unit can provide information on planned activities.

The type of macroinvertebrate sample will be determined based on the type of assessment needed. In general biorecons will be used for routine watershed assessments and screening while SQSH will be used when a more defensible assessment is needed and for clarification of ambiguous biorecons. It can also be used to confirm biorecons where score does not, in the opinion of the biologist, reflect true stream conditions. (For example richness is high but abundance appears low).

There are occasions when a biorecon will be preferred:

- Streams in middle and east TN where good quality riffles are naturally not available. (For example bedrock dominant, boulder step-pool, lower gradient where SQBANK guidelines are not developed and non-wadeable streams). Judgement should be used to determine if the targeted habitat would be the most productive in the absence of human disturbance. If not, a biorecon should be conducted instead of a SQSH.
- Sediment dominated streams where the riffle is the cleanest substrate due to fast flow and may represent refugia. (Conversely if a riffle is inundated by sediment to where it is no longer a high quality riffle it should be sampled using a SQKICK.)
- Streams that are obviously impaired with extremely limited habitat (Should score a 5 on the biorecon.)
- Streams with a history of good SQSH scores (36 or higher).

Genus level biorecons are more sensitive but require more time and taxonomic expertise. Often family level biorecons are adequate screening tools especially when

biological community is obviously diverse or highly stressed. If more sensitivity is needed, a semi-quantitative sample may be more useful than a genus level biorecon especially if richness is high but abundance is low.

Figures 1-4 provide guidelines for determining what type of biological sample is most appropriate.

- Ecoregion reference sites (ECO and FECO) – Biorecon and SQSH (Figure 1).
- NPDES permit actions, enforcement, nutrient TMDL, Pre/post BMP, Pre/post ARAP, potential ETW, CADDIS – SQSH (Figure 2).
- 303(d) list – SQSH or Biorecon (Figure 3).
- Watershed Assessment – SQSH or Biorecon (Figure 4).

Biological Sample Decision Making Flowcharts

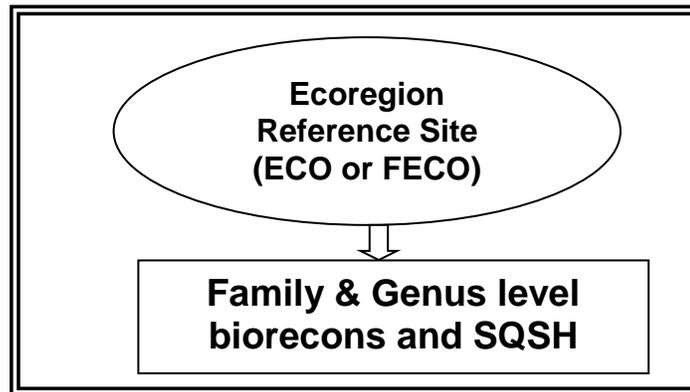


Figure 1: Biological Sample Decision Making Chart for Ecoregion Reference Sites.

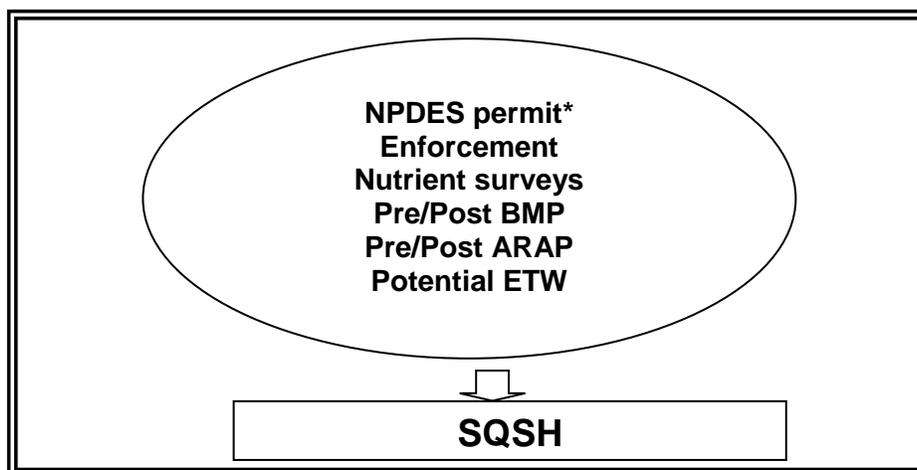


Figure 2: Biological Sample Decision Making Chart for NPDES, Enforcement, Nutrient, BMP, ARAP, and Potential ETW Sites. * Also, do SQSH for new or expanded permit action that is not currently assessed.

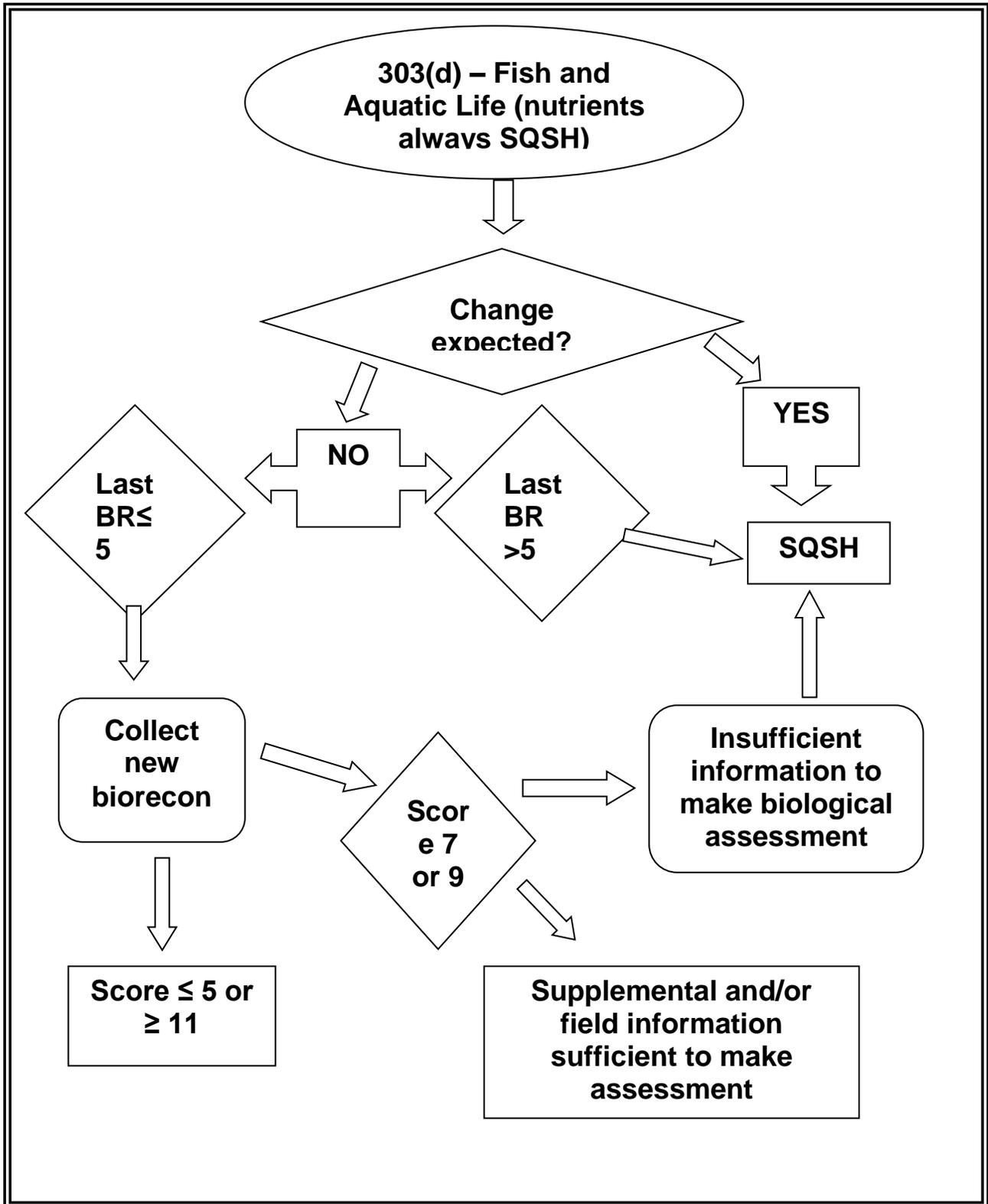


Figure 3: Biological Sample Decision Making Chart for 303(d) Listed Sites.

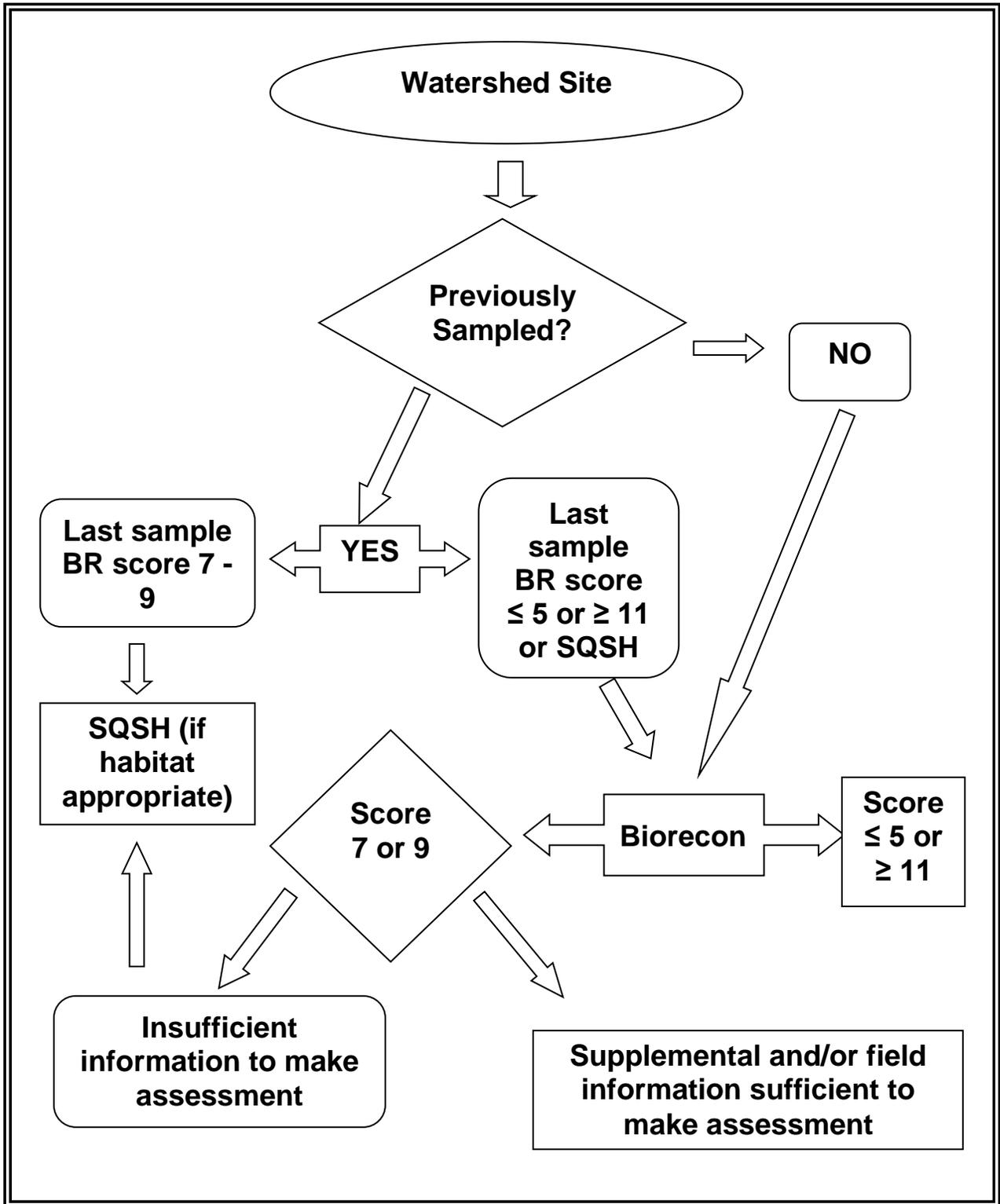


Figure 4: Biological Sample Decision Making Chart for Watershed Sites.

3. 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. Determine whether an upstream or watershed **reference site** is needed or if the study site can be compared to biocriteria (Appendix A) or biorecon guidelines (Tables 4 and 5) derived from the ecoregion reference database. In order to compare to biocriteria, (SQSH) or biorecon guidelines:
 - i. the watershed upstream of the test site must:
 - Be at least 80% within the specified bioregion
 - Be of the appropriate upstream drainage area
 - ii. SQSH must be collected using the collection method designated for that bioregion (SQKICK or SQBANK).

Compare all appropriate semi-quantitative samples to biocriteria. Depending on study purposes or if the study stream does not meet requirements for the reference database, an upstream sample or an appropriate watershed reference may need to be collected. Instructions for comparing data to an alternate reference are provided in Protocol K.

Compare biorecons on streams whose upstream drainage is at least 80% within a bioregion to guidelines developed from the ecoregion reference database (Tables 4 and 5). If the test stream crosses multiple bioregions upstream of the test site, select an appropriate upstream or watershed reference. (An alternative is to compare the site to guidelines for each appropriate bioregion, however if assessments differ another reference must be used). Instructions for comparing data to an alternate reference are provided in Protocol F.

- b. 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.
- c. 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.

- d. Unless the stream is small or extremely turbulent, an in-flow will usually hug the stream bank with little lateral mixing 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.
- e. All sampling stations under comparison during a study should have similar habitat unless the object of the study is to determine the effects of habitat degradation.
- f. Sampling stations for macroinvertebrates should be located within the same reach of where sampling for chemical and physical parameters will be located if appropriate habitat is available. If the macroinvertebrates 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 tribs, discharges, construction, agriculture, road crossings or other activities that would influence the stream between the chemical and biological sampling points.
- g. 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.
- h. 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.)
- i. Stream must have had flow for a minimum of 30 days prior to sampling. Avoid habitats that may not have been submerged for 30 days, isolated pools or stagnant water.

Protocol B – Assigning DWR Station ID

A list of existing stations is available as a drop-down on the event e-Form (Appendix B) and the station reference table on Waterlog. If a station does not exist, a new station may be typed in. However, before creating a new station ID, always check waterlog station reference table (under waters tab) to make sure a station has not already been created at that location.

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. 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 Planning and Standards section if there is any question or if there are naming errors associated with existing stations.

If new stations are created they should be uploaded to the stations staging table in waterlog 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 guidance documents for completion and waterlog upload (BESERG) are available on SharePoint or by contacting PAS.

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).

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

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, 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 stream name is the one found on the USGS 7.5 minute topographic map or equivalent GIS layer. Do not use other sources such as gazetteer, TDOT 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 and correspond to the latitude and longitude for easy comparison between multiple stations on the same waterbody. If river mile is shown on the USGS map, measure from those. If not, only use GIS (preferred), or <https://streamstatsags.cr.usgs.gov/streamstats/> to measure stream miles. Always use the 1:24,000 scale. When using GIS use the ArcView measuring tool, do not use the NHD flowline layer or Reach File Index. Do not use TDEC on-line assessment map measuring tool as it is not accurate due to rounding.

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 5, river mile 0 for Bearden Creek would start at the confluence with the original channel of the Clinch River as marked on the topo within Melton Hill Lake. Follow the original stream channel line if marked on the topo (do not use “poly lines”). If the original stream channel is not marked on the topo, 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 PAS to have the stations reassigned.

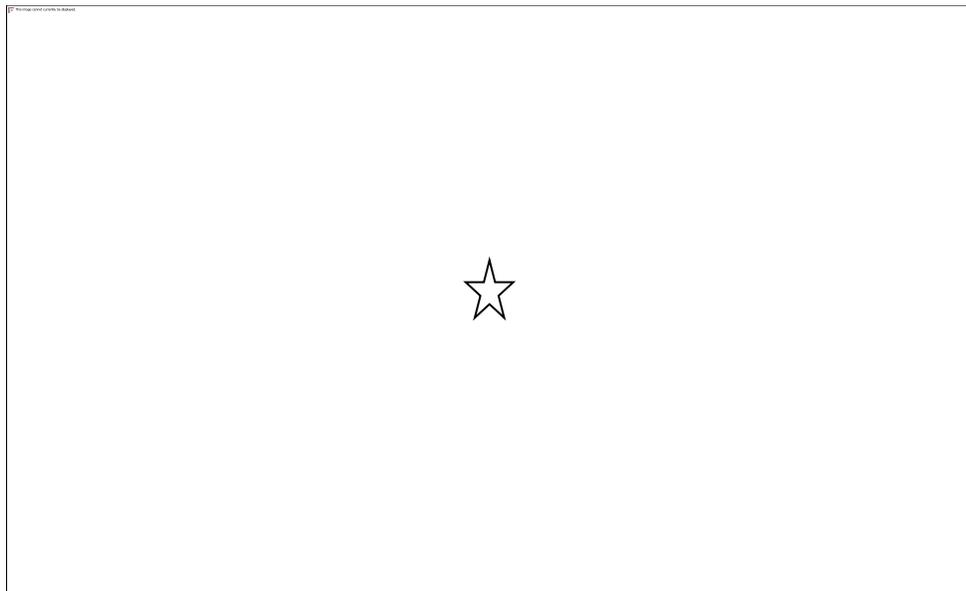


Figure 5: Start of River Mile for Measuring Creeks Within Embayment Areas.

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 FEEO designation no matter what the purpose of sampling. If new ecoregion reference sites are added, contact Planning and Standards (PAS) 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 24 scale USGS topographical map or GIS layer. (Do not use the Gazetteer, local name, TDOT signs etc.).**
- b. The next five characters designate the river mile. This will be written as three whole numbers, a decimal and a tenth space. For example, river mile 1.2 would be written as 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).
- c. The last two characters designate the county (or state if not in Tennessee). Use the County Identification table in Appendix B 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 1.5 on Puncheoncamp Creek in Greene County would be PUNCH001.5GE

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
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 features 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 B. 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 trib 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 0.5 on an unnamed tributary that flows into a second unnamed tributary at river mile 0.1 which, in turn flows into Turkey Creek at river mile 9.0 in Gibson County would be TURKE9.0T0.1T0.5GI (Figure 6).

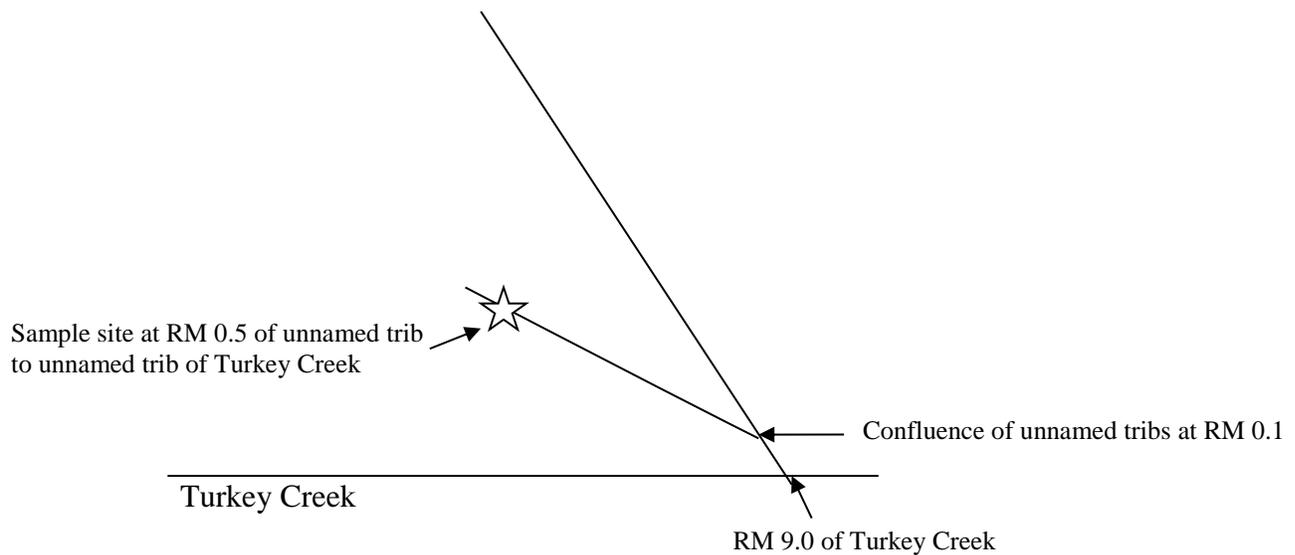


Figure 6: Naming Scheme for Stations Located on Unnamed Tributaries to Unnamed Tributaries. Station ID TURKE9.0T0.1T0.5GI

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 A. If the station is in another state, 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 A. 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.).
- (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 A. 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.

c. 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 A. 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 A. 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 (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 letter L or R to designate the right or left descending shore.
- c. Use the appropriate two-letter county or state abbreviation from Appendix A. 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 the water quality database) then use station ID 5. This would be designated S05.
- c. Use the appropriate two-letter county or state abbreviation from Appendix A. 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, 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 waterlog (Protocol E and SPERG). Multi-probe or individual meters meeting specifications in Table 1 can be used.

Measure dissolved oxygen, pH, temperature and conductivity before biological samples are collected. (If also collecting chemical or bacteriological samples, measure field parameters after these samples are collected). Place the probe upstream of where surface water samples were collected. Allow sensors to equilibrate before recording measurements. Document all measurements including duplicates on the field parameter electronic data sheets.

Table 1: 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

* Areas of mining or other high conductivity/low pH may need a higher range.

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.

Probes should be gently washed after coming in from the field and before drift checks are done. Begin and end the sampling run with cleaned probes to ensure the instrument is ready for calibration and will yield more accurate data.

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 7). 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. 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.

Date	Meter	Project	Init.	Parameter	Standard	Reading	Adj	Comments
3/6/02	YSI-A	Davis Ck	JEB	Conductivity	142	120	142	Cleaned contacts
3/6/02	YSI-A	Davis Ck	JEB	Conductivity	142	140	NA	Drift Check

Figure 7: Meter Calibration Log

- a. **Frequency:** It is necessary to calibrate DO probes each morning of use and at each site where necessary (see # 2). 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, otherwise calibrating these probes once a week is acceptable. A drift check should be performed weekly for temperature. Drift checks for DO probes are not necessary if the meter was recalibrated in the field.
- b. **Temperature:** To check the calibration of the temperature probe place an 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.
- c. **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. Electrolyte and KCL pellets should be replaced monthly in most cases, every 2 weeks in low ionic strength environments. pH electrode should not be submerged during storage.
- d. **Dissolved Oxygen:** The DO probe must be calibrated using either Winkler Titration (mg/l) or air calibration (% saturation) each morning prior to use. Most probes automatically compensate for temperature changes. Some probes also automatically compensate for pressure changes. An ASTM r 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 $\pm 5^{\circ}\text{C}$ change in temperature (higher or lower). If the DO 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 1.

- e. **Conductivity:** Calibrate at 0 and the highest expected conductivity value. When using YSI or other 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.

2. Probe Placement:

Ideally, measure water parameters after collecting chemical and bacteriological samples and before measuring flow or collecting other samples (i.e. macroinvertebrate, periphyton). Turn on the meter(s) and if there is a DO 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 on firm substrate (preferably rock). Do not allow the probe(s) to sink into soft substrate. 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 in the area of 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 in the field notebook or the stream survey field sheet to the specified resolution (Table 9).

If DO readings are erratic or DO is less than 5 mg/l, check the membrane for wrinkles or bubbles or tears. If it is an Luminescent DO 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 DO 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 DO 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 waterlog. 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 waterlog. Indicate potential environmental causes of low or high pH in meter problems.

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 DO 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. All results are to be recorded to the resolution specified in Table 1. Rinse the probes with tap water after use at each site to avoid contamination.

4. Record Field Parameters:

Document the field measurements on the field parameter datasheet. Specific conductivity must be measured in umhos/cm or uS/cm, dissolved oxygen in ppm (mg/l), and temperature in °C. If measurement is outside of criteria and 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 5). Drift checks can be done in the field as long as 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 DO 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 DO 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 drift check fails for any parameter, do not upload data. Indicate on electronic stream survey sheet that there was a problem with the meter for that parameter.

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 week. Duplicate measurements should be taken at each site and recorded on the stream survey sheet.

Protocol D – Habitat Assessment

Copies of all field forms and examples of excel spread-sheet header format are provided in appendix B of this document. E-Forms are available on SharePoint or by contacting PAS. See Biological Survey Electronic Reporting Guidance (BSERG) for details on using e-Forms (Part I) and uploading to Waterlog (Part II). 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.

- a. DWR and TDH staff should upload datasheet from e-Form to Waterlog within 30 days of habitat assessment (and/or within 1 week of sending sample to lab). Do not send habitat sheets to the lab. If doing duplicates, only load consensus to Waterlog.
- b. Habitat assessments conducted by other stakeholders (such as the regulated community) should send a copy of the excel spreadsheet (header format provided in appendix B or contact PAS for e-Form) to Planning and Standards Unit, DWR, TDEC.

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 any macroinvertebrate sample is collected. This assessment must be conducted on the same day the biological sample is collected. Although generally only macroinvertebrate 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. 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 streams 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 <http://tdeconline.tn.gov/dwr/>. The Planning and Standards 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 1-10). 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 meters) with the location of the macroinvertebrate sample the middle of the stream reach. If a longer sampling reach was used to collect macroinvertebrate 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 a pass/fail based on the median reference condition for each ecoregion.** The four broad categories are just a convenient tool to quadrisection 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 2). 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. Attach additional pages if needed. The station number, assessor and date should be included on any additional pages. 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

If using e-Forms, header information will already be populated from the BioEvent.

Header information should be filled out completely. It is important to also complete header information on the second page (back) since documents are often sent as pdf files and pages may become separated. If using e-Forms, header information will already be populated from the BioEvent.

DWR Station ID: If using e-Form, select from drop-down list. If the station is not on the drop-down list or when using paper forms, check stations reference table in waterlog 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. TVA 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 PAS if existing stations are named inappropriately. EFOs and state lab should load station information directly in the staging table in Waterlog using e-Form. Others should submit new station information to PAS using standardized excel spreadsheet (format provided in Appendix C (contact PAS for e-Form)). -.

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

Monitoring Location Name: This is the stream name which should match USGS (topographic map or GIS coverage), or use unnamed tributary to named receiving stream. Do not use local names that are not on the map.

Date: Enter date of assessment (mm/dd/yyyy)

Time: Enter time (24 hour clock no colons)

Monitoring Location: This is the point on the waterbody that is being sampled. If it is an existing station, use location in stations table in Waterlog (automatically populated on e-Forms). If it is a new station, use road names or features identifiable on topographic map if possible. When designating location reference identifiable feature on road or topographic map. 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:

- Upstream STP (specify what STP).
- Stinky STP – Specify upstream or downstream, how far, and which outfall if there is more than one.
- Behind Mr. Jones House. – Mr. Jones may move or next sampler may not know where Mr. Jones lives, use 123 Penny Lane Instead.

- Playground (camp site, church, landfill, park etc.) – Use name of playground and road location or other map feature.
- Off Highway 123 – Roads are long, add another landmark (for example off Hwy 123 approx. 0.5 mile upstream of intersection with Bumpass Rd.
- Highway 123 Bridge – Specify upstream or downstream and how far.
- Farm Road: There are a lot of farms, be more specific.

Field Log Number: 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 (BR, SQSH, Periphyton, Chemicals). Use the format (Primary assessor initials followed by date with no separations and then a 2 digit running number for the day. If it is a duplicate give it the next number in line. For example

- KJL0131201701 would be a habitat sample assessed by KJL on 01-31-17 at the first site of the day.
- KJL0131201702 would be a duplicate habitat sample assessed by KJL on 01-31-17 at the first site of the day.
- KJL0131201703 would be a habitat sample assessed by KJL on 01-31-17 at the second site of the day.

HUC: Specify 8 digit HUC number (will be auto-populated if using DWR electronic datasheet at an existing station.)

Group: Specify watershed assessment group will be auto-populated if using DWR electronic datasheet at an existing station.). This is especially important in watersheds that are split between groups such as 06010102, 06010201 and 06020001.

Ecoregion: Specify ecoregion of stream reach. (will be auto-populated if using DWR electronic datasheet at an existing station.) For new station check station location at <http://tdeconline.tn.gov/dwr/>

Check if consensus or duplicate assessment, otherwise leave blank.

If using paper forms, fill in Station ID, Field log number, date and initials of assessor on back of field sheet. (If field sheet is faxed or single-side copied at a later date, this will help identify the second half of the assessment if they are separated).

Note: If this is a QC, two separate habitat field sheets should be completed independently. Consensus scores may be marked on one of the field sheets (differentiate between investigator and consensus) or a separate sheet may be used. Only the consensus data are uploaded to Waterlog.

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

The moderate to high gradient habitat assessment e-Form 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, rip-rap, 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 newfall)
- 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 rip-rap 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 ($\leq 18''$) 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 ($\leq 18''$) 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 ($\leq 18''$) 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, or 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 be 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 an 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 in pools or slow areas will score higher than sediment on point bars and islands.

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 – Water 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 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, off-road vehicle activity 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. Add livestock access, check categories too.

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. 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 or 4-wheel 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/sand dredging is minimal. There is no evidence of 4-wheel 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. There is no evidence of 4-wheel activity.

16 – Evidence of past 4-wheel vehicle activity. 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 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 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 is expected.
 - 11- New channelization in up to 40% of stream reach. Modification is stable, well vegetated with natural vegetation, no erosion potential. (If not stable score 10).
- Marginal:** Channelization, dredging or 4-wheel activity 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 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 off-road vehicles, 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 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 erosion include crumbling, unvegetated banks, sloughing, exposed tree roots, and 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 determined from base of bank to top.

Optimal: Banks stable, evidence of erosion or bank failure absent or minimal; little potential for future problems, < 5% of the bank affected.

10 – No signs of instability evident. Banks sloping. Little erosion potential.

9 – Some erosion evident or 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.

8 – 5 - 15% of bank has areas of healed over 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 lower if banks are steep.

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

5 – 30 - 40% of bank has areas of erosion or other signs of instability. If approaching 40%, score lower if banks are steep.

4 – 40 - 50% of bank has areas of erosion or other signs of instability. If approaching 50%, score lower if banks are steep.

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.

Poor: Unstable: many eroded areas; raw areas frequent along straight sections and bends; obvious 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 large trees will score highest. Erosion and undercut banks are disruption of vegetative protection. Rock bluff walls also do not provide vegetative protection and should score lower.

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 TN 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 not 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 vegetation but one class not well represented. Other classes allowed to grow to full height. Non-natives may be present but do not affect natural vegetation growth.

Marginal: 50 - 70% of the bank covered by undisturbed native 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% undisturbed, score suboptimal 7 **if** all vegetation including non-native are 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% undisturbed, 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 cropped and not allowed to grow to full height or non-native vegetation is dominant.

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 non-native 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, picnic areas, bare soil, buildings, logging, campgrounds, golf courses, power-lines 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 average 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 actively grazed 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 unpaved, narrow 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.

Sub-optimal: 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 m 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, rip-rap etc.

Habitats that are generally found in low gradient streams include:

- Undercut banks
- Submerged roots
- Macrophyte beds
- Submerged trees (not newfall)
- 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 rip-rap 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 – Macrophytes 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.

Sub-optimal: 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 but are of sufficient size and depth to support fish populations.

8 – Large-deep pools are at least 1 yard providing distinct habitat but are of insufficient length to support fish populations.

7 – Smaller stream, deep pools are less than 1 yard 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). 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). 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.

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

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 are 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 – Water 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 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, or 4-wheel activity (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. 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 or 4-wheel 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. 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. 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 or 4-wheel 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 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 is expected.

11 – New channelization in up to 40% of stream reach. Modification is stable, well vegetated with natural vegetation, no erosion potential. (If not stable score 10.)

Marginal: Channelization, dredging 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 been 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 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, 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) 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 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 TN 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 not 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.

Sub-optimal: 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.

Scoring

Total the 10 habitat parameters and compare the score to the appropriate season and drainage are in the Habitat Assessment Guidelines (Table 2) 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.

Table 2: 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 TMI in each ecoregion.

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 Grad.	109	≥ 98	>107	≥ 111
65j	High Grad.	≥ 148	≥ 169	≥ 152	≥ 157
66d	High Grad.	≥ 157	≥ 158	≥ 146	≥ 157
66e	High Grad.	≥ 158	≥ 152	≥ 143	≥ 148
66f	High Grad.	≥ 135	≥ 136	≥ 148	≥ 140
66g	High Grad.	≥ 140	≥ 140	≥ 150	≥ 124
66j	High Grad.	≥ 145	≥ 139	≥ 115	≥ 132
67f	High Grad.	≥ 131	≥ 128	≥ 133	≥ 123
67g	High Grad.	≥ 106	≥ 103	≥ 136	≥ 129
67h	High Grad.	≥ 156	≥ 148	≥ 125	≥ 146
67i	High Grad.	≥ 114	≥ 117	≥ 114	≥ 117
68a	High Grad.	≥ 135	≥ 145	≥ 139	≥ 128
68b	High Grad.	≥ 124	≥ 129	≥ 137	≥ 143
68c	High Grad.	≥ 131	≥ 124	≥ 163	≥ 155
69d	High Grad.	≥ 133	≥ 123	≥ 134	≥ 123
69e	High Grad.	≥ 127	≥ 122	≥ 151	≥ 136
71e	High Grad.	≥ 113	≥ 114	≥ 145	≥ 130
71f	High Grad.	≥ 126	≥ 123	≥ 129	≥ 126
71g	High Grad.	≥ 126	≥ 128	≥ 119	≥ 149
71h	High Grad.	≥ 115	≥ 114	≥ 132	≥ 123
71i	High Grad.	≥ 112	≥ 99	≥ 113	≥ 114
71i	Low Grad.	≥ 106	≥ 114	NA	NA
73a	Low Grad.	≥ 118	≥ 118	≥ 106	≥ 106
74a	High Grad.	≥ 124	≥ 122	≥ 108	≥ 116
74b	Low Grad.	≥ 108	≥ 108	≥ 134	≥ 113

Protocol E: Stream Survey Field Sheet

Biologist/Environmental Specialist

The stream survey field information must be completed when macroinvertebrate surveys are done. Information on the field sheet is designed to help make assessment decisions and provide supplemental information for interpreting biological sample results. Add additional information, not included on the field sheet, as needed. **Earlier versions should no longer be used.** Consult all personnel present during sampling for additional observations that may have been overlooked before leaving the site.

Copies of all field forms and examples of excel spread-sheet header format are provided in appendix B of this document. E-Forms are available on SharePoint or by contacting PAS. E-forms can be completed directly in field (if Tablets are available) or transferred from worksheets to e-Form upon return. The e-Form will generate a spreadsheet that may be uploaded to Waterlog. See Biological Survey Electronic Reporting Guidance (BSERG) for details on using e-Forms (Volume I) and uploading to Waterlog (Volume 2).

- DWR and TDH staff should upload datasheet to Waterlog within 30 days of habitat assessment (and/or within 1 week of sending sample to lab). Do not send to the lab with bug samples.
- Stream surveys completed by other stakeholders (such as the regulated community) should send a copy of the excel spreadsheet to Planning and Standards Unit, DWR, TDEC. (the header format for the spreadsheet is provided in appendix C, or contact PAS for e-Form).

1. Header Information

If using e-Forms, header information will already be populated from the BioEvent.

- a. **DWR Station ID:** Check current stations table in waterlog 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. TVA 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 PAS if existing stations are named inappropriately.
- b. **Samplers:** Include initials of all samplers at the event.
- c. **Monitoring Location Name:** The waterbody name should match USGS (for example topographic map or GIS coverage), or use unnamed tributary to named receiving stream. Do not use local names that are not on the map.

- d. **Date:** Enter date of assessment (MM/DD/YYYY)
- e. **Time:** Enter time (24 hour clock no colons)
- f. **Monitoring Location:** This is the point on the waterbody that is being sampled. If it is an existing station, use location in stations table in Waterlog. If it is a new station, use road names or features identifiable on topographic map if possible. When designating location reference identifiable feature on road or topographic map. 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:

Upstream STP (specify what STP).

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

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

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

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

Highway 123 Bridge – Specify upstream or downstream and how far.

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

- g. **Organization:** Environmental field office or other sampling agency. Use code found in Appendix B, unless agency is not listed.
- h. **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/>
- i. **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/>
- j. **U/S ecoregion:** If the upstream drainage is in another ecoregion record this in U/S ECO. Contact PAS if uncertain of ecoregion.
- k. **County** is the county name where the station is located (even if most of drainage is in another county). If using DWR electronic datasheets, county will be auto-populated for existing stations. For streams which form county boundaries, be consistent with other stations located on the stream. Do not use state or federal codes.

- l. **Latitude and Longitude** are to be recorded in decimal degrees measured by GPS. 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. If discrepancies are discovered, notify PAS of need to correct database information once you have confirmed the correct location and GPS reading are accurate.
- m. **HUC**: Specify 8 digit HUC number
- n. **WS Group**: Specify watershed assessment group. This is especially important in watersheds that are split between groups such as 06010102, 06010201 and 06020001.
- o. **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/>.
- p. **Field Log Number**

Samples must be assigned a field log number to allow complete reconstruction, from initial field records, through data storage 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. If using paper forms the same field log number should be assigned to all samples collected at that site that day (BR, SQSH, Periphyton, Chemicals). 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.)

- KJL0131201701 would be all of the samples (habitat, biorecon, SQSH, periphyton etc.) collected or assessed by KJL on 01-31-17 at the first site of the day.
- KJL0131201702 would be the duplicate samples collected or assessed by KJL on 01-31-17 at the first site of the day.
- KJL0131201703 would be would be all of the samples (habitat, biorecon, SQSH, periphyton etc.) collected or assessed by KJL on 01-31-17 at the second site of the day.
- KJL0201201701 would be all of the samples (habitat, biorecon, SQSH, periphyton etc.) collected or assessed by KJL on 02-01-17 at the first site of the day

- q. **Project Name:** If using DWR electronic datasheet, select project name associated with the project purpose. The most common ones are included on the form as a check box (watershed, 303(d), Antideg, ECO, FECO). If sampling for another project specify in the “Other” field. Use project codes found in Appendix E or Waterlog Reference Table if possible. If a new project needs to be added contact PAS.
- r. **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 Waterlog Reference Table if possible. If a new project needs to be added contact PAS
- s. **Activity Type:** Indicate the type of activity as listed in Table 3.

Table 3: Stream Survey Activity Types

Activity Type (Official name)	Activity Type Code	Sample Type	Description
Sample-Routine	Sample	BR or SQSH + Habitat Assessment	BR or SQSH sample collected, no QC.
Quality Control Sample-Field Replicate	QC Sample	BR or SQSH Field Duplicate	BR or SQSH Field duplicate may or may not include habitat QC
Field Msr/Obs-Habitat Assessment	Habitat	Habitat Assessment only	Habitat Assessment with no bug sample. No duplicate.
Quality Control Field Replicate Habitat Assessment	QC Habitat	Habitat Assessment QC	Habitat assessment independent duplicates with Consensus uploaded. No bug samples collected.
Quality Control Sample-Lab Duplicate	QC ID	Taxonomic QC	Lab duplicate with 2 taxonomists independently identifying sample.

2. Sample Information

- a. **Sample Status.** Indicate the status of the sample. If the sample could not be collected indicate if another attempt will be made to collect the sample when conditions improve.
- 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).

3. Field Parameters

Use calibrated meters for all field measurements (protocol C)

Designate what type of meter (and which meter) was used to make readings. The measurements for each parameter (including duplicates) are recorded in the appropriate boxes. All measurements are recorded in the units specified on the field sheet. Record any other field measurements, such as percent oxygen saturation, turbidity or TDS that were taken at the time of sampling

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 waterlog. 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 (bad 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 and do not record value.

4. Photographs

A digital photographic record is to be kept on each sampling station. Photographs of the general stream condition and potential pollution sources 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 whether photos were taken and describe including identification numbers. Photos should be saved on PAS SharePoint under the EFO folder. Use the field log number in the file name. Example KJL17072017001 Upstream.

5. Weather

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

6. Physical Characteristics and Light Penetration

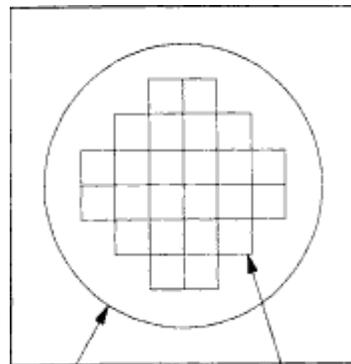
- a. Indicate stream gradient in sample reach.
- b. Estimate average stream width of reach area in yards. (This is wetted width.)
- c. Estimate stream at deepest point (usually pool) in yards
- d. Estimate average canopy for the entire reach and record value.

- 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). The densiometer is a convex mirror etched into 24 ¼-inch boxes (Figure 8). 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.

Note: If also collecting periphyton, the densiometer measurements from the five transects recorded on the periphyton worksheet will take the place of these measurements.



Photo provided by Joellyn Brazille, Memphis EFO



Cook et al. 1995

Figure 8: Spherical Densiometer

7. 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.

8. **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 and type.
 - 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.). Diurnal dissolved oxygen patterns may not be affected.
 - High: Algae frequent, possible nutrient loading, probably causing diurnal DO 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 DO swings indicated, Observable reduction of niche and probable change in biotic community structure.
- f. 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 ARAP permits a pebble count may be desirable to provide a more concise measure of change in substrate.)
- g. Surrounding Land Use: Select up to 4 surrounding land uses that affect the immediate stream reach. Describe any other land uses under stream information.
- h. 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.

i. 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. If using e-Form, do not use commas however other punctuation marks like semicolons or periods may be used

j. Stream Sketch –

A station sketch is made at the time of sampling. This sketch should be detailed enough so that subsequent sampling teams or data reviewers can determine where samples were taken and what potential sources of impairment were present. Use a separate sheet of paper if necessary. At a minimum, the sketch should include a rough outline of stream sinuosity, direction of flow, location of riffles and pools, location of samples (benthic, chemical, field parameters), location of bridges or any other man-made structures (include distance from sampling point), location of tributaries, run-off ditches, discharges, livestock access, and any other potential pollution sources. It is helpful to designate which direction is north.

Protocol F - Biorecon (Reconnaissance/Screening)

The Biorecon method is a modification of EPA's *Rapid Bioassessment for Use in Wadeable Streams and Rivers* (Barbour et. al., 1999).

This method is a standardized screening tool used by division staff for problem identification and/or prioritizing sites for further assessment, monitoring or protection. The method is not intended for use by non-Division staff for any purpose.

Primary sampler and taxonomist must meet minimum requirements outlined in Section I.G.

Because the biorecon is qualitative and involves limited data generation, its effectiveness depends largely on the experience of the biologist performing the assessment. The method is designed to be expedient and requires an experienced and well-trained biologist to be effective. The biologist should have stream assessment experience, knowledge of aquatic ecology and expertise in benthic macroinvertebrate taxonomy and community structure for the ecoregion in which they are conducting the assessment. Primary investigators must meet minimum requirements outlined in Section I.G.

The biorecon is most useful in discriminating clearly impaired or non-impaired areas from those areas requiring further investigation. However, chemical samples, in-stream water quality measurements, field observations, professional expertise, estimates of taxa abundance, identification to a lower taxonomic level and/or habitat data can help clarify assessment decisions in ambiguous situations.

Biorecons cannot be compared to biocriteria or to semi-quantitative samples. Only qualitative richness biometrics which do not include measurements of relative abundance can be calculated. Metrics may be compared to the biorecon guidance derived from biorecons conducted at ecoregion reference sites (Tables 3-4). They are not to be used for regulatory purposes such as permit compliance.

There are occasions when a biorecon will be preferred when doing assessments:

- Streams in middle and east TN where good quality riffles are naturally not available. (For example bedrock dominant, boulder step-pool, lower gradient where SQBANK guidelines are not developed and non-wadeable streams). Judgement should be used to determine if the targeted habitat would be the most productive in the absence of human disturbance. If not, a biorecon should be conducted instead of a SQSH.
- Sediment dominated streams where the riffle is the cleanest substrate due to fast flow and may represent refugia. (Conversely if a riffle is inundated by sediment to where it is no longer a high quality riffle it should be sampled using a SQKICK.)

- Streams that are obviously impaired with extremely limited habitat (Should score a 5 on the biorecon.)
- Streams with a history of good SQSH scores (36 or higher).

The flow charts in Protocol A should be used when determining when biorecon sampling is appropriate.

If biorecon IDs are completed by the EFO, final ID and metric spreadsheets should be uploaded to Waterlog as soon as possible after ID completion (preferably within a week if workload priorities allow). All IDs must be completed and uploaded by June 30 of the watershed sampling year so assessments can be scheduled in the fall.

Note that habitat and/or assessment forms must be uploaded prior to taxa or metric forms to create an event in waterlog.

See Biological Survey Electronic Reporting Guidance (BSERG) for details on how to complete electronic field sheets and upload to waterlog.

If biorecons are sent to the lab for ID, the lab will upload taxa list and metrics to Waterlog and will notify the EFO when completed. (The EFO will be responsible for uploading habitat, water parameters and field surveys before the taxa can be reported.)

1. Biorecon Field Sheet Header and assigning log numbers.

See BSERG guidance (Biological Survey Electronic Reporting Guidance for instructions.)

Samples will automatically be assigned a Field Log Number when entered on the e-Form. If the sample is a biorecon and the voucher is identified at the EFO, Ben Sample ID (lab log number) will be assigned automatically by the electronic reporting form. If the sample is a biorecon, SQSH or periphyton that is going to the lab for analysis, the lab will assign the Ben Samp ID through their LIMs System.

2. Taxonomic Level

Unless this is an ecoregion or headwater reference site, either genus level or family level biorecons can be conducted. (Both genus and family must be reported at reference sites). Genus level biorecons are more sensitive but require more time and taxonomic expertise. Often family level biorecons are adequate screening tools especially when biological community is obviously diverse or highly stressed. If more sensitivity is needed, a semi-quantitative sample may be more useful than a genus level biorecon especially if richness is high but abundance is low.

On both genus and family biorecons all individuals in the following taxa groups will be combined and counted as one record (either Chironomidae or Oligochaeta):

- Chironomidae
- Oligochaeta

Do not include any semi-aquatic taxa, Curculionidae, Collembola or micro/meio-crustacea

Taxa Groups Excluded from Metric Calculations (compiled from taxa that have historically been collected by DWR)

- Anthicidae
- Carabidae
- Chrysomelidae
- Cladocera
- Collembola
- Copepoda
- Curculionidae
- Gerridae
- Gyridae (adults)
- Ostroca
- Staphylinidae
- Veliidae

Indicate target taxonomic level on the biorecon field data sheet. (Note in some cases when doing a genus level biorecon, an immature or damaged individual can only be identified to family, this is still considered a genus level biorecon.) To adhere to metric calibrations, no genera should be identified on a family level biorecon even if the taxonomist is able to identify further.

3. Habitat Selection

Determine what habitat is available and the relative percent contribution of each habitat. Record percent habitat on the biorecon field sheet (even for those not sampled).

Select up to four of the most productive habitats for sampling a total of 4 aliquots. Only consider habitats that comprise more than 5% of the available habitat in the stream -reach. Do not split habitats (no half-jabs) – do not collect more than 4 habits. Productive habitats include riffles/swift-runs, slow-run/pool rocks, leaves, woody debris/snags, undercut banks/tree roots, macrophyte beds, and fine sediment. Other productive habitats that comprise more than 5% of the available habitat in the stream reach may also be selected. Estimate approximately 0.5 yards of sampling area for any habitat selected.

Proportion the selected habitats into four aliquots based on percent contribution. For example, if the selected habitats are riffle (50%), leaf packs (30%) and undercut banks (20%) the sample would be comprised of two riffle kicks, one leaf collection and one bank collection. Never sample more than four habitats and only collect a total of four aliquots. Record the number of aliquots from each habitat on the Biorecon Field Sheet.

4. Sample Collection

Sample selected habitats using a 500 micron mesh triangular dip net (13 inches wide). Use the appropriate techniques which are described below depending on the type of habitat. Take care not to over-sample since this could skew results as reference data is calibrated to 4 aliquots from a maximum of 4 habitats.

a. Riffle/Swift-Run Kick:

Position the net on the bottom of the stream and disturb the substrate by shuffling and kicking your feet the width of the net and for approximately 0.5 yard upstream of the net. Use hands or soft brush to scrape clinging organisms off larger rocks. This is considered 1 aliquot from a riffle habitat.

b. Slow-Run and/or Pool Rock:

Select several rocks of various sizes equaling approximately 0.5 square yard of surface area in slow run and/or pool areas. Select equivalent number and size of rocks to approximate the width of the net and extending 0.5 yards. Avoid rocks that are embedded. The net should be positioned under the rock while lifting to capture escapees or place in a sieve bucket or pan before picking. This is considered 1 aliquot from a slow run rock and/or pool rock habitat.

c. Leaf Habitat (pack or accumulation):

Collect three single handfuls (baseball size) of leaves by positioning the net downstream or under the leaves, then scooping the leaves into the net by hand. (If leaves are accumulated in deep area scoop the net to collect approximately the same amount of material). Select leaves from various locations (riffle, run, and pool if possible). The leaves should be submerged and show evidence of being consumed by benthic macroinvertebrates (50% decomposition is optimal). Avoid collecting recently deposited or fully decomposed leaf litter. This is considered 1 aliquot from a leaf habitat.

d. Snags/Woody debris:

Select snags and/or woody debris that have been submerged for a relatively long period (not recent deadfall). Sample submerged woody debris by jabbing in medium-sized snag material (sticks and branches). The snag habitat may be kicked first to help dislodge organisms, after placing the net downstream of the snag. Accumulated woody material in pool areas are also considered snag habitat. A single jab is approximately the width of the net and extending 0.5 yards (skim surface area do not dig deeply into debris.). Avoid sampling sediment. This is considered 1 aliquot from snag or woody debris.

e. Undercut Banks and/or Tree Roots

Select bank habitat that is undercut with submerged hanging roots or plants. Submerged tree roots that are not undercut may also be sampled. Thrust the net vigorously under the bank to dislodge clinging organisms. A single aliquot is approximately two net width jabs. Avoid digging into the sediment, as this constitutes another habitat type. This is considered one aliquot from undercut banks and/or tree roots.

f. Macrophytes

In deep water, sample aquatic plants that are rooted on the bottom of the stream by drawing the net through the vegetation from the bottom to the surface of the water. In shallow water, bump or jab the net along the bottom in the rooted area. Avoid collecting sediment if possible. Either type of macrophyte jab should not exceed 0.5 linear yards (two net widths) even if collected from multiple beds. This is considered one aliquot from macrophytes.

g. Fine sediment

Sediment is found in quiet areas of the stream. Select fine silt, sand or muck with minimal gravel. Seek areas with evidence of tunneling by burrowing macroinvertebrates. Gently skim the net through the sediment for 0.5 yard length and approximately two inches deep. This is considered one aliquot from sediment.

5. Sample Sorting/Identification

Picking should be done in the field in a well-lit area and upon a stable surface such as a camp-table, flat boulder, sand bar etc. to avoid disturbing the pan.

Vouchers are combined in one bottle, but it is helpful to pick each habitat separately to help with selecting voucher specimens since different taxa prefer different habitats. Examine large materials (rocks, leaves, sticks) for organisms and then discard. Rinse the remainder of the debris using a sieve, (or swish the net in the creek). Transfer small amounts of debris to a white pan with a little stream water for field sorting. Keep the rest of the sample submerged. Scan the debris and water for organisms.

If doing a family biorecon, record field identification (or description for later identification at field office if uncertain.) Unless this is a QC site or identification is uncertain, vouchers do not need to be routinely collected for family biorecons. Vouchers of any families where ID is uncertain and complete vouchers of all taxa at 10% of sites must be collected. Vouchers should also be collected if there is a possibility that more definitive (genus level) identification may be necessary.

If doing a genus level bioecon, record field identification or description of each distinct taxon on the bioecon field sheet (so that you can recognize it back at the office). Voucher specimens of each unique taxon are required for genus level identifications. Any taxa not found on the Tennessee taxa list (Appendix C) must be sent to the lab for expert verification and inclusion in state reference collection.

On the bioecon field sheet for both family and genus bioecon, record the relative abundance of each taxon (1, 2, 3, 4). This will help with determination of impairment in ambiguous bioecon. Indicate relative abundance for both field identification and voucher identification (if collected) in the appropriate boxes for each taxon on the bioecon field sheet. If, after voucher identification, relative abundance cannot be estimated (for example multiple taxa were identified that were not differentiated in the field), place a 0 in the voucher box for that taxon and make a comment about abundance of family.

For reporting and upload to waterlog, only the Final ID and Final estimate are used.

- 1 = rare (1-3 organisms)
- 2 = common (4-9 organisms)
- 3 = abundant (10-49 organisms)
- 4 = dominate (> 50 organisms)
- 0 = uncertain (used to indicate voucher identification with uncertain abundance)

6. Voucher Specimens

Do not retain any threatened or endangered species. Check coverage to determine whether T&E species are likely in the stream reach and make sure you are able to recognize them in the field. When in doubt do not retain. Indicate in comment area of stream survey sheet identification and number of animals released. If species was not previously recorded in that stream reach complete ETW form and submit to Planning and Standards. Notify Natural Areas Unit. If T&E species are inadvertently added to sample contact TWRA (and USFWS if federally listed.)

- a. Family level bioecon. Vouchers (of all taxa in sample) are only required at 10% of sites and any taxon where family cannot be field differentiated (for example Leuctridae/Capniidae; Baetidae/Ameletidae; Polymitarcyidae/Ephemeroidea; Ephemerellidae/Leptohyphidae/Caenidae; Psychomyiidae/Polycentropodidae; Corduliidae/Libellulidae; Unenoidae/Limnephilidae/Odontoceridae; or early instars).
- b. Genus level bioecon. Vouchers are required at all sites. Taxa that are not included on Tennessee taxa list (Appendix C) must be sent to the lab for expert verification and inclusion in state reference collection.

Place one or more representatives of each taxon in a small bottle containing 80% ethanol. If identifying to genus level, preserve several individuals of families that commonly have multiple genera that are difficult to differentiate in the field such as Heptageniidae, Hydropsychidae, and many stonefly families. Include individuals that vary in color and/or size. Since the biorecon is designed to be a fast screening tool, try to limit voucher specimens to a few representatives that are thought to be distinct taxa. But make sure you have enough representatives to include unique taxon. Select a few from each sampled habitat. Consult historic taxa lists from area streams to get an idea of what taxa are generally found. Fifty animals or less should be adequate in most ecoregion/stream types although up to a hundred may be necessary in taxa rich streams. This will be easier with experience. If more definitive identifications are necessary, it would probably be more appropriate to collect a semi-quantitative sample.

Place an internal tag with the station ID, date, sampler's initials and sample type inside the bottle (Figure 9). Attach an external sample tag to the outside of the bottle (Figure 10). Alternatively, the same information can be written on the outside of the bottle using indelible ink.

DAVIS0012.5CL
COL: JEB/DRM
3/6/02
BIORECON

Figure 9: Example of Internal Tag.

Program/Billing Code	Site No. DAVIS01254	County Code 13	Month/Day/Year 3/06/02	Time 1200	Designate Comp. Grab
Station Location: Davis G 100yds u/s Dairy			Sampler: JEB/DRM		
Field #	Remarks: Biorecon	Biological	Fed/chemical	Pesticides/PCBs	Petroleum Hydrocarbons
Lab Sample No.				Volatile Organics	Extractable Organics
				Metals	Cyanide
				Microbiologicals	COD, TOC, Nutrients
				BOD, Solids	ANALYSES
					Preservative: No <input type="checkbox"/> Yes <input type="checkbox"/>

Figure 10: External Tag

At the EFO, check the voucher organisms using a dissecting scope for accuracy in field identification. When conducting genus level biorecons identify all taxa to genus except chironomids, oligochaetes, acari, nematodes, and nematomorphs. Whichever target taxonomic level is selected, be consistent throughout the sample. For example, do not identify EPT to genus in a family level biorecon. Record appropriate changes for field misidentifications on the biorecon field sheet and indicate relative abundance (or 0 if uncertain) for each verified taxon.

Retain voucher animals for five years for QC purposes or in case further identification is needed at a later date. Add the name of the taxonomist, log number and date identified to the existing internal and external field tags (Figure 11).

Any genera identified, that are not on the taxa list in Appendix C should be sent to the TDH lab for verification and inclusion in the statewide reference collection.

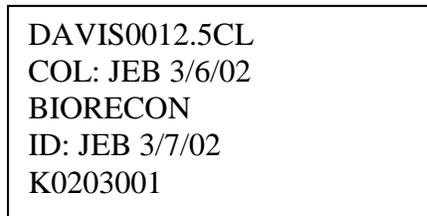


Figure 11: Example of Internal Tag After Sample Identification

- 7..It is important that all taxonomists use the same primary keys for consistency in identification and nomenclature. In 2017, the primary key for EPT will continue to be Merritt and Cummins 4th edition since the new EPT of the Southeastern U.S (Morris et al, 2017). was not released until after metrics were calibrated. However EFOs and the state lab should use the EPT of the Southeastern U.S. for all reference (ECO and FECO) to aid in recalibration of metrics and scoring revisions in 2018. Once these are published, they will be used for all sample types.
8. **Biometric Calculation** – After confirming field identifications, calculate three qualitative biometrics (that do not rely on relative abundance). Do not calculate NCBI or any other metric that relies on more quantitative sampling or subsampling protocols. Never include exuvia, empty caddis cases or empty mollusk shells when calculating biometrics although these can be noted for additional information.

The e-Form will calculate metric values. Use tables 4-7 to score each metric and enter the index score in the space provided. If identified to genus level, only report genus level scores unless it is a reference sites (ECO, FECO).

All ecoregions

- a. **Taxa Richness (TR)** – The total number of distinct taxa found at a site. Do not include micro/meio-crustacea, Collembola, Curculionidae, semi-aquatic taxa such as Gerridae and Veliidae, empty caddis cases, empty mollusk shells, exuvia, non-aquatics or winged adults. Do not count unidentified genera as a separate taxon, unless they are clearly a different genus (or family) than those identified. Indicate in comment field if unidentified taxa are unique. Count all chironomids as one taxon for both family and genus level biorecons. Indicate in comment whether red or non-red are more abundant.

On both genus and family biorecons all individuals in the following taxa groups will be combined and counted as one record (either Chironomidae or Oligochaeta).

- Chironomidae
- Oligochaeta

Taxa Groups Excluded from Metric Calculations (compiled from taxa that have historically been collected by DWR).

- Anthicidae
- Carabidae
- Chrysomelidae
- Cladocera
- Collembola
- Copepoda
- Curculionidae
- Gerridae
- Gyrinidae (adults)
- Ostrocada
- Staphylinidae
- Veliidae

All ecoregions except 73

- b. **Ephemeroptera, Plecoptera and Trichoptera (EPT)** – The total number of distinct taxa found in EPT orders at the site. (Do not include empty caddis cases, exuvia, non-aquatics or winged adults). Do not count unidentified genera as a separate taxon, unless they are clearly a different genus (or family) than those identified.
- c. **Intolerant Taxa (IT)** – The number of intolerant taxa (defined as having an NCBI value from 0.00 to 3.00) found at the site. Appendix C contains a list of families that should be counted as intolerant and a table of NCBI scores for genera. For statewide consistency and comparability to the reference database, **DO NOT** count any animals intolerant that are not on this list.

When doing genus level biorecons, if an animal can only be identified to family and there are no other genera present in that family, it should be considered intolerant if it is an intolerant family. Likewise, for new genera where a tolerance value has not been assigned, it will be considered an intolerant taxa if the family is intolerant (see protocol k for assigning NCBI values).

Table 4: Scoring Guidance for Family Level Biorecons

**4a. Scoring Guidance for Family Level Biorecons in Streams > 2.5 sq. Mile Drainage
 (All Ecoregions Except 73)**

Bio-region	Season	Taxa Richness (TR)			EPT			Intolerant Taxa (IT)		
		5	3	1	5	3	1	5	3	1
65abei	Jan-June	> 17	9-17	< 9	> 6	4-6	< 4	> 3	2-3	< 2
65abei	July-Dec	> 18	9-18	< 9	> 8	4-8	< 4	> 2	2	< 2
65j	Jan-June	> 17	9-17	< 9	> 10	5-10	< 5	> 5	3-5	< 3
65j	July-Dec	> 18	10-18	< 10	> 8	4-8	< 4	> 5	3-5	< 3
66deik	Jan-June	> 14	7-14	< 7	> 8	5-8	< 5	> 7	4-7	< 4
66deik	July-Dec	> 14	7-14	< 7	> 8	5-8	< 5	> 7	4-7	< 4
66fgj	Jan-June	> 19	10-19	< 10	> 11	6-11	< 6	> 9	5-9	< 5
66fgj	July-Dec	> 17	9-17	< 9	> 10	6-10	< 6	> 7	4-7	< 4
67fghi	Jan-June	> 21	11-21	< 11	> 9	5-9	< 5	> 6	4-6	< 4
67fghi	July-Dec	> 17	9-17	< 9	> 7	4-7	< 4	> 4	3-4	< 3
68ad	Jan-June	> 22	11-22	< 11	> 10	5-10	< 5	> 5	3-5	< 3
68ad	July-Dec	> 20	10-20	< 10	> 9	5-9	< 5	> 6	4-6	< 4
68b	Jan-June	> 18	9-18	< 9	> 10	5-10	< 5	> 6	4-6	< 4
68b	July-Dec	> 13	7-13	< 7	> 6	3-6	< 3	> 4	2-4	< 2
68c	Jan-June	> 15	8-15	< 8	> 8	5-8	< 5	> 5	3-5	< 3
68c	July-Dec	> 13	7-13	< 7	> 5	3-5	< 3	> 3	2-3	< 2
69de	Jan-June	> 20	10-20	< 10	> 12	7-12	< 7	> 9	5-9	< 5
69de	July-Dec	> 18	9-18	< 9	> 8	5-8	< 5	> 6	4-6	< 4
71e	Jan-June	> 18	10-18	< 10	> 8	5-8	< 5	> 3	2-3	< 2
71e	July-Dec	> 18	9-18	< 9	> 7	4-7	< 4	> 3	2-3	< 2
71fgh	Jan-June	> 20	11-20	< 11	> 10	5-10	< 5	> 5	3-5	< 3
71fgh	July-Dec	> 18	10-18	< 10	> 7	4-7	< 4	> 4	2-4	< 2
71i	Jan-June	> 18	10-18	< 10	> 5	3-5	< 3	> 3	2-3	< 2
71i	July-Dec	> 18	9-18	< 9	> 6	3-6	< 3	> 2	2	< 2
74a	Jan-June	> 10	6-10	< 6	> 3	2-3	< 2	> 1	1	< 1
74a	July-Dec	> 11	6-11	< 6	> 3	2-3	< 2	> 1	1	< 1
74b	Jan-June	> 15	8-15	< 8	> 4	2-4	< 2	> 1	1	< 1
74b	July-Dec	> 13	7-13	< 7	> 4	3-4	< 3	> 1	1	< 1

**Scoring guidance for family level biorecons in Streams > 2.5 sq. mile drainage
 (Ecoregion 73 Only)**

Bio-region	Season	Taxa Richness (TR)			ETO			CRMOL		
		5	3	1	5	3	1	5	3	1
73ab	Jan-June	> 11	6-11	< 6	> 2	1-2	< 1	> 3	1-3	< 1
73ab	July-Dec	> 13	7-13	< 7	> 4	2-4	< 2	> 3	2-3	< 2

4b. Scoring Guidance for Family Level Biorecons in Headwater Streams \leq 2.5 sq. mile Drainage (All Ecoregions Except 73)

Bio-region	Season	Taxa Richness (TR)			EPT			Intolerant Taxa (IT)		
		5	3	1	5	3	1	5	3	1
65abei	Jan-June	> 14	8-14	< 8	> 7	4-7	< 4	> 3	2-3	< 2
65abei	July-Dec	> 11	6-11	< 6	> 4	2-4	< 2	> 2	2-3	< 2
65j	Jan-June	> 17	9-17	< 9	> 6	4-6	< 4	> 4	2-4	< 2
65j	July-Dec	> 16	9-16	< 9	> 6	3-6	< 3	> 4	3-4	< 3
66deik	Jan-June	> 14	8-14	< 8	> 9	5-9	< 5	> 7	4-7	< 4
66deik	July-Dec	> 12	6-12	< 6	> 8	4-8	< 4	> 6	3-6	< 3
66fgj	Jan-June	> 19	10-19	< 10	> 12	7-12	< 7	> 8	5-8	< 5
66fgj	July-Dec	> 16	9-16	< 9	> 10	5-10	< 5	> 7	4-7	< 4
67fghi	Jan-June	> 14	7-14	< 7	> 8	4-8	< 4	> 5	3-5	< 3
67fghi	July-Dec	> 18	10-18	< 10	> 10	5-10	< 5	> 7	4-7	< 4
68ad	Jan-June	> 10	6-10	< 6	> 4	3-4	< 3	> 2	2	< 2
68ad	July-Dec	> 10	6-10	< 6	> 4	3-4	< 3	> 2	2	< 2
68b	Jan-June	> 14	8-14	< 8	> 8	4-8	< 4	> 4	3-4	< 3
68b	July-Dec	> 12	6-12	< 6	> 5	3-5	< 3	> 2	2	< 2
68c	Jan-June	> 16	9-16	< 9	> 10	5-10	< 5	> 7	4-7	< 4
68c	July-Dec	> 15	8-15	< 8	> 9	5-9	< 5	> 6	4-6	< 4
69de	Jan-June	> 12	6-12	< 6	> 9	5-9	< 5	> 6	4-6	< 4
69de	July-Dec	> 10	6-10	< 6	> 6	4-6	< 4	> 5	3-5	< 3
71e	Jan-June	> 17	9-17	< 9	> 8	5-8	< 5	> 5	3-5	< 3
71e	July-Dec	> 16	8-16	< 8	> 6	3-6	< 3	> 2	2	< 2
71fgh	Jan-June	> 17	9-17	< 9	> 10	5-10	< 5	> 6	4-6	< 4
71fgh	July-Dec	> 16	8-16	< 8	> 7	4-7	< 4	> 4	2-4	< 2
71i	Jan-June	> 15	8-15	< 8	> 5	3-5	< 3	> 3	2-3	< 2
71i	July-Dec	> 15	8-15	< 8	> 5	3-5	< 3	> 3	2-3	< 2
74a	Jan-June	> 9	5-9	< 5	> 2	1-2	< 1	> 1	1	< 1
74a	July-Dec	> 11	6-11	< 6	> 2	1-2	< 1	> 1	1	< 1
74b	Jan-June	> 8	5-8	< 5	> 1	1	< 1	> 1	1	< 1
74b	July-Dec	> 14	7-14	< 7	> 3	2-3	< 2	> 1	1	< 1

Scoring guidance for family level biorecons in Headwater Streams \leq 2.5 sq. mile drainage (Ecoregions 73 Only)

Bio-region	Season	Taxa Richness (TR)			ETO			CRMOL		
		5	3	1	5	3	1	5	3	1
73ab	Jan-June	> 7	4-7	< 4	> 1	1	< 1	> 3	2-3	< 2
73ab	July-Dec	> 7	4-7	< 4	> 1	1	< 1	> 3	2-3	< 2

**5a. Scoring Guidance for Genus Level Biorecons in Streams > 2.5 sq. mile Drainage.
 (All Ecoregions Except 73)**

Bio-region	Season	Taxa Richness (TR)			EPT			Intolerant Taxa (IT)		
		5	3	1	5	3	1	5	3	1
65abei	Jan-June	> 19	10-19	< 10	> 7	4-7	< 4	> 3	2-3	< 2
65abei	July-Dec	> 20	10-20	< 10	> 8	4-8	< 4	> 2	2	< 2
65j	Jan-June	> 22	11-22	< 11	> 12	7-12	< 7	> 8	4-8	< 4
65j	July-Dec	> 19	10-19	< 10	> 9	5-9	< 5	> 5	3-5	< 3
66deik	Jan-June	> 17	9-17	< 9	> 11	6-11	< 6	> 11	6-11	< 6
66deik	July-Dec	> 18	9-18	< 9	> 12	7-12	< 7	> 12	6-12	< 6
66fgj	Jan-June	> 33	17-33	< 17	> 23	12-23	< 12	> 19	10-19	< 10
66fgj	July-Dec	> 25	13-25	< 13	> 17	9-17	< 9	> 15	8-15	< 8
67fghi	Jan-June	> 31	16-31	< 16	> 14	7-14	< 7	> 11	6-11	< 6
67fghi	July-Dec	> 27	14-27	< 14	> 12	7-12	< 7	> 8	5-8	< 5
68ad	Jan-June	> 35	18-35	< 18	> 19	10-19	< 10	> 12	6-12	< 6
68ad	July-Dec	> 33	17-33	< 17	> 15	8-15	< 8	> 13	7-13	< 7
68b	Jan-June	> 22	11-22	< 11	> 13	7-13	< 7	> 8	5-8	< 5
68b	July-Dec	> 16	8-16	< 8	> 8	5-8	< 5	> 4	2-4	< 2
68c	Jan-June	> 18	10-18	< 10	> 10	5-10	< 5	> 8	4-8	< 4
68c	July-Dec	> 17	9-17	< 9	> 8	4-8	< 4	> 7	4-7	< 4
69de	Jan-June	> 28	14-28	< 14	> 18	9-18	< 9	> 13	7-13	< 7
69de	July-Dec	> 24	13-24	< 13	> 14	7-14	< 7	> 10	6-10	< 6
71e	Jan-June	> 21	11-21	< 11	> 10	5-10	< 5	> 6	4-6	< 4
71e	July-Dec	> 21	11-21	< 11	> 7	4-7	< 4	> 4	3-4	< 3
71fgh	Jan-June	> 26	13-26	< 13	> 12	7-12	< 7	> 9	5-9	< 5
71fgh	July-Dec	> 24	12-24	< 12	> 9	5-9	< 5	> 7	4-7	< 4
71i	Jan-June	> 22	12-22	< 12	> 7	4-7	< 4	> 5	3-5	< 3
71i	July-Dec	> 22	11-22	< 11	> 6	4-6	< 4	> 4	3-4	< 3
74a	Jan-June	> 12	7-12	< 7	> 4	2-4	< 2	> 1	1	< 1
74a	July-Dec	> 13	7-13	< 7	> 4	3-4	< 3	> 1	1	< 1
74b	Jan-June	> 19	10-19	< 10	> 4	3-4	< 3	> 2	2	< 2
74b	July-Dec	> 16	9-16	< 9	> 6	3-6	< 3	> 1	1	< 1

**Scoring Guidance for Genus Level Biorecons in Streams > 2.5 sq. mile Drainage.
 (Ecoregions 73 Only)**

Bio-region	Season	Taxa Richness (TR)			ETO			CRMOL		
		5	3	1	5	3	1	5	3	1
73ab	Jan-June	> 11	6-11	< 6	> 1	1	< 1	> 4	2-4	< 2
73ab	July-Dec	> 13	7-13	< 7	> 3	2-3	< 2	> 4	2-4	< 2

5b. Scoring Guidance for Genus Level biorecons in Headwater Streams \leq 2.5 sq. mile Drainage. (All Ecoregions except 73)

Bio-region	Season	Taxa Richness (TR)			EPT			Intolerant Taxa (IT)		
		5	3	1	5	3	1	5	3	1
65abei	Jan-June	> 16	8-16	< 8	> 7	4-7	< 4	> 5	3-5	< 3
65abei	July-Dec	> 12	7-12	< 7	> 4	3-4	< 3	> 3	2-3	< 2
65j	Jan-June	> 17	9-17	< 9	> 6	4-6	< 4	> 4	2-4	< 2
65j	July-Dec	> 17	9-17	< 9	> 6	3-6	< 3	> 4	3-4	< 3
66deik	Jan-June	> 17	9-17	< 9	> 12	7-12	< 7	> 12	6-12	< 6
66deik	July-Dec	> 16	8-16	< 8	> 12	6-12	< 6	> 11	6-11	< 6
66fgj	Jan-June	> 26	14-26	< 14	> 16	9-16	< 9	> 14	8-14	< 8
66fgj	July-Dec	> 20	10-20	< 10	> 12	6-12	< 6	> 10	6-10	< 6
67fghi	Jan-June	> 17	9-17	< 9	> 11	6-11	< 6	> 9	5-9	< 5
67fghi	July-Dec	> 24	13-24	< 13	> 14	7-14	< 7	> 10	6-10	< 6
68ad	Jan-June	> 10	6-10	< 6	> 4	3-4	< 3	> 3	2-3	< 2
68ad	July-Dec	> 10	6-10	< 6	> 4	3-4	< 3	> 3	2-3	< 2
68b	Jan-June	> 18	9-18	< 9	> 10	5-10	< 5	> 5	3-5	< 3
68b	July-Dec	> 16	8-16	< 8	> 7	4-7	< 4	> 2	1-2	< 1
68c	Jan-June	> 19	10-19	< 10	> 14	7-14	< 7	> 8	5-8	< 5
68c	July-Dec	> 17	9-17	< 9	> 11	6-11	< 6	> 7	4-7	< 4
69de	Jan-June	> 13	7-13	< 7	> 10	6-10	< 6	> 7	4-7	< 4
69de	July-Dec	> 12	7-12	< 7	> 8	4-8	< 4	> 6	3-6	< 3
71e	Jan-June	> 22	11-22	< 11	> 11	6-11	< 6	> 6	4-6	< 4
71e	July-Dec	> 19	10-19	< 10	> 6	4-6	< 4	> 5	3-5	< 3
71fgh	Jan-June	> 20	11-20	< 11	> 12	6-12	< 6	> 10	5-10	< 5
71fgh	July-Dec	> 18	10-18	< 10	> 8	4-8	< 4	> 6	4-6	< 4
71i	Jan-June	> 17	9-17	< 9	> 7	4-7	< 4	> 4	3-4	< 3
71i	July-Dec	> 17	9-17	< 9	> 7	4-7	< 4	> 4	3-4	< 3
74a	Jan-June	> 13	7-13	< 7	> 3	2-3	< 2	> 1	1	< 1
74a	July-Dec	> 12	7-12	< 7	> 2	1-2	< 1	> 1	1	< 1
74b	Jan-June	> 9	5-9	< 5	> 2	1-2	< 1	> 1	1	< 1
74b	July-Dec	> 19	10-19	< 10	> 3	2-3	< 2	> 1	1	< 1

Scoring Guidance for Genus Level Biorecons in Headwater Streams \leq 2.5 sq. mile Drainage. (Ecoregions 73 Only)

Bio-region	Season	Taxa Richness (TR)			ETO			CRMOL		
		5	3	1	5	3	1	5	3	1
73ab	Jan-June	> 6	4-6	< 4	> 1	1	< 1	> 3	2-3	< 2
73ab	July-Dec	> 6	4-6	< 4	> 1	1	< 1	> 3	2-3	< 2

Score Interpretation for Family and Genus Level Biorecons:

Biorecons are a screening tool that help the biologist evaluate the condition of the benthic community. Generally, the following guidelines can be used when evaluating biorecon scores.

- 11-15 = Diverse benthic community *
- 7-9 = Ambiguous (Need Additional Information)
- ≤ 5 = Stressed benthic community

* Field estimates of the abundance of EPT and Intolerant taxa and dominance of any taxon should be considered when interpreting biorecon scores. Low abundance of intolerant taxa and/or dominance of facultative or tolerant organisms may indicate a stressed community even if scores are good.

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.

Scoring for stream types not included in Tables 3 or 4:

In streams that do not fit the drainage area and bioregion or are atypical of the bioregion, it will be necessary to sample a reference site at the same time. For example an upstream or watershed reference could be used. In order to compare sites trisect the reference value for each metric:

- Score 5 > One less than [metric value – (metric value/3)]
- Score 3 < lowest score 5 – (metric value/3) to one less than lowest score 5
- Score 1 < lowest score 3

For example,

To calculate the reference-based scoring for family richness, if the number of distinct families at the reference site were 20:

Score 5 would be $\geq 20 - (20/3)$ which is 13

Since 13 distinct families is the lowest number that would score a 5, in order to calculate the range for a score of 3 would be $< 13 - (13/3)$ to 13 (or 9 to 12)

Since 9 is the lowest number of families that would score a 3, in order to calculate a range for a score of 1 would be < 9

The same procedure would be used to calculate the scoring ranges for other metrics such as EPT richness and intolerant richness or for genus level.

10. Report

Once vouchers are identified and taxa lists finalized, transfer final IDs to the taxa e-Form. The e-Form will calculate metrics. Enter the appropriate index score and which SOP is used for scoring (2017 if using this document). The e-Form will calculate the metrics. Use these to determine the index score at either the genus or family level.

Once the index score is calculated enter information in either the genus or family biometric e-Form. Only record both if this is an ecoregion (including ECO and FECO) site.

Upload both taxa list and metric scores to the appropriate tables in Waterlog upon completion. This is done by whoever (EFO or LAB) does the final ID. .

See Biological Survey Electronic Reporting Guidance (BSERG) for details on using e-Forms (Part I) and uploading to Waterlog (Part II).

Copies of all field forms and examples of excel spread-sheet format are provided in appendix B of this document. E-Forms are available on SharePoint or by contacting PAS.

Protocol G – Field Collection Techniques for Semi-Quantitative Single Habitat Sample (SQSH)

Primary sampler must meet minimum requirements outlined in Section I.G.

Collect a semi-quantitative single habitat sample (SQSH) when a quantifiable assessment of the benthic community is needed. **See flow charts Protocol A for guidance.** This method is directly comparable to the Division's numeric translators for biocriteria found in the Water Quality Standards. It is the required method for the regulated community to meet permit requirements. The SQSH is a more defensible and sensitive method than the biocon. When both sample types have been collected, semi-quantitative sample results will take precedence over biocon results.

The semi-quantitative single habitat sample will generally be used for:

- a. 303(d) list removal or addition (a biocon can be used if it shows the site clearly supporting or non-supporting)
- b. Nutrient TMDLs
- c. Permit compliance and enforcement
- d. Exceptional Tennessee Water designation for exceptional biological diversity.
- e. Pre/post BMP or ARAP
- f. CADDIS analysis
- g. Trend Analysis
- h. Ecoregion or headwater reference sites (along with genus level biocon)
- i. Confirmation of ambiguous biocons when supporting information is not adequate for assessment.
- j. Any study that has the potential of being used in litigation or for regulatory purposes.

In order for the data to be compared to the reference database:

- a. Samples must be collected in the exact manner outlined in this section.
- b. The upstream watershed must be 80% within the bioregion.
- c. The drainage area must be comparable to those in the reference database for that bioregion (Appendix A).

There are three methods of semi-quantitative sample collection:

- a. SQKICK (Riffle streams larger than 1 yard wide)
- b. Modified SQKICK (Riffle streams less than 1 yard wide or too shallow for the 1 meter kick net)
- c. SQBANK (Non-riffle streams)

For SQSH samples, no organisms are picked in the field. Removal of organisms from collected debris (sorting) is conducted in the laboratory using a dissecting microscope.

Do not retain any threatened or endangered species. Check coverage to determine whether T&E species are likely in the stream reach and make sure you are able to recognize them in the field. When in doubt do not retain. Indicate in comment area of stream survey sheet identification and number of animals released. If species was not previously recorded in that stream reach complete ETW form and submit to Planning and Standards. Notify Natural Areas Unit. If T&E species are inadvertently added to sample contact TWRA (and USFWS if federally listed.)

The type of sample collected will depend on the stream type and/or ecological subregion. Ecoregions can be determined for specific stream segments by using Tennessee's Online Water Quality Assessment Data viewer <http://tdeconline.tn.gov/dwr/> . Contact the Planning and Standards Unit if there is uncertainty about what ecoregion a stream is located in.

a. Semi-quantitative Riffle Kick (SQKICK)

Collect a semi-quantitative riffle kick (SQKICK) in ecological subregions 65j, 66d, 66e, 66f, 66g, 67f, 67g, 67h, 67i, 68a, 68b, 68c, 69d, 71e, 71f, 71g, 71h, 74a, and riffle streams in 71i. If a riffle is not present, a semi-quantitative bank sample can be collected, but will not be directly comparable to the reference criteria. Therefore, an upstream or off-site reference SQBANK will also need to be collected (this can be a bank sample collected at one or more of the established ecoregion reference sites).

If riffles have been compromised by sedimentation or are embedded, they should still be sampled since impacts are being measured. For small (< 1 yard wide) or shallow streams, the modified kick method (protocol, see b, should be used).

1. Use a (two-person) one square meter kick net with a 500-micron mesh to sample the riffle. If necessary, use rocks to weight the bottom edge to prevent the flow of water beneath the net. At each site, collect two kicks: one from an area of fast current velocity and one from an area of slower current velocity. Always collect the downstream sample first. Avoid areas with large leaf packs caught on the rocks if possible. If the stream is too small to do two riffle kicks in a single riffle, sample two separate riffles. (In extremely small or shallow streams, sample 4 riffles using the modified SQKICK for small streams – method b.)
2. One biologist holds the net at an angle that allows the current to flow into it making sure the bottom is in contact with the substrate and the top of the net is above the surface of the water. The net should have the maximum wetted area by laying it back as far as possible, while keeping the top of the net above the surface of the water. The second biologist disturbs the substrate for approximately one-meter distance and the width of the net (one meter) upstream of the net by kicking and shuffling the substrate. This causes organisms and debris to flow into the net. Larger rocks may be lifted and rubbed with the hands or a soft brush to remove clinging organisms.

3. Once the kick is completed, allow time for the lighter debris to finish floating into the net. The biologist who performed the kick then grabs the two pole ends at the bottom of the net and carefully lifts the net out of the water while the other biologist continues to hold the upper end making sure the top of the net does not dip below the water surface allowing organisms to escape. If the top of the net dips under the water and debris flows out, discard the sample and collect another kick. Carry the net horizontally to the bank for processing.
4. Composite the debris from both kicks. Carefully position the net in a 500 micron sieve bucket. Rinse debris and organisms, off the net into the sieve bucket. Make sure to get all debris and organisms. Thoroughly rinse the sample to remove fine sediment. Large rocks or organic material, such as whole leaves, large rocks or sticks, are discarded after rinsing and removing clinging organisms. All other debris is persevered for laboratory sorting under a microscope. Transfer the debris to a wide mouth or plastic container. Using forceps, remove all organisms clinging to the net and add them to the sample container.

If upon cursory examination of the debris, it does not appear that a minimum of 200 organisms have been collected after 2 kicks, perform additional kicks in the same reach until at least 200 organisms are assured. Document the number and location of kicks on the stream survey field sheet and write the number of kicks on the sample tag. If all riffle habitat is exhausted before 200 organisms are collected, document on the stream survey field sheet. Note that samples where more than 2 kicks are necessary to find 200 organisms will be evaluated with extra caution regardless of score.

5. Place the composited debris in a wide mouth plastic container. Unless there is a large amount of organic matter preserve with 80% ethanol. If organic matter such as algae or decomposed leaves constitutes 25% or more of the debris, preserve with full strength ethanol. Include an internal tag (written in pencil on water-proof paper) with the DWR Station ID, date, sampler's initials and sample type inside the container with the debris (Figure 7). Attach an external sample tag to the outside of the container. Standard external tags for both biological and chemical samples are obtained from the state lab (Figure 8).

Instead of an external tag, the site information can be printed in indelible ink (i.e. Sharpie) on the sample lid. The external tag information must include the Station ID, Stream name, location, sampler's initials, date sampled, time sampled and sample type (Figure 12). A biological sample request form, including chain of custody, must be completed prior to delivery to the state lab for identification (Appendix B).

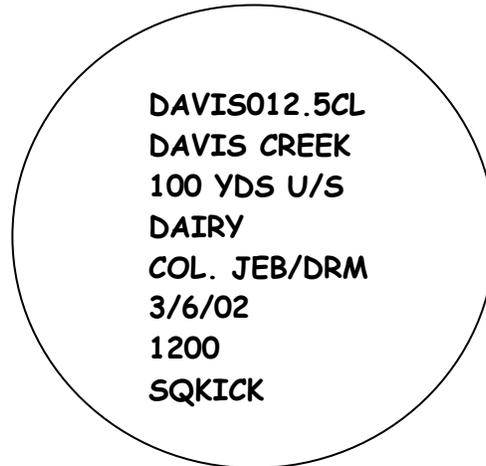


Figure 12: Example of External Tag Information (on sample lid)

b. Modified SQKICK (small and/or shallow streams)

1. In extremely small streams, where riffles are less than one yard wide, or in those that are too shallow to use a 1 meter kick net, collect a one person stationary kick using an 18-inch single handle rectangular net with a 500-micron mesh.
2. Sample four separate riffles. Starting with a downstream riffle, hold the net perpendicular to the flow making certain the bottom of the net is in contact with the substrate at all times. Disturb the substrate upstream of the net for an area approximately 18 inches long and the width of the net. Do not allow the net to move during the kick as it might cause organisms to drift under the net. Once the kick is complete, allow time for all debris to finish flowing into the net.
3. Composite the debris from all four kicks. Use forceps, to remove all organisms clinging to the net and add them to the debris. Thoroughly rinse the sample to remove fine sediment. Large rocks or organic material such as whole leaves and branches, are discarded after rinsing and removing clinging organisms. If upon cursory examination of the debris, it does not appear that 200 organisms are in the composited sample, collect additional kicks and add them to the composite. If all riffle habitat is exhausted before 200 organisms are collected, document on the stream survey field sheet in the comment field and on the sample request form. Document the total number of kicks on the sample tag and on the stream survey field sheet.
4. After removing large rocks, leaves and sticks all debris is sorted in the lab under a microscope. Place the composited debris in a wide mouth plastic container. Unless there is a large amount of organic matter preserve with 80% ethanol. If organic matter such as algae or decomposed leaves constitutes 25% or more of the debris, preserve with full strength ethanol. Include an internal tag with the DWR station ID, date, sampler's initials and sample type inside the container with the debris (Figure 7).

Attach an external sample tag to the outside of the container. For DWR staff, standard external tags for both biological and chemical samples are obtained from the state lab (Figure 8). Instead of an external tag, the site information can be written in indelible ink (i.e. Sharpie) on the sample lid. The external tag information must include the DWR Station ID, Stream name, location, sampler's initials, date sampled, time sampled and sample type (Figure 10). A biological sample request form including, chain of custody, must be completed prior to delivery to the state lab for identification (Appendix B).

c. Semi-Quantitative Bank Sample (SQBANK)

In ecoregions 65a, 65b, 65e, 65i, 73a, 74b, collect a semi-quantitative bank sample (SQBANK) (even if riffles are present) for comparison to the reference criteria. Also, use the SQBANK method in ecoregions 67f and 71i streams without riffle areas.

1. Use a triangular dip net with a 500-micron mesh to sample the rooted undercut bank. Collect the samples by jabbing the net below the surface of the water using an upward/forward thrusting motion designed to dislodge macroinvertebrates from the roots. Sample three separate areas of the reach including at least one sample from each bank if possible. Collect samples from different velocities and different bank types (i.e. overhanging tree roots, undercut grass banks) if possible. Macrophyte beds or snags may be substituted if rooted banks are not available. Sample approximately one linear meter (approximately 3 triangular net widths) at each of the three sampling locations. It may be necessary to collect more than 3 sampling location to get 9 linear meters if habitat areas are small.
2. Thoroughly rinse the sample by gently swishing the net through the water. Do not let the net opening dip below the surface of the water. A sieve bucket can be used if fine sediment clogs the net. Visually inspect any large organic matter such as whole leaves and sticks. Remove any organisms clinging to these materials and add to the smaller debris, before discarding the large material. Using forceps, remove any organisms clinging to the net and add to the sample. Composite the debris from all three bank samples. If upon cursory examination of the debris, it does not appear that 200 organisms have been collected, additional bank samples may be collected. If all rooted bank habitat is exhausted before 200 organisms are collected, document on the stream survey field sheet. Document the total number and location of bank jabs on the stream survey field sheet and the number of bank jabs on the sample tag.
3. Once large rocks, leaves and sticks are removed, the remaining debris is to be sorted in the laboratory under a microscope. Place the composited debris in a wide mouth plastic container. Unless there is a large amount of organic matter preserve with 80% ethanol. If organic matter such as algae or decomposed leaves constitutes 25% or more of the debris, preserve with full strength ethanol.

Include an internal tag with the station ID, date, sampler's initials and sample type inside the container with the debris (Figure 7). Attach an external sample tag to the outside of the container. Standard external tags for both biological and chemical samples are obtained from the state lab (Figure 8). Instead of an external tag, the site information can be written in indelible ink (i.e. Sharpie) on the sample lid. The external tag information must include the Station ID, stream name, location, sampler's initials, date sampled, time sampled and sample type (Figure 10). A biological sample request form, including chain of custody, must be completed prior to delivery to the state lab for identification (Appendix B).

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 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. If using paper forms the same field log number should be assigned to all samples collected at that site that day (BR, SQSH, Periphyton, Chemicals). Use the format (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.

- KJL0131201701 would be all of the samples (habitat, biorecon, SQSH, periphyton etc.) collected or assessed by KJL on 01-31-2017 at the first site of the day.
- KJL0131201702 would be the duplicate samples collected or assessed by KJL on 01-31-2017 at the first site of the day.
- KJL0131201703 would be would be all of the samples (habitat, biorecon, SQSH, periphyton etc.) collected or assessed by KJL on 01-31-17 at the second site of the day.
- KJL0201201701 would be all of the samples (habitat, biorecon, SQSH, periphyton etc.) collected or assessed by KJL on 02-01-17 at the first site of the day.
- KJL0201201702 would be all of the samples (habitat, biorecon, SQSH, periphyton etc.) collected or assessed by KJL on 02-01-17 at the second site of the day.

If the sample is a biorecon and the voucher is identified at the EFO, an Activity ID must also be assigned. This can be the same as the field log number plus BF if it is a family biorecon or BG if it is a Genus level biorecon.. If the sample is a biorecon, SQSH or periphyton that is going to the lab for analysis, the lab will assign the Activity ID.

A log is to be kept in the field office of all biological samples collected. Waterlog can be used to generate this log (Figure 13). 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 waterlog for habitat, stream survey and biorecons identified by the EFO.

A second log will be kept at the lab, which will also include sample identification information (Figure 14).

Transport to Lab

All semi-quantitative samples collected by DWR environmental field offices are to be sent to the state laboratory (TDH) for identification as soon as possible after collection.

(Samples collected by non-WPC staff may be identified by any qualified macroinvertebrate taxonomist who has met quality assurance requirements specified in Section II and follows the sorting, subsampling and taxonomic protocols specified in this document). The Nashville Lab is the only state laboratory with the capability to identify macroinvertebrate samples. Contact the Aquatic Biology Section at 615-262-6327 to coordinate sample drop-off. A biological sample request form, including chain of custody must be completed and accompany all biological samples (Appendix B).

It is recommended that at least one staff member in each EFO be certified to ship ethanol. This does not have to be a biologist. Shipping is recommended for samples with a priority turn-around such as anti-degradation, enforcement and complaints. Routine watershed samples can be ferried by staff when traveling to Nashville on business. It should be noted that 8 gallons (16 samples) is the maximum number that can be legally transported by private vehicle at one time.

Ethanol is considered by OSHA to be a hazardous material, only certified personnel may legally ship samples. Any certified DWR staff can ship samples directly from the EFO. Anyone in TDEC wanting to ship 95% ethanol **MUST** first complete the **Hazardous Materials Transportation Training Modules, Version 5.1, Modules 1-6D with a score of 70 or above**. These Modules are available on CD from the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration. There are two (2) accompanying CDs entitled *General Awareness and Familiarization* and *Emergency Response Guidebook ERG2008 Mobile Software*.

Sample priorities:

Biological sample priorities are set by the Planning and Standards Unit who coordinates with the state lab. Before completing the “date needed” on the sample request form, contact PAS if results are needed outside the following priority.

- a. Watershed sample (including TMDLs and ecoregion sites) completed by June 30 of the fiscal year following the monitoring year for the group provided no sample is completed more than one year after receipt. For example Group 2 sample collection will start in July 2017 and end June 2018. Sample analysis is to be completed no later than June 2019. EFO QC samples will be completed the same time as the watershed group due date.
- b. Anti-degradation samples within 30 days of receipt.
- c. Special projects by agreed upon date as stipulated by grant.
- d. Priority samples (such as enforcement, complaints, spills) – contact Aquatic Biology Section, if lab receives too many priority requests, PAS will coordinate.

Field Log Number	Ben Samp ID	DWR Station ID	Monitoring Location Name	Location	Date Col.	Time Col.	Init. Col.	Type	EFO ID	EFO ID Date	Date to Water log	Date sent to lab
LEE0131201701	Assigned by Lab	DAVIS012.5CL	Davis Ck	100 yds u/s Dairy	01/31/2017	1200	LEE	SQKICK	NA	NA	NA	02/28/2017
LEE0131201702	LEE0131201702BG	DAVIS001.3CL	Davis Ck	Hwy Z	01/31/2017	1500	LEE	BR Genus	LEE	02-26-2017	02-27-2017	NA

Figure 13: Macroinvertebrate Sample Collection and Biorecon ID Log (EFO) – Electronic log preferred- information can be generated through Waterlog.

Ben Samp ID (Activity ID)	Field Log #	Station ID	Source	Location	Date Col.	Time Col.	EFO	Init. Col.	Type	Date Received by Lab	Sort By	Sort Date	ID By	ID Date	Date to Water log
N000053210	LEE01312017-01	DAVIS012.5CL	Davis Ck	100 yds u/s Dairy	01/31/2017	1200	K	LEE	SQKICK	02/28/2017	CAP	03/28/2017	CAP	03/29/2017	5/03-31-2017

Figure 14: Macroinvertebrate Sample ID Log (Lab)

Protocol I - Subsampling Procedures for Semi-Quantitative Samples

All semi-quantitative samples are to be reduced to a 200+/- 20% (160-240) organism subsample using the following technique. This method comes directly from section 7.3 (pages 7-9) of the 1999 guidance, Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA 841-B-99-002).

1. Thoroughly rinse the sample in a 500-micron mesh sieve to remove preservative and fine sediment. Large organic material (whole leaves, twigs, etc.) not removed in the field should be rinsed, visually inspected and discarded. It may be necessary to soak the sample contents in water for about 15 minutes to hydrate the benthic organisms, which will prevent them from floating on the water surface during sorting. If the sample was stored in more than one container, the contents of all containers for a given sample should be combined at this time. Gently mix the sample by hand while rinsing to make it homogenous.
2. Transfer the cleaned sample to a gridded pick subsampler (or similar apparatus). The subsample is a white plastic cutting tray that measures approximately 18" x 12½" x 2¼". The tray is divided into 2"x2" grids and marked with indelible ink. Note: it is preferable that a sieve insert or raised grid divider be used to separate the grids. Remove the animals and debris using a combination of scoop and transfer pipette.
3. If the debris will not fit in one tray, use two or more trays. Thoroughly mix the debris and divide equally between the trays. Sort the same grids for both trays. For example, if grid # 5 is randomly selected, both # 5 grids are picked. This will count as one grid out of 28.
4. Add enough water (or ethanol) to evenly distribute the debris. Gently shake and swirl the tray until the organisms are evenly distributed within the tray. Remove the excess water with a suction device (i.e. turkey baster with a 500 micron or smaller screen over the aperture), to the point where the sample is settled onto the bottom of the tray. If a raised grid insert is not being used, care should be taken not to pull organisms towards the area of suction.
5. Randomly select four numbers corresponding to squares (grids) within the gridded subsampling pan. Remove all material (organisms and debris) from the four grids and place the material into a dish or jar with a small amount of water. Any organism that is lying over a line separating two grids is considered to be on the grid containing its head. If it is not possible to determine the location of the head (i.e. oligochaetes), the organism is considered to be in the grid containing most of the body.
6. If there are 160-240 organisms (cumulative of the four grids) then subsampling is completed. If there are fewer than 160 organisms, continue selecting grids one at a time until between 160 and 240 organisms are selected. If more than 240 organisms are contained in the first four grids, transfer the contents of the four grids to a second gridded pan. Randomly select grids for this second subsampling as was done for the first, sorting grids four (and then one) at a time until the second subsample contains 160-240 organisms.

If it is estimated that the first four grids of the second subsample contain more than 240 organisms, transfer the four grids to another pan and conduct a third subsample. Continue creating subsamples until there are 160-240 organisms.

7. Transfer the subsample, a small amount at a time to a petri dish for sorting (removing organisms). Complete all sorting under a dissecting scope, removing and preserving all organisms in 80% ethanol. If the number of organisms from the four-grid subsample does not equal the specified number of 160-240, randomly choose a fifth grid and pick out all organisms in that grid. If the addition of the fifth grid fulfills the quota, then the subsampling is complete. If not, choose additional grids (one at a time) until the quota is reached or surpassed. All the organisms from the final grid that is randomly selected are removed even if the quota is reached midway through the picking of the grid.

If, after microscopic sorting, more than 240 organisms are found, transfer all organisms to a small gridded dish (36 grids). Subsample by groups of first four and then one random grid until the target of 160-240 organisms is achieved.

8. Place the sorted debris in a separate container and preserve in 80% ethanol. Include both external and internal tags (Figures 2 and 3). Add the words "sorted debris" to the tag information. Save the remaining unsorted sample debris residue in a separate container labeled "sample residue". This container should include the original sample label and internal tag.
9. Place the sorted 160-240 organism subsample into a glass vial and preserve in 80% ethanol. Place an internal tag written in pencil on waterproof paper citing the log number, station ID, date collected and taxonomist inside each vial (Figure 4). Position the label so it can be read through the vial.

All chironomids and oligochaetes in the subsample are to be identified individually (do not subsample and extrapolate). Mount slides in a permanent mounting media (i.e. CMC-10). Label slides with the station id, date collected, taxonomist initials and slide box number.

10. After sorting is completed, record the appropriate information (log number, station ID, sorters initials, date sorted and the number of organisms found) in the QC logbook (Figure 8, Section II-C).
11. All organisms and debris shall be retained as separately preserved samples for at least 5 years from collection date. Ethanol must be disposed of as a hazardous waste.

Protocol J - Taxonomy of Semi-Quantitative Samples

Biologist with credentials and documented expertise in macroinvertebrate taxonomy in accordance with I.G.

Semi-quantitative samples collected by DWR are to be sent to the central state lab for analysis in Nashville

1. Identify all organisms to genus except Acari, Nematoda, Nemetera Brachiobdellida, immature Tubificinae, Lumbriculidae and Nematomorpha using the primary taxonomic keys listed in Appendix D. (Secondary keys will only be used to assist with difficult specimens.) Do not count animals that are missing heads, exuviae, empty shells, empty caddis cases, or terrestrial life stages. Only count aquatic/semi-aquatic benthic taxa. Do not count semi-aquatic taxa Collembola, or mico-crustacea

Taxa Groups Excluded from Metric Calculations (included in 2011 and earlier calibrations)

- Anthicidae
 - Carabidae
 - Chrysomelidae
 - Cladocera
 - Collembola
 - Copepoda
 - Curculionidae
 - Gerridae
 - Gyrinidae (adults)
 - Ostrocada
 - Staphylinidae
 - Veliidae
2. Calculate all biometrics at the specified level only. The primary keys will be updated as new literature is available. It is important that all taxonomists use the same primary keys for consistency in identification and nomenclature. In 2017, the primary key for EPT will be Merritt and Cummins since the new EPT of the Southeastern U.S. was not released until after metrics were calibrated. However, EFOs and the state lab should use the EPT of the Southeastern U.S. for all reference (ECO and FECO) to aid in recalibration of metrics in 2018 when metrics will be recalibrated and revised scoring guidelines will be published for use in all samples.

New taxa (not already in Waterlog reference table) will be entered by the state lab in the EDAS SQSH database and uploaded to Waterlog invert reference staging table.

3. After identifying all taxa in the subsample, return them to the vial and add fresh preservative (80% ethanol). Initial, date and add the log number to the internal tag (Figure 10). Store the sample for a minimum of five years from collection date..
4. Mount chironomids, oligochaetes and other small organisms on slides for identification. Use a permanent mounting media such as CMC-10 which clears the mount so a separate clearing agent is not necessary. Use round coverslips (12 mm) for small specimens. Place one organism under each coverslip. A maximum of 10 coverslips can be placed on each slide. Square coverslips (22mm) can be used to mount larger specimens. Place one to three organisms under each coverslip with a maximum of 3 coverslips per slide.

Mount chironomid larvae so that their bodies are viewed laterally and their heads are viewed ventrally. Apply enough pressure to the coverslip so that the mandibles are opened exposing the mentum. The S1 setae, premandibles and pectin epipharyngias should also be visible. Mount oligochaetes laterally with minimal pressure. The mounting media should extend past the edges of the coverslip to allow for shrinkage during drying. Allow the slides to air-dry at least 24 hours before attempting identification. (A slide dryer can be used to dry mounts faster if desired). Label slides with the log number, station ID, date, taxonomist initials and slide box slot number. Keep labeled slides in a slide box a minimum of five years after completion of the study.

Note: Do not subsample any organisms including chironomids and oligochaetes further. Identify each organism in the 160-240 organism subsample.

Protocol K - Data Reduction of Semi-Quantitative Samples

A macroinvertebrate index, based on seven biometrics, has been developed by the Division for use in semi-quantitative macroinvertebrate surveys (Arnwine and Denton, 2001). This index is based on ecoregion reference data and calibrated by bioregion. The calibrated scoring criteria can be used in all streams that fit the sample criteria for that region (habitat sampled, sampling protocol, drainage area) and have at least 80% of their upstream drainage in the same bioregion.

For streams that do not meet the profile (for instance non-riffle streams in bioregions that are calibrated to a SQKICK sample, streams that have more than 20% of their upstream drainage in other bioregions or streams whose drainage area is larger or smaller than that specified in biocriteria), calculate the same seven biometrics. However, the index tables cannot be used for scoring, since these samples are not comparable to streams in the ecoregion reference database. Compare the biometrics to an appropriate upstream or watershed reference.

1. Using the raw benthic data from the semi-quantitative subsample (kick or bank), calculate a numerical value for each of the seven biometrics. Calculate all biometrics using taxa identified to the genus level except for specified taxa (Acari, Branchiobdellida, Nematomorpha, Nematoda, Hydra, immature Tubificidae, Lumbriculidae) or those too young or too damaged to identify to this level. Species identification is not to be used. Do not count Collembola, semi-aquatic taxa or micro/meio-crustacea.

When a large proportion of individuals (> 10% for any family) cannot be identified past family, the unknown individuals should be proportionately assigned to identified genera within the family before calculating metrics. (Does not apply to unknown Naididae which can be left at family level.)

$$X = U * \frac{\text{Genus A}}{T}$$

Where X = Number of Undetermined organisms in a family to be assigned to genus A

Genus (A) = Number of individuals within a specific genus.

U = Total number of individuals within a family not identified to genus

T = Total number of individuals within a family identified to genus level.

Solve for X for each genera within a family rounding to the nearest whole number.

Add X to Genus A for reporting. Flag as estimated value.

Repeat for each undetermined genus in sample.

For example if 8 Hydropsychidae could not be identified in a sample containing 37 Cheumatopsyche and 9 Hydropsyche and 1 Ceratopsyche. To determine the number of unknown taxa that would be added to Cheumatopsyche and how many would be assigned to Hydropsyche:

$$X (\text{Cheumatopsyche}) = 8 * 37/47 = 6$$

$$X (\text{Hydropsyche}) = 8*9/47 = 2$$

$$X (\text{Ceratopsyche}) = 8*1/47 = 0$$

The Final count for metric calculations would be:

Family	Initial ID	Count	Final ID	Count	Comment
Hydropsychidae	Ceratopsyche	1	Ceratopsyche	1	
Hydropsychidae	Cheumatopsyche	37	Cheumatopsyche	43	6 unknown + 37 known
Hydropsychidae	Hydropsyche	9	Hydropsyche	11	2 unknown + 9 known
Hydropsychidae	Und spp.	8			

a. **TR** (Taxa Richness)

Total the number of distinct genera found in the subsample. Taxa that could only be identified to family are included only if they exhibit distinct characteristics separating them from other genera in the family. (Document on taxa list if an unidentified organism is determined to be a distinct taxon.)

b. **EPT** (Ephemeroptera Plecoptera Trichoptera Richness)

Total the number of genera within the orders Ephemeroptera, Plecoptera and Trichoptera. Taxa that could only be identified to family are included only if they exhibit distinct characteristics separating them from other genera in the family.. (Document on taxa list if an unidentified organism is determined to be a distinct taxon.)

Alternate metric for ecoregion 73

ETO (Ephemeroptera, Trichoptera and Odonata Richness). – The total number of distinct genera within the orders Ephemeroptera, Plecoptera and Odonata. Taxa that could only be identified to family are included only if they are the only taxon found in that family or it is probably that they are distinct from other taxa identified to genus within the family. (Document on taxa list if an unidentified organisms is determined to be a distinct taxon.)

c. **% EPT-Cheum** (EPT Abundance excluding *Cheumatopsyche* spp.)

$$\% \text{ EPT} = \frac{\text{Total (Ephemeroptera + Plecoptera + Trichoptera)} - \text{Cheumatopsyche}}{\text{Total number of individuals in the subsample}} \times 100$$

Any undetermined Hydropsychidae should be counted as Cheumatopsyche in the same proportion as confirmed identifications.

d. **%OC** (Percent oligochaetes and chironomids)

$$\%OC = \frac{\text{Total number of Oligochaeta} + \text{Chironomidae}}{\text{Total number of individuals in the subsample}} \times 100$$

e. **NCBI** (North Carolina Biotic Index includes tolerance scores from other indices found in EPA RBP when no value is available for NC). Family value is to be assigned when there is no genus level tolerance value. Values in Appendix C should be used when available. See note for assigning other values for unlisted taxa for future calibrations.

$$NCBI = \frac{\sum x_i t_i}{N \text{ (exclusive if no } t_i)}$$

where: x_i = number of individuals within a taxon

t_i = tolerance value of a taxon (Appendix C)

N = total number of individuals in the subsample that have been assigned a tolerance value (exclude animals for which no tolerance value is assigned see following note).

Note: For new taxa, tolerance values found in the latest version of the North Carolina Department of Environment and Natural Resources QSSOP should be assigned <http://h2o.enr.state.nc.us/esb/BAUwww/benthossop.pdf>. If only species level tolerance values are available, genus level is determined by averaging species. If a North Carolina tolerance score has not been assigned for a taxon, regional tolerance values in appendix B of EPA's Rapid Bioassessment protocols may be substituted. (Barbour et. al., 1999). Order of preference is Southeast, Midwest, Upper Midwest, Mid-Atlantic then Northwest. If there is no genus level tolerance value for new taxon in any of these documents, the family level tolerance value found in appendix C should be used.

f. **% Clingers - CHEUM** (Percent contribution of organisms (primary for genus) that build fixed retreats or have adaptations to attach to surfaces in flowing water excluding Cheumatopsyche spp.)

A list of taxa designated as clingers is located in Appendix C. Merritt and Cummins, 2008 is used as authority for determination of primary clingers (if multiple habits are listed, only those where clinger is listed first are used.)

$$\% \text{ Clingers} = \frac{\text{Total number of clinger individuals} - \text{Cheumatopsyche}}{\text{Total individuals in the sample}} \times 100$$

Alternative biometric for ecoregion 73

%CRMOL (Percent contribution of Crustacea and Mollusca).

$$\%CRMOL = \frac{\text{Total number of Crustacea and Mollusca}}{\text{Total individuals in the sample}} \times 100$$

g **%TNUTOL (% TN Nutrient Tolerant Organisms)**

$$\% TNUTOL = \frac{\text{Total number of Cheumatopsyche, Stenelmis, Polypedilum, Cricotopus, Cricotopus/Orthocladus, Lirceus, Caenis, Gastropoda, Oligochaeta}}{\text{Total individuals in the sample}} \times 100$$

After calculating values for the seven biometrics, equalize the data by assigning a score of 0, 2, 4 or 6 based on comparison to the ecoregion reference database for the bioregion and stream size (Appendix A). Total the seven scores to calculate the TMI (Tennessee Macroinvertebrate Index).

A score of 32 or higher is considered to pass biocriteria guidelines in all ecoregions. 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.

Alternative Reference Stream Method

Some sites may not meet the conditions necessary for comparison to the biocriteria tables in Appendix A. This will happen when:

- a. The streams has 2.5 or less square miles drainage upstream of the sample site and headwater guidelines have not yet been developed for that bioregion. Drainage area size can be determined at <http://water.usgs.gov/osw/streamstats/tennessee.html>.
- b. The stream is less than 80% within a bioregion upstream of the sample site.
- c. The stream does not naturally have the habitat specified for comparison (for example low gradient non-riffle streams in bioregions where riffle criteria are specified. However, streams where the riffle is buried in sediment or otherwise compromised due to human disturbance should still be considered riffle streams).

In these cases, an alternative reference sample should be collected. The reference can be upstream, within the same watershed or within the same bioregion. Reference site selection should follow the same guidelines used for selection of ecoregion reference streams as specified in Protocol M. The alternative reference should be collected at the same time and using the same method (SQKICK or SQBANK) used at the test site.

Once the reference sample is collected, scoring ranges for each metric will be calculated based on quadrisection of the reference values for each metric. Reference data and scoring table, including ranges calculated for each metric, should be included with data report. For metrics that were expected to decrease with increased pollution (TR, EPT, %EPT-Cheum, %Clingers):

- Score 6: \geq reference value $-$ Reference value/4
- Score 4: $<$ lowest possible 6 to lowest possible 6 $-$ reference/4
- Score 2: $<$ lowest possible 4 to lowest possible 4 $-$ reference/4
- Score 0: $<$ lowest possible 2

For example:

If there were 30 distinct taxa found at the reference site, the scoring for taxa richness would be calculated by

- Score 6: $30 - (30/4)$ or ≥ 22
- Score 4: $22 - (30/4)$ or 14 to 21
- Score 2: $14 - (30/4)$ or 6 to 14
- Score 0: < 6

For metrics that were expected to increase with increased pollution (%OC, NCBI, %TNUTOL):

- Score 6: $<$ reference value $+$ (highest possible value for metric $-$ reference value)/4
- Score 4: $>$ highest possible 6 to highest possible 6 $+$ (highest possible value for metric $-$ reference value)/4
- Score 2: $>$ highest possible 4 to 0.1 $+$ highest possible 4 $+$ (highest possible value for metric $-$ reference value)/4
- Score 0: $>$ highest possible 2

For example, if the %OC at the reference site was 20%,

- Score 6: $\leq 20\% + [(100\% - 20\%)/4]$ or $\leq 40.0\%$
- Score 4: $40\% + (100\% - 20\%)/4$ or 40.1% to 60.0%
- Score 2: $60\% + (100\% - 20\%)/4$ or 60.1% to 80.0%
- Score 0: $> 80.0\%$

Protocol L: Report Preparation

DWR and TDH lab staff are required to use the e-Forms for reporting Biorecon metrics, taxa lists, habitat assessments, field parameters and stream surveys and upload to Staging Tables in Waterlog. Pictures are uploaded to PAS SharePoint.

The TDH lab is required to use EDAS queries (SQSH Biometrics and SQSH Taxa List) to generate excel spreadsheets and upload to Waterlog Staging Tables. Samplers are notified when data are uploaded.

The regulated community are required to submit all SQSH metrics, taxa lists, habitat assessments, field parameters and stream surveys in a excel spreadsheet report format compatible with Waterlog upload (Appendix B) to PAS or the Mining Section. DWR e-forms may be used to generate excel spreadsheet for everything except the SQSH metrics and taxa lists. In addition to spreadsheets, written reports may also be submitted and will be uploaded to SharePoint under the appropriate watershed.

e-Forms are available on SharePoint or by contacting PAS.

<https://tennessee.sharepoint.com/sites/environment/DWR/PAS/SitePages/Home.aspx> . Always use the most current e-Forms. Reference tables used in the forms will be updated annually in July.

Instructions for completing the e-forms can be found in BSERG, Part I, 2017. Instructions for upload to Waterlog Staging Tables can be found in BSERG, Part II, 2017.

Note when using e-Forms, the BioEvent Worksheet must be completed first (Appendix B) in order to populate header information on other forms.

Biorecons

Once vouchers are identified and taxa lists finalized, transfer final IDs to the taxa e-form. The e-Form will calculate metrics. Use these to determine the index score at either the genus or family level. Enter the appropriate index score and which SOP is used for scoring (2017 if using this document).

Once the index score is calculated enter information in either the genus or family biometric e-Form. Only record both if this is an ecoregion (including ECO and FECO) site.

Upload both taxa list and metric scores to the appropriate staging tables in Waterlog upon completion

Copies of all field forms and examples of excel spread-sheet format are provided in appendix B of this document. E-Forms are available on SharePoint or by contacting PAS.

Semi-quantitative Samples

a. Aquatic Biology Section – State Laboratory

After sample completion and QC (by agreed due date) the lab will upload taxa lists and biometric reports in the appropriate staging tables in Waterlog. Notify sampler that data are available.

New taxa (not already in Waterlog reference table) will be sent to PAS (EDAS query) or uploaded to Waterlog reference staging table when it becomes 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.

Copies of Chain of Custody should be uploaded to SharePoint.

b. Biological Consultants (Regulated Community)

After collection the consulting biologists must retain all samples and paperwork (sample request form/COC, habitat assessments, stream survey field sheet) copy of all paperwork and voucher specimens for a minimum of five years from collection date.

After sample completion and QC, electronic spreadsheets in the approved format (see appendix B) of taxa lists, metric calculations, habitat assessments, field parameters and stream survey sheets should be sent to the Planning and Standards Unit or Mining Unit (if it is a Mining permit) for upload to Waterlog. (Electronic forms can be obtained from the Planning and Standards Unit.) Copies of all reports and paperwork should be sent to the Planning and Standards Unit and all recipients specified in the permit.

Results should not be submitted until QC in accordance with Section II of the QSSOP is complete. However, data should not be held past the due date specified in the permit. Instead, QC should be done prior to completion of a 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. Consulting biologists shall provide a verification of QC with the report submittal.

Protocol M: Reference stream selection

The following guidelines are for selection of ecoregion reference streams. When selecting a project specific reference sites for atypical test streams the same guidelines should apply. Stream size, habitat, gradient and geology should be similar to the test site.

- Stream type, flow regime and substrate are typical of the Level IV ecoregion (or test site for atypical streams). Perennial streams will be targeted. Intermittent streams may be selected if this is typical of headwaters for the ecoregion.
- Streams are in a protected watershed or upstream land-use is primarily forested. In heavily urban or agricultural bioregions, stations will be selected where upstream watershed is least disturbed and is comparable to percent forested of other established reference streams.

Include range of % forested for each bioregion (headwater/wadeable)

- Riparian vegetation zone is well established with all size classes represented. Invasives constitute less than 10% of streamside vegetation.
- The upstream watershed does not contain a municipality, mining area or permitted discharger and is not heavily impacted by nonpoint source or other non-regulated source of pollution.
- Upstream drainage is at least 80% within a single Level IV ecoregion.
- The stream flows in its natural channel. There are no flow or water level modification structures such as dams, irrigation canals or field drains.
- No power lines or pipelines or any structure that is routinely cleared crosses upstream of the monitoring station.
- The upstream watershed contains few or no roads.

I.J - DATA AND RECORDS MANAGEMENT

All biological data and associated field information will be stored in the division's Waterlog database. COC and photos will be stored on SharePoint.

Biorecon and semi-quantitative stations are established in Waterlog. The Planning and Standards Unit is responsible for maintaining the stations list. During watershed planning before the start of each fiscal year, the Quality Team member or their designee in each EFO should check that all biological stations for their area have been entered in waterlog with complete information and that the site does not exist under another station ID. Any new stations should be uploaded to the staging table in Waterlog. PAS will be responsible for QC'ing the new stations, verifying that they are not an established station under another name, assigning a monitoring ID (TNW) and uploading to the final table in Waterlog.

Biorecon metric and taxa lists identified by the EFO are uploaded to waterlog within 30 days of completion of identification and by June 30 of the watershed assessment year. .

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 Waterlog within 30 days of field survey.

Taxa lists, metrics and TMI scores from DWR semi-quantitative samples are uploaded to Waterlog by the Aquatic Biology Section, Lab Services, TDH on or before sample due date. An email will be sent to the field offices when new SQSH data have been uploaded.

The regulated community will send excel spreadsheets, not pdfs, using standard format (Appendix B) of macroinvertebrate taxa lists, metric calculations, TMI scores, habitat sheets, field parameters and field survey sheets to PAS for QC and upload to Waterlog. Except for mining which will be uploaded by the mining section. Contact PAS for e-Forms.

Copies of paper files COC, stream sketches and pictures are uploaded on SharePoint in PAS under the appropriate EFO. (Eventually these will be uploaded with associated field data in Waterlog). Contact PAS for more information.

Assessment information for each stream segment will be entered in the Assessment Database (ADB) by the Planning and Standards Unit (PAS). By 2018 the ADB will be replaced by ATTAINS (Assessment, TMDL Tracking and Implementation System) in Waterlog. PAS staff will meet with WPC 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 ASSURANCE /QUALITY CONTROL

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 QC Practices

- 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 Planning and Standards Unit. Major responsibilities will include monitoring QC activities to determine conformance, distributing quality related information, training personnel on QC requirements and procedures, reviewing QA/QC plans for completeness, noting inconsistencies, and signing off on the QA plan and reports.
- Quality Team Member (In-house QC officer) - One WPC biologist/environmental specialist 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. Taxonomic Reference Collection and vouchers
2. 10% duplicate of BR collection, identification and habitat assessment.
3. 10 duplicate collection of SQSH and Periphyton
4. Train new biological staff and those assisting biologists.
5. Ensure biorecons, habitat assessments, field parameters and stream survey forms are uploaded to Waterlog in a timely manner.
6. Ensure samples are delivered to the laboratory following requirements for hazardous materials and that chain of custody is maintained.
7. Proper storage and disposal of ethanol.
8. Obtaining supplies and equipment
9. Maintenance and repair of sampling equipment.
10. Meter calibration, sampling/taxonomic and QC logs are maintained.
11. Maintain QSSOP updates and make sure all staff are aware of changes.

- Training - Unless prohibited by budgetary 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 biologists/environmental specialists conducting macroinvertebrate 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. A separate consensus field sheet should be submitted with both original data sheets. Indicate on habitat assessment sheet if duplicate and/or consensus completed. Note only the consensus form is uploaded to waterlog.
2. Biorecon Collection A second biorecon will be collected at a minimum of 10% of the sites by a separate biologist. This should be conducted at the same time, or at least within two weeks of the original survey. If assessment does not agree (not-impaired, ambiguous, or impaired) biologists should investigate reason for disagreement. Results from the more representative sample should be used. Both are uploaded to waterlog, indicate on comment field which is most representative. If no reason could be determined for discrepancy, both biologists should collect another sample.
3. Semi-quantitative Sample - A second semi-quantitative 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). Since this sampling method requires two people, it will not be possible in most offices for an independent team to conduct the sampling. Therefore, the same team can collect the samples with each investigator independently selecting the sample spot and performing the kick. At least once a year, a team from another EFO or the state lab should collect the QC sample.

If assessment results do not agree (both scores above or below 32) the following action will take place until agreement is reached:

- a. 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. This will not count as part of the required 10% duplicates.
- b. If there was no discrepancy in field conditions or collection method, the lab will re-id both samples. If both scores agree, QC is complete.

- c. If scores do not agree, the lab will re-examine both subsamples for overlooked organisms and re-id. If both scores agree, QC is complete.
 - d. If scores do not agree, the lab will re-subsample and id both samples
 - e. If samples still do not agree, all 4 taxa lists will be combined, statistically reduced to a 200 organisms subsample and re-scored. This will not count as a QC sample.
4. **Chain of Custody** Chain of custody 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. Chain of custody must also accompany any contract samples (semi-quantitative samples being sent to the lab). 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 line four. The person who logs the sample in signs the last line.

C. QC Log

A list of all samples sorted and/or identified by each biologist/environmental specialist 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 15). The QC log must contain the following information:

1. Field log number
2. Activity ID
3. DWR Station ID
4. Sample type
5. Initials of taxonomist and sorter
6. Number of organisms picked in subsample (semi-quantitative samples only)
7. Date completed
8. Initials of person performing QC
9. Number of organisms found in re-pick (semi-quantitative samples only)
10. Percent sorting efficiency (semi-quantitative samples only).
11. Date of QC identification
12. Initials of QC taxonomist
13. Results of taxonomic QC (satisfactory/unsatisfactory)

Field Log Number	BenSampID	Station ID	Sample Type	Sort By	Sort Date	# org.	Sort QC	QC Date	QC # org.	Sort Eff.	S/U	ID By	ID Date	QC ID	QC Date	S/U
J0201001	J0201001	BIFFL003.0DY	SQKICK													
J0201002	J0201002	BIGGS000.7WY	SQKICK	AJF	3/11/02	190	PDS	3/20/02	10	95%	S	AJF	3/11/02	PDS	3/20/02	S
J0201003	J0201003	BMHOL002.0OB	SQKICK													
J0201004	J0201004	CANE001.8WY	SQKICK													
J0201005	J0201005	CGROU001.2WY	SQKICK													
J0201006	J0201006	CLEAR001.2HN	SQKICK													
J0201007	J0201007	CLOVE001.4OB	SQKICK													
J0201008	J0201008	CSPRI002.4DY	SQKICK													
J0202001	J0202001	CYPRE00.6WY	SQKICK													
J0202002	J0202002	CYPRE000.6OB	SQKICK													
J0202003	J0202003	DAVID002.6OB	SQKICK													
J0202004	J0202004	GRASS000.8OB	SQKICK													
J0203001	J0203001	HFORK006.8OB	SQKICK													
J0203002	J0203002	HOOSI000.5OB	SQKICK													
J0203003	J0203003	HURRI002.6WY	SQKICK													
J0203004	J0203004	HURRI003.9WY	SQKICK													
J0203005	J0203005	HURRI1T1.1WY	SQKICK													
J0203006	J0203006	MILL004.0OB	SQKICK													
J0203007	J0203007	NFOBI005.9OB	SQKICK	AJF	3/15/02	220	PDS	3/20/02	14	94%	S	AJF	3/15/02	PDS	3/20/02	S
J0203008	J0203008	NFOBI018.0WY	SQKICK													
J0203009	J0203009	NFOBI026.5WY	BR													
J0203010	J0203010	NFOBI040.6HN	BR	NA	NA	NA	NA	NA	NA	NA	NA	AJF	3/16/02	PDS	3/20/02	S
J0203011	J0203011	OBION020.9DY	BR													
J0203012	J0203012	OBION044.3DY	BR													

Figure 15: Example of Macroinvertebrate QC Log

D. Sorting Efficiency (Semi-Quantitative Samples Only)

1. Each biologist responsible for sample sorting, regardless of previous experience, will have every sample QC'ed by a second biologist who has already achieved 90% sorting efficiency (documented) until the original biologist has passed 90% sorting efficiency on a sample. A record of this is kept in the QC log. Once a biologist has passed their first QC, they are QC'ed on 10% of subsequent samples (randomly selected).
2. Each biologist involved in sorting of semi-quantitative benthic macroinvertebrate samples will have 10% of their subsamples (debris) resorted by a second experienced biologist. The sample to be QC'ed is randomly chosen by the person performing the QC after every group of 10 samples has been completed. (Or fewer if less than 10 are completed before due date). A sorting efficiency of 90% must be maintained. If fewer than 90% of the organisms are recovered, every sample prior to that one in the same group of 10 is resorted until a sample that has met the 90% requirement is found. The next group of 10 starts after the unsatisfactory sample.

The sorting efficiency is calculated by:

$$\text{Sorting efficiency} = \frac{\# \text{ organisms found in initial pick}}{\text{Total \# organisms, both picks}} \times 100$$

If fewer than 90% of organisms are found, the additional animals are added to the final ID of the first pick. If this puts the final subsample over 240 organisms transfer all organisms to a small gridded dish (36 grids). Subsample by groups of first four and then one random grid until the target of 160-240 organisms is achieved. If permanent mounts have already been made of the first pick, a 200 organism subsample should be calculated statistically:

$$\text{Taxon a} = 200 * \frac{\# \text{ taxon a found in both picks}}{\text{Total \# organisms both picks}}$$

Round to nearest whole number.

3. Log results in the QC log.
4. All sorting QC must be completed before the data are released to ensure accuracy of results. However samples, should not be held up waiting for QC. Instead QC should be performed prior to completion of group of 10. 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.
5. All subsample debris is preserved in 80% ethanol and kept in a labeled container for a minimum of 5 years from collection date. The original sample, from which the subsample was taken, is kept in a separate labeled container for the same period. Samples are disposed of following hazardous waste protocols for ethanol after five years from collection date.

E. Taxonomic Verification

1. All biologists are to be trained and show proficiency for genus level identification of each group of organisms. (Except Acari, Nematoda, Nematomorpha, Branchiobdellida, Enchytraeidae and Lumbriculidae). If the biologist will only be performing family level bio-recons, they need only demonstrate proficiency at the family level. If the biologist will only be performing genus level bio-recons, they do not need to demonstrate proficiency in chironomids or oligochaetes. If the biologist will be performing SQSH, they must demonstrate genus level proficiency in all taxa groups.
2. The same taxonomic keys for each group will be used by all taxonomists. Consistency in taxonomic keys is essential because couplets in different keys can result in identification discrepancies through differences in nomenclature or inconsistency of characters used for separation of taxa. This is particularly true where genera may exhibit great variability due to regionalization. Approved keys are listed in Appendix D. Keys will be updated continually as new literature is made available. However, biologists should not utilize new keys for anything other than supplemental information until they are approved by the central QC coordinator (PAS) and incorporated into the SOP to be used by all Division biologists/ES. New literature will be discussed at the annual training meetings. If new keys are approved for use as primary keys, taxa from reference stations will be reviewed to ensure that the most recent nomenclature is being used for reference information.
3. Each new biologist/ES, regardless of previous experience, will have every sample QC'ed by another biologist/ES (who has passed QC) until they have satisfactorily completed taxonomic QC on a sample. A record of this is kept in the QC log. Once a biologist/ES has satisfactorily completed their first QC, 10% of their identified samples will be randomly checked by another biologist/ES. The sample to be QC'ed is randomly chosen by the QC'er after every 10th sample is completed (or fewer depending on due date). The biologist/ES performing the QC will identify every organism in the sample without consulting the original taxonomist's list. Once the second identification is complete, the two biologists/ES will go over any discrepancies together.
4. For bio-recons, assessment results must be the same (supporting, ambiguous or non-supporting) to pass QC. (Note for family level bio-recons where complete vouchers are not collected on every sample, taxonomic QC will be on every 10th sample when the entire voucher is retained instead of random).
5. To satisfy taxonomic QC requirements for Semi-Quantitative samples,

The QC coordinator calculates the following 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. If both taxonomic QC is performed on the same sample where sorting efficiency is checked, only the animals found in the original pick will be used for QC.

- A. *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.

- B. *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.

- C. *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:

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

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

8. Unless specified otherwise by project goals and objectives, the measurement quality objectives (MQO) are:

$$\begin{aligned} PDE &\leq 5 \\ PTD &\leq 15 \\ PTC &\geq 95 \\ PTD_{abs} &\leq 5 \end{aligned}$$

6. Log results in the QC logbook.
7. Complete all taxonomic QC before releasing results ensure accuracy of results. Reports should never be held waiting for QC, if necessary perform QC prior to completion of group of 10. If, for any reason, results are released prior to QC completion, send an addendum to all report recipients with any adjusted information after QC is complete.

F. Voucher Collections

1. Family Level Biorecons – Representative specimens of families difficult to field identify, should always be collected for dissecting scope verification. Voucher collections including representatives of each taxon must be collected at a minimum of 10% of sites for verification by dissecting scope. If mis-identifications occur, vouchers should be collected at all sites for those families missed until biologist has demonstrated proficiency in field identifications for that taxon.
2. Genus level – Vouchers collections including representatives of each taxon must be collected at every site for verification by dissecting scope.
3. All voucher samples must be maintained for five years from collection date.

G. Reference Collections

1. The designated QC officer (quality team member) for each EFO will maintain a permanent reference collection consisting of all taxa identified by that EFO. In addition, a master collection of all taxa identified in the state will be kept in the central laboratory. The organisms in the centralized master reference collection will be verified by outside experts recognized for expertise in a particular taxonomic group.
2. A list of verified organisms found in the state is provided in Appendix E and will be in the master taxa table in waterlog. If new organisms, not on the verified state taxa list are identified by the EFO, the quality team member will send a representative of that taxon to the central laboratory. The laboratory will have the new taxon verified by an outside expert, will add the organism to the central reference collection and will notify all regional offices and PAS of its addition to the verified taxa list for Tennessee. Experts used for verification must meet the qualifications provided in Appendix E.
3. Each EFO and central laboratory reference collection will be catalogued with discrete collection numbers assigned to each taxon in each facility. Assign unique numbers that identify the reference location to specimens as they are added into the collection. For example, if sequential numbering is used, N0001 would be the first specimen in the Nashville EFO collection. Maintain an accession catalog of all reference material in a permanently bound log or electronic format with backup on a separate system. Each entry must contain the following information:
 - Accession number (This must be unique for each group of organisms in each collection)
 - Complete name (genus, authority = who id'ed or verified it, date identified)
 - Higher taxa (family, order, class)

- Locality data (Waterbody, location, county, ecoregion, station id)
 - Sample habitat
 - Name of collector/date of collection
 - Name of taxonomist
 - Name of verifier if appropriate
 - Number of specimens
4. Arrange specimens for ease of use, (according to accession number or in phylogenetic order). Retain wet specimens in 80% ethanol in small screw cap vials with rubber or Teflon lined caps or rubber stoppered vials. Retain large specimens in appropriate size specimen jars sealed with electrical tape to reduce evaporation. Inspect vials monthly for evaporation adding 80% ethanol as needed. Keep permanently mounted microscope slides in a slide storage box. Seal the edges of the coverslips to prevent shrinkage of media over time.
 5. Clearly label all reference vials and slides. Place the labels in the vial with wet specimens or attach to slides for mounted specimens. Label information at a minimum must include:
 - Full name of the organism (Order, family, genus)
 - Accession number (reference number)
 - Station ID number
 - Ecoregion
 - Collection date
 - Collector
 - Taxonomist
 - Verifier

H. Data Reduction QC

1. Raw data (taxonomic lists and counts) will be stored in the taxonomic tables in Waterlog and in EPA WQX/STORET.
2. A second staff member will check all computer data entry for correctness by direct comparison with any field or laboratory handwritten data sheets. This step is not necessary if using tablets loaded with DWR data sheets. The person performing the data entry QC initial and dates each page of the checked printout in red ink
3. A second staff member will check ten percent of all biometrics and scoring that were hand calculated. If an error is found, all of the calculations for that biometric in that sample set are checked. The person performing the QC initials and dates each checked metric in red ink.
4. QC information is kept a minimum of five years.
5. All data reduction QC is completed before results are released.

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APPENDIX A

ECOREGION REFERENCE INFORMATION

**BIOCRITERIA TABLES
ECOREGION REFERENCE STREAMS
HEADWATER ECOREGION REFERENCE STREAMS
REGIONAL EXPECTATIONS FOR INDIVIDUAL HABITAT PARAMETERS**

Bioregion: 65abei Season: January-June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQBANK Drainage > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 36	25 – 36	12 – 24	< 12
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT-Cheum	> 25.8	17.2 – 25.8	8.6 – 17.1	< 8.6
% OC	< 53.6	53.6 – 69.0	69.1 – 84.5	> 84.5
NCBI	< 6.54	6.54 – 7.69	7.70 – 8.84	> 8.84
% Clingers-Cheum	> 25.2	16.9 – 25.2	8.4 – 16.8	< 8.4
% TNutol	< 28.5	28.5 – 52.2	52.3 – 76.1	> 76.1

Bioregion: 65abei Season: July-December Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQBANK Drainage > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 35	24 – 35	12 – 23	< 12
EPT Richness (EPT)	> 8	6 – 8	3 – 5	< 3
% EPT-Cheum	> 31.2	20.9 – 31.2	10.4 – 20.8	< 10.4
% OC	< 47.2	47.2 – 64.7	64.8 – 82.4	> 82.4
NCBI	< 6.39	6.39 – 7.59	7.60 – 8.79	> 8.79
% Clingers-Cheum	> 29.2	19.5 – 29.2	9.8 – 19.4	< 9.8
% TNutol	< 28.8	28.8 – 52.5	52.6 – 76.2	> 76.2

Bioregion: 65abei Season: January-June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Headwater Method = SQBANK Drainage ≤ 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 30	21 – 30	10 – 20	< 10
EPT Richness (EPT)	> 4	3 – 4	2	< 2
% EPT-Cheum	> 39.0	26.0 – 39.0	13.0 – 25.9	< 13.0
% OC	< 50.9	50.9 – 67.2	67.3 – 83.6	> 83.6
NCBI	< 5.67	5.67 – 7.11	7.12 – 8.55	> 8.55
% Clingers-Cheum	> 17.4	11.7 – 17.4	5.8 – 11.6	< 5.8
% TNutol	< 29.0	29.0 – 52.6	52.7 – 76.3	> 76.3

Bioregion: 65abei		Headwater Method = SQBANK		
Season: July-December (Fall)		Drainage ≤ 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 30	21 – 30	10 – 20	< 10
EPT Richness (EPT)	> 6	4 – 6	2 – 3	< 2
% EPT-Cheum	> 36.4	24.3 – 36.4	12.2 – 24.2	< 12.2
% OC	< 41.6	41.6 – 61.0	61.1 – 80.5	> 80.5
NCBI	< 5.74	5.74 – 7.15	7.16 – 8.58	> 8.58
% Clingers-Cheum	> 17.8	11.9 – 17.8	6.0 – 11.8	< 6.0
% TNutol	< 25.8	25.8 – 50.5	50.6 – 75.2	> 75.2

Bioregion 65j		Method = SQKICK		
Season: January – June		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 30	21– 30	10– 20	< 10
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT-Cheum	> 44.1	29.5– 44.1	14.7 – 29.4	< 14.7
% OC	< 34.4	34.4 – 56.2	56.3 – 78.1	> 78.1
NCBI	< 5.01	5.01 – 6.67	6.68 – 8.33	> 8.33
% Clingers-Cheum	> 47.1	31.5 – 47.1	15.7 – 31.4	< 15.7
% TNutol	< 28.0	28.0 – 52.0	52.1 – 76.0	> 76.0

Bioregion 65j		Method = SQKICK		
Season: July-December		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19– 27	9 – 18	< 9
EPT Richness (EPT)	> 9	7 – 9	3 – 6	< 3
% EPT-Cheum	> 51.0	34.0 – 51.0	17.0 – 33.9	< 17.0
% OC	< 35.0	35.0 – 56.6	56.7 – 78.3	> 78.3
NCBI	< 5.42	5.42 – 6.94	6.95 – 8.47	> 8.47
% Clingers-Cheum	> 44.2	29.5 – 44.2	14.8 – 29.4	< 14.8
% TNutol	< 29.5	29.5 – 52.9	53.0 – 76.5	> 76.5

Bioregion 65j		Headwater		
Season: January – June		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 29	20 – 29	10 – 19	< 10
EPT Richness (EPT)	> 8	6 – 8	3 – 5	< 3
% EPT-Cheum	> 34.2	22.9 – 34.2	11.4 – 22.8	< 11.4
% OC	< 40.6	40.6 – 60.4	60.5 – 80.2	> 80.2
NCBI	< 5.35	5.35 – 6.89	6.90 – 8.45	> 8.45
% Clingers-Cheum	> 31.4	21.0 – 31.4	10.5 – 20.9	< 10.5
% TNutol	< 37.5	37.5 – 58.3	58.4 – 79.1	> 79.1

Bioregion 65j		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 33	23 – 33	11 – 22	< 11
EPT Richness (EPT)	> 12	8 – 12	4 – 7	< 4
% EPT-Cheum	> 42.8	28.6 – 42.8	14.3 – 28.5	< 14.3
% OC	< 35.2	35.2 – 56.7	56.8 – 78.4	> 78.4
NCBI	< 5.57	5.57 – 7.04	7.05 – 8.52	> 8.52
% Clingers-Cheum	> 46.9	31.4 – 46.9	15.7 – 31.3	< 15.7
% TNutol	< 34.1	34.1 – 56.0	56.1 – 78.0	> 78.0

Bioregion 66deik		Method = SQKICK		
Season: January – June		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 33	23 – 33	11 – 22	< 11
EPT Richness (EPT)	> 16	11 – 16	6 – 10	< 6
% EPT-Cheum	> 56.7	37.9 – 56.7	18.9 – 37.8	< 18.9
% OC	< 32.8	32.8 – 55.1	55.2 – 77.6	> 77.6
NCBI	< 4.06	4.06 – 6.04	6.05 – 8.02	> 8.02
% Clingers-Cheum	> 54.7	36.6 – 54.7	18.3 – 36.5	< 18.3
% TNutol	< 26.5	26.5 – 50.9	51.0 – 75.5	> 75.5

Bioregion 66deik Season: July-December Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQKICK Drainage: > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 33	22 – 33	11 – 21	< 11
EPT Richness (EPT)	> 15	11 – 15	5 – 10	< 5
% EPT-Cheum	> 58.2	38.9 – 58.2	19.4 – 38.8	< 19.4
% OC	< 29.9	29.9 – 53.2	53.3 – 76.6	> 76.6
NCBI	< 4.25	4.25 – 6.16	6.17 – 8.08	> 8.08
% Clingers-Cheum	> 54.3	36.3 – 54.3	18.1 – 36.2	< 18.1
% TNutol	< 26.2	26.2 – 50.7	50.8 – 75.4	> 75.4

Bioregion 66deik Season: January – June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Headwater Method = SQKICK Drainage: ≤ 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 34	23 – 34	12 – 22	< 12
EPT Richness (EPT)	> 14	10 – 14	5 – 9	< 5
% EPT-Cheum	> 51.2	34.2 – 51.2	17.1 – 34.1	< 17.1
% OC	< 32.5	32.5 – 54.9	55.0 – 77.5	> 77.5
NCBI	< 4.55	4.55 – 6.36	6.37 – 8.18	> 8.18
% Clingers-Cheum	> 49.1	32.8 – 49.1	16.4 – 32.7	< 16.4
% TNutol	< 25.7	25.7 – 50.4	50.5 – 75.2	> 75.2

Bioregion 66deik Season: July-December Target TMI = 32 Scoring calibrated to 160-240 organism sample		Headwater Method = SQKICK Drainage: ≤ 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 31	22 – 31	11 – 21	< 11
EPT Richness (EPT)	> 14	10 – 14	5 – 9	< 5
% EPT-Cheum	> 55.3	36.9 – 55.3	18.5 – 36.8	< 18.5
% OC	< 30.8	30.8 – 53.8	53.9 – 76.9	> 76.9
NCBI	< 4.57	4.57 – 6.38	6.39 – 8.19	> 8.19
% Clingers-Cheum	> 53.6	35.8 – 53.6	17.9 – 35.7	< 17.9
% TNutol	< 26.7	26.7 – 51.1	51.2 – 75.5	> 75.5

Bioregion: 66fgj Season: January – June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQKICK Drainage: > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 32	22 – 32	11 – 21	< 11
EPT Richness (EPT)	> 15	11–15	5 –10	< 5
% EPT-Cheum	> 49.7	33.2– 49.7	16.6 – 33.1	< 16.6
% OC	< 31.1	31.1 – 54.0	54.1 – 77.0	> 77.0
NCBI	< 4.18	4.18 – 6.12	6.13 – 8.06	> 8.06
% Clingers-Cheum	> 54.4	36.3 – 54.4	18.2 – 36.2	< 18.2
% TNutol	< 27.2	27.2 – 51.4	51.5 – 75.7	> 75.7

Bioregion: 66fgj Season: July-Dec Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQKICK Drainage: > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 34	23 – 34	12 – 22	< 12
EPT Richness (EPT)	> 16	11–16	6 –10	< 6
% EPT-Cheum	> 56.2	37.5– 56.2	18.8 – 37.4	< 18.8
% OC	< 29.8	29.8 – 53.1	53.2 – 76.6	> 76.6
NCBI	< 4.64	4.64 – 6.42	6.43 – 8.21	> 8.21
% Clingers-Cheum	> 51.6	34.5 – 51.6	17.2 – 34.4	< 17.2
% TNutol	< 28.0	28.0 – 51.9	52.0 – 76.0	> 76.0

Bioregion: 66fgj Season: January – June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Headwater Method = SQKICK Drainage: ≤ 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 34	23 – 34	12 – 22	< 12
EPT Richness (EPT)	> 14	10–14	5 –9	< 5
% EPT-Cheum	> 40.5	27.1– 40.5	13.5 – 27.0	< 13.5
% OC	< 42.1	42.1 – 61.3	61.4 – 80.7	> 80.7
NCBI	< 4.91	4.91 – 6.60	6.61 – 8.30	> 8.30
% Clingers-Cheum	> 41.2	27.5 – 41.2	13.8 – 27.4	< 13.8
% TNutol	< 28.3	28.3 – 52.2	52.3 – 76.1	> 76.1

Bioregion: 66fgj		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 31	21 – 31	11 – 20	< 11
EPT Richness (EPT)	> 14	10–14	5 – 9	< 5
% EPT-Cheum	> 49.8	33.3– 49.8	16.6 – 33.2	< 16.6
% OC	< 32.1	32.1 – 54.7	54.8 – 77.3	> 77.3
NCBI	< 4.48	4.48 – 6.32	6.33 – 8.16	> 8.16
% Clingers-Cheum	> 54.5	36.4 – 54.5	18.2 – 36.3	< 18.2
% TNutol	< 27.5	27.5 – 51.6	51.7 – 75.8	> 75.8

Bioregion 67fghi		Method = SQKICK		
Season: January – June		Drainage > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 30	20 – 30	10 – 19	< 10
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT-Cheum	> 40.3	27.0 – 40.3	13.5 – 26.9	< 13.5
% OC	< 28.1	28.1 – 52.0	52.1 – 76.0	> 76.0
NCBI	< 4.74	4.74 – 6.49	6.50 – 8.24	> 8.24
% Clingers-Cheum	> 50.7	33.9 – 50.7	16.9 – 33.8	< 16.9
% TNutol	< 31.3	31.3 – 54.1	54.2 – 77.1	> 77.1

Bioregion 67fghi		Method = SQKICK		
Season: July-December		Drainage > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 26	18 – 26	9 – 17	< 9
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT-Cheum	> 43.5	29.1 – 43.5	14.5 – 29.0	< 14.5
% OC	< 27.0	27.0 – 51.3	51.4 – 75.6	> 75.6
NCBI	< 5.26	5.26 – 6.83	6.84 – 8.42	> 8.42
% Clingers-Cheum	> 53.5	35.7 – 53.5	17.9 – 35.6	< 17.9
% TNutol	< 33.2	33.2 – 55.4	55.5 – 77.7	> 77.7

Bioregion: 67fghi		Headwater		
Season: January – June		Method = SQKICK		
Target TMI = 32		Drainage ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 32	22 – 32	11 – 21	< 11
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT-Cheum	> 49.2	32.8 – 49.2	16.4 – 32.7	< 16.4
% OC	< 27.7	27.7 – 51.7	51.8 – 75.9	> 75.9
NCBI	< 4.82	4.82 – 6.54	6.55 – 8.27	> 8.27
% Clingers-Cheum	> 50.6	33.8 – 50.6	16.9 – 33.7	< 16.9
% TNutol	< 28.0	28.0 – 51.9	52.0 – 76.0	> 76.0

Bioregion: 67fghi		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 29	20 – 29	10 – 19	< 10
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT-Cheum	> 43.4	29.0 – 43.4	14.5 – 28.9	< 14.5
% OC	< 28.7	28.7 – 52.4	52.5 – 76.2	> 76.2
NCBI	< 5.05	5.05 – 6.69	6.70 – 8.35	> 8.35
% Clingers-Cheum	> 53.3	35.6 – 53.3	17.8 – 35.5	< 17.8
% TNutol	< 28.4	28.4 – 52.2	52.3 – 76.1	> 76.1

Bioregion: 67fghi		Method = SQBANK		
Season: January – June		Drainage >2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 28	20 – 28	10 – 19	< 10
EPT Richness (EPT)	> 6	5 – 6	2 – 4	< 2
% EPT-Cheum	> 25.9	17.4 – 25.9	8.7 – 17.3	< 8.7
% OC	< 50.0	50.0 – 66.6	66.7 – 83.3	> 83.3
NCBI	< 6.67	6.67 – 7.77	7.78 – 8.89	> 8.89
% Clingers	> 20.1	13.5 – 20.1	6.7 – 13.4	< 6.7
% TNutol	< 45.1	45.1 – 63.3	63.4 – 81.7	> 81.7

Bioregion: 67fghi		Method = SQBANK		
Season: July - December		Drainage >2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 27	18 – 27	9 – 17	< 9
EPT Richness (EPT)	> 5	4 – 5	2 – 3	< 2
% EPT-Cheum	> 43.6	29.2 – 43.6	14.6 – 29.1	< 14.6
% OC	< 29.4	29.4 – 52.9	53.0 – 76.4	> 76.4
NCBI	< 5.85	5.85 – 7.22	7.23 – 8.61	> 8.61
% Clingers	> 34.9	23.3 – 34.9	11.7 – 23.2	< 11.7
% TNutol	< 41.7	41.7 – 61.1	61.2 – 80.5	> 80.5

Bioregion 68ad		Method = SQKICK		
Season: January – June		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 33	23 – 33	11 – 22	< 11
EPT Richness (EPT)	> 12	9 – 12	4 – 8	< 4
% EPT-Cheum	> 51.3	34.3 – 51.3	17.1 – 34.2	< 17.1
% OC	< 32.1	32.1 – 54.7	54.8 – 77.3	> 77.3
NCBI	< 4.76	4.76 – 6.50	6.51 – 8.25	> 8.25
% Clingers-Cheum	> 47.7	31.9 – 47.7	15.9 – 31.8	< 15.9
% TNutol	< 28.0	28.0 – 51.9	52.0 – 76.0	> 76.0

Bioregion 68ad		Method = SQKICK		
Season: July - December		Drainage: > 2.5 square miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 35	24 – 35	12 – 23	< 12
EPT Richness (EPT)	> 14	10 – 14	5 – 9	< 5
% EPT-Cheum	> 49.6	33.1 – 49.6	16.6 – 33.0	< 16.6
% OC	< 29.6	29.6 – 53.0	53.1 – 76.5	> 76.5
NCBI	< 5.11	5.11 – 6.73	6.74 – 8.37	> 8.37
% Clingers-Cheum	> 57.7	38.5 – 57.7	19.3 – 38.4	< 19.3
% TNutol	< 31.9	31.9 – 54.5	54.6 – 77.3	> 77.3

Bioregion 68ad		Method = SQKICK		
Season: January-June		Drainage: ≤2.5 square miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 32	22 – 32	11 – 21	< 11
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT-Cheum	> 56.5	37.8 – 56.5	18.9 – 37.7	< 18.9
% OC	< 33.2	33.2 – 55.4	55.5 – 77.7	> 77.7
NCBI	< 5.41	5.41 – 6.94	6.95 – 8.47	> 8.47
% Clingers-Cheum	> 28.5	19.1 – 28.5	9.5 – 19.0	< 9.5
% TNutol	< 29.5	29.5 – 52.9	53.0 – 76.5	> 76.5

Bioregion 68ad		Method = SQKICK		
Season: July - December		Drainage: ≤2.5 square miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 30	21 – 30	10 – 20	< 10
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT-Cheum	> 44.2	29.5 – 44.2	14.8 – 29.4	< 14.8
% OC	< 42.5	42.5 – 61.6	61.7 – 80.8	> 80.8
NCBI	< 5.82	5.82 – 7.20	7.21 – 8.60	> 8.60
% Clingers-Cheum	> 47.3	31.6 – 47.3	15.8 – 31.5	< 15.8
% TNutol	< 33.4	33.4 – 55.5	55.6 – 77.8	> 77.8

Bioregion 68b		Method = SQKICK		
Season: January - June		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 27	18 – 27	9 – 17	< 9
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT-Cheum	> 55.5	37.1 – 55.5	18.5 – 37.0	< 18.5
% OC	< 50.6	50.6 – 67.0	67.1 – 83.5	> 83.5
NCBI	< 5.71	5.71 – 7.14	7.15 – 8.57	> 8.57
% Clingers-Cheum	> 28.2	18.8 – 28.2	9.4 – 18.7	< 9.4
% TNutol	< 40.3	40.3 – 60.1	60.2 – 80.1	> 80.1

Bioregion 68b		Method = SQKICK		
Season: July-December		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 23	16 – 23	8 – 15	< 8
EPT Richness (EPT)	> 9	7 – 9	3 – 6	< 3
% EPT-Cheum	> 41.2	27.5 – 41.2	13.8 – 27.4	< 13.8
% OC	< 31.3	31.3 – 54.2	54.3 – 77.1	> 77.1
NCBI	< 5.07	5.07 – 6.71	6.72 – 8.35	> 8.35
% Clingers-Cheum	> 41.6	27.8 – 41.6	13.9 – 27.7	< 13.9
% TNutol	< 34.7	34.7 – 56.4	56.5 – 78.2	> 78.2

Bioregion 68b		Headwater		
Season: January - June		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 26	18 – 26	9 – 17	< 9
EPT Richness (EPT)	> 9	7 – 9	3 – 6	< 3
% EPT-Cheum	> 44.6	29.8 – 44.6	14.9 – 29.7	< 14.9
% OC	< 34.0	34.0 – 55.9	56.0 – 78.0	> 78.0
NCBI	< 5.54	5.54 – 7.02	7.03 – 8.51	> 8.51
% Clingers-Cheum	> 35.2	23.5 – 35.2	11.8 – 23.4	< 11.8
% TNutol	< 29.9	29.9 – 53.2	53.3 – 76.6	> 76.6

Bioregion 68b		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT-Cheum	> 46.9	31.3 – 46.9	15.7 – 31.2	< 15.7
% OC	< 30.8	30.8 – 53.8	53.9 – 76.9	> 76.9
NCBI	< 5.41	5.41 – 6.93	6.94 – 8.47	> 8.47
% Clingers-Cheum	> 41.9	28.0 – 41.9	14.0 – 27.9	< 14.0
% TNutol	< 32.3	32.3 – 54.8	54.9 – 77.4	> 77.4

Bioregion 68c		Method = SQKICK		
Season: January - June		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 30	21 – 30	10 – 20	< 10
EPT Richness (EPT)	> 13	9 – 13	5 – 8	< 5
% EPT-Cheum	> 59.7	39.8 – 59.7	19.9 – 39.7	< 19.9
% OC	< 30.1	30.1 – 53.3	53.4 – 76.7	> 76.7
NCBI	< 4.48	4.48 – 6.31	6.32 – 8.16	> 8.16
% Clingers-Cheum	> 42.6	28.4 – 42.6	14.2 – 28.3	< 14.2
% TNutol	< 27.3	27.3 – 51.5	51.6 – 75.7	> 75.7

Bioregion 68c		Method = SQKICK		
Season: July - December		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 28	19 – 28	10 – 18	< 10
EPT Richness (EPT)	> 9	7 – 9	3 – 6	< 3
% EPT-Cheum	> 38.9	26.0 – 38.9	13.0 – 25.9	< 13.0
% OC	< 30.5	30.5 – 53.6	53.7 – 76.8	> 76.8
NCBI	< 4.93	4.93 – 6.61	6.62 – 8.31	> 8.31
% Clingers-Cheum	> 42.9	28.7 – 42.9	14.3 – 28.6	< 14.3
% TNutol	< 30.7	30.7 – 53.8	53.9 – 76.9	> 76.9

Bioregion 68c		Headwater		
Season: January-June		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 9	7 – 9	3 – 6	< 3
% EPT-Cheum	> 52.2	34.9 – 52.2	17.4 – 34.8	< 17.4
% OC	< 37.2	37.2 – 58.1	58.2 – 79.0	> 79.0
NCBI	< 4.70	4.70 – 6.46	6.47 – 8.23	> 8.23
% Clingers-Cheum	> 27.7	18.5 – 27.7	9.3 – 18.4	< 9.3
% TNutol	< 26.0	26.0 – 50.6	50.7 – 75.3	> 75.3

Bioregion 68c		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 12	9 – 12	4 – 8	< 4
% EPT-Cheum	> 51.8	34.6 – 51.8	17.3 – 34.5	< 17.3
% OC	< 31.1	31.1 – 54.0	54.1 – 77.0	> 77.0
NCBI	< 4.92	4.92 – 6.61	6.62 – 8.30	> 8.30
% Clingers-Cheum	> 32.0	21.4 – 32.0	10.7 – 21.3	< 10.7
% TNutol	< 29.4	29.4 – 52.9	53.0 – 76.4	> 76.4

Bioregion 69de		Method = SQKICK		
Season: January - June		Drainage: > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 32	22 – 32	11 – 21	< 11
EPT Richness (EPT)	> 15	11 – 15	5 – 10	< 5
% EPT-Cheum	> 60.8	40.6 – 60.8	20.3 – 40.5	< 20.3
% OC	< 33.3	33.3 – 55.5	55.6 – 77.7	> 77.7
NCBI	< 3.87	3.87 – 5.91	5.92 – 7.95	> 7.95
% Clingers-Cheum	> 53.9	36.0 – 53.9	18.0 – 35.9	< 18.0
% TNutol	< 26.9	26.9 – 51.2	51.3 – 75.6	> 75.6

Bioregion: 69de		Method = SQKICK		
Season: July-December		Drainage: > 2.5 square miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 31	21 – 31	11 – 20	< 11
EPT Richness (EPT)	> 12	9 – 12	4 – 8	< 4
% EPT-Cheum	> 56.6	37.8 – 56.6	18.9 – 37.7	< 18.9
% OC	< 31.4	31.4 – 54.2	54.3 – 77.1	> 77.1
NCBI	< 5.02	5.02 – 6.67	6.68 – 8.34	> 8.34
% Clingers-Cheum	> 53.2	35.5 – 53.2	17.8 – 35.4	< 17.8
% TNutol	< 28.0	28.0 – 51.9	52.0 – 76.0	> 76.0

Bioregion: 69de		Headwater		
Season: January-June		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 square miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 28	20 – 28	10 – 19	< 10
EPT Richness (EPT)	> 10	8 – 10	4 – 7	< 4
% EPT-Cheum	> 59.5	39.7 – 59.5	19.9 – 39.6	< 19.9
% OC	< 33.0	33.0 – 55.3	55.4 – 77.6	> 77.6
NCBI	< 4.39	4.39 – 6.26	6.27 – 8.13	> 8.13
% Clingers-Cheum	> 27.9	18.7 – 27.9	9.3 – 18.6	< 9.3
% TNutol	< 25.8	25.8 – 50.5	50.6 – 75.2	> 75.2

Bioregion: 69de		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage: ≤ 2.5 square miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT-Cheum	> 44.9	30.0 – 44.9	15.0 – 29.9	< 15.0
% OC	< 39.4	39.4 – 59.6	59.7 – 79.8	> 79.8
NCBI	< 4.67	4.67 – 6.44	6.45 – 8.22	> 8.22
% Clingers-Cheum	> 43.6	29.1 – 43.6	14.6 – 29.0	< 14.6
% TNutol	< 27.1	27.1 – 51.4	51.5 – 75.7	> 75.7

Bioregion 71e		Method = SQKICK		
Season: January - June		Drainage: > 2.5 square miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT-Cheum	> 38.6	25.8 – 38.6	12.9 – 25.7	< 12.9
% OC	< 30.0	30.0 – 53.3	53.4 – 76.6	> 76.6
NCBI	< 5.50	5.50 – 6.99	7.00 – 8.50	> 8.50
% Clingers-Cheum	> 48.2	32.2 – 48.2	16.1 – 32.1	< 16.1
% TNutol	< 37.8	37.8 – 58.5	58.6 – 79.2	> 79.2

Bioregion 71e Season: July-December Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQKICK Drainage: > 2.5 square miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 24	17 – 24	8 – 16	< 8
EPT Richness (EPT)	> 7	6 – 7	3 – 5	< 3
% EPT-Cheum	> 44.9	30.0 – 44.9	15.0 – 29.9	< 15.0
% OC	< 26.0	26.0 – 50.6	50.7 – 75.3	> 75.3
NCBI	< 5.53	5.53 – 7.01	7.02 – 8.51	> 8.51
% Clingers-Cheum	> 49.6	33.1 – 49.6	16.6 – 33.0	< 16.6
% TNutol	< 38.2	38.2 – 58.7	58.8 – 79.4	> 79.4

Bioregion 71e Season: January - June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Headwater Method = SQKICK Drainage: ≤ 2.5 square miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 25	17 – 25	9 – 16	< 9
EPT Richness (EPT)	> 8	6 – 8	3 – 5	< 3
% EPT-Cheum	> 45.2	30.2 – 45.2	15.1 – 30.1	< 15.1
% OC	< 30.9	30.9 – 53.9	54.0 – 76.9	> 76.9
NCBI	< 5.45	5.45 – 6.96	6.97 – 8.48	> 8.48
% Clingers-Cheum	> 24.0	16.0 – 24.0	8.0 – 15.9	< 8.0
% TNutol	< 38.1	38.1 – 58.7	58.8 – 79.3	> 79.3

Bioregion 71e Season: July-December Target TMI = 32 Scoring calibrated to 160-240 organism sample		Headwater Method = SQKICK Drainage: ≤ 2.5 square miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 8	6 – 8	3 – 5	< 3
% EPT-Cheum	> 19.0	12.7 – 19.0	6.4 – 12.6	< 6.4
% OC	< 34.8	34.8 – 56.5	56.6 – 78.2	> 78.2
NCBI	< 5.79	5.79 – 7.19	7.20 – 8.59	> 8.59
% Clingers-Cheum	> 42.2	28.2 – 42.2	14.1 – 28.1	< 14.1
% TNutol	< 41.2	41.2 – 60.7	60.8 – 80.4	> 80.4

Bioregion 71fgh Season: January - June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQKICK Drainage > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 28	19 – 28	10 – 18	< 10
EPT Richness (EPT)	> 11	8 – 11	4 – 7	< 4
% EPT-Cheum	> 49.4	33.0 – 49.4	16.5 – 32.9	< 16.5
% OC	< 31.2	31.2 – 54.1	54.2 – 77.0	> 77.0
NCBI	< 4.96	4.96 – 6.63	6.64 – 8.32	> 8.32
% Clingers-Cheum	> 50.4	33.7 – 50.4	16.8 – 33.6	< 16.8
% TNutol	< 30.9	30.9 – 53.8	53.9 – 76.9	> 76.9

Bioregion 71fgh Season: July-December Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQKICK Drainage > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 28	19 – 28	10 – 18	< 10
EPT Richness (EPT)	> 10	8 – 10	4 – 7	< 4
% EPT-Cheum	> 51.0	34.1 – 51.0	17.0 – 34.0	< 17.0
% OC	< 27.8	27.8 – 51.8	51.9 – 75.9	> 75.9
NCBI	< 5.21	5.21 – 6.80	6.81 – 8.40	> 8.40
% Clingers-Cheum	> 52.5	35.1 – 52.5	17.5 – 35.0	< 17.5
% TNutol	< 31.1	31.1 – 54.0	54.1 – 77.0	> 77.0

Bioregion: 71fgh Season: January - June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Headwater Method = SQKICK Drainage ≤ 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 28	20 – 28	10 – 19	< 10
EPT Richness (EPT)	> 12	8 – 12	4 – 7	< 4
% EPT-Cheum	> 58.0	38.7 – 58.0	19.4 – 38.6	< 19.4
% OC	< 28.4	28.4 – 52.2	52.3 – 76.1	> 76.1
NCBI	< 4.62	4.62 – 6.41	6.42 – 8.20	> 8.20
% Clingers-Cheum	> 39.9	26.7 – 39.9	13.3 – 26.6	< 13.3
% TNutol	< 28.3	28.3 – 52.2	52.3 – 76.1	> 76.1

Bioregion: 71fgh		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 27	18 – 27	9 – 17	< 9
EPT Richness (EPT)	> 9	7 – 9	3 – 6	< 3
% EPT-Cheum	> 49.5	33.1 – 49.5	16.5 – 33.0	< 16.5
% OC	< 26.7	26.7 – 51.1	51.2 – 75.5	> 75.5
NCBI	< 5.10	5.10 – 6.72	6.73 – 8.36	> 8.36
% Clingers-Cheum	> 47.5	31.7 – 47.5	15.9 – 31.6	< 15.9
% TNutol	< 31.0	31.0 – 53.9	54.0 – 77.0	> 77.0

Bioregion 71i		Method = SQKICK		
Season: January - June		Drainage > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 22	15 – 22	8 – 14	< 8
EPT Richness (EPT)	> 7	6 – 7	3 – 5	< 3
% EPT-Cheum	> 33.0	22.1 – 33.0	11.0 – 22.0	< 11.0
% OC	< 36.8	36.8 – 57.8	57.9 – 78.9	> 78.9
NCBI	< 6.07	6.07 – 7.37	7.38 – 8.69	> 8.69
% Clingers-Cheum	> 45.5	30.4 – 45.5	15.2 – 30.3	< 15.2
% TNutol	< 47.5	47.5 – 64.9	65.0 – 82.5	> 82.5

Bioregion 71i		Method = SQKICK		
Season: July-December		Drainage > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 22	15 – 22	8 – 14	< 8
EPT Richness (EPT)	> 7	5 – 7	3 – 4	< 3
% EPT-Cheum	> 35.4	23.7 – 35.4	11.8 – 23.6	< 11.8
% OC	< 28.6	28.6 – 52.3	52.4 – 76.2	> 76.2
NCBI	< 5.72	5.72 – 7.14	7.15 – 8.57	> 8.57
% Clingers-Cheum	> 55.0	36.7 – 55.0	18.4 – 36.6	< 18.4
% TNutol	< 46.4	46.4 – 64.2	64.3 – 82.1	> 82.1

Bioregion 71i		Headwater		
Season: January - June		Method = SQKICK		
Target TMI = 32		Drainage ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 24	17 – 24	8 – 16	< 8
EPT Richness (EPT)	> 7	5 – 7	3 – 4	< 3
% EPT-Cheum	> 37.1	24.8 – 37.1	12.4 – 24.7	< 12.4
% OC	< 31.3	31.3 – 54.2	54.3 – 77.1	> 77.2
NCBI	< 6.04	6.04 – 7.35	7.36 – 8.68	> 8.68
% Clingers-Cheum	> 42.2	28.2 – 42.2	14.1 – 28.1	< 14.1
% TNutol	< 42.2	42.2 – 61.4	61.5 – 80.7	> 80.7

Bioregion 71i		Headwater		
Season: July-December		Method = SQKICK		
Target TMI = 32		Drainage ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 24	17 – 24	8 – 16	< 8
EPT Richness (EPT)	> 7	5 – 7	3 – 4	< 3
% EPT-Cheum	> 37.1	24.8 – 37.1	12.4 – 24.7	< 12.4
% OC	< 31.3	31.3 – 54.2	54.3 – 77.1	> 77.2
NCBI	< 6.04	6.04 – 7.35	7.36 – 8.68	> 8.68
% Clingers-Cheum	> 42.2	28.2 – 42.2	14.1 – 28.1	< 14.1
% TNutol	< 42.2	42.2 – 61.4	61.5 – 80.7	> 80.7

Bioregion 71i		Method = SQBANK		
Season: January - June		Drainage > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 31	21 – 31	11 – 20	< 11
EPT Richness (EPT)	> 6	5 – 6	2 – 4	< 2
% EPT-Cheum	> 19.3	12.9 – 19.3	6.5 – 12.8	< 6.5
% OC	< 34.9	34.9 – 56.5	56.6 – 78.3	> 78.3
NCBI	< 7.02	7.02 – 8.01	8.02 – 9.00	> 9.00
% Clingers-Cheum	> 14.8	9.9 – 14.8	5.0 – 9.8	< 5.0
% TNutol	< 38.9	38.9 – 59.2	59.3 – 79.6	> 79.6

Bioregion 71i Season: July-December Scoring calibrated to 160-240 organism sample		Method = SQBANK Drainage > 2.5 sq miles Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 24	17 – 24	8 – 16	< 8
EPT Richness (EPT)	> 4	3 – 4	2	< 2
% EPT-Cheum	> 31.4	21.0 – 31.4	10.5 – 20.9	< 10.5
% OC	< 29.3	29.3 – 52.8	52.9 – 76.4	> 76.4
NCBI	< 7.03	7.03 – 8.02	8.03 – 9.01	> 9.01
% Clingers-Cheum	> 20.0	13.4 – 20.0	6.7 – 13.3	< 6.7
% TNutol	< 49.4	49.4 – 66.2	66.3 – 83.1	> 83.1

Bioregion 73ab Season: January – June Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQBANK Drainage: > 2.5 sq miles. Includes non-wadeable Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 22	15 – 22	8 – 14	< 8
ETO Richness	> 3	3	1 – 2	< 1
% EPT-Cheum	> 9.6	6.5 – 9.6	3.2 – 6.4	< 3.2
% OC	< 29.2	29.2 – 52.7	52.8 – 76.4	> 76.4
NCBI	< 7.58	7.58 – 8.38	8.39 – 9.19	> 9.19
% CRMOL	> 45.2	30.2 – 45.2	15.1 – 30.1	< 15.1
% TNutol	< 42.5	42.5 – 61.6	61.7 – 80.8	> 80.8

Bioregion 73ab Season: July-December Target TMI = 32 Scoring calibrated to 160-240 organism sample		Method = SQBANK Drainage: > 2.5 sq miles. Includes non-wadeable Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 24	17 – 24	8 – 16	< 8
ETO Richness	> 4	3 – 4	2	< 2
% EPT-Cheum	> 26.8	17.9 – 26.8	9.0 – 17.8	< 9.0
% OC	< 43.5	43.5 – 62.2	62.3 – 81.1	> 81.1
NCBI	< 7.54	7.54 – 8.36	8.37 – 9.18	> 9.18
% CRMOL	> 28.0	18.7 – 28.0	9.4 – 18.6	< 9.4
% TNutol	< 39.3	39.3 – 59.5	59.6 – 79.7	> 79.7

Bioregion 73ab		Headwater		
Season: January-June		Method = SQBANK		
Target TMI = 32		Drainage: \leq 2.5 sq miles.		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 22	15 – 22	8 – 14	< 8
ETO Richness	> 3	3	1 – 2	< 1
% EPT-Cheum	> 9.6	6.5 – 9.6	3.2 – 6.4	< 3.2
% OC	< 29.2	29.2 – 52.7	52.8 – 76.4	> 76.4
NCBI	< 7.58	7.58 – 8.38	8.39 – 9.19	> 9.19
% CRMOL	> 45.2	30.2 – 45.2	15.1 – 30.1	< 15.1
% TNutol	< 42.5	42.5 – 61.6	61.7 – 80.8	> 80.8

Bioregion 73ab		Headwater		
Season: July-December		Method = SQBANK		
Target TMI = 32		Drainage: \leq 2.5 sq miles.		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 22	15 – 22	8 – 14	< 8
ETO Richness	> 3	3	1 – 2	< 1
% EPT-Cheum	> 9.6	6.5 – 9.6	3.2 – 6.4	< 3.2
% OC	< 29.2	29.2 – 52.7	52.8 – 76.4	> 76.4
NCBI	< 7.58	7.58 – 8.38	8.39 – 9.19	> 9.19
% CRMOL	> 45.2	30.2 – 45.2	15.1 – 30.1	< 15.1
% TNutol	< 42.5	42.5 – 61.6	61.7 – 80.8	> 80.8

Bioregion 74a		Method = SQKICK		
Season: January – June		Drainage > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 18	13 – 18	6 – 12	< 6
EPT Richness (EPT)	> 5	4 – 5	2 – 3	< 2
% EPT-Cheum	> 28.8	19.3 – 28.8	9.6 – 19.2	< 9.6
% OC	< 51.8	51.8 – 67.8	67.9 – 83.9	> 83.9
NCBI	< 6.77	6.77 – 7.84	7.85 – 8.92	> 8.92
% Clingers-Cheum	> 59.2	39.5 – 59.2	19.8 – 39.4	< 19.8
% TNutol	< 48.0	48.0 – 65.3	65.4 – 82.6	> 82.6

Bioregion 74a		Method = SQKICK		
Season: July - December		Drainage > 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 19	14 – 19	7 – 13	< 7
EPT Richness (EPT)	> 4	4	2 – 3	< 2
% EPT-Cheum	> 42.4	28.4 – 42.4	14.2 – 28.3	< 14.2
% OC	< 30.9	30.9 – 53.9	54.0 – 76.9	> 76.9
NCBI	< 6.63	6.63 – 7.75	7.76 – 8.87	> 8.87
% Clingers-Cheum	> 30.1	20.2 – 30.1	10.1 – 20.1	< 10.1
% TNutol	< 35.6	35.6 – 57.0	57.1 – 78.5	> 78.5

Bioregion 74a		Method = SQKICK		
Season: January-June		Drainage ≤ 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 19	13 – 19	7 – 12	< 7
EPT Richness (EPT)	> 2	2	1	< 1
% EPT-Cheum	> 16.7	11.2 – 16.7	5.6 – 11.1	< 5.6
% OC	< 54.2	54.2 – 69.4	69.5 – 84.7	> 84.7
NCBI	< 6.39	6.39 – 7.59	7.60 – 8.79	> 8.79
% Clingers-Cheum	> 18.6	12.5 – 18.6	6.2 – 12.4	< 6.2
% TNutol	< 46.3	46.3 – 64.1	64.2 – 82.1	> 82.1

Bioregion 74a		Method = SQKICK		
Season: July - December		Drainage ≤ 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 19	13 – 19	7 – 12	< 7
EPT Richness (EPT)	> 2	2	1	< 1
% EPT-Cheum	> 16.7	11.2 – 16.7	5.6 – 11.1	< 5.6
% OC	< 54.2	54.2 – 69.4	69.5 – 84.7	> 84.7
NCBI	< 6.39	6.39 – 7.59	7.60 – 8.79	> 8.79
% Clingers-Cheum	> 18.6	12.5 – 18.6	6.2 – 12.4	< 6.2
% TNutol	< 46.3	46.3 – 64.1	64.2 – 82.1	> 82.1

Bioregion: 74b		Method = SQBANK		
Season: January – June		Drainage > 2.5 sq miles		
Target TMI = 32		(includes non-wadeable)		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 35	24 – 35	12 – 23	< 12
EPT Richness (EPT)	> 10	7 – 10	4 – 6	< 4
% EPT-Cheum	> 41.5	27.7 – 41.5	13.9 – 27.6	< 13.9
% OC	< 47.3	47.3 – 64.8	64.9 – 82.4	> 82.4
NCBI	< 6.50	6.50 – 7.66	7.67 – 8.83	> 8.83
% Clingers	> 28.2	18.9 – 28.2	9.4 – 18.8	< 9.4
% TNutol	< 36.2	36.2 – 57.4	57.5 – 78.7	> 78.7

Bioregion: 74b		Method = SQBANK		
Season: July-December		Drainage > 2.5 sq miles		
Target TMI = 32		(includes non-wadeable)		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 33	22 – 33	11 – 21	< 11
EPT Richness (EPT)	> 7	6 – 7	3 – 5	< 3
% EPT-Cheum	> 28.9	19.3 – 28.9	9.7 – 19.2	< 9.7
% OC	< 47.2	47.2 – 64.7	64.8 – 82.4	> 82.4
NCBI	< 6.54	6.54 – 7.69	7.70 – 8.84	> 8.84
% Clingers	> 26.4	17.7 – 26.4	8.8 – 17.6	< 8.8
% TNutol	< 32.4	32.4 – 54.9	55.0 – 77.4	> 77.4

Bioregion: 74b		Headwater Method = SQBANK		
Season: January – June		Drainage ≤ 2.5 sq miles		
Target TMI = 32		Genus Level Identification		
Scoring calibrated to 160-240 organism sample				
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 2	2	1	< 1
% EPT-Cheum	> 5.8	3.9 – 5.8	2.0 – 3.8	< 2.0
% OC	< 55.1	55.1 – 70.0	70.1 – 85.0	> 85.0
NCBI	< 6.84	6.84 – 7.89	7.90 – 8.94	> 8.94
% Clingers	> 35.4	23.7 – 35.4	11.8 – 23.6	< 11.8
% TNutol	< 32.6	32.6 – 55.0	55.1 – 77.5	> 77.6

Bioregion: 74b		Headwater		
Season: July-December		Method = SQBANK		
Target TMI = 32		Drainage ≤ 2.5 sq miles		
Scoring calibrated to 160-240 organism sample		Genus Level Identification		
Metric	6	4	2	0
Taxa Richness (TR)	> 27	19 – 27	9 – 18	< 9
EPT Richness (EPT)	> 3	3	1 – 2	< 1
% EPT-Cheum	> 10.3	6.9 – 10.3	3.5 – 6.8	< 3.5
% OC	< 58.8	58.8 – 72.5	72.6 – 86.2	> 86.2
NCBI	< 6.46	6.46 – 7.63	7.64 – 8.82	> 8.82
% Clingers	> 11.5	7.7 – 11.5	3.9 – 7.6	< 3.9
% TNutol	< 32.8	32.8 – 55.1	55.2 – 77.6	> 77.6

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
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

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
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 Shheds 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
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 Lurel 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

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO6702	Active	Fisher Creek	06010104 Holston	RM 0.6, U/S Bray Road	Hawkins	36.49	-82.94027
ECO6707	Active	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
ECO68A27	Active	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

Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
ECO71E19	Active	Calebs Creek	05130206 Red	U/S Maxie/Carr Rd	Robertson	36.49237	-87.0066
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	Active	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
ECO71I14	Active	Little Flat Creek	06040002 Upper Duck	RM 3.6, U/S Will Brown Rd	Maury	35.69903	-86.83872
ECO71I15	Active	Harpeth River	05130204 Harpeth	RM 105.7, D/S McDaniel Rd	Williamson	35.8325	-86.70019
ECO73A01	Active	Cold Creek	08010100 Mississippi	RM 14.4, U/S Long Hole Rd	Lauderdale	35.7425	-89.6994

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
ECO74B12	Active	Wolf River	08010210 Wolf	RM 72.7, U/S Yager Rd	Fayette	35.0325	-89.24583

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

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
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
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
FECO66J04	Active	Blackburn Fork	06020002 Hiwassee	RM 1.7; 0.2 Miles U/S of Black Hollow Road Ne Crossing	Bradley	35.22474	-84.97055
FECO67F02	Active	Mill Creek	06010207 Clinch-Lower	RM 1.1, Off Cave Rd	Roane	35.84999	-84.38210

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
FECO67F04	Active	Sutton Branch	06010206 Powell	RM 0.1, Off Rob Camp Church Rd	Claiborne	36.558	-83.422
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
FECO67H01a	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
FECO69D01	Active	New RV 1 UT	05130104 Cumberland-South Fork	RM 0.1, U/S Hwy 116	Morgan	36.12090	-84.43214

Headwater Ecoregion Reference Streams:

SITE #	STATUS	STREAM	USGS HUC	LOCATION	COUNTY	LATITUDE	LONGITUDE
FECO69D02	Inactive	Straight Fork	05130104 Cumberland-South Fork	RM 1; Frozen Head State Park	Morgan	36.121387	-84.44889
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
FECO71E02	Active	Savage Branch	05130206 Red	RM 1.2, U/S Distillery Rd off Hwy 76	Robertson	36.47534	-86.76083
FECO71F01	Active	Little Swan Creek UT	06040003 Duck-Lower	RM 0.1, Off DP Humphreys Rd	Lewis	35.50053	-87.41683
FECO71F03	Active	Ethridge Hollow	06040003 Duck-Lower	RM 0.1, U/S Hwy 230	Humphreys	35.9407	-87.6530
FECO71F04	Active	Little Marrowbone Creek UT (Henry)	05130202 Cumberland Lower Cheatham Lake	RM 0.1, U/S Little Marrowbone Rd in Beaman City Park	Davidson	36.27212	-86.9049
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
FECO71H05	Active	Hurricane Creek UT	06030003 Upper Elk	RM0.1; U/S Fulks Hollow Road	Moore	35.3261	-86.3021
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 Wanut 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 Jwy 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
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	Embedd edness	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
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

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

ECO	Season*	Epifaunal Substrate	Embedd edness	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)
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 high grad.	Spring	12	13	NA	10	NA	10	14	11	13	NA	6	7	4
71I high grad	Fall	9	10	NA	10	NA	8	10	14	13	NA	5	5	4
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
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

APPENDIX B

FORMS, FIELD SHEETS AND REPORTS

RECORD OF BIOLOGIST CREDENTIALS
NEW STATION E-FORM
SAMPLING EVENT E-FORM
FIELD PARAMETER E-FORM
HABITAT ASSESSMENT FIELD SHEETS
HEADERS FOR HABITAT ELECTRONIC REPORT
STREAM SURVEY INFORMATION E-FORM
HEADERS FOR STREAM SURVEY ELECTRONIC REPORT
BIORECON FIELD SHEET
MACROINVERTEBRATE TAXA REPORTING FORMAT
BIORECON METRIC REPORTING FORMAT
SQSH METRIC REPORTING FORMAT
BIOLOGICAL SAMPLE REQUEST INCLUDING CHAIN OF CUSTODY FORM

See SharePoint <https://tennessee.sharepoint.com/sites/environment/DWR/PAS/SitePages/Home.aspx>
or contact PAS for copies of all e-Forms and guidance documents for completing e-forms and upload to
waterlog (BESERG and SPERG).

Record of Biologist Credentials for Macroinvertebrate Surveys and/or Taxonomy

(Maintain updated record on SharePoint or send copy to PAS for posting.)

<https://tennessee.sharepoint.com/sites/environment/DWR/PAS/SitePages/Home.aspx>

Name	Title
Organization	Date
University	B.S. major
University	M.S. major
University	Doctorate
Macroinvertebrate Field Surveys # Yrs Experience	
Describe Specific Experience:	
Date Passed Initial DWR Field QC	QC'ed by
Macroinvertebrate Taxonomy # Year's Experience:	
Taxonomic Expertise (Circle Lowest Level)	Family Genus Species
Date Passed Initial DWR Taxonomic ID QC	QC'ed by
Taxonomic Certifications	
Macroinvertebrate Publications	
Date Passed Initial DWR SQSH Sorting QC	QC'ed by
Additional Information Concerning Macroinvertebrate Survey and/ or Taxonomic Expertise	

New Station e-Form

New DWR Station - Surface Water Stations Only

DWR Station ID:	
Monitoring Location Name:	
Monitoring Location:	
County:	
River Mile:	
Latitude:	
Longitude (include -):	
Ecoregion:	
u/s ECO:	
HUC:	
HUC Name:	
WBID:	
WS Grp:	
Drainage Area:	
HUC 12:	
Organization:	
State Name:	
Reservoir Name:	
Water Type:	
Station Comment:	

Sampling Event e-Form

DWR Station ID:		Samplers:		Organization:	
Monitoring Location ID:		Date:		Time:	
Monitoring Location Name:				Field Log Number:	
Monitoring Location:					
County:		Ecoregion:		u/s ECO:	
Latitude:		HUC:		WS Grp:	
Longitude:		WBID:		Drainage Area:	
Project Name:		Project ID:		Activity Type:	
Lead Samper's Initials:					

Field Parameter e-Form

Sample Sequence:	10			Time:				
DWR Station ID:				Monitoring Location ID:	#N/A		Field Log Number:	0100190010
Monitoring Location Name:	#N/A			Monitoring Location:	#N/A			
Project Name:			Project ID:	#N/A		Activity Type:		
Field Parameters:	1 st	2 nd	Meter Problems:		1 st	2 nd	Meter Problems:	
pH (su):				DO %:				
Conductivity (umhos):				Turbidity (NTU):				
Temperature (C°):				TDS (mg/L):				
Dissolved Oxygen (mg/L):				Flow (cfs):				
Notes:								

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)
 (See Protocol E for detailed descriptions and rank information)

DWR Station ID:					Habitat Assessment By:															
Monitoring Location Name:					Date:			Time:												
Monitoring Location:					Field Log Number:															
HUC:			WS Group:		Ecoregion:			QC: <input type="checkbox"/> Duplicate <input type="checkbox"/> 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 boulders 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. Others 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 or 4-wheel 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 or 4-wheel 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 or 4-wheel 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. 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 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:

HABITAT ASSESSMENT FIELD SHEET- LOW GRADIENT STREAMS (FRONT)
 (Revised 06-09-17 – See Protocol E for detailed description and rank information)

DWR Station ID:					Habitat Assessment By:															
Monitoring Location Name:					Date:			Time:												
Monitoring Location:					Field Log Number:															
HUC:			WS Group:		Ecoregion:			QC: <input type="checkbox"/> Duplicate <input type="checkbox"/> 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: _____														
6. Channel Alteration	Optimal	Suboptimal					Marginal					Poor									
	Channelization, dredging or 4-wheel activity absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging or 4-wheel 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 or 4-wheel 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. Instream habitat greatly altered or removed. Artificial structures may 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. 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	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 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 below guidelines, result of (circle): Natural Conditions or Human Disturbance

Describe

Headers for Habitat Electronic Report Submittal (if not using e-Form)

DWR_STATION_ID
ACTIVITY_START_DATE
FIELD_LOG_NUMBER
MONITORING_LOCATION_ID
PROJECT_ID
PROJECT_NAME
INDEX_PERIOD
ORGANIZATION
SAMPLER
ACTIVITY_TYPE
HABITAT_ASSESSOR
HABITAT_TYPE
EPIFAUNAL_SUBSTRATE
EPIFAUNAL_SUBSTRATE_COMMENTS
EMBEDDEDNESS
EMBEDDEDNESS_COMMENTS
VELOCITY_DEPTH_REGIME
VELOCITY_DEPTH_REGIME_COMMENTS
SEDIMENT_DEPOSITION
SEDIMENT_DEPOSITION_COMMENTS
CHANNEL_FLOW_STATUS
CHANNEL_ALTERATION
CHANNEL_ALTERATION_COMMENTS
FREQUENCY_OF_REOXYGENATION
FREQUENCY_OF_REOX_COMMENTS
BANK_STABILITY_LDB
BANK_STABILITY_LDB_COMMENTS
BANK_STABILITY_RDB
BANK_STABILITY_RDB_COMMENTS
VEGETATIVE_PROTECTION_LDB
VEG_PROTECTION_LDB_COMMENTS
VEGETATIVE_PROTECTION_RDB
VEG_PROTECTION_RDB_COMMENTS
RIPARIAN_WIDTH_LDB
RIPARIAN_WIDTH_LDB_COMMENTS
RIPARIAN_WIDTH_RDB
RIPARIAN_WIDTH_RDB_COMMENTS
CHANNEL_SUBSTRATE_CHAR
CHANNEL_SUB_CHAR_COMMENTS
POOL_VARIABILITY
POOL_VARIABILITY_COMMENTS
CHANNEL_SINUOSITY
CHANNEL_SINUOSITY_COMMENTS
TOTAL_HABITAT_SCORE

STREAM SURVEY INFORMATION

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: <input type="checkbox"/> Collected <input type="checkbox"/> Seasonally Dry <input type="checkbox"/> Frequently Dry <input type="checkbox"/> No Channel <input type="checkbox"/> Too Deep (Not Wadeable) <input type="checkbox"/> Too Deep (Temporary) <input type="checkbox"/> Permanent Barrier <input type="checkbox"/> Fenced <input type="checkbox"/> Landowner Denial: <input type="checkbox"/> Temporary Barrier <input type="checkbox"/> Posted Plan to revisit? <input type="checkbox"/> Yes <input type="checkbox"/> No
Flow Conditions: <input type="checkbox"/> Dry <input type="checkbox"/> Isolated Pools <input type="checkbox"/> Stagnant <input type="checkbox"/> Low <input type="checkbox"/> Moderate <input type="checkbox"/> High <input type="checkbox"/> Bankful <input type="checkbox"/> Flooding

Sample	Collected?	Comment	Sample	Collected?	Comment
Biorecon			Periphyton		
SQKICK			Other		
SQBANK			Describe Other Sample:		

Chemicals/Bacteria: None Routine Nutrient Metals *E. coli* Organics Other _____

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): <input type="checkbox"/> Flat <input type="checkbox"/> Low <input type="checkbox"/> Moderate <input type="checkbox"/> High <input type="checkbox"/> Cascades
Average Stream Width: <input type="checkbox"/> Very Small (<1.5yd) <input type="checkbox"/> Small (1.5-3yd) <input type="checkbox"/> Med. (3-10yd) <input type="checkbox"/> Large (10-25yd) <input type="checkbox"/> Very Large (>25yd)
Maximum Stream Depth: <input type="checkbox"/> Shallow (<0.3yd) <input type="checkbox"/> Medium (0.3-0.6yd) <input type="checkbox"/> Deep (0.6 – 1yd) <input type="checkbox"/> 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: <input type="checkbox"/> Deeply incised <input type="checkbox"/> Bluff/Wall <input type="checkbox"/> Undercut <input type="checkbox"/> Sloughing <input type="checkbox"/> Steep terrain <input type="checkbox"/> Gentle Slope
Bank Slope RDB: <input type="checkbox"/> Deeply incised <input type="checkbox"/> Bluff/Wall <input type="checkbox"/> Undercut <input type="checkbox"/> Sloughing <input type="checkbox"/> Steep terrain <input type="checkbox"/> Gentle Slope
Manmade Modification: <input type="checkbox"/> None <input type="checkbox"/> Rip-Rap <input type="checkbox"/> Cement <input type="checkbox"/> Gabions <input type="checkbox"/> Channelized <input type="checkbox"/> Dam <input type="checkbox"/> Dredging <input type="checkbox"/> Bridge <input type="checkbox"/> ATV

Stream Characteristics:

Sediment Deposits: <input type="checkbox"/> None <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> Excessive <input type="checkbox"/> Blanket
Sediment Type: <input type="checkbox"/> None <input type="checkbox"/> Sand <input type="checkbox"/> Silt <input type="checkbox"/> Mud <input type="checkbox"/> Clay <input type="checkbox"/> Sludge <input type="checkbox"/> Mn Precipitant <input type="checkbox"/> Orange Flocculent
Turbidity: <input type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Muddy <input type="checkbox"/> Milky <input type="checkbox"/> Tannic <input type="checkbox"/> Planktonic Algae <input type="checkbox"/> Dyed
Foam/Surface Sheen: <input type="checkbox"/> None <input type="checkbox"/> Nutrient <input type="checkbox"/> Surfactant <input type="checkbox"/> Bacteria
Algae: <input type="checkbox"/> None <input type="checkbox"/> Slight <input type="checkbox"/> Moderate <input type="checkbox"/> High <input type="checkbox"/> Choking Type: <input type="checkbox"/> Diatoms <input type="checkbox"/> Green <input type="checkbox"/> Filamentous <input type="checkbox"/> Blue-green

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID:	Date:	Assessors:
------------------------	--------------	-------------------

Dominate Substrate: (More than 25%) Check all that apply

- | | | |
|--|--|--|
| Riffle | Run | Pool |
| <input type="checkbox"/> Boulders (>10") | <input type="checkbox"/> Boulders (>10") | <input type="checkbox"/> Boulders (>10") |
| <input type="checkbox"/> Cobble (2.5-10") | <input type="checkbox"/> Cobble (2.5-10") | <input type="checkbox"/> Cobble (2.5-10") |
| <input type="checkbox"/> Gravel (0.1-2.5") | <input type="checkbox"/> Gravel (0.1-2.5") | <input type="checkbox"/> Gravel (0.1-2.5") |
| <input type="checkbox"/> Bedrock | <input type="checkbox"/> Bedrock | <input type="checkbox"/> Bedrock |
| <input type="checkbox"/> Sand | <input type="checkbox"/> Sand | <input type="checkbox"/> Sand |
| <input type="checkbox"/> Silt (not gritty) | <input type="checkbox"/> Silt (not gritty) | <input type="checkbox"/> Silt (not gritty) |
| <input type="checkbox"/> Clay (Slick) | <input type="checkbox"/> Clay (Slick) | <input type="checkbox"/> Clay (Slick) |

Surrounding Land Uses (list additional land uses under comments)

- | | | | | |
|-------------------------------------|-------------------------------------|--------------------------------------|--|---------------------------------------|
| <input type="checkbox"/> Forest | <input type="checkbox"/> Grazing | <input type="checkbox"/> Stormwater | <input type="checkbox"/> STP/WWTP | <input type="checkbox"/> Construction |
| <input type="checkbox"/> Wetland | <input type="checkbox"/> Row Crops | <input type="checkbox"/> Urban | <input type="checkbox"/> Industry | <input type="checkbox"/> Impoundment |
| <input type="checkbox"/> Park | <input type="checkbox"/> CAFO/Dairy | <input type="checkbox"/> Commercial | <input type="checkbox"/> Mining/Dredging | <input type="checkbox"/> ATV/OHV |
| <input type="checkbox"/> Hay/Fields | <input type="checkbox"/> Logging | <input type="checkbox"/> Residential | <input type="checkbox"/> Road/Hwy/RR | <input type="checkbox"/> 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.

Headers for Stream Survey Electronic Report submittal (if not using e-Form)

DWR_STATION_ID
ACTIVITY_START_DATE
FIELD_LOG_NUMBER
MONITORING_LOCATION_ID
PROJECT_ID
PROJECT_NAME
ORGANIZATION
SAMPLER
SAMPLE_STATUS
REVISIT
FLOW_CONDITION
BIORECON
SQKICK
SQBANK
PERIPHYTON
OTHER
CHEMICALS_BACTERIA
PHOTOS_TAKEN
PHOTOS_DESCRIPTION
PREVIOUS_48_HRS_PRECIP
AIR_TEMP
GRADIENT
AVG_WIDTH
MAX_DEPTH
CANOPY_EST
CANOPY_MEASURE
BANK_HEIGHT
HIGH_WATER_MARK
LDB_SLOPE
RDB_SLOPE
MANMADE_MODS
SED_DEPO
SED_TYPE
TURBIDITY
FOAM_SHEEN
ALGAE
ALGAE_TYPE
RIFFLE_DOMINATE_SUB
RUN_DOMINATE_SUB
POOL_DOMINATE_SUB
LANDUSE
SLIGHT_HUMAN_DISTURB
MOD_HUMAN_DISTURB
HIGH_HUMAN_DISTURB
OTHER_INFO_STRESSORS

STATE OF TENNESSEE - ENVIRONMENTAL LABORATORY



Please Print Legibly

Biological Analysis

**Schedule must be Arranged in advance for all tests (615)262-6327

Project/Site No.		Screening Bioassays		Chronic Bioassays		Branch Lab Number	
Project Name		(Cannot be used for permitting)		Chronic Cd		Chain of Custody (sign full name)	
Station No.	County	48 hr Static Screening Cd		Log Number		1. Collected by	
Description		Log Number		LC50 @ 24 hrs		Date	
Stream Mile		LC50 @ 24 hrs		LC50 @ 48 hrs		Time	
Depth		LC50 @ 48 hrs		LC50 @ 72 hrs		Delivered to	
Collection Date		48 hr Static Screening Pp		LC50 @ 96 hrs		Date	
Time		Log Number		Survival		Time	
Sampler's Name (Print)		LC50 @ 24 hrs		NOAEC		2. Received by	
Sampling Agency		LC50 @ 48 hrs		LOAEC		Date	
Billing Code		48 hr Static Definitive Cd		Reproduction		Time	
If Priority, Date Needed		Log Number		NOAEC		3. Received by	
Send Report to		LC50 @ 24 hrs		LOAEC		Date	
G. Denton, DWR/PAS/CO Nashville		LC50 @ 48 hrs		IC25		Time	
Field Log Number: 01001900		Log Number		Chronic Pp		4. Rec'd in Lab by	
Contact Hazard Unknown		LC50 @ 24 hrs		Log Number		Date	
Date Reported		LC50 @ 48 hrs		LC50 @ 24 hrs		Time	
By		NOAEC		LC50 @ 48 hrs		Logged in by	
Reviewed By		LOAEC		LC50 @ 72 hrs		Date	
Reviewed by		96 hr Static Definitive Pp		LC50 @ 96 hrs		Time	
BIOLOGICAL SURVEYS		Log Number		LC50 @ 120 hrs		Additional Information	
Macroinvertebrate Recon		LC50 @ 24 hrs		LC50 @ 144 hrs		1. Approx. volume of sample	
Rapid Bioassessment (State SOP)		LC50 @ 48 hrs		LC50 @ 168 hrs		2. Nearest town or city	
Intensive Survey - Surber		NOAEC		Survival		3. Others present at collection	
Intensive Survey - Dendy		LOAEC		NOAEC		4. Number of other samples collected at same	
Fish Population Recon		96 hr Static Definitive Cd		LOAEC		time at this point	
Fish Population Intensive		Log Number		IC25		5. Field collection procedure, handling and/or	
Fish Tissue Collection		LC50 @ 24 hrs		Chlorine Residual		preservation of this sample	
Chlorophyll Analysis		LC50 @ 48 hrs		Lab Parameters		6. Mode of transportation to lab	
Log Number		LC50 @ 72 hrs		pH		7. Sample/cooler sealed by	
Chlorophyll a		LC50 @ 96 hrs		Cond.		8. Date sample/cooler sealed	
Pheophyton		NOAEC		D.O.		9. Remarks	
SPECIAL STUDIES		LOAEC		Temp.		Biological EDD uploaded to Waterlog.	
(Please Specify)		96 hr Static Definitive Pp		Chlorine Residual		6. Mode of transportation to lab	
BR Family Lab Log No:		Log Number		Lab Parameters		7. Sample/cooler sealed by	
BR Genera Lab Log No:		LC50 @ 24 hrs		pH		8. Date sample/cooler sealed	
SQKICK Lab Log No:		LC50 @ 48 hrs		Cond.		9. Remarks	
SQBank Lab Log No:		LC50 @ 72 hrs		D.O.		Biological EDD uploaded to Waterlog.	
Periphyton Lab Log No:		LC50 @ 96 hrs		Temp.		6. Mode of transportation to lab	
Other Lab Log No:		NOAEC		Chlorine Residual		7. Sample/cooler sealed by	
Describe Other:		LOAEC		Lab Parameters		8. Date sample/cooler sealed	

APPENDIX C

BIOMETRIC INFORMATION

**INTOLERANT MACROINVERTEBRATE FAMILIES FOR BIORECONS
TENNESSEE TAXA LIST INCLUDING NCBI SCORES, INTOLERANT TAXA LIST,
CLINGER LIST AND VERIFICATION STATUS**

**Intolerant Macroinvertebrate Families for Biorecons
(Based on average genus NCBI scores for Tennessee taxa within families)**

Ephemeroptera

- Ameletidae
- Ephemerellidae
- Ephemeridae
- Heptageniidae
- Leptophlebiidae
- Leptophyphidae
- Neophemeridae
- Polymitarcyidae
- Potomanthidae

Plecoptera

- Capniidae
- Chloroperlidae
- Leuctridae
- Peltoperlidae
- Perlidae
- Perlodidae
- Pteronarcyidae

Trichoptera

- Apataniidae
- Brachycentridae
- Calamoceratidae
- Glossosomatidae
- Goeridae
- Helicopsychidae
- Lepidostomatidae
- Molannidae
- Odontoceridae
- Philopotamidae
- Rhyacophilidae
- Sericostomatidae
- Uenoidae

Coleoptera

- Ptilodactylidae

Diptera

- Athericidae
- Blephariceridae

Tennessee Taxa List 2017

(Will be revised in TN Fiscal Year 2018 to include nomenclature changes in accordance with SE EPT Key published July 2017).

Includes NCBI scores, intolerant taxa, list, clinger list and verification status. NCBI scores supplemented with other tolerance indices when not available. (See protocol L)

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
			Gastropoda				
			Hirudinea	8			
			Nematoda	6			
			Nematomorpha	6			
			Nemertea	4.8			
			Oligochaeta	8			
			Platyhelminthes				
Acariformes			Acari	5.5			
Aeolosomatida	Aeolosomatidae		Aeolosomatidae	4			V
Aeolosomatida	Aeolosomatidae	Aeolosoma	Aeolosoma	4			V
Amphipoda			Amphipoda	7.2			
Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	7.2			V
Amphipoda	Crangonyctidae	Stygobromus	Stygobromus				V
Amphipoda	Crangonyctidae		Crangonyctidae	7.2			
Amphipoda	Gammaridae	Gammarus	Gammarus	7.1			V
Amphipoda	Gammaridae		Gammaridae	7.1			
Amphipoda	Hyalellidae	Hyalella	Hyalella	7.2			V
Architaenioglossa	Viviparidae	Campeloma	Campeloma	5.8			V
Architaenioglossa	Viviparidae	Viviparus	Viviparus	6			
Architaenioglossa	Viviparidae		Viviparidae	6			
Basommatophora	Ancylidae		Ancylidae	6.6			
Basommatophora	Ancylidae	Ferrissia	Ferrissia	6.6			V
Basommatophora	Ancylidae	Laevapex	Laevapex	6.6			V
Basommatophora	Lymnaeidae	Fossaria	Fossaria	6			
Basommatophora	Lymnaeidae	Lymnaea	Lymnaea	6			
Basommatophora	Lymnaeidae		Lymnaeidae	7.9			V
Basommatophora	Lymnaeidae	Pseudosuccinea	Pseudosuccinea	7.7			V
Basommatophora	Lymnaeidae	Stagnicola	Stagnicola	8.1			
Basommatophora	Physidae		Physidae	8.7			

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Basommatophora	Physidae	Physa	Physa	8.7			
Basommatophora	Physidae	Physella	Physella	8.8			V
Basommatophora	Planorbidae		Planorbidae	7.1			
Basommatophora	Planorbidae	Gyraulus	Gyraulus	4.2			
Basommatophora	Planorbidae	Helisoma	Helisoma	6.6			
Basommatophora	Planorbidae	Menetus	Menetus	7.6			
Basommatophora	Planorbidae	Micromenetus	Micromenetus	8.2			
Basommatophora	Planorbidae	Planorbella	Planorbella	6.8			
Basommatophora	Planorbidae	Planorbula	Planorbula	7.1			
Branchiobdellida	Branchiobdellida	Branchiobdellida	Branchiobdellida	6			V
Coleoptera	Dryopidae		Dryopidae	4.1		cn	
Coleoptera	Dryopidae	Helichus	Helichus	4.1		cn	V
Coleoptera	Dryopidae	Pelonomus	Pelonomus	4.1			
Coleoptera	Dytiscidae		Dytiscidae	6.4			
Coleoptera	Dytiscidae	Acilius	Acilius	6.4			V
Coleoptera	Dytiscidae	Agabetes	Agabetes	6.4			
Coleoptera	Dytiscidae	Agabus	Agabus	6.4			V
Coleoptera	Dytiscidae	Bidessonotus	Bidessonotus	6.4			V
Coleoptera	Dytiscidae	Copelatus	Copelatus	6.4			V
Coleoptera	Dytiscidae	Coptotomus	Coptotomus	8.5			V
Coleoptera	Dytiscidae	Desmopachria	Desmopachria	6.4			
Coleoptera	Dytiscidae	Heterosternuta	Heterosternuta	6.4			V
Coleoptera	Dytiscidae	Hydaticus	Hydaticus	6.4			
Coleoptera	Dytiscidae	Hydroporus	Hydroporus	7			V
Coleoptera	Dytiscidae	Hydrovatus	Hydrovatus	6.4			V
Coleoptera	Dytiscidae	Hygrotus	Hygrotus	6.4			
Coleoptera	Dytiscidae	Laccodytes	Laccodytes	6.4			
Coleoptera	Dytiscidae	Laccophilus	Laccophilus	9.8			V
Coleoptera	Dytiscidae	Liodessus	Liodessus	6.4			
Coleoptera	Dytiscidae	Lioporeus	Lioporeus	4			V
Coleoptera	Dytiscidae	Matus	Matus	6.4			V
Coleoptera	Dytiscidae	Neoporus	Neoporus	4.45			V
Coleoptera	Dytiscidae	Platambus	Platambus	6.4			V
Coleoptera	Dytiscidae	Rhantus	Rhantus	3.6			
Coleoptera	Dytiscidae	Uvarus	Uvarus	6.4			
Coleoptera	Elmidae	Ancyronyx	Ancyronyx	6.8		cn	V

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Coleoptera	Elmidae	Dubiraphia	Dubiraphia	5.5		cn	V
Coleoptera	Elmidae	Elmidae	Elmidae	4.41		cn	
Coleoptera	Elmidae	Gonielmis	Gonielmis	0	Intol	cn	
Coleoptera	Elmidae	Macronychus	Macronychus	4.7		cn	V
Coleoptera	Elmidae	Microcylloepus	Microcylloepus	3.3		cn	V
Coleoptera	Elmidae	Optioservus	Optioservus	2.1	Intol	cn	V
Coleoptera	Elmidae	Oulimnius	Oulimnius	1.9	Intol	cn	V
Coleoptera	Elmidae	Promoresia	Promoresia	0	Intol	cn	V
Coleoptera	Elmidae	Stenelmis	Stenelmis	5.6		cn	V
Coleoptera	Gyrinidae		Gyrinidae (Do not count adults)	5.4			
Coleoptera	Gyrinidae	Dineutus	Dineutus (Do not count adults)	5.8			V
Coleoptera	Gyrinidae	Gyrinus	Gyrinus (Do not count adults)	8.4			V
Coleoptera	Haliplidae		Haliplidae	8.4			
Coleoptera	Haliplidae	Haliplus	Haliplus	8.4			V
Coleoptera	Haliplidae	Peltodytes	Peltodytes	8.4			V
Coleoptera	Helophoridae	Helophorus	Helophorus	7.6			V
Coleoptera	Hydrophilidae		Hydrophilidae	7.5			
Coleoptera	Hydrophilidae	Berosus	Berosus	8.8			V
Coleoptera	Hydrophilidae	Cymbiodyta	Cymbiodyta	2	Intol		V
Coleoptera	Hydrophilidae	Derallus	Derallus	7.5			V
Coleoptera	Hydrophilidae	Dibolocelus	Dibolocelus	6			
Coleoptera	Hydrophilidae	Helochares	Helochares	4			V
Coleoptera	Hydrophilidae	Helocombus	Helocombus	2	Intol		
Coleoptera	Hydrophilidae	Hydrobiomorpha	Hydrobiomorpha	7.5			
Coleoptera	Hydrophilidae	Hydrobius	Hydrobius	7.1			V
Coleoptera	Hydrophilidae	Hydrochus	Hydrochus	6.6			V
Coleoptera	Hydrophilidae	Hydrophilus	Hydrophilus	2	Intol		
Coleoptera	Hydrophilidae	Laccobius	Laccobius	6.5			V
Coleoptera	Hydrophilidae	Paracymus	Paracymus	4			V
Coleoptera	Hydrophilidae	Sperchopsis	Sperchopsis	4.4		cn	V
Coleoptera	Hydrophilidae	Tropisternus	Tropisternus	9.3			V
Coleoptera	Hydroptilidae	Enochrus	Enochrus	8.5			
Coleoptera	Lutrochidae	Lutrochus	Lutrochus	2.9	Intol	cn	V
Coleoptera	Noteridae	Hydrocanthus	Hydrocanthus	7.1			V
Coleoptera	Noteridae	Suphisellus	Suphisellus	4			V
Coleoptera	Noteridae		Noteridae	5.5			

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Coleoptera	Psephenidae		Psephenidae	3.3		cn	
Coleoptera	Psephenidae	Ectopria	Ectopria	4.3		cn	V
Coleoptera	Psephenidae	Psephenus	Psephenus	2.3	Intol	cn	V
Coleoptera	Ptilodactylidae	Anchytarsus	Anchytarsus	2.4	Intol	cn	V
Coleoptera	Ptilodactylidae		Ptilodactylidae	2.4	Intol	cn	
Coleoptera	Scirtidae		Scirtidae	6.8			
Coleoptera	Scirtidae	Cyphon	Cyphon	7			V
Coleoptera	Scirtidae	Elodes	Elodes	6.8			
Coleoptera	Scirtidae	Prionocyphon	Prionocyphon	7			V
Coleoptera	Scirtidae	Scirtes	Scirtes	6.8			V
Decapoda	Cambaridae	Cambaridae	Cambaridae	6			
Decapoda	Cambaridae	Cambarus	Cambarus	7.5			V
Decapoda	Cambaridae	Orconectes	Orconectes	2.7	Intol		V
Decapoda	Cambaridae	Procambarus	Procambarus	9.3			
Decapoda	Palaemonidae	Palamontes	Palaemonetes	8.7			V
Decapoda	Palaemonidae		Palaemonidae	8.7			
Decapoda			Decapoda	6			
Diptera	Athericidae		Athericidae	1.4	Intol		
Diptera	Athericidae	Atherix	Atherix	0.9	Intol		V
Diptera	Blephariceridae	Blepharicera	Blepharicera	0	Intol	cn	
Diptera	Blephariceridae		Blephariceridae	0	Intol	cn	
Diptera	Ceratopogonidae	Alluaudomyia	Alluaudomyia	6			
Diptera	Ceratopogonidae	Atrichopogon	Atrichopogon	6.1			V
Diptera	Ceratopogonidae	Bezzia	Bezzia	6			
Diptera	Ceratopogonidae	Bezzia/Palpomyia	Bezzia/Palpomyia	6			V
Diptera	Ceratopogonidae	Ceratopogon	Ceratopogon	6			
Diptera	Ceratopogonidae	Ceratopogonidae	Ceratopogonidae	6.8			
Diptera	Ceratopogonidae	Culicoides	Culicoides	8.6			V
Diptera	Ceratopogonidae	Dasyhelea	Dasyhelea	4			
Diptera	Ceratopogonidae	Forcipomyia	Forcipomyia	4			V
Diptera	Ceratopogonidae	Mallochohelea	Mallochohelea	6.8			T
Diptera	Ceratopogonidae	Monohelea	Monohelea	6.8			
Diptera	Ceratopogonidae	Palpomyia	Palpomyia	5.7			
Diptera	Ceratopogonidae	Probezzia	Probezzia	6.8			
Diptera	Ceratopogonidae	Serromyia	Serromyia	6.8			
Diptera	Ceratopogonidae	Sphaeromias	Sphaeromias	6.8			
Diptera	Ceratopogonidae	Stilobezzia	Stilobezzia	6.8			
Diptera	Chaoboridae		Chaoboridae	8.5			

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Diptera	Chaoboridae	Chaoborus	Chaoborus	8.5			V
Diptera	Chaoboridae	Mochlonyx	Mochlonyx	8.5			
Diptera	Chironomidae		Chironomidae				
Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	7.1			V
Diptera	Chironomidae	Acampptocladus	Acampptocladus				
Diptera	Chironomidae	Acricotopus	Acricotopus				
Diptera	Chironomidae	Alotanypus	Alotanypus				
Diptera	Chironomidae	Antillocladius	Antillocladius				
Diptera	Chironomidae	Apedilum	Apedilum	5.69			V
Diptera	Chironomidae	Apsectrotanypus	Apsectrotanypus	1	Intol		V
Diptera	Chironomidae	Axarus	Axarus	2	Intol		V
Diptera	Chironomidae	Brillia	Brillia	5.7			V
Diptera	Chironomidae	Brundiniella	Brundiniella	2	Intol		V
Diptera	Chironomidae	Cardiocladius	Cardiocladius	6.2			V
Diptera	Chironomidae	Chaetocladius	Chaetocladius	4			V
Diptera	Chironomidae	Chernovskiiia	Chernovskiiia	6			
Diptera	Chironomidae	Chironomus	Chironomus	9.3			V
Diptera	Chironomidae	Cladopelma	Cladopelma	3.5			V
Diptera	Chironomidae	Cladotanytarsus	Cladotanytarsus	4			V
Diptera	Chironomidae	Clinotanypus	Clinotanypus	7.8			V
Diptera	Chironomidae	Coelotanypus	Coelotanypus	8			V
Diptera	Chironomidae	Conchapelopia	Conchapelopia	8.4			V
Diptera	Chironomidae	Constempellina	Constempellina	0	Intol		V
Diptera	Chironomidae	Corynoneura	Corynoneura	5.7			V
Diptera	Chironomidae	Crico./Ortho.	Cricotopus/Orthocla dius	7.44		cn	V
Diptera	Chironomidae	Cricotopus	Cricotopus	7.44		cn	V
Diptera	Chironomidae	Cryptochironomus	Cryptochironomus	6.4			V
Diptera	Chironomidae	Cryptotendipes	Cryptotendipes	6.2			V
Diptera	Chironomidae	Demicryptochironom us	Demicryptochirono mus	2.2	Intol		V
Diptera	Chironomidae	Diamesa	Diamesa	6.6			V
Diptera	Chironomidae	Diamesinae	Diamesinae	4.7		cn	
Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	7.2			V
Diptera	Chironomidae	Diplocladius	Diplocladius	8			V
Diptera	Chironomidae	Djalmabatista	Djalmabatista	4			V
Diptera	Chironomidae	Doithrix	Doithrix				
Diptera	Chironomidae	Einfeldia	Einfeldia	7.1			
Diptera	Chironomidae	Endochironomus	Endochironomus	7.8		cn	

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Diptera	Chironomidae	Endotribelos	Endotribelos				
Diptera	Chironomidae	Epoicocladius	Epoicocladius	0.1	Intol		V
Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	3.45			V
Diptera	Chironomidae	Euryhapsis	Euryhapsis				
Diptera	Chironomidae	Fittkauimyia	Fittkauimyia	5.6			V
Diptera	Chironomidae	Georthocladius	Georthocladius	0	Intol		V
Diptera	Chironomidae	Glyptotendipes	Glyptotendipes	8.6			V
Diptera	Chironomidae	Goeldichironomus	Goeldichironomus	10			V
Diptera	Chironomidae	Guttipelopia	Guttipelopia	2	Intol		
Diptera	Chironomidae	Harnischia	Harnischia	9.1			V
Diptera	Chironomidae	Hayesomyia	Hayesomyia	4.6			
Diptera	Chironomidae	Heleniella	Heleniella	0	Intol		V
Diptera	Chironomidae	Helopelopia	Helopelopia	6.2			V
Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	2.6	Intol		V
Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	9.2			V
Diptera	Chironomidae	Kiefferulus	Kiefferulus	8			V
Diptera	Chironomidae	Kloosia	Kloosia				V
Diptera	Chironomidae	Krenopelopia	Krenopelopia				
Diptera	Chironomidae	Krenosmittia	Krenosmittia	0	Intol		V
Diptera	Chironomidae	Kribiodorum	Kribiodorum	4			V
Diptera	Chironomidae	Labrundinia	Labrundinia	6.2			V
Diptera	Chironomidae	Larsia	Larsia	6.5			V
Diptera	Chironomidae	Lauterborniella	Lauterborniella				
Diptera	Chironomidae	Limnophyes	Limnophyes	7.4			V
Diptera	Chironomidae	Lopescladius	Lopescladius	1.2	Intol		V
Diptera	Chironomidae	Meropelopia	Meropelopia	4			V
Diptera	Chironomidae	Mesosmittia	Mesosmittia				
Diptera	Chironomidae	Metriocnemus	Metriocnemus	2	Intol		V
Diptera	Chironomidae	Microchironomus	Microchironomus	4			V
Diptera	Chironomidae	Micropsectra	Micropsectra	2.4	Intol		V
Diptera	Chironomidae	Microtendipes	Microtendipes	4.6		cn	V
Diptera	Chironomidae	Nanocladius	Nanocladius	7.4			V
Diptera	Chironomidae	Natarsia	Natarsia	9.5			V
Diptera	Chironomidae	Neostempellina	Neostempellina				V
Diptera	Chironomidae	Neozavrelia	Neozavrelia				
Diptera	Chironomidae	Nilotanypus	Nilotanypus	4.1			V
Diptera	Chironomidae	Nilothauma	Nilothauma	5.1			V
Diptera	Chironomidae	Odontomesa	Odontomesa				V

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Diptera	Chironomidae	Omisis	Omisis	4			
Diptera	Chironomidae	Orthoclaadiinae	Orthoclaadiinae	5.3			
Diptera	Chironomidae	Orthocladus	Orthocladus	4.4			V
Diptera	Chironomidae	Pagastia	Pagastia	1.5	Intol		V
Diptera	Chironomidae	Pagestiella	Pagastiella	2.5	Intol		V
Diptera	Chironomidae	Paraboreochlus	Paraboreochlus				V
Diptera	Chironomidae	Parachaetocladus	Parachaetocladus	0.7	Intol		V
Diptera	Chironomidae	Parachironomus	Parachironomus	8			V
Diptera	Chironomidae	Paracladopelma	Paracladopelma	6.3			V
Diptera	Chironomidae	Paracricotopus	Paracricotopus	10			V
Diptera	Chironomidae	Parakiefferiella	Parakiefferiella	4.8			V
Diptera	Chironomidae	Paralauterborniella	Paralauterborniella	4.9		cn	V
Diptera	Chironomidae	Paramerina	Paramerina	4.1			V
Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	3.9			V
Diptera	Chironomidae	Paraphaenocladus	Paraphaenocladus	3.3			V
Diptera	Chironomidae	Parapsectra	Parapsectra	1.52	Intol		
Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	8			V
Diptera	Chironomidae	Paratendipes	Paratendipes	5.6			V
Diptera	Chironomidae	Paratrachocladus	Paratrachocladus	8.5			
Diptera	Chironomidae	Parochlus	Parochlus				
Diptera	Chironomidae	Pectrotanypus	Psectrotanypus	10			V
Diptera	Chironomidae	Pentaneura	Pentaneura	5			V
Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	6.85		cn	V
Diptera	Chironomidae	Platysmittia	Platysmittia				V
Diptera	Chironomidae	Polypedilum	Polypedilum	6.1			V
Diptera	Chironomidae	Potthastia	Potthastia	5.4			V
Diptera	Chironomidae	Procladius	Procladius	8.8			V
Diptera	Chironomidae	Prodiamesa	Prodiamesa	8.8			
Diptera	Chironomidae	Prodiamesinae	Prodiamesinae	8.8			
Diptera	Chironomidae	Psectrocladius	Psectrocladius	3.6			V
Diptera	Chironomidae	Psectrotanypus	Psectrotanypus				V
Diptera	Chironomidae	Pseudochironomus	Pseudochironomus	4.9			V
Diptera	Chironomidae	Pseudorthocladus	Pseudorthocladus	1.5	Intol		V
Diptera	Chironomidae	Pseudosmittia	Pseudosmittia	2	Intol		V
Diptera	Chironomidae	Psilometriocnemus	Psilometriocnemus				
Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	4.7			V
Diptera	Chironomidae	Rheopelopia	Rheopelopia	0.3	Intol		V
Diptera	Chironomidae	Rheosmittia	Rheosmittia	6.8			V

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Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	6.5		cn	V
Diptera	Chironomidae	Robackia	Robackia	3.1			V
Diptera	Chironomidae	Saetheria	Saetheria	7.3			V
Diptera	Chironomidae	Smittia	Smittia	2	Intol		V
Diptera	Chironomidae	Stelechomyia	Stelechomyia (Kribiodorum)	4			
Diptera	Chironomidae	Stempellina	Stempellina	0	Intol		V
Diptera	Chironomidae	Stempellinella	Stempellinella	5.6			V
Diptera	Chironomidae	Stenochironomus	Stenochironomus	6.3			V
Diptera	Chironomidae	Stictochironomus	Stictochironomus	5.4			V
Diptera	Chironomidae	Stilocladius	Stilocladius	0.98	Intol		V
Diptera	Chironomidae	Sublettea	Sublettea	1.4	Intol		V
Diptera	Chironomidae	Symbiocladius	Symbiocladius	2	Intol		V
Diptera	Chironomidae	Sympotthastia	Sympotthastia	4.5			
Diptera	Chironomidae	Synorthocladius	Synorthocladius	4.2			V
Diptera	Chironomidae	Tanypus	Tanypus	9.2			V
Diptera	Chironomidae	Tanytarsini	Tanytarsini				
Diptera	Chironomidae	Tanytarsus	Tanytarsus	6.6			V
Diptera	Chironomidae	Thienemanniella	Thienemanniella	6.4			V
Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	8.4			
Diptera	Chironomidae	Tribelos	Tribelos	6.4			V
Diptera	Chironomidae	Trissopelopia	Trissopelopia	0	Intol		
Diptera	Chironomidae	Tvetenia	Tvetenia	3.55			V
Diptera	Chironomidae	Unniella	Unniella	0	Intol		V
Diptera	Chironomidae	Xenochironomus	Xenochironomus	6.6			V
Diptera	Chironomidae	Xestochironomus	Xestochironomus	2			V
Diptera	Chironomidae	Xylotopus	Xylotopus	6.1			V
Diptera	Chironomidae	Zavrelia	Zavrelia	6.1			
Diptera	Chironomidae	Zavreliella	Zavreliella	6			
Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	8.6			V
Diptera	Culicidae		Culicidae	8			
Diptera	Culicidae	Aedes	Aedes	8			V
Diptera	Culicidae	Anopheles	Anopheles	8.6			V
Diptera	Culicidae	Culex	Culex	10			V
Diptera	Culicidae	Psorophora	Psorophora	8			
Diptera	Culicidae	Wyeomyia	Wyeomyia	8			
Diptera	Dixidae		Dixidae	3.7			
Diptera	Dixidae	Dixa	Dixa	2.5	Intol		V

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Diptera	Dixidae	Dixella	Dixella	4.9			V
Diptera	Dolichopodidae		Dolichopodidae	7			
Diptera	Empididae	Chelifera	Chelifera	6			
Diptera	Empididae	Clinocera	Clinocera	6		cn	V
Diptera	Empididae	Empididae	Empididae	7.6			
Diptera	Empididae	Hemerodromia	Hemerodromia	6			V
Diptera	Empididae	Neoplasta	Neoplasta	8			V
Diptera	Empididae	Roederiodes	Roederiodes	8		cn	V
Diptera	Empididae	Trichoclinocera	Trichoclinocera	8		cn	V
Diptera	Ephydriidae		Ephydriidae	6			
Diptera	Ephydriidae	Ephydra	Ephydra	6			
Diptera	Ephydriidae	Notiphila	Notiphila	6			
Diptera	Ephydriidae	Scatella	Scatella	6			V
Diptera	Muscidae		Muscidae	5.3			
Diptera	Muscidae	Limnophora	Limnophora	8.4			
Diptera	Nymphomyiidae	Nymphomyia	Nymphomyia			cn	V
Diptera	Phoridae	Dohrniphora	Dohrniphora				
Diptera	Phoridae	Phoridae	Phoridae				V
Diptera	Psychodidae		Psychodidae	9.64			
Diptera	Psychodidae	Pericoma/Telmatoscopus	Pericoma/Telmatoscopus	4.2			V
Diptera	Psychodidae	Psychoda	Psychoda	9.64			V
Diptera	Ptychopteridae	Bittacomorpha	Bittacomorpha	8			V
Diptera	Ptychopteridae	Ptychoptera	Ptychoptera	8			V
Diptera	Sciomyzidae		Sciomyzidae	6			
Diptera	Sciomyzidae	Dictya	Dictya	6			V
Diptera	Sciomyzidae	Sepedon	Sepedon	2	Intol		V
Diptera	Simuliidae	Cnephia	Cnephia	6		cn	
Diptera	Simuliidae	Ectemnia	Ectemnia	0	Intol	cn	
Diptera	Simuliidae	Prosimulium	Prosimulium	4.5		cn	V
Diptera	Simuliidae	Simuliidae	Simuliidae	4.7		cn	
Diptera	Simuliidae	Simulium	Simulium	4.9		cn	V
Diptera	Simuliidae	Stegopterna	Stegopterna	4.7		cn	V
Diptera	Stratiomyidae	Allognosta	Allognosta	7			V
Diptera	Stratiomyidae	Caloparyphus	Caloparyphus	7			V
Diptera	Stratiomyidae	Euparyphus	Euparyphus	5.1			
Diptera	Stratiomyidae	Myxosargus	Myxosargus	5.1			V
Diptera	Stratiomyidae	Nemotelus	Nemotelus	4			

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Diptera	Stratiomyidae	Odontomyia	Odontomyia	8			V
Diptera	Stratiomyidae	Oxycera	Oxycera	0	Intol		
Diptera	Stratiomyidae	Stratiomyidae	Stratiomyidae	5.1			V
Diptera	Stratiomyidae	Stratiomys	Stratiomys	8.1			
Diptera	Syrphidae	Neoascia	Neoascia	9.7			
Diptera	Syrphidae	Syrphidae	Syrphidae	9.7			V
Diptera	Tabanidae		Tabanidae	7.6			
Diptera	Tabanidae	Chlorotabanus	Chlorotabanus	7.6			
Diptera	Tabanidae	Chrysops	Chrysops	6.7			
Diptera	Tabanidae	Diachlorus	Diachlorus	7.6			
Diptera	Tabanidae	Hybomitra	Hybomitra	7.6			
Diptera	Tabanidae	Tabanus	Tabanus	8.5			V
Diptera	Tanyderidae	Protoplasa	Protoplasa	4			V
Diptera	Tipulidae	Antocha	Antocha	4.4		cn	V
Diptera	Tipulidae	Cryptolabis	Cryptolabis	5.3			V
Diptera	Tipulidae	Dactylolabis	Dactylolabis	5.3			V
Diptera	Tipulidae	Dicranota	Dicranota	0	Intol		V
Diptera	Tipulidae	Erioptera	Erioptera	4.6			V
Diptera	Tipulidae	Gonomyia	Gonomyia	6			V
Diptera	Tipulidae	Helius	Helius	2	Intol		V
Diptera	Tipulidae	Hexatoma	Hexatoma	3.5			V
Diptera	Tipulidae	Leptotarsus	Leptotarsus				V
Diptera	Tipulidae	Limnophila	Limnophila	4			V
Diptera	Tipulidae	Limonia	Limonia	9.3			V
Diptera	Tipulidae	Lipsothrix	Lipsothrix	5.3			V
Diptera	Tipulidae	Molophilus	Molophilus	6			V
Diptera	Tipulidae	Ormosia	Ormosia	6.5			V
Diptera	Tipulidae	Paradelphomyia	Paradelphomyia	5.3			
Diptera	Tipulidae	Pedicia	Pedicia	2	Intol		V
Diptera	Tipulidae	Pilaria	Pilaria	7			
Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	6.2			
Diptera	Tipulidae	Rhabdomastix	Rhabdomastix	8			
Diptera	Tipulidae	Tipula	Tipula	7.5			V
Diptera	Tipulidae	Tipulidae	Tipulidae	5.3			
Ephemeroptera			Ephemeroptera				
Ephemeroptera	Ameletidae	Ameletus	Ameletus	0	Intol		V
Ephemeroptera	Ameletidae		Ameletidae	0	Intol		
Ephemeroptera	Baetidae	Acentrella	Acentrella	2.5	Intol		V

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Ephemeroptera	Baetidae	Acerpenna	Acerpenna	3.7			V
Ephemeroptera	Baetidae	Baetidae	Baetidae	6			
Ephemeroptera	Baetidae	Baetis	Baetis	6			V
Ephemeroptera	Baetidae	Callibaetis	Callibaetis	9.2			V
Ephemeroptera	Baetidae	Centroptilum	Centroptilum	3.8			V
Ephemeroptera	Baetidae	Dipheter	Dipheter	1.2	Intol		V
Ephemeroptera	Baetidae	Fallceon	Fallceon	6			V
Ephemeroptera	Baetidae	Heterocloeon	Heterocloeon	3.7			V
Ephemeroptera	Baetidae	Iswaeon	Iswaeon	4.4			V
Ephemeroptera	Baetidae	Labiobaetis	Labiobaetis	4.6			V
Ephemeroptera	Baetidae	Paracloeodes	Paracloeodes	8			V
Ephemeroptera	Baetidae	Plauditus	Plauditus	4			V
Ephemeroptera	Baetidae	Procloeon	Procloeon	1.9	Intol		V
Ephemeroptera	Baetidae	Pseudocentroptioides	Pseudocentroptioides	6			V
Ephemeroptera	Baetidae	Pseudocloeon	Pseudocloeon	4.63			
Ephemeroptera	Baetiscidae	Baetisca	Baetisca	3.2			V
Ephemeroptera	Baetiscidae		Baetiscidae	4.2			
Ephemeroptera	Caenidae		Caenidae	6			
Ephemeroptera	Caenidae	Brachycercus	Brachycercus	2.1	Intol		V
Ephemeroptera	Caenidae	Caenis	Caenis	6.8			V
Ephemeroptera	Ephemerellidae	Attenella	Attenella	1.1	Intol	cn	V
Ephemeroptera	Ephemerellidae	Dannella	Dannella	2	Intol	cn	V
Ephemeroptera	Ephemerellidae	Drunella	Drunella	0.1	Intol	cn	V
Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	2.1	Intol	cn	V
Ephemeroptera	Ephemerellidae	Ephemerellidae	Ephemerellidae	2	Intol	cn	
Ephemeroptera	Ephemerellidae	Eurylophella	Eurylophella	4		cn	V
Ephemeroptera	Ephemerellidae	Penelomax	Penelomax	2.1	Intol	cn	
Ephemeroptera	Ephemerellidae	Serratella	Serratella	2	Intol	cn	V
Ephemeroptera	Ephemerellidae	Teloganopsis	Teloganopsis	2.6	Intol	cn	
Ephemeroptera	Ephemerellidae	Timpanoga	Timpanoga	7		cn	V
Ephemeroptera	Ephemeridae	Ephemera	Ephemera	2	Intol		V
Ephemeroptera	Ephemeridae	Ephemeridae	Ephemeridae	2.2	Intol		
Ephemeroptera	Ephemeridae	Hexagenia	Hexagenia	4.4			V
Ephemeroptera	Ephemeridae	Pentagenia	Pentagenia	2.2	Intol		
Ephemeroptera	Heptageniidae	Cinygmula	Cinygmula	0	Intol	cn	V
Ephemeroptera	Heptageniidae	Epeorus	Epeorus	1.6	Intol	cn	V

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Ephemeroptera	Heptageniidae	Heptagenia	Heptagenia	1.9	Intol	cn	V
Ephemeroptera	Heptageniidae	Heptageniidae	Heptageniidae	3	Intol	cn	
Ephemeroptera	Heptageniidae	Leucrocuta	Leucrocuta	2	Intol	cn	V
Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	3.1		cn	V
Ephemeroptera	Heptageniidae	Nixe	Nixe	0	Intol	cn	
Ephemeroptera	Heptageniidae	Rhithrogena	Rhithrogena	0	Intol	cn	V
Ephemeroptera	Heptageniidae	Stenacron	Stenacron	3.5		cn	V
Ephemeroptera	Heptageniidae	Stenonema	Stenonema	6.9		cn	V
Ephemeroptera	Isonychiidae	Isonychia	Isonychia	3.6			V
Ephemeroptera	Isonychiidae		Isonychiidae	3.6			
Ephemeroptera	Leotophlebiidae	Habrophlebia	Habrophlebia	4			V
Ephemeroptera	Leptohyphidae	Leptohyphidae	Leptohyphidae	2	Intol		
Ephemeroptera	Leptohyphidae	Tricorythodes	Tricorythodes	5			V
Ephemeroptera	Leptophlebiidae	Choroterpes	Choroterpes	0	Intol	cn	V
Ephemeroptera	Leptophlebiidae	Habrophlebia	Habrophlebia	0.3	Intol		V
Ephemeroptera	Leptophlebiidae	Habrophlebiodes	Habrophlebiodes	1	Intol		V
Ephemeroptera	Leptophlebiidae	Leptophlebia	Leptophlebia	6			V
Ephemeroptera	Leptophlebiidae	Leptophlebiidae	Leptophlebiidae	2.5	Intol		
Ephemeroptera	Leptophlebiidae	Neochoroterpes	Neochoroterpes	2.5	Intol		
Ephemeroptera	Leptophlebiidae	Paraleptophlebia	Paraleptophlebia	1.2	Intol		V
Ephemeroptera	Metropodidae	Siphloplecton	Siphloplecton	3.3			V
Ephemeroptera	Neoephemeridae	Neoephemera	Neoephemera	1.5	Intol		V
Ephemeroptera	Polymitarciidae		Polymitarciidae	1.5	Intol		
Ephemeroptera	Polymitarciidae	Ephoron	Ephoron	2	Intol		V
Ephemeroptera	Potamanthidae	Anthopotamus	Anthopotamus	1.5	Intol		V
Ephemeroptera	Potamanthidae		Potamanthidae	1.5	Intol		
Ephemeroptera	Siphonuridae		Siphonuridae	6			
Ephemeroptera	Siphonuridae	Siphonurus	Siphonurus	6			V
Gordiida	Gordiidae	Gordius	Gordius	6			
Haplonemertea	Tetrastemmatidae	Prostoma	Prostoma	6.6			
Haplotaxida	Lumbricidae	Haplotaxis	Haplotaxis	3.6			V
Hemiptera	Belostomatidae		Belostomatidae	9.5			
Hemiptera	Belostomatidae	Belostoma	Belostoma	9.5			V
Hemiptera	Belostomatidae	Lethocerus	Lethocerus	4			
Hemiptera	Corixidae	Corixidae	Corixidae	8.7			
Hemiptera	Corixidae	Palmacorixa	Palmacorixa	6			V

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Hemiptera	Corixidae	Sigara	Sigara	8.7			V
Hemiptera	Corixidae	Trichocorixa	Trichocorixa	5			V
Hemiptera	Gelastocoridae	Gelastocoris	Gelastocoris	6			V
Hemiptera	Hebridae	Hebrus	Hebrus				V
Hemiptera	Hebridae	Lipogomphus	Lipogomphus				V
Hemiptera	Hydrometridae	Hydrometra	Hydrometra	6			V
Hemiptera	Naucoridae	Pelocoris	Pelocoris	7.01			V
Hemiptera	Nepidae	Ranatra	Ranatra	6.3			V
Hemiptera	Nepidae		Nepidae	6.3			
Hemiptera	Notonectidae		Notonectidae	6.4			
Hemiptera	Notonectidae	Buenoa	Buenoa	4			V
Hemiptera	Notonectidae	Notonecta	Notonecta	8.71			V
Hemiptera	Pleidae	Neoplea	Neoplea	6			V
Hemiptera	Pleidae	Paraplea	Paraplea	6			
Hemiptera	Pleidae	Pleidae	Pleidae	6			
Hemiptera	Saldidae	Micracanthia	Micracanthia	10			V
Hemiptera	Saldidae	Pentacora	Pentacora	10			
Hemiptera	Saldidae	Saldidae	Saldidae	10			
Heterostropha	Valvatidae	Valvata	Valvata	8			V
Hydroida	Hydridae	Hydra	Hydra	6			
Isopoda	Asellidae		Asellidae	7.9			
Isopoda	Asellidae	Asellus	Asellus	4.2			
Isopoda	Asellidae	Caecidotea	Caecidotea	8.4			V
Isopoda	Asellidae	Lirceus	Lirceus	7.4			V
Isopoda			Isopoda	7.4			
Lepidoptera	Crambidae	Parapoynx	Parapoynx				
Lepidoptera	Lepidoptera	Lepidoptera	Lepidoptera				
Lepidoptera	Nepticulidae		Nepticulidae				
Lepidoptera	Noctuidae	Noctuidae	Noctuidae				V
Lepidoptera	Noctuidae	Simyra	Simyra				P
Lepidoptera	Pyalidae	Acentria	Acentria	5			
Lepidoptera	Pyalidae	Crambus	Crambus	3.6			P
Lepidoptera	Pyalidae	Munroessa/Syncllita	Munroessa/Syncllita	3.6			P
Lepidoptera	Pyalidae	Petrophila	Petrophila	3.6		cn	V
Lepidoptera	Pyalidae	Pyalidae	Pyalidae	3.6			
Lepidoptera	Pyalidae	Syncllita	Syncllita	3.6			
Lepidoptera	Tortricidae		Tortricidae	6			
Lepidoptera	Tortricidae	Archips	Archips	6			V

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Lumbriculida	Lumbricidae		Lumbricidae	10			
Lumbriculida	Lumbriculidae	Eclipidrilus	Eclipidrilus	5			
Lumbriculida	Lumbriculidae	Lumbriculidae	Lumbriculidae	7			V
Lumbriculida	Lumbriculidae	Lumbriculus	Lumbriculus	7			V
Megaloptera			Megaloptera			cn	
Megaloptera	Corydalidae		Corydalidae	5.28		cn	
Megaloptera	Corydalidae	Chauliodes	Chauliodes	9		cn	P
Megaloptera	Corydalidae	Corydalus	Corydalus	5.2		cn	V
Megaloptera	Corydalidae	Nigronia	Nigronia	5.35		cn	V
Megaloptera	Sialidae	Sialis	Sialis	7			V
Megaloptera	Sialidae		Sialidae	7			
Mermithida	Mermithidae	Mermithidae	Mermithidae	6			
Mysidacea	Mysidae	Mysis	Mysis				
Mysidacea	Mysidae	Taphromysis	Taphromysis				V
Neotaenioglossa	Hydrobiidae	Amnicola	Amnicola	4.1			
Neotaenioglossa	Hydrobiidae	Hydrobiidae	Hydrobiidae	4.1			V
Neotaenioglossa	Pleuroceridae		Lithasia				V
Neotaenioglossa	Pleuroceridae		Pleuroceridae	6			
Neotaenioglossa	Pleuroceridae	Elimia	Elimia	2.7	Intol		V
Neotaenioglossa	Pleuroceridae	Io	Io fluvialis				
Neotaenioglossa	Pleuroceridae	Leptoxis	Leptoxis	1.7	Intol		V
Neotaenioglossa	Pleuroceridae	Pleurocera	Pleurocera	6			V
Neuroptera			Neuroptera	6.5			
Neuroptera	Sisyridae	Climacia	Climacia	6.5			
Neuroptera	Sisyridae	Sisyra	Sisyra				
Odonata			Anisoptera				
Odonata			Odonata				
Odonata			Zygoptera				
Odonata	Aeshnidae		Aeshnidae	5			
Odonata	Aeshnidae	Basiaeschna	Basiaeschna	6			V
Odonata	Aeshnidae	Boyeria	Boyeria	2	Intol		V
Odonata	Aeshnidae	Nasiaeschna	Nasiaeschna	6.6			V
Odonata	Calopterygidae		Calopterygidae	6			
Odonata	Calopterygidae	Calopteryx	Calopteryx	7.5			V
Odonata	Calopterygidae	Hetaerina	Hetaerina	4.9			V
Odonata	Coenagrionidae		Coenagrionidae	8			

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Odonata	Coenagrionidae	Amphiagrion	Amphiagrion	8.77			
Odonata	Coenagrionidae	Argia	Argia	8.3			V
Odonata	Coenagrionidae	Chromagrion	Chromagrion	2	Intol		
Odonata	Coenagrionidae	Enallagma	Enallagma	8.5			V
Odonata	Coenagrionidae	Ischnura	Ischnura	9.5			V
Odonata	Cordulegastridae	Cordulegaster	Cordulegaster	5.7			V
Odonata	Cordulegastridae		Cordulegastridae	5.7			
Odonata	Corduliidae		Corduliidae	5.7			
Odonata	Corduliidae	Didymops	Didymops	2.4	Intol		V
Odonata	Corduliidae	Epitheca	Epitheca	8			V
Odonata	Corduliidae	Helocordulia	Helocordulia	5.8			V
Odonata	Corduliidae	Macromia	Macromia	6.2			V
Odonata	Corduliidae	Neurocordulia	Neurocordulia	5.3			V
Odonata	Corduliidae	Somatochlora	Somatochlora	8.9			V
Odonata	Gomphidae	Arigomphus	Arigomphus	5.2			V
Odonata	Gomphidae	Dromogomphus	Dromogomphus	5.6			V
Odonata	Gomphidae	Gomphidae	Gomphidae	4			
Odonata	Gomphidae	Gomphus	Gomphus	5.9			V
Odonata	Gomphidae	Hagenius	Hagenius	4.4			V
Odonata	Gomphidae	Lanthus	Lanthus	1.6	Intol		V
Odonata	Gomphidae	Ophiogomphus	Ophiogomphus	5.9			V
Odonata	Gomphidae	Progomphus	Progomphus	8.2			V
Odonata	Gomphidae	Stylogomphus	Stylogomphus	5			V
Odonata	Gomphidae	Stylurus	Stylurus	4			V
Odonata	Lestidae	Archilestes	Archilestes	8			V
Odonata	Lestidae	Lestes	Lestes	9.4			
Odonata	Lestidae		Lestidae	9.4			
Odonata	Libellulidae		Libellulidae	9.55			
Odonata	Libellulidae	Erythemis	Erythemis	9.7			V
Odonata	Libellulidae	Libellula	Libellula	9.4			V
Odonata	Libellulidae	Nannothemis	Nannothemis	9.55			
Odonata	Libellulidae	Pachydiplax	Pachydiplax	9.6			V
Odonata	Libellulidae	Perithemis	Perithemis	9.4			V
Odonata	Libellulidae	Plathemis	Plathemis	9.8			V
Plecoptera	Capniidae	Allocaupnia	Allocaupnia	3.3		cn	V
Plecoptera	Capniidae	Capniidae	Capniidae	3	Intol		
Plecoptera	Capniidae	Paracapnia	Paracapnia	0.1	Intol		V
Plecoptera	Chloroperlidae		Chloroperlidae	0	Intol	cn	

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Plecoptera	Chloroperlidae	Alloperla	Alloperla	1	Intol	cn	V
Plecoptera	Chloroperlidae	Haploperla	Haploperla	1.4	Intol	cn	V
Plecoptera	Chloroperlidae	Rasvena	Rasvena	0	Intol		V
Plecoptera	Chloroperlidae	Suwallia	Suwallia	2.6	Intol	cn	V
Plecoptera	Chloroperlidae	Sweltsa	Sweltsa	0.2	Intol	cn	V
Plecoptera	Leuctridae		Leuctridae	0	Intol		
Plecoptera	Leuctridae	Leuctra	Leuctra	1.5	Intol	cn	V
Plecoptera	Leuctridae	Paraleuctra	Paraleuctra	1.5	Intol		
Plecoptera	Leuctridae	Zealeuctra	Zealeuctra	0	Intol		V
Plecoptera	Nemouridae		Nemouridae	4.5			
Plecoptera	Nemouridae	Amphinemura	Amphinemura	3.8			V
Plecoptera	Nemouridae	Nemoura	Nemoura	2	Intol		V
Plecoptera	Nemouridae	Ostrocera	Ostrocera	4.5			V
Plecoptera	Nemouridae	Paranemoura	Paranemoura	4.5			V
Plecoptera	Nemouridae	Prostoia	Prostoia	5.2			V
Plecoptera	Nemouridae	Shipsa	Shipsa	4.5			
Plecoptera	Nemouridae	Soyedina	Soyedina	0	Intol		V
Plecoptera	Peltoperlidae		Peltoperlidae	2.7	Intol	cn	
Plecoptera	Peltoperlidae	Peltoperla	Peltoperla	4.2		cn	V
Plecoptera	Peltoperlidae	Tallaperla	Tallaperla	1.3	Intol	cn	V
Plecoptera	Peltoperlidae	Viehopera	Viehopera	2.7	Intol	cn	
Plecoptera	Perlidae	Acroneuria	Acroneuria	1.9	Intol	cn	V
Plecoptera	Perlidae	Agnetina	Agnetina	1.1	Intol	cn	V
Plecoptera	Perlidae	Attaneuria	Attaneuria	0	Intol	cn	
Plecoptera	Perlidae	Beloneuria	Beloneuria	0	Intol	cn	V
Plecoptera	Perlidae	Eccopectura	Eccopectura	4.7		cn	V
Plecoptera	Perlidae	Hansonoperla	Hansonoperla	2	Intol		V
Plecoptera	Perlidae	Neoperla	Neoperla	2.1	Intol	cn	V
Plecoptera	Perlidae	Paragnetina	Paragnetina	1.7	Intol	cn	V
Plecoptera	Perlidae	Perlesta	Perlesta	2.9	Intol	cn	V
Plecoptera	Perlidae	Perlidae	Perlidae	2	Intol	cn	
Plecoptera	Perlidae	Perlinella	Perlinella	1.3	Intol	cn	
Plecoptera	Perlodidae	Clioperla	Clioperla	5.2		cn	V
Plecoptera	Perlodidae	Cultus	Cultus	1.5	Intol	cn	
Plecoptera	Perlodidae	Diploperla	Diploperla	2.8	Intol	cn	P
Plecoptera	Perlodidae	Diura	Diura	2	Intol	cn	
Plecoptera	Perlodidae	Helopicus	Helopicus	1.2	Intol	cn	V
Plecoptera	Perlodidae	Hydroperla	Hydroperla	2.2	Intol	cn	V

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Plecoptera	Perlodidae	Isogenoides	Isogenoides	0.5	Intol	cn	V
Plecoptera	Perlodidae	Isoperla	Isoperla	3.2		cn	V
Plecoptera	Perlodidae	Malirekus	Malirekus	1	Intol		V
Plecoptera	Perlodidae	Perlodidae	Perlodidae	2.2	Intol	cn	
Plecoptera	Perlodidae	Remenus	Remenus	0.9	Intol	cn	V
Plecoptera	Perlodidae	Yugus	Yugus	0	Intol	cn	V
Plecoptera	Plecoptera	Plecoptera	Plecoptera				
Plecoptera	Pteronarcyidae	Pteronarcys	Pteronarcys	1.8	Intol	cn	V
Plecoptera	Pteronarcyidae		Pteronarcyidae	1.8	Intol	cn	
Plecoptera	Taeniopterygidae		Taeniopterygidae	5.3			
Plecoptera	Taeniopterygidae	Oemopteryx	Oemopteryx	5.3			P
Plecoptera	Taeniopterygidae	Strophopteryx	Strophopteryx	3.3			V
Plecoptera	Taeniopterygidae	Taenionema	Taenionema	2	Intol		V
Plecoptera	Taeniopterygidae	Taeniopteryx	Taeniopteryx	6			V
Rhynchobdellida	Glossiphoniidae	Helobdella	Helobdella	9.3			
Rhynchobdellida	Glossiphoniidae	Mooreobdella	Mooreobdella	9.4			
Rhynchobdellida	Glossiphoniidae	Placobdella	Placobdella	8.55			
Rhynchobdellida	Glossiphoniidae		Glossiphoniidae	8.6			
Solitaria	Barentsiidae	Urnatella	Urnatella				
Trichoptera			Trichoptera				
Trichoptera	Apataniidae	Apatania	Apatania	0.6	Intol	cn	V
Trichoptera	Apataniidae		Apataniidae	0.6	Intol	cn	V
Trichoptera	Beraeidae	Beraea	Beraea				
Trichoptera	Brachycentridae		Brachycentridae	1.5	Intol	cn	
Trichoptera	Brachycentridae	Brachycentrus	Brachycentrus	2.2	Intol	cn	V
Trichoptera	Brachycentridae	Micrasema	Micrasema	0.8	Intol	cn	V
Trichoptera	Calamoceratidae		Calamoceratidae	1.65	Intol		
Trichoptera	Calamoceratidae	Anisocentropus	Anisocentropus	1.3	Intol		V
Trichoptera	Calamoceratidae	Heteroplectron	Heteroplectron	2	Intol		V
Trichoptera	Dipseudopsidae	Phylocentropus	Phylocentropus	4.8			V
Trichoptera	Dipseudopsidae		Dipseudopsidae	4.8			
Trichoptera	Glossosomatidae	Agapetus	Agapetus	0	Intol	cn	V
Trichoptera	Glossosomatidae	Culoptila	Culoptila	1	Intol	cn	
Trichoptera	Glossosomatidae	Glossosoma	Glossosoma	1.4	Intol	cn	V
Trichoptera	Glossosomatidae	Glossosomatidae	Glossosomatidae	1.2	Intol	cn	
Trichoptera	Glossosomatidae	Matrioptila	Matrioptila	0	Intol	cn	V
Trichoptera	Glossosomatidae	Protoptila	Protoptila	2.3	Intol	cn	V
Trichoptera	Goeridae		Goeridae	0.85	Intol	cn	
Trichoptera	Goeridae	Goera	Goera	0.7	Intol	cn	V
Trichoptera	Goeridae	Goerita	Goerita	0	Intol	cn	
Trichoptera	Helicopsychidae	Helicopsyche	Helicopsyche	0	Intol	cn	V

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Trichoptera	Helicopsychidae		Helicopsychidae	0	Intol	cn	
Trichoptera	Hydropsychidae	Arctopsyche	Arctopsyche	0	Intol	cn	V
Trichoptera	Hydropsychidae	Ceratopsyche	Ceratopsyche	1.3	Intol	cn	V
Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	6.6		cn	V
Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	2.3	Intol	cn	V
Trichoptera	Hydropsychidae	Homoplectra	Homoplectra	4.1		cn	V
Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	4.3		cn	V
Trichoptera	Hydropsychidae	Hydropsychidae	Hydropsychidae	4.1		cn	
Trichoptera	Hydropsychidae	Macrostemum	Macrostemum	3.4		cn	V
Trichoptera	Hydropsychidae	Parapsyche	Parapsyche	0	Intol	cn	V
Trichoptera	Hydropsychidae	Potamyia	Potamyia	4		cn	
Trichoptera	Hydropsychidae	Symphitopsyche	Symphitopsyche	1.6	Intol	cn	
Trichoptera	Hydroptilidae	Agraylea	Agraylea	2	Intol		
Trichoptera	Hydroptilidae	Dibusa	Dibusa	0	Intol	cn	V
Trichoptera	Hydroptilidae	Hydroptila	Hydroptila	6.5		cn	V
Trichoptera	Hydroptilidae	Hydroptilidae	Hydroptilidae	5.55			
Trichoptera	Hydroptilidae	Leucotrichia	Leucotrichia	4.5		cn	V
Trichoptera	Hydroptilidae	Mayatrichia	Mayatrichia	0	Intol	cn	V
Trichoptera	Hydroptilidae	Metrichia	Metrichia	5.55			V
Trichoptera	Hydroptilidae	Neotrichia	Neotrichia	0	Intol	cn	V
Trichoptera	Hydroptilidae	Ochrotrichia	Ochrotrichia	4		cn	V
Trichoptera	Hydroptilidae	Orthotrichia	Orthotrichia	8.3		cn	V
Trichoptera	Hydroptilidae	Oxyethira	Oxyethira	2.2	Intol		V
Trichoptera	Hydroptilidae	Stactobiella	Stactobiella	1.3	Intol	cn	V
Trichoptera	Lepidostomatidae	Lepidostoma	Lepidostoma	1	Intol		V
Trichoptera	Lepidostomatidae	Lepidostomatidae	Lepidostomatidae	1	Intol		
Trichoptera	Lepidostomatidae	Theliopsyche	Theliopsyche	0	Intol		
Trichoptera	Leptoceridae	Ceraclea	Ceraclea	2.2	Intol		V
Trichoptera	Leptoceridae	Leptoceridae	Leptoceridae	3.15			
Trichoptera	Leptoceridae	Mystacides	Mystacides	2.6	Intol		V
Trichoptera	Leptoceridae	Nectopsyche	Nectopsyche	4.9			V
Trichoptera	Leptoceridae	Oecetis	Oecetis	5.1		cn	V
Trichoptera	Leptoceridae	Setodes	Setodes	0	Intol	cn	V
Trichoptera	Leptoceridae	Triaenodes	Triaenodes	4.1			V
Trichoptera	Limnephilidae	Frenesia	Frenesia	3.86			V
Trichoptera	Limnephilidae	Glyphopsyche	Glyphopsyche	3.86			
Trichoptera	Limnephilidae	Hesperophylax	Hesperophylax	2	Intol		
Trichoptera	Limnephilidae	Hydatophylax	Hydatophylax	2.4	Intol		V
Trichoptera	Limnephilidae	Ironoquia	Ironoquia	6.7			V

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Trichoptera	Limnephilidae	Limnephilidae	Limnephilidae	3.86			
Trichoptera	Limnephilidae	Limnephilus	Limnephilus	2	Intol		V
Trichoptera	Limnephilidae	Pycnopsyche	Pycnopsyche	2.5	Intol		V
Trichoptera	Molannidae	Molanna	Molanna	2	Intol		V
Trichoptera	Odontoceridae		Odontoceridae	0.5	Intol		
Trichoptera	Odontoceridae	Psilotreta	Psilotreta	0.5	Intol		V
Trichoptera	Philopotamidae	Chimarra	Chimarra	3.3		cn	V
Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	1	Intol	cn	V
Trichoptera	Philopotamidae	Fumonta	Fumonta	2.2	Intol		
Trichoptera	Philopotamidae	Philopotamidae	Philopotamidae	2.2	Intol	cn	
Trichoptera	Philopotamidae	Wormaldia	Wormaldia	2.4	Intol	cn	V
Trichoptera	Phryganeidae		Phryganeidae	6.05			
Trichoptera	Phryganeidae	Oligostomis	Oligostomis	6.2			V
Trichoptera	Phryganeidae	Ptilostomis	Ptilostomis	5.9			V
Trichoptera	Polycentropodidae	Cernotina	Cernotina	4		cn	
Trichoptera	Polycentropodidae	Cyrnellus	Cyrnellus	6.8		cn	V
Trichoptera	Polycentropodidae	Neureclipsis	Neureclipsis	4		cn	V
Trichoptera	Polycentropodidae	Nyctiophylax	Nyctiophylax	0.8	Intol	cn	V
Trichoptera	Polycentropodidae	Paranyctiophylax	Paranyctiophylax	0.9	Intol	cn	V
Trichoptera	Polycentropodidae	Polycentropodidae	Polycentropodidae	3.68		cn	
Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	3.1		cn	V
Trichoptera	Psychomyiidae	Lype	Lype	3.9		cn	V
Trichoptera	Psychomyiidae	Psychomyia	Psychomyia	2.5	Intol	cn	V
Trichoptera	Psychomyiidae	Psychomyiidae	Psychomyiidae	3.2		cn	
Trichoptera	Rhyacophilidae	Rhyacophila	Rhyacophila	1	Intol	cn	V
Trichoptera	Rhyacophilidae		Rhyacophilidae	1	Intol	cn	
Trichoptera	Sericostomatidae	Agarodes	Agarodes	0.7	Intol		V
Trichoptera	Sericostomatidae	Fattigia	Fattigia	0	Intol		V
Trichoptera	Uenoidae		Uenoidae	1.6	Intol	cn	
Trichoptera	Uenoidae	Neophylax	Neophylax	1.6	Intol	cn	V
Tricladida	Dugesiidae	Girardia	Girardia	7.23			
Tricladida	Dugesiidae	Girardia	Girardia tigrina	7.1			
Tricladida	Planariidae	Cura	Cura	5.5			
Tricladida	Planariidae	Cura	Cura foremanii	5.5			
Tricladida	Planariidae	Dugesia	Dugesia	7.1			
Tricladida	Planariidae	Sphalloplana	Sphalloplana	6.3			
Tricladida	Planariidae		Planariidae	6.3			
Tricladida	Planariidae	Phagocata	Phagocata	6.3			

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Tubificida	Enchytraeidae	Enchytraeidae	Enchytraeidae	9.8			V
Tubificida	Enchytraeidae	Enchytraeus	Enchytraeus	9.8			
Tubificida	Enchytraeidae	Fridericia	Fridericia	9.8			
Tubificida	Enchytraeidae	Hemienchytraeus	Hemienchytraeus	9.8			
Tubificida	Enchytraeidae	Marionina	Marionina	9.8			
Tubificida	Enchytraeidae	Mesenchytraeus	Mesenchytraeus	9.8			
Tubificida	Naididae		Ninae	8			
Tubificida	Naididae		Tubificinae	10			
Tubificida	Naididae	Aulodrilus	Aulodrilus	7			
Tubificida	Naididae	Branchiura	Branchiura	8.6			
Tubificida	Naididae	Bratislavia	Bratislavia	8.28			V
Tubificida	Naididae	Chaetogaster	Chaetogaster	7			
Tubificida	Naididae	Dero	Dero	9.8			V
Tubificida	Naididae	Haemonais	Haemonais	4			V
Tubificida	Naididae	Ilyodrilus	Ilyodrilus	9.3			V
Tubificida	Naididae	Isochaetides	Isochaetides	7.7			
Tubificida	Naididae	Limnodrilus	Limnodrilus	9.5			V
Tubificida	Naididae	Nais	Nais	8.7			V
Tubificida	Naididae	Ophidonais	Ophidonais	2	Intol		P
Tubificida	Naididae	Paranais	Paranais				V
Tubificida	Naididae	Piguetiella	Piguetiella	6			V
Tubificida	Naididae	Potamothrinx	Potamothrinx	6			
Tubificida	Naididae	Pristina	Pristina	7.7			V
Tubificida	Naididae	Pristinella	Pristinella	7.7			V
Tubificida	Naididae	Quistadrilus	Quistadrilus	3.9			V
Tubificida	Naididae	Rhyacodrilus	Rhyacodrilus	10			V
Tubificida	Naididae	Slavina	Slavina	8.4			V
Tubificida	Naididae	Specaria	Specaria	4			
Tubificida	Naididae	Spirosperma	Spirosperma	5.4			V
Tubificida	Naididae	Stephensoniana	Stephensoniana	4			P
Tubificida	Naididae	Stylaria	Stylaria	8.4			V
Tubificida	Naididae	Tubifex	Tubifex	9.9			P
Tubificida	Naididae	Varichaetodrilus	Varichaetodrilus				V
Tubificida	Naididae	Vejdovskyella	Vejdovskyella				V
Unionoida	Unionidae		Unionidae	6			
Unionoida	Unionidae	Plectomerus	Plectomerus	6			
Veneroida			Bivalvia				
Veneroida	Corbiculidae	Corbicula	Corbicula	6.6			V

Order	Family	Genus	FinalID	NCBI	Intol (0.00- 3.00)	Clinger (cn)	Verify Status
Veneroida	Corbiculidae		Corbiculidae	6.6			
Veneroida	Dreissenidae	Dreissena	Dreissena	8			
Veneroida	Sphaeriidae	Eupera	Eupera	5.7			
Veneroida	Sphaeriidae	Musculium	Musculium	7.5			
Veneroida	Sphaeriidae	Pisidium	Pisidium	6.6			V
Veneroida	Sphaeriidae	Sphaeriidae	Sphaeriidae	6.9			
Veneroida	Sphaeriidae	Sphaerium	Sphaerium	7.2			V
Veneroida	Unionidae	Alasmidonta	Alasmidonta	0.65	Intol		

V = Verified by Taxonomic Expert

P = Pending Verification

APPENDIX D

TAXONOMIC INFORMATION

**GENUS LEVEL TAXONOMIC KEYS
CRITERIA FOR TAXONOMIC EXPERTS
TAXONOMIC SPECIALISTS FOR REFERENCE VERIFICATION**

GENUS LEVEL TAXONOMIC KEYS (Primary Key for each group is listed first)

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ANNELIDA

Tubificidae and Naididae

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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.** Is an 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 invertebrate 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 an invertebrate collection (one or more groups) including that for which the applicant seeks recognition as a taxonomic/systematic expert.
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 one / several group(s) of aquatic macroinvertebrates; the course must have been inclusive of the group for which the applicant seeks recognition as a taxonomic/systematic expert.
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.

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Ceratopogonidae

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Steve Murphee, PhD
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Empididae and Stratiomyidae

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Athericidae, Blephariceridae, Dixidae, Ephydriidae, Psychodidae, Sciomyzidae

No specialists available.

APPENDIX E

SUPPLEMENTARY INFORMATION

**PROJECT NAMES AND IDS
ORGANIZATIONS
COUNTY ABBREVIATIONS AND CODE NUMBERS
EXOTIC PLANTS IN TENNESSEE**

Project Names and IDs

Project ID	Project Name
TNPR0080	303(d)
TNPR0029	71iPM
TNPR0002	Agriculture
TNPR0084	AIR DEPOSITION
TNPR0003	Ambient
TNPR0004	Antidegradation
TNPR0005	ARAP
TNPR0082	ATV Park
TNPR0071	Auburn University
TNPR0089	Border State not TDEC
TNPR0065	Clean Lakes Statewide Assessment
TNPR0006	Coalfields
TNPR0019	Complaint
TNPR0063	Compliance
TNPR0043	Conductivity
TNPR0020	Construction
TNPR0044	Copperhill
TNPR0045	Corridor K
TNPR0092	DEIDS
TNPR0047	Dissolved Oxygen
TNPR0046	Diurnal
TNPR0007	DOE-O
TNPR0086	Drinking Water Lake Study
TNPR0037	Ecoregion
TNPR0048	Elk River
TNPR0021	Enforcement
TNPR0008	EPA
TNPR0038	FECO
TNPR0088	Fish Kill
TNPR0061	Flood
TNPR0090	Healthy Watersheds
TNPR0059	HRWA
TNPR0022	Inspection
TNPR0030	ISP
TNPR0024	Kingston
TNPR0083	Landfill
TNPR0057	Mercury
TNPR0064	Mercury Sediment Study
TNPR0027	MS4

Project ID	Project Name
TNPR0041	NLS
TNPR0053	NPDES Permit
TNPR0058	NRCS
TNPR0009	NRDA
TNPR0010	ORNL
TNPR0076	Periphyton Study
TNPR0049	Post Flood
TNPR0077	Pre Excavation
TNPR0035	QC
TNPR0068	Recreational Area
TNPR0054	REFERENCE
TNPR0055	RESERVOIR
TNPR0062	Restoration
TNPR0039	SEMN
TNPR0091	Special Studies Project
TNPR0023	Spill
TNPR0060	Superfund - External
TNPR0087	Superfund - TDEC
TNPR0028	Surface Mining
TNPR0012	TDOT
TNPR0018	Tissue
TNPR0001	TMDL
TNPR0050	TN-KY
TNPR0036	Training
TNPR0013	TVA
TNPR0014	TWRA
TNPR0056	UNIDENTIFIED
TNPR0078	URS Corporation
TNPR0015	USACE
TNPR0016	USGS
TNPR0017	UTC
TNPR0051	Watershed
TNPR0066	Willamette Clearcutting
TNPR0085	WSA
TNPR0031	WSA 2004
TNPR0032	WSA 2008
TNPR0033	WSA 2010
TNPR0081	WSA-SE

Organizations

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
ARC	Aquatic Resource Center
ARCADIS	ARCADIS Consulting
ARI	ARI Environmental Inc.
AUB	Auburn University
BCS	BCS Consulting
BDY	BDY Environmental LLC
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
Chattanooga EFO	TDEC Chattanooga Environmental Field Office
CLEVESW	Cleveland Stormwater
Columbia EFO	TDEC Columbia Environmental Field Office
Cookeville EFO	TDEC Cookeville Environmental Field Office
CRWA	Clinch River Watershed Association
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
ENSAFE	ENSAFE consulting
ENVIRON	ENVIRON International Corporation
EPA	United States Environmental Protection Agency
ESC	Environmental Science Corporation
ETC	Environmental Testing Laboratories
FLLA	Fort Loudoun Lake Association
G&M	Griggs & Maloney Incorporated
GSH	Glenn Springs Holding, Inc.
HCWQ	Hamilton County Water Quality
Jackson EFO	TDEC Jackson Environmental Field Office
Johnson City EFO	Johnson City Environmental Field Office
Knoxville EFO	Knoxville Environmental Field Office
MBEL	Moccasin Bend Environmental Lab
MDEQ	Mississippi Department of Environmental Quality
MEAD	Mead Paper
Memphis EFO	TDEC Memphis Environmental Field Office
Microbac	Microbac Laboratory
Mining Section	TDEC Mining Section
NAL	National Analytical Laboratories (aka NWA & NWALAB)
Nashville EFO	TDEC Nashville Environmental Field Office

Organization	Organization Full Name
NASHVILLE ZOO	Nashville Zoo
NC	National Coal
NCO	TDEC DWR Nashville Central Office
NEWFIELDS	Newfields Consulting
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
PCC	Premium Coal Company
PFWD	Pigeon Forge Water Development
PFWD 03403	Pigeon Forge Water Development
RE	Ramboll Environ
SBC	S. Bradford Cook Consultant
SHWWTPÂ	Springhill Waste Water Treatment Plant
SLI	Skelly and Loy Consultants
SME	S&ME Inc.
SSG	Sevier Stormwater Group
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 LAB	Tennessee Department of Health Environmental Laboratory
TDOT	Tennessee Department of Transportation
TEC	TEC Environmental Laboratories Inc
TLI	Technical Laboratories Inc
TRIAD	Triad Environmental Consultants
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
Unknown	Historical data - organization not recorded
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
VA	State of Virginia Environmental Program
WMS	TDEC Watershed Management Unit
WP	Waypoint Analytical Inc
WPC	TDEC Water Pollution Control

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
BLEDSON	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
HAMBLÉN	HA	32	063	SMITH	SM	80	159
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

COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS	COUNTY NAME	WPC CO ABBR	TN CO NO	NATIONAL TN FIPS
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 field guides can be found at: <http://www.tnipc.org/invasive-plants/> Distribution maps for Tennessee can be found at <https://plants.usda.gov/gallery.html.html>.

Growth Form	Scientific Name	Common Name
Trees	<i>Ailanthus altissima</i> (Mill.) Swingle	Tree of Heaven
	<i>Albizia julibrissin</i> Durz.	Mimosa
	<i>Paulownia tomentosa</i> (Thunb.) Sieb.&Zucc. ex Steud.	Princess tree
	<i>Populus alba</i> L.	White poplar
	<i>Broussonetia papyrifera</i> (L.) L'Her. ex Vent.	Paper mulberry
	<i>Melia azedarach</i> L.	Chinaberry
	<i>Pyrus calleryana</i> Decne.	Bradford pear
	<i>Triadica (Sapium) sebiferum</i> (L.) Roxb.	Chinese tallowtree
	Shrubs	<i>Elaeagnus umbellata</i> Thunb.
<i>Elaeagnus pungens</i> Thunb.		Thorny-olive
<i>Ligustrum sinense</i> Lour.		Chinese privet
<i>Ligustrum vulgare</i> L.		Common privet
<i>Lonicera fragrantissima</i> Lindl. & Paxton		January jasmine
<i>Lonicera maackii</i> (Rupr.) Maxim.		Amur bush honeysuckle
<i>Lonicera morrowii</i> A. Gray		Morrow's bush honeysuckle
<i>Lonicera tatarica</i> L.		Tartarian honeysuckle; twinsisters
<i>Lonicera x bella</i> Zabel		Bush honeysuckle
<i>Rosa multiflora</i> Thunb.		Multiflora rose
<i>Spiraea japonica</i> L.f.		Japanese spiraea
<i>Berberis thunbergii</i> DC		Japanese barberry
<i>Euonymus alata</i> (Thunb.) Sieb.		Burning bush
<i>Ligustrum japonicum</i> Thunb.		Japanese privet
<i>Elaeagnus angustifolia</i> L.		Russian olive
<i>Alnus glutinosa</i> (L.) Gaertn.		Sticky alder
<i>Hibiscus syriacus</i> L.		Rose of Sharon
<i>Rhodotypos scandens</i> (Thunb.) Makino	Jetbead	

Growth Form	Scientific Name	Common Name
	<i>Buddleia davidii</i> Franch.	Butterfly bush
Woody Vines	<i>Celastrus orbiculata</i> Thunb.	Asian bittersweet
	<i>Euonymus fortunei</i> (Turcz.) Hand.-Mazz.	Winter creeper
	<i>Hedera helix</i> L.	English ivy
	<i>Lonicera japonica</i> Thunb.	Japanese honeysuckle
	<i>Wisteria sinensis</i> (Sims) DC	Chinese wisteria
	<i>Wisteria floribunda</i> (Willd.) DC	Japanese wisteria
	<i>Vinca minor</i> L.	Common periwinkle
	<i>Rhamnus frangula</i> L.	Alder buckthorn
	<i>Ampelopsis brevipedunculata</i> (Maxim.) Trautv.	Amur peppervine
	<i>Rhamnus cathartica</i> L.	European buckthorn
Woody Perennials	<i>Mahonia beali</i> (Fortune) Carriere	Oregon grape
	<i>Nandina domestica</i> Thunb.	Nandina, sacred-bamboo
	<i>Rubus phoenicolasius</i> Maxim.	Wineberry
Herbaceous Vines	<i>Dioscorea oppositifolia</i> L.	Air-potato
	<i>Pueraria montana</i> (Lour.) Merr.	Kudzu
	<i>Clematis ternifolia</i> DC	Leatherleaf clematis
	<i>Vicia sativa</i> L.	Garden vetch
	<i>Cardiospermum halicacabum</i> L.	Balloonvine, love-in-a-puff
	<i>Tribulus terrestris</i> L.	Puncturevine
	<i>Polygonum perfoliatum</i> L.	Mile-a-minute
"Stout" Herbs	<i>Polygonum cuspidatum</i> Seib. & Zucc.	Japanese knotweed; Japanese bamboo
Herbs	<i>Alliaria petiolata</i> (Bieb.) Cavara & Grande	Garlic-mustard
	<i>Lespedeza cuneata</i> (Dum.-Cours.) G. Don	Sericea lespedeza
	<i>Lythrum salicaria</i> L. [all varieties and cultivars]	Purple loosestrife
	<i>Solanum viarum</i> Dunal	Tropical soda apple
	<i>Artemisia vulgaris</i> L.	Mugwort, common wormwood
	<i>Carduus nutans</i> L.	Musk thistle, nodding thistle
	<i>Centaurea biebersteinii</i> DC	Spotted knapweed
	<i>Cirsium arvense</i> (L.) Scop.	Canada thistle

Growth Form	Scientific Name	Common Name
	<i>Cirsium vulgare</i> (Savi) Ten.	Bull thistle
	<i>Conium maculatum</i> L.	Poison hemlock
	<i>Coronilla varia</i> L.	Crown vetch
	<i>Daucus carota</i> L.	Wild carrot, Queen Anne's-lace
	<i>Dipsacus fullonum</i> L.	Fuller's teasle
	<i>Dipsacus laciniatus</i> L.	Cutleaf teasle
	<i>Hesperis matronalis</i> L.	Dame's rocket
	<i>Lespedeza bicolor</i> Turcz.	Bicolor lespedeza, shrubby bushclover
	<i>Lysimachia nummularia</i> L.	Moneywort, creeping Jenny
	<i>Melilotus albus</i> Medik.	White sweet clover
	<i>Melilotus officinalis</i> (L.) Lam.	Yellow sweet clover
	<i>Murdannia keisak</i> (Hassk.) Hand.-Mazz.	Asian spiderwort
	<i>Polygonum caespitosum</i> Blume	Bunchy knotweed, oriental ladies-thumb
	<i>Torilis arvensis</i> (Huds.) Link	Spreading hedge-parsley
	<i>Tussilago farfara</i> L.	Coltsfoot
	<i>Verbascum thapsus</i> L.	Common mullein
	<i>Xanthium strumarium</i> L.	Common cocklebur
	<i>Allium vineale</i> L.	Field Garlic
	<i>Buglossoides arvensis</i> (L.) I.M. Johnston	Corn gromwell
	<i>Centaurea cyanus</i> L.	Bachelor's button, cornflower
	<i>Chrysanthemum leucanthemum</i> L.	Ox-eye daisy
	<i>Chicorium intybus</i> L.	Chicory
	<i>Eschscholzia californica</i> Cham.	California poppy
	<i>Fatoua villosa</i> (Thunb.) Nakai	Hairy crabweed
	<i>Glechoma hederacea</i> L.	Gill-over-the-ground, ground ivy
	<i>Iris pseudoacorus</i> L.	Pale-yellow iris
	<i>Kummerowia stipulacea</i> (Maxim.) Makino	Korean clover
	<i>Kummerowia striata</i> (Thunb.) Schindl.	Japanese clover
	<i>Ornithogalum umbellatum</i> L.	Star of Bethlehem
	<i>Pastinaca sativa</i> L.	Wild parsnip
	<i>Polygonum persicaria</i> L.	Lady's thumb

Growth Form	Scientific Name	Common Name
	<i>Senna obtusifolia</i> (L.) H.S. Irwin & Barneby	Sicklepod senna
	<i>Tragopogon dubius</i> Scop.	Yellow goat's-beard
	<i>Urtica dioica</i> L.	Stinging nettle
	<i>Xanthium spinosum</i> L.	Spiny cocklebur
	<i>Bupleurum rotundifolium</i> L.	Hound's-ear, hare's-ear
	<i>Cosmos bipinnatus</i> Cav.	Garden cosmos
	<i>Cosmos sulphureus</i> Cav.	Sulphur cosmos
	<i>Echium vulgare</i> L.	Viper's bugloss
	<i>Hypericum perforatum</i> L.	Goatweed, St. John's-wort
	<i>Mentha spicata</i> L.	Spearmint
	<i>Mentha x piperita</i> L.	Peppermint
	<i>Muscari atlanticum</i> Boiss. & Reut.	Grape hyacinth
	<i>Muscari botryoides</i> (L.) Mill.	Common grape hyacinth
	<i>Senecio vulgaris</i> L.	Ragwort
	<i>Setaria verticillata</i> (L.) P. Beauv.	Bur-foxtail
	<i>Solanum dulcamara</i> L.	Bittersweet
	<i>Stachys floridana</i> Shuttlew. ex Benth.	Hedge nettle
Grasses	<i>Microstegium vimineum</i> (Trin.) A. Camus	Nepalgrass; Japanese grass
	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	Common reed
	<i>Sorghum halepense</i> (L.) Pers.	Johnson grass
	<i>Arthraxon hispidus</i> (Thunb.) Makino	Hairy jointgrass
	<i>Bromus commutatus</i> Schrad.	Meadow brome
	<i>Bromus japonicus</i> Thunb. ex Murray	Japanese brome
	<i>Bromus secalinus</i> L.	Rye brome
	<i>Bromus tectorum</i> L.	Thatch brome
	<i>Festuca arundinacea</i> Schreb.	Tall fescue
	<i>Festuca pratensis</i> Huds.	Meadow fescue
	<i>Miscanthus sinensis</i> Andersson	Zebra grass, Chinese silver grass
	<i>Setaria faberi</i> R.A.W. Herrm.	Nodding foxtail-grass
	<i>Setaria italica</i> (L.) P. Beauv.	Foxtail-millet
	<i>Setaria pumila</i> (Poir.) Roem. & Schult.	Yellow foxtail, smooth millet
	<i>Setaria viridis</i> (L.) P. Beauv.	Green millet

Growth Form	Scientific Name	Common Name
	<i>Arundo donax</i> L.	Giant reed, elephant grass
	<i>Bromus catharticus</i> Vahl	Bromegrass, rescue grass
	<i>Bromus inermis</i> Leyss.	Smooth bromegrass
	<i>Agrostis stolonifera</i> L.	Weeping love grass
	<i>Bromus hordeaceus</i> L.	Soft brome
	<i>Bromus sterilis</i> L.	Poverty brome
	<i>Imperata cylindrica</i> (L.) Beauv.	Cogon Grass
	<i>Phalaris canariensis</i> L.	Canary grass
	<i>Rottboellia cochinchinensis</i> (Lour.) Clayton	Itchgrass
Aquatic Plants	<i>Myriophyllum spicatum</i> L.	Eurasian water milfoil
	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Alligatorweed
	<i>Hydrilla verticillata</i> (L.f.) Royle	Hydrilla, water thyme
	<i>Myriophyllum aquaticum</i> (Vell.) Verdc.	Parrot's feather, water milfoil
	<i>Rorippa nasturtium-aquaticum</i> (L.) Hayek	Watercress
	<i>Potamogeton crispus</i> L.	Curly pondweed
	<i>Egeria densa</i> Planch.	Brazilian elodea, Brazilian water- weed
	<i>Najas minor</i> All.	Water nymph
	<i>Salvinia molesta</i> Mitchell	Aquarium water-moss

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
ECO71F28	CL	Little Swan Creek	Meriwether Lewis National Monument	35.52888	-87.4536	71f	06040003
ECO71H17	CK	Clear Fork Creek	100 yds. u/s Cripps Ln. (Old Metal Bridge)	35.928651	-85.992117	71H	05130108
MYATT005.1 CU	CK/TV A	Myatt Creek	Myatt Creek Rd	36.1299	-84.98272	68a	06010208
WOLF002.7C O	TVA	Wolf Creek	Off Hwy 25/70 Near Wolf Creek Road	35.92242	-82.94656	66g	06010105

SEMN Monitoring Protocols

I. 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 Habitat Assessment
4. Complete Stream Survey Sheet
5. Complete Climate Change Field Sheet (below)
6. Collect periphyton sample and complete Rapid Periphyton Survey Data Sheet
7. Measure canopy using densiometer at 5 transects
8. Deploy Hobo continuous temperature/water depth loggers
9. Take instantaneous measurements of DO, Temp, Cond, pH
10. Measure flow along same transect where logger is deployed.
11. Collect water quality samples listed below.

July

1. Complete Stream Survey Sheet
2. Complete Climate Change Field Sheet (below)
3. Measure canopy using densiometer at 1 transects
4. Download data from Hobo continuous temperature/water depth loggers
5. Take instantaneous measurements of DO, Temp, Cond, 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 (see below for more detail).
3. Complete Habitat Assessment
4. Complete Stream Survey Sheet
5. Complete Climate Change Field Sheet (below)
6. Measure canopy using densiometer at 1 transects
7. Download Hobo continuous temperature/water depth data.
8. Take instantaneous measurements of DO, Temp, Cond, 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 (below)
3. Measure canopy using densiometer at 1 transects
4. Download data from Hobo continuous temperature/water depth loggers
5. Take instantaneous measurements of DO, Temp, Cond, pH
6. Measure flow along same transect where logger is deployed.
7. Collect water quality samples listed below.

II. SEMN Sampling:

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)

3 “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 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 (minimum)

- 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. Instantaneous flow measurements should also be recorded along same transect during field visits for calibration.

G. Physical/chemical parameters

- Instantaneous measurements of flow, temperature, DO, 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

III. 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 insure consistency.

A. Semi-quantitative Riffle Kick (SQKICK):

Subsample to 300 +/- 10% organisms following 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 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.

IV. Data Management

Continuous Monitoring data will be uploaded to TN CON database (see CMERG guidance document) quarterly. Macroinvertebrate and diatom data will be uploaded to Waterlog and WQX every six months by TDH Lab or PAS.

TN SEMN Field Sheet

Station ID:	Agency: Assessors:
Stream Name:	Date: Time:
Location:	SQKICK Log Number:
HUC:	Periphyton Log Number (April):

Qualitative Habitat Samples

Habitat	# Jabs	EFO Log #	Habitat	# Jabs	EFO Log #
Rooted Bank (3 net widths)			Fine Sediment (3 net widths ~4 cm deep)		
Macrophytes (3 net widths)			Leaf Pack (3 handfuls)		
Pool Rock (6 cobble or 3 boulders)			Woody Debris/Snags (3 net widths or 3 handfuls)		

Water Loggers Download/Deployed: Date: _____ **Time:** _____ **Lat/Long:**
 _____ **Air Logger Download/Deployed: Date:** _____ **Time:**
 _____ **Lat/Long:** _____

Water depth from surface to HOBO sensor hole: _____ **feet**
Water Samples collected: _____ **Time:** _____
Flow : _____ **cfs**

Dominant streamside vegetation:

Dominant composition of leaf packs:

Describe any observed changes from last site visit:

Describe any Deviations from protocol:

(See back for seasonal checklist)

Station ID: _____ Date: _____ Initials: _____

Seasonal Checklist (Optional)

April Checklist:

- Collect water samples (Routine, Nutrient, Metals, & TOC) store on ice following TDEC protocol.
- Record instantaneous quality parameters (pH, conductivity, Temperature, DO) readings.
- Take pictures
- Download and redeploy HOBO air temperature logger.
- Download and redeploy HOBO water temperature logger.
- Record water depth from surface to the HOBO logger sensor.
- Measure flow across transect following TDEC SOP.
- Collect SQKICK following TDEC SOP.
- Collect Qualitative Habitats, field picking all unique species. Keep habitats separate.
- In watershed group year, collect riffle habitats to complete biorecon.
- Complete Stream Survey Field Sheet.
- Complete High Gradient Habitat Assessment Sheet.
- Complete Climate Change Field Sheet (over).
- Complete Rapid Periphyton Survey Data Sheet including densiometer readings at 5 transects.
- Collect and preserve periphyton samples following TDEC protocol.

July and January Checklist:

- Collect water samples (Routine, Nutrient, Metals, & TOC) and store on ice.
- Record instantaneous quality parameters (pH, conductivity, Temperature, DO) readings.
- Download and redeploy HOBO air temperature logger.
- Download and redeploy HOBO water temperature logger.
- Record water depth from surface to the HOBO logger sensor.
- Measure flow across transect following TDEC SOP.
- Complete Stream Survey Field Sheet. (Record densiometer readings.)
- Complete Climate Change Field Sheet (over).

September Checklist:

- Collect water samples (Routine, Nutrient, Metals, & TOC) and store on ice.
- Record instantaneous quality parameters (pH, conductivity, Temperature, DO) readings.
- Take pictures
- Download and redeploy HOBO air temperature logger.
- Download and redeploy HOBO water temperature logger.
- Record water depth from surface to the sensor on the HOBO logger
- Measure flow across transect following TDEC SOP.
- Collect SQKICK following TDEC SOP.
- Collect Qualitative Habitats, field picking all unique species. Keep habitats separate.
- In watershed group year, collect riffle habitats to complete biorecon.
- Complete Stream Survey Field Sheet. (Record densiometer readings.)
- Complete High Gradient Habitat Assessment Sheet.
- Complete Climate Change Field Sheet (over).

APPENDIX G

NOTICE OF REVISIONS 2006-2011

NOTICE OF REVISIONS RECORD 2006
NOTICE OF REVISIONS RECORD 2011

NOTICE OF REVISION(S) RECORD 2006

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-1-03	xii	Minor	Replace MEFO recipient
10-01-03	II/B/1	Minor	Clarify Station Naming Protocol
10-01-03	II/D/4	Minor	Additional Information for Habitat Assessments
10-01-03	II/D/5 Table 1	Major	Revised Regional Habitat Guidelines
10-01-03	II/F/5	Major	Provide Biorecon Scoring Guidelines for 73a
10-01-03	II/F/6 Table 2	Major	Revised family level biorecon assessment guidelines
10-01-03	II/F/8 Table 3	Major	Revised Genus level biorecon assessment guidelines
10-01-03	II/G/1	Minor	Add online assessment database as source for determining ecoregions.
10-01-03	II/G/2	Minor	Clarify procedures for additional SQKICK sampling to insure 200 organisms sample.
10-01-03	II/G/4	Minor	Clarify procedures for additional modified SQKICK sampling to insure 200 organism sample
10-01-03	II/G/5	Minor	Clarify procedures for additional SQBANK sampling to insure 200 organism sample.
10-01-03	Appendix A 2-7	Major	Updated biocriteria tables.
10-01-03	Appendix A 8-14	Major	Added location and status to ecoregion reference stream table. Added new reference streams.
10-01-03	Appendix A 15-16	Major	Added Table of regional expectations for individual habitat parameters.
10-01-03	Appendix B 4-7	Minor	Revised header information on habitat assessment field sheets.
03-03-03	Appendix B 12	Minor	Revised macroinvertebrate assessment report sheet.
10-01-03	Appendix C 2	Major	Added Peltoperlidae to list of intolerant macroinvertebrate families for biorecons.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-01-03	Appendix C 3-6	Major	Updated intolerant macroinvertebrate genera for biorecons.
10-01-03	Appendix C 7-21	Major	Updated NCBI scores for Tennessee Taxa.
10-01-03	Appendix C 22-25	Major	Added taxa to list of clinger organisms.
10-01-03	Appendix E	Major	Added taxa to verified taxa list.
10-12-06	V	Minor	Change Commissioner's name
10-12-06	V	Minor	Change QA manager's name.
10-12-06	VIII	Minor	Update reviewers
10-12-06	X	Minor	Update notice of revisions.
10-12-06	Section 1.1, Protocol B, Page 2	Minor	Add naming scheme of UT to UT
10-12-06	Section 1.1, Protocol C, Page 1	Minor	Update meter specifications to match chemical QSSOP.
10-12-06	Section 1.1, Protocol F, page 4	Minor	Clarify how chironomids are counted in richness metric for biorecons.
10-12-06	Section 1.1, Protocol F, Page 6 and 7	Major	Tables 2 and 3 updated based on reference data.
10-12-06	Section 1.1, Protocol J Page 2	Minor	Clarification of Slide labeling procedure.
10-12-06	Section II, Protocol K Page 2 Item f	Major	%NUTOL replaced %Dominant
10-12-06	Appendix A	Major	Biocriteria tables updated based on new reference data. Tables separated by season, metric ranges and target scores adjusted. Bioregion 66f combined with 66deg.
10-12-06	Appendix A	Major	Update ecoregion reference stream list.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-12-06	Appendix B	Minor	Revised header information on habitat assessment field sheets, stream survey field sheet and biorecon field sheet.
10-12-06	Appendix B	Minor	Macroinvertebrate Assessment report revised.
10-12-06	Appendix C	Minor	Added additional taxa to NCBI score list.
10-12-06	Appendix C	Minor	Added Nymphoridae to list of clingers.
10-12-06	Appendix E	Minor	Added taxa to the verified taxa list.

This revision(s) has been reviewed and approved. It becomes effective on: 10 - 23 - 2006

Paul E. Davis

Paul Davis
Director
Division of Water Pollution Control

10/24/06

Date

Charles L. Head

Charles Head
TDEC Quality Assurance Manager

10-23-06

Date

NOTICE OF REVISION(S) RECORD 2011

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-21-10	Section I.D	Minor	Updated Health and Safety Warnings and Cautions.
10-21-10	Section II.A	Minor	Added provision to relocate ecoregion reference sites upstream if localized problem develops.
10-21-10	Section I.C	Minor	Added definitions and acronyms.
10-21-10	Section I.I Protocol .A	Major	Added sample priority list.
10-21-10	Section I.I Protocol A	Major	Added biological sample decision making flowcharts.
10-21-10	Section I.I Protocol A	Minor	Added provision for intermittent discharges to site selection protocol.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-21-10	Section I.I Protocol A	Minor	Clarified site selection.
10-21-10	Section I.I Protocol B	Minor	Added quick field reference method summary.
10-21-10	Section I.I Protocol B	Minor	Updated station naming protocols.
10-21-10	Section I.I. Protocol D Table 2.	Major	Re-calibrated habitat assessment guideline scores. Removed impairment categories.
10-21-10	Section I.I Protocol D Table 2.	Major	Added habitat assessment guidelines for headwater streams.
10-21-10	Section I.I Protocol D Appendix B	Major	Revised habitat assessment protocols and field sheets.
10-21-10	Section I.I Protocol F	Major	Revised biorecon voucher requirements for family.
10-21-10	Section I.I Protocol F	Minor	Clarified biometric calculation information.
10-21-10	Section I.I Protocol F Tables 3 and 4.	Major	Recalibrated biorecon scoring guidelines.
10-21-10	Section I.I Protocol F Tables 3 and 4.	Major	Added biorecon scoring guidelines for headwater streams.
10-21-10	Section I.I Protocol G	Minor	Added shallow streams to modified kick protocol.
10-21-10	Section I.I Protocol H.	Major	Added supply and bottle acquisition procedure.
10-21-10	Section I.I Protocol H	Minor	Updated logging information.
10-21-10	Section I.I Protocol H	Minor	Added sample transport information to protocol H.
10-21-10	Section I.I. Protocol J	Minor	Clarified report preparation information. Added digital picture submittal.
10-21-10	Section I.I Protocol L	Major	Added protocol for scoring SQSH in streams that do not fit biocriteria guidelines.
10-21-10	Section I.I. Protocol L Appendix A	Major	Calibrated %NUTOL to Tennessee taxa, renamed %TNUTOL.

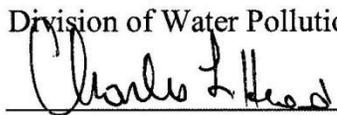
Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
10-21-10	Section I.I. Protocol L Appendix A	Major	Replace %EPT with %EPT-Cheum.
10-21-10	Section I.I. Protocol L	Minor	Rearranged order of biometrics to correspond with biometrics tables.
10-21-10	Section I.I Protocol L	Major	Removed biological condition table 4. Added information on index interpretation (pass/fail).
10-21-10	Section I.J.	Minor	Update data and records management.
10-21-10	Section I.I Protocol M	Major	Added protocols for reference stream site selection.
10-21-10	Section II	Major	Added corrective actions to QA/QC.
10-21-10	Appendix A	Minor	Updated reference streams table. Added headwater reference stream table.
10-21-10	Appendix B	Minor	Added list of exotic plants.
10-21-10	Appendix B	Minor	Revised macroinvertebrate assessment report.
10-21-10	Appendix C	Major	Updated Appendix C
10-21-10	Appendix D	Minor	Updated taxonomic keys
01-06-11	Appendix C and E	Major	Combined Verified taxa list, NCBI scores and clinger designation into one list called Tennessee taxa list 2011.
02-09-11	Section I.H	Minor	Changed alcohol acquisition procedure.
02-09-11	Section I.I.	Minor	Changed procedure for transporting samples to lab.
5-2-11	Section I.C and I.I Protocol E	Minor	Clarified location of canopy measurements.
5-2-11	Section I.I Protocol A	Minor	Clarified sample priorities.
5-2-11	Section I.I Protocol B	Minor	Clarified stream mile measurements.
5-2-11	Section I.I Protocol B	Major	Revised naming protocols for unnamed tribs.
5-2-11	Section I.I Protocol D	Major	Added further clarification for scoring of habitat assessments especially for channel flow status and channel alteration categories.

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
5-2-11	Section I.I Protocol F	Minor	Added clarification in biorecon method.
5-2-11	Section I.I Protocol F Table 4 and 5	Major	Recalibrated scoring criteria for family and genus level biorecons.
5-2-11	Section I.I Protocol G	Minor	Added clarification in SQSH method.
5-2-11	Section II	Major	Added clarification for biorecon vouchers and reference collections.
5-2-11	Appendix A	Major	Revised biocriteria tables (drainage area, taxonomic level, recalibrated ranges). Added headwater tables.
5-2-11	Appendix B	Major	Revised stream survey field sheet.
5-2-11	Appendix B	Major	Revised Habitat assessments field sheets to further clarify category scoring.
5-2-11	Appendix B	Major	Revised biorecon field sheet
5-2-11	Appendix E	Major	Added criteria for taxonomic experts adapted from NABs.
5-16-11	Section I.I Protocol J	Minor	Clarification of tolerance value sources for North Carolina Biotic Index.
5-25-11	Appendix D	Minor	Added supplemental taxonomic keys Updated list of taxonomic specialists

This revision has been reviewed and approved. It becomes effective on July 1, 2011.


 Paul Davis, Director
 Division of Water Pollution Control

6/9/11
 Date


 Charles Head
 TDEC Quality Assurance Manager

6/9/11
 Date

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