DWR-WQP-P-01-QSSOP-Chem-Bact-082918

Quality System Standard Operating Procedure For Chemical and Bacteriological Sampling of Surface Water

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

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

1.) Effective Date: January 2022

2.) Signatures:

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Document Revision History

(Detailed revision record for each document can be found in Appendix D)

Revision Number	Date	Brief Summary of Change
6	2022	Updated personnel changes and MDL's. Added landfill sampling parameters. Added clarification on shipping out organic samples and added E. coli split sampling for non drinking water certified contract labs. Changed Mercury sampling from optional to required for long term trend sites. Changed bottle sizes for bacti sampling.
5	2018	Formatted SOP in accordance with Policy Template. Removed closed TDH laboratories. Revised division name. Updated bottle container and storage requirements. Updated all TDH lab contacts. Revised Station ID naming protocol. Added new Appendix to house previous revisions. Added clarification on failed probe values and sample tag requirements. Updated antiquated storage policies and added electronic navigation to documents. Introduced electronic generation of EPA recommended Field Log Number in an Excel workbook system with use of LabReq forms. Updated MDL's for all tests and the contract labs involved. Updated office locations.
4	August 1,2011	Updated MDL's, updated sampling procedure for metals and mercury, revised Cyanide procedure, updated Lab Request forms, clarified QC sample, created separate MDL tables, clarified parameter sampling for FECO sites ,revised Station ID naming protocol, added procedure for failing field equip., added flow necessary for FECO and ECO and changed frequency for WQ database sent from WPU to EFO
3	December 01, 2009	Updated post drift probe check protocol, reworded inferences, revised bottle requirements, revised Station ID naming protocol, added parameters as optional for 303(d) monitoring, revised MDL's,

		updated wording throughout and added protocol for sampling order.
2	July 01, 2008	Clarify safety, added protocol for assigning Station ID's, revised protocols, added new forms and revised available tests.
1	March 01, 2004	Detailed clarification of bottle requirements, explanation of paperwork requirements, addition of necessary calculations, addition of tables and images for guidance and general protocol explanations.
0	June 20, 1996	Initial SOP

DIVISION OF WATER RESOURCES
QUALITY SYSTEMS STANDARD OPERATING PROCEDURES FOR CHEMICAL AND BACTERIOLOGICAL SAMPLING OF SURFACE WATER

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DIVISION OF WATER RESOURCES

QUALITY SYSTEM STANDARD OPERATING PROCEDURE FOR CHEMICAL AND BACTERIOLOGICAL SAMPLING OF SURFACE WATER

TITLE AND APPROVAL PAGE

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PLAN COVERAGE	General instructions for chemical and bacteriological sampling of surface waters and measurement of water parameters, flow and quality control in Tennessee by the Division of Water Resources.

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Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

As a part of the 2021 review process, the following individuals reviewed and/or provided comments used in this document.

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SURFACE WATER

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 Deputy Commissioner and Quality Assurance Manager of any changes that occur. Other stakeholders shall be notified, as appropriate and documented on the "Document Distribution" list.

EVALUATION PROCEDURE:
QS-SOP FOR CHEMICAL AND BACTERIOLOGICAL SAMPLING OF SURFACE WATER

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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QS-SOP DOCUMENT DISTRIBUTION LIST

Copies of this document were distributed to the following individuals in TDEC and TDH. 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 Watershed Planning Unit.
This 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/PAS/Shared%20Documents/Forms/AllItems.aspx.

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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. 2CFR1500.11; 40CFR35 www.epa.gov/quality. This includes the implementation of a Quality Management Plan as written by the contract holder with Data Quality Objectives (DQOs) set in Quality Assurance Project Plans (QAPPs) for specific projects. The organization may elect to support portions of the QAPP through technical or administrative standard operating procedures (SOPs), as specified by the quality system. As a contract holder and through memoranda of agreement, the Tennessee Department of Environment and Conservation is required to maintain such a system.

This Quality System Standard Operating Procedure (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, is intended to assist the division in maintaining their quality control and quality assurance processes and ensures compliance with government regulations. It provides specific operational direction for the division's Quality Assurance Project Plan for Chemical and Bacteriological Sampling of Surface Water.

Although this QS-SOP is compiled for TDEC-DWR employees, it is recognized that outside agencies will utilize this QS-SOP for their sampling purposes. Use of this QS-SOP is highly recommended to ensure consistency and accuracy of the data provided to DWR.

In practice of this QS-SOP an Excel Lab Request form will be used to help complete paperwork and electronic transfer of information pertaining to the following: the TDH Sample Request forms, Chain of Custody's, Sample Tags, Field Parameters, etc. Any technical assistance that is needed in the completion of this information can be found in greater step by step detail in the most current version of the Stream Parameter Electronic Reporting Tutorial (SPERT) found on SharePoint at https://tennessee.sharepoint.com/sites/environment/DWR/PAS/PAS/SitePages/Home.aspx. This is also where you will find the most current version of the LabReq form. If any assistance is needed for use of these workbooks or to access SharePoint please contact Kim Laster at Kim.Laster@tn.gov for invitation rights.

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

I. PROCEDURES

I.A. Scope, Applicability and Regulatory Requirements

The purpose of this Quality Systems Standard Operating Procedure (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 waters. This SOP describes the chemical and bacteriological surface water collection process and delineates all steps in the process including water sample collection, quality control sample collection, documentation, water parameters and flow measurement. This SOP is only intended to describe routine conditions encountered during a surface water-sampling event.

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

That laboratories performing chemical analysis must maintain NELAC or ISO/IEC 17025 for surface waters and have drinking water certification or the equivalent for E. coli analysis. Follow EPA approved and lab certified methodologies as well as meet the MDL's listed in Appendix B.

Federal Statutory Authority

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

Tennessee Statutory Authority

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

Tennessee Regulatory Authority

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

I.B. Summary of Method

This document describes procedures approved by the Division of Water Resources for collecting chemical and bacteriological samples of surface water. The objective of surface water sampling is to obtain a representative sample that does not deteriorate or become contaminated before it is analyzed. To verify the accuracy and representativeness of sample analyses, proper sample collection and preservation techniques, and appropriate quality control measures must be followed.

Protocols are explained for collecting a representative sample using the appropriate sample container, preservative, and collection techniques for both wadeable and non-wadeable waters. Protocols are specified for the most common sample types including bacteriological, routine, nutrient, metal, NPDES extractables and volatiles and pesticides/PCBs. General protocols are also described for the specifications and accurate use of various devices associated with chemical and bacteriological surveys including multi-parameter probes, continuous monitoring probes, automatic samplers, and flow meters. To ensure the integrity of all samples, protocols concerning sample custody, chain of custody, and quality control samples are also included in this document.

I.C. Definitions and Acronyms

Ambient Monitoring: Routine sampling and evaluation of receiving waters not necessarily associated with periodic disturbance.

Bias: Consistent deviation of measured values from the true value, caused by systematic errors in a procedure.

Composite Sample: Composite samples can be time or flow proportional. Time integrated composite samples are collected over time, either by continuous sampling or mixing discrete samples. Flow proportional composite samples are composed of a number of samples sized relative to flow. Composite samples may also be combined manually by collecting grab samples at various intervals in a waterbody.

Convex meniscus: The curved upper surface of a liquid column that is convex when the containing walls are wetted by the liquid.

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

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

Grab Sample: Grab samples consist of either a single discrete sample or individual samples collected at a specific place and time or over as short a time as possible that represents the composition of the sample only at that time and place.

Holding Time: Maximum amount of time a sample may be stored before analysis as required in 40 CFR, Part 136

Kemmerer: A type of discrete depth sampler. A Kemmerer is composed of a cylinder with stoppers on each end that can be closed remotely with the use of a weighted messenger.

Lentic waters: Contained waters with restricted flows including lakes, ponds, wetlands and reservoirs.

Lotic waters: Flowing waters including rivers and streams.

Matrix: Refers to the type of material that makes up the sample.

Organic-free Reagent-Grade Water (Type I): Potable water that has been distilled then passed through a standard deionizing resin column and filtered through activated carbon. The water must meet analyte free water criteria, specific to the parameter being analyzed, and have no detectable metals, inorganic compounds, pesticides, herbicides, or extractable or volatile organic compounds. This water may be obtained from the TDH Environmental Central or Branch Laboratories. Organic-free reagent-grade water should not be stored more than 28 days.

Primary Sampler: Refers to the sampler responsible for the sample.

Quality Assurance (QA): Includes quality control functions and involves a totally integrated program for ensuring the reliability of all monitoring and all measurement data; the process of management review and oversight at the planning, implementation and completion stages of date collection activities. Its goal is to assure the data provided are of high quality and scientifically defensible.

Quality Control (QC): Refers to routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process; focuses on detailed technical activities needed to achieve data of the quality specified by data quality objectives. QC is implemented at the field or bench level.

Reference Database: Biological, chemical, physical, and bacteriological data from ecoregion reference sites.

Recommend: Advise as the best course of action. Synonyms: optional, may, should.

Require: Obligatory or necessary. Synonyms: must or shall.

Split Sample: A sample that has been portioned into two or more containers from a single sample container or sample mixing container. This type of sample is used to measure sample handling variability and to compare analytical methods.

Thalweg: A line representing the greatest surface flow and deepest part of a channel.

Trace Metals: Low-level metal analyses requiring ultra-clean sample collection and laboratory analyses generally reported in the low parts per trillion range.

Wadeable: Rivers and streams less than 4 feet deep unless there is a dangerous current or other extreme conditions deemed as unsafe.

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

Acronyms

ASTM	American Society of Testing and Materials
ATCC	American Type Culture Collection
BOE	Bureau of Environment
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CADDIS	Causal Analysis/Diagnosis Decision Information System
CFR	Code of Federal Regulations
CFS	Cubic Feet/Second
CHEFO	Chattanooga Environmental Field Office
CKEFO	Cookeville Environmental Field Office
CLEFO	Columbia Environmental Field Office
CO	Central Office
COC	Chain of Custody
D.O.	Dissolved Oxygen
DOR	Division of Remediation
DQOs	Data Quality Objectives
DWR	Division of Water Resources
EFO	Environmental Field Office
ES	Environmental Specialist
EPA	Environmental Protection Agency
EPH	Extractable Petroleum Hydrocarbons
Ft/S	Feet per Second
GIS	Geographic Information System
GPS	Global Positioning System
GRO	Gasoline Range Organics
IC	Ion Chromatography
JCEFO	Johnson City Environmental Field Office
JEFO	Jackson Environmental Field Office
KEFO	Knoxville Environmental Field Office
LabReq	Lab Request Excel Workbook File
LDB	Left Descending Bank
LEW	Left Edge of Water
LIMS	Laboratory Information Management System
LS	Lab Services
MC	Mid Channel

MDL	Method Detection Limit
MEFO	Memphis Environmental Field Office
MPN	Most Probable Number
MS	Mining Section
NCR	No Carbon Required
NEFO	Nashville Environmental Field Office
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAS	Planning and Standards Section
PCBs	Polychlorinated Biphenyls
PFD	Personal Floatation Device
QAPPs	Quality Assurance Project Plans
QA/QC	Quality Assurance/Quality Control
QSSOP	Quality System Standard Operating Procedure
RDB	Right Descending Bank
REW	Right Edge of Water
RM	River Mile
RPD	Relative Percent Duplicate
SCF	Suspected Contamination Field
SCX	Suspected Contamination Unknown
SDS	Safety Data Sheets
SEMN	Southeast Monitoring Network
SOP	Standard Operating Procedure
SPERT	Stream Parameter Electronic Reporting Tutorial
SQSH	Semi-Quantitative Single Habitat
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leeching Procedure
TDEC	Tennessee Department of Environment and Conservation
TDH	Tennessee Department of Health
TMDL	Total Maximum Daily Loading
TOC	Total Organic Carbon
TOPO	Topographic Map
TWRA	Tennessee Wildlife Resources Agency
USGS	United States Geological Survey
WMS	Watershed Management Section
WPC	Water Pollution Control
WPU	Watershed Planning Unit

I.D. Health and Safety Warnings

Adapted from Klemm et al., 1990

1. Employee safety is of the utmost priority. If conditions are not safe; reschedule sampling for another date and time. Do not enter water during flood conditions. Always secure equipment such as meters when working in a boat or canoe

2. Know how to swim and/or use a PFD when entering the water.

3. Always wear waders with a belt to prevent them from filling with water in case of a fall. If it is necessary to wade in high velocity and high flow streams it is advisable to wear a PFD. Do not wear waders in a boat or canoe.

4. Follow Tennessee boating laws and regulation. Information is available through the Tennessee Wildlife Resources Agency (TWRA). PFDs are required when operating a boat. Staff born after January 1, 1989 must have a Tennessee Boater Education Certificate issued by TWRA. Annual boat safety training is recommended for all employees.

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

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

7. Any person allergic to bee stings or other insect bites should have needed medications in the event of an allergic reaction and instruct others in the party on how to use the allergy kit.

8. Carry communication equipment in the field in case of an emergency.

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

10. Consider all surface waters a potential health hazard due to toxic substances or pathogens. Minimize exposure as much as possible and avoid splashing. Do not eat, drink, smoke, apply cosmetics or handle contact lenses while collecting samples. Wearing gloves limits exposure to potential health hazards. Clean exposed body parts (face, hands, and arms) immediately

after contact with these waters. Carry phosphate-free soap and an adequate supply of clean water, disinfectant wipes, and/or waterless sanitizer.

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

Table 1: Recommended Vaccinations

Vaccination	No. of shots	Interval	Booster
Hepatitis B	3	0, 1, 6 months	NA
Tetanus	1	NA	10 years
Polio	1, if childhood series completed	NA	20 years
Typhoid	2	1 month	3 years

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

13. Safety Data Sheets (SDS) are available for all preservatives and other hazardous chemicals. Everyone working with these agents or handling preserved bottles must be familiar with the location and contents of the SDS. Notify supervisor or safety officer if SDS sheets cannot be located.

14. Powder-free nitrile gloves must be worn when handling blank water or collecting metal samples. Either powder-free nitrile or latex gloves can be used for other sampling.

15. Check to make sure lids are tightly fastened and pre-preserved bottles are stored in an upright position.

16. In very hot weather, store pre-preserved bottles on ice to avoid acid vaporization and a potentially hazardous situation when opening a swollen bottle. Pressurized bottles can spray acid when opened and could cause acid burns on eyes and exposed skin.

17. When traveling in a state 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.

19. In the event of a life-threatening emergency, go to 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 www.tn.gov/treasury. Always complete and file an accident report if medical assistance is

provided for an injury. https://www.tn.gov/workforce/injuries-at-work/employers/employers/reporting-a-claim.htmL

20. If water conditions necessitate that water samples be collected from a bridge, appropriate safety precautions must be considered and are recommended to ensure the safety of personnel as well as drivers. OSHA's *Manual on Uniform Traffic Control Devices* (2009) provides safety instructions for work on and near roadways. Since chemical sampling events occupy a location for less than one hour (Short Duration-Work), OSHA allows for simplified traffic control procedures. Specialized safety equipment should be used to warn oncoming traffic of staff present on the bridge.
    - Orange safety vest for every member of the sampling team
    - At least three orange traffic cones or traffic warning triangles
    - Magnetic amber strobe light (and spare batteries)

    If stopping a vehicle on the shoulder of the road, use a warning signal to alert other drivers.
    - Use collapsible reflective triangles which often come in sets of three.
    - Place the first warning triangle approximately 20-30 yards behind the vehicle.
    - Arrange other triangles another 10-15 yards beyond the first one.

    If stopping around a blind corner where it would be difficult for drivers to see, it would be best to place at least one triangle prior to the curve to given traffic an advanced warning.

    Use extreme caution when working on the bridge and around traffic. All personnel involved in sampling from the bridge should wear an orange safety vest while working from the bridge. If possible, park the vehicle out of the lane of traffic before crossing the bridge on the upstream side. Set the parking brake, turn on the emergency lights and place the magnetic strobe light (turned on) on the roof of the vehicle where it is most visible to on-coming traffic. Spend as little time on the bridge as possible. To avoid falls, try to avoid leaning on or climbing over railings.

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

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

I.E. Cautions

1. Avoid sampling bias by following the procedures outlined in this QSSOP. Document any deviations.

2. Avoid cross contamination of samples. Always use new certified-clean bottles for chemical samples and sterilized bottles for bacteriological samples. It is recommended that samples be placed in colorless plastic zip-type bags to avoid cross contamination in the cooler.

3. Use the standardized Station ID naming protocol for all surface water samples (Protocol B). Continue to use established naming protocols ecoregion and headwater reference sites. Check the stations table in Waterlog to make sure a station has not already been established with a different Station ID. Notify WPU of any discrepancies. Make sure the Station ID is included on all paperwork and tags associated with the sample.

4. Measure stream length from mouth to headwaters. When measuring embayment's, measure length of original channel from confluence with the original channel of the main stem. Use GIS to measure stream miles. When using GIS use the ArcView measuring tool, do not use the Reach File INdex of the NHD flowline layer which measures in straight lines. The USGS site http://water.usgs.gov/osw/streamstats/tennessee.htmL or TDEC on-line assessment map http://tdeconline.tn.gov/dwr/ may be used.

5. To avoid errors, it is recommended to calibrate all meters at the beginning of each day. Perform a drift check at the end of each day (or following morning if arriving late.). If the meter calibration is off by more than 0.2 units for pH, temperature, or D.O. when measured in mg/L, by more than 10% for conductivity, or 10% D.O. when measured in % saturation, make note in acceptable field parameters but do not upload failed parameters to Waterlog.

6. Record all time in a 24-hour (military) clock format.

7. Write all dates in mm/dd/yy or mm/dd/yyyy format. (For example, March 2, 2022 would be 03/02/2022.) When uploading to Waterlog, remember to specify the activity date is in this format.

8. Record all distance measurements in feet or yards. Flow is measured in cubic feet per second (cfs). If instrument or tape measure is in different units, record the actual readings and convert to appropriate units before reporting results.

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

10. Make sure to use the appropriate units for all field measurements as indicated in protocol J (Instantaneous field parameters).

11. If an error is made in any documentation, draw a single line through the error, so that it is readable and write the correction above. Date and initial the correction. Do not white out or place several lines through errors.

12. If at all possible chemical and biological (SQSH) samples should be collected on the same day (required for CADDIS analysis). It is preferred that the chemical and biological (SQSH) sampling of a single station not be separated by more than four weeks.

13. 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 verify names follow logical progression from downstream to upstream. Upload new stations to Waterlog.

I.F. Interferences

1. Document all deviations from protocol.

2. Unless the study design requires flood or post-flood sampling, avoid sampling in flooded conditions or immediately after a flood.

3. Avoid sampling streams reduced to isolated pools

4. Flag (do not upload but make a note of) dissolved oxygen when measured in mg/L, pH, temperature and conductivity readings if post-trip drift checks show meter calibrations to be off by more than 0.2 units (or 10% for conductivity and dissolved oxygen when measured in % saturation). All readings taken between initial calibration and drift check should be reviewed and flagged with a EFAI (Equipment Failure) or FDC (Drift Check Failed) qualifier and a comment about drift check and should not be uploaded if sampler determines data are unlikely to be representative of actual conditions.

5. Properly clean any reusable sample contact equipment such as Nalgene® bucket, Teflon Kemmerer or bailer, or composite samplers between uses. See Section I.H and I.I, Protocol E for cleaning procedures for sampling equipment.

6. Do not smoke while collecting samples.

7. It is required that powder-free nitrile gloves be worn when obtaining blank source water, preparing QC blanks, or collecting metal samples. Either powder-free nitrile or latex gloves can be used for other sampling.

8. Before collecting nutrient samples, wash hands with phosphate-free soap.

9. When collecting samples, avoid contaminating samples by using lotions, insecticides, sunscreens, or other chemicals on your skin.

10. Atmospheric metals from automobile exhaust, cigarette smoke, bridges, wires or poles can also contaminate samples. Collect samples at least 100 yards upstream of bridges, wires, poles, or roads when possible.

11. To ensure a representative sample and/or to avoid contamination, do not sample from banks, shorelines, or docks. If thalweg cannot be reached due to depth, collect sample using boat or from bridge. If necessary, sample may be collected outside of thalweg as long as it is within the main current.

I.G. Personnel Qualifications and Training

Minimum Education Requirements: B.S. in any science, engineering, or B.S. candidate under the supervision of experienced staff.

Minimum experience: There is no substitute for field experience. It is recommended that all staff have at least six months of field experience before selecting sampling sites. For on-the-job training, new employees should accompany experienced staff to as many different studies and sampling situations as possible. During this training period, the new employees are encouraged to perform all tasks involved in sample collection under the supervision of an experienced staff member.

Quality Team Members are to be selected by EFO DWR managers to oversee quality control and training and help ensure the protocols outlined in this document are properly followed. Quality Team Leader is a centralized chemical and bacteriological QC coordinator. Quality Team Leader and Members should be experienced water quality personnel who have been trained in water quality sampling and quality control (Section II.A).

Sampler Expertise: Use and calibration of standard water quality monitoring meters (conductivity, DO, pH, and temperature meters), flow meters and wading rods, subsurface sampling devices, discrete depth sampling devices (Kemmerer and peristaltic pump), composite samplers, GPS, and boats.

Sampler Training:

Protocols outlined in this SOP

- Station selection and assigning station identification numbers
- Sample collection procedures, equipment cleaning, and use for wadeable and non-wadeable surface water collections
- Cleaning, maintenance, and use of automatic samplers
- Completion of sample identification tags, sample request forms and chain-of-custody
- TDH laboratory requirements for sample submission
- Calibration and maintenance of instantaneous and continuous water parameter probes
- Calibration and maintenance of flow meters
- Use of map wheels, topographic maps, GPS units, cameras and other equipment
- Bacteriological analyses
- Quality System Requirements, Quality Assurance Project Plan
- Boating laws and regulations. Information is available through the Tennessee Wildlife Resources Agency. Staff born after January 1, 1989 must have a Tennessee Boater Education Certificate issued by TWRA.
- Health and Safety

I.H. Equipment and Supplies

Prior to any sampling trip, gather and inspect all necessary gear. Replace or repair any damaged equipment. Order sample bottles at least two weeks before they are needed (Appendix A). Calibrate all meters prior to the sampling trip (minimally once a week if used). Make sure routine maintenance is up to date. Upon return from a trip, take care of any equipment repairs or replacements immediately. Necessary equipment will vary per project, but the following is a standardized list.

1. General Field Equipment

- Waders
- External sample tags
- Sample request forms
- Field Flow Sheet or field book
- Topographic maps (USGS quadrangle maps) may also be referred to as topos or quads
- Tennessee Atlas and Gazetteer
- GPS unit or computer with built in GPS for recording latitude and longitude in decimal degrees
- Cell Phone or other communication device (recommended)
- Calibrated dissolved oxygen meter
- Calibrated pH meter
- Calibrated conductivity meter, (µS, micro siemen units)
- Temperature meter or thermometer in ^{o}C
- Field barometer if needed for on-site DO calibration
- Repair kit for water parameter meters (DO replacement membrane if applicable for multi-day trips)
- Calibrated flow meter, wading rod (10th of feet markings), and sensor cable
- Measuring or surveyors' tape (50, 100, 200 feet) in 10th of feet markings and rope long enough to span the river or stream
- Stakes (minimum 3), clamps (minimum 4), and hammer or other means of securing measuring tape
- Flow meter manual and screwdriver
- Spare batteries for all meters, flashlights, GPS and camera.
- Waterproof pens (Sharpies®), pencils and black ballpoint ink pens (not roller-ball)
- Flashlights in case detained after dark
- Duct tape for emergency repairs
- First aid kit
- Watch
- Map wheel (for calculating stream miles if new stations are to be assigned in field and GIS is not available)
- Disposable beakers if needed for shallow stream sample collection

- Sample bottles + 10% QC bottles, extra bottles
- 1 gallon plastic zip-type bags (recommended)
- Powder-free nitrile gloves (Required for when preparing QC blanks and metal samples). Either powder-free nitrile or latex gloves can be used for other sampling. Latex gloves may provide more protection from pathogens.
- Shoulder length powder-free nitrile gloves (if collecting trace metals or low-level mercury)
- State ID badge and business cards
- Ice stored in coolers (ice may be placed in plastic bags for easier handling then dumped over bottle after the last samples are collected)
- Clean coolers
- Temperature blank bottle (1/cooler)
- Custody seals if required (see Section I.I, Protocol C).
- Digital camera or field computer with camera, for documenting potential pollution sources and waterbody conditions
- Graduated Cylinder if needed for measuring adequate sample amounts.

a. Additional Items Needed for Non-Wadeable Sites

- Bacteriological sampling: swing sampler or other appropriate bottle holder or sterile sampling device
- Inorganic chemical sampling: Teflon® or High-Density Polyethylene (Nalgene®) bucket attached to a rope, Teflon® Kemmerer, bailer, or peristaltic pump
- Organic chemical sampling: stainless steel bucket (attached to a rope), Kemmerer, or bailer
- Stopwatch or watch with second hand for estimating flow.

If Using a Boat

- Boat with appropriate safety equipment, paddles, and PFDs. Comply with TWRA regulations which are found at https://www.tn.gov/twra/boating.htmL.

b. Additional Items Needed for Field Cleaning Equipment

- Phosphate-free laboratory-grade detergent
- Tap water stored in a clean covered tank, or squeeze bottle
- Deionized water stored in a clean covered tank or squeeze bottle

c. Additional Items Needed for Diurnal Monitoring

- Continuous monitoring probe

- Sensor cable
- Laptop computer programmed for the continuous monitoring multi-probe
- Field manual for the probe and software
- Stainless steel cable or chain
- Crimps
- Crimp and wire cutter pliers
- Nylon cable
- Appropriate anchoring and/or flotation device such as:
    - Rebar and hammer (firm substrate)
    - Wooden board (soft sand/silt substrate)
    - Concrete block (soft sand/silt substrate)
    - Float with probe holder to suspend the probe in the water column and a weight to hold it in place (deeper waters)

d. Additional Items Needed for Automatic Sampling

- Automatic sampler
- New Silastic® or equal tubing
- New Teflon® or Tygron® or equal tubing
- Clamps and/or electrical ties
- Spare batteries
- Ice

2. Sample Container Acquisition

At least two weeks (preferably one month) prior to needing sample bottles for routine scheduled sampling place a bottle order (Appendix A) with the TDH Environmental Lab and notify the environmental and microbiological sample coordinators of when samples will be arriving (Table 2). Remember to include an adequate number of bottles for quality assurance testing of at least 10% of planned samples. TDH Environmental Laboratory has requested, "all samples submitted for analysis should be properly collected in bottles furnished and prepared by the Environmental Laboratories" (Tennessee Department of Health, 2001).

When receiving a bottle order, make sure the correct numbers of bottles are present and the lids on the pre-preserved bottles are tight to avoid preservative leakage and possible acid burns. Always keep numerous spare bottles on hand for unscheduled complaint and emergency sampling. Pre-preserved sampling containers may be stored up to manufacturer's expiration date. Pre-preserved bottles should have the date of preservation attached to them. If not, contact the TDH lab for the corresponding paperwork to ensure acknowledgement of expiration date.

Note: If using another TDEC contract laboratory, contact the specific lab about obtaining bottles. Make sure that minimum required detection limits (Appendix B) can be met and results will be sent to WPU.

Table 2: TDH Environmental Laboratory Contact Information

Nashville Central Laboratory 630 Hart Lane Nashville, TN 37247	Knoxville Regional Laboratory 2101 Medical Center Way Knoxville, TN 37912
Environmental Sample Coordinator: (615) 262-6346	Microbiological Sample Coordinator: (865) 549-5203
Microbiological Sample Coordinator: (615) 262-6337	
After Hours Emergency Number (all labs): (615) 262-6300	

The TDH Environmental Laboratory will continue to provide chemical, bacteriological, organic and other specially preserved bottles not included on the sample container request form such as cyanide and also bottles for 1,4-Dioxane analysis. To obtain these items, all regular bottle requests, have sampling issues, concerns, or questions please contact:

Patrick Leathers
(615) 262-6487
Patrick.Leathers@tn.gov

Sample Receiving
(615)262-6358
TDOH-ENVLogin.Health@tn.gov

For special projects like spills, fish kills, and any organics sampling/testing inquiries, please contact the following.

Dr. Marc Rumpler
(615)-262-6302
Marc.Rumpler@tn.gov

3. Sample container descriptions

a. Bacteriological Collection Bottles

Collect bacteriological samples in sterile polypropylene screw-cap bottles pre-preserved with sodium thiosulfate and EDTA. These bottles may be obtained from TDH Environmental Laboratory or other TDEC contract laboratories.

Bacteriological bottles should minimally be labeled with a preparation date. Some laboratories also label bottles with an expiration date. Bacteriological bottles have an expiration date provided per manufacturer. Do not use expired bottles. To ensure an adequate volume of water is available for analyses, use the provided bacti bottles and fill completely. If using two bottles, they are considered one sample and should be labeled with the same collection time. **If the sample will be analyzed only for *E. coli*, and no other pathogens, collect one bacti bottle provided by the *E. coli* testing lab.** See protocol C for complete instructions on collecting bacteriological samples from surface waters.

b. Inorganic Collection Bottles

Collect inorganic samples in the proper sample bottle with the appropriate preservative (Table 3). Pre-preserved sample containers may be stored and used before their provided expiration date, which includes analysis. These bottles should minimally be labeled with a preparation date. Only use certified pre-cleaned single-use plastic bottles for routine, nutrient, metal, mercury, cyanide, boron, TOC and TCLP sampling. Oil and grease, phenols, sulfides, and flash point samples are collected in properly cleaned (Section I.H) glass bottles.

See Protocol C for complete instructions on collection of inorganic samples. Special precautions are given for the collection of trace metal and low-level mercury samples. Protocols D, E, and F specify collection techniques for wadeable and non-wadeable waterbodies.

c. Organic Collection Bottles

The most commonly requested organic analyses are NPDES extractable and volatiles, and pesticides/PCBs (Table 4). All organic samples are collected into properly cleaned amber bottles or vials. Pre-preserved bottles should minimally be labeled with a preparation date and preferably an expiration date. See Protocol C for complete instructions on collection of volatile samples. If analyses other than those listed here are needed, contact the sample receiving section of TDH Environmental Laboratory or other TDEC contract laboratory for the appropriate sample container and sampling method.

Table 3: Inorganic Sample Bottles and Preservatives

Sample Type	Bottle Type	Preservative
BOD	1L plastic (this test requires the whole bottle, do not combine other tests), outsourced to Pace	None
CBOD	1L plastic (this test requires the whole bottle, do not combine other tests), outsourced to Pace	None
Settleable Solids	1L plastic (this test requires the whole bottle, do not combine other tests)	None
Total Dissolved Solids, TSS (suspended solids) Total Residue, **Alkalinity,** **Acidity**	(All or up to all of these parameters (TDS, TSS, total residue, alkalinity and acidity) in any combination can be analyzed from one 1L Plastic Bottle	None
Turbidity **IC parameters**; Sulfate, Silica, Orthophosphate, Nitrate, Nitrite, Fluoride, Chloride **Color,** True and Apparent	250 mL Plastic, State Lab Tested (All or up to all of these parameters (Turbidity, IC parameters and color) in any combination can be tested from one 250mL plastic bottle)	None
Nutrient	500 mL plastic	1 mL sulfuric acid (H_2SO_4) (Reagent-Grade)
COD	500mL plastic (nutrient bottle), outsourced to Pace	1 mL sulfuric acid (H_2SO_4) (Reagent-Grade)
Metals & Mercury	1L plastic	None, preserved in lab

Sample Type	Bottle Type	Preservative
Low Level Mercury	250mL clear Boston round glass bottle. This test requires this entire bottle. Do not combine with other tests. Do not use this bottle for regular Mercury or Metals tests. Special sampling procedure needed.	1.25mL Optima grade HCL
Hexavalent Chromium	250 mL bottle. This test requires the entire bottle, do not combine tests. Outsourced to Pace	None
Cyanide	1L plastic, outsourced, *Call ahead for kits to be made available	pH>12; 5 mL of 50% sodium hydroxide (NaOH) at collection. If KI paper indicates chlorine, add 0.6g ascorbic acid ($C_6H_8O_6$) before adding NaOH. If sulfides are detected by lead acetate paper, add 1g of Cadmium Chloride ($CdCl_2$) after adding NaOH.
Oil & Grease	1L glass, wide mouth with Teflon® lined lid, outsourced to Pace	2 mL sulfuric acid (H_2SO_4) (Reagent-Grade)
Phenols, total*	1L glass, amber with Teflon® lined lid, outsourced to Pace	2 mL sulfuric acid (H_2SO_4) (Reagent-Grade)
Sulfide	500 mL glass, outsourced to Pace	2 mL zinc acetate (ZnAc) in the lab. 5 mL 50% sodium hydroxide (NaOH) in field.
Flash Point (Ignitability)	16-ounce glass jar with Teflon® lined lid, outsourced.	0.75 mL hydrochloric acid (HCl) (Reagent-Grade)
Total Organic Carbon (TOC)	One 250mL plastic bottle	1 mL phosphoric acid (H_3PO_4) (Reagent-Grade)
Toxicity Characteristic Leaching Procedure (TCLP)	16-ounce glass jar, Outsourced	None
Low Level pH	One 250mL plastic bottle	None

Table 4: Organic Sample Bottles and Preservatives

Test	Container	Preservative
Base/Neutral/Acids Extractables*		
NPDES Extractables	Pace Outsourced: 2 - 1L Amber Glass	None
Pesticides/PCBs		
Target Analyte List (TAL) Extractables		
Nitrobodies (suspected explosives)		
Semivolatiles		
Volatiles and Petroleum Hydrocarbons (Outsourced to Pace)		
NPDES Volatiles*	Three - 40-mL amber vials with Teflon®-lined septa caps, <u>no headspace</u>	1:1 Hydrochloric Acid (HCl) (Reagent-Grade)
Target Analyte List (TAL) Volatiles*		
Benzene, Toluene, Ethylbenzene, Xylenes (BTEX)*	Three – 40-mL amber vials with Teflon® lined septa caps, <u>no headspace</u>	1:1 Hydrochloric Acid (HCl) (Reagent-Grade)
Gasoline Range Organics (GRO)*		
Extractable Petroleum Hydrocarbons (EPH)*	One – 4L amber jug	1:1 Hydrochloric Acid (HCl) (Reagent-Grade)

* Be sure to request the correct corresponding bottle containers from TDH and inqure from TDH where the samples should be sent.

In hot weather, transport empty preserved bottle in a cooler to prevent condensation of acids. Store unused containers in a cool environment.

4. Equipment Cleaning

a. Wader Cleaning Procedure

Rinse mud and debris from waders between sampling sites to avoid cross-contamination. Mud may be rinsed from waders in creek or river before leaving the site.

b. Cooler Clean Procedure

To avoid cross-contamination between samples, clean all sample storage coolers between uses with hot phosphate-free laboratory grade soapy water and thoroughly rinse with hot tap water. Allow coolers to air-dry with the lid open. Once dry, store in a clean area with lids closed to avoid contamination from air-born particles. If coolers will be reused immediately, they do not need to be air dried after being washed and rinsed.

c. Field Parameter Bucket Cleaning Procedure

If a bucket will only be used for the measurement of field parameters, rinse it once with surface water from the site before the field parameter sample is collected. Likewise, rinse the bucket once with tap water after the sample is collected. When the bucket becomes visibly dirty, muddy, or oily, clean the bucket following sample equipment cleaning procedure (Section I.I., Protocol C). Multiple clean buckets can be taken on a sample run so that one bucket doesn't have to be washed between each site.

d. Sampling Equipment Cleaning Procedure

Clean all reusable equipment that comes in direct contact with sample water, such as Kemmerer, properly constructed sample bucket (Protocol F), or automatic sampler, between uses. It is preferable to arrange the sampling schedule so the equipment can be cleaned in the controlled environment of the EFO lab. If it is not possible to return to the EFO between sampling stations, the field cleaning procedure in Section I.I. Protocol C must be followed. Document any deviation from this procedure.

(1). Soap Wash – Wash the equipment with a phosphate-free laboratory detergent, such as Sparkleen® and hot tap water. Use a clean scrub pad to remove any surface film or particulate matter. Store the soap in a clean container and pour directly from the container.

(2). Tap Water Rinse – Rinse the equipment thoroughly with hot tap water.

(3). Deionized Water Rinse – Rinse equipment at least twice with deionized water using either a squeeze bottle or the outlet hose from the deionizing system. If the sampling equipment is being cleaned for the collection of organic samples, the rinse water must be organic-free reagent-grade water dispensed from a Teflon® squeeze bottle or a Teflon® outlet hose.

(4). Air-Dry – Allow opened equipment to air-dry on a clean surface before storage in a clean area.

I.I. Procedures

Protocol A - Selection of Sample Type and Site Location

Sampler
Central Office Coordinator

1. Sample Analyses Selection

The majority of samples are used for multiple purposes, regardless of the primary sampling objective. For example, TMDL samples will also be used for assessments, criteria development and ecoregion calibration. Therefore, all samples must have the same confidence in the accuracy of the sample quality and analyses. The study objective will determine what parameters need to be analyzed from a given sample (Table 5). The parameters in turn determine the types of samples that need to be collected (Appendix B). Table 6 provides information on bottle types needed for the most common monitoring activities.

Consult DWR's annual Tennessee Water Quality Monitoring and Assessment Program Plan and the Quality Assurance Project Plan for 106 monitoring for the most current information on specific details on planned sampling objectives. Samples collected for different purposes will have different sampling needs. Table 5 provides information on sample needs for some routine sampling activities.

a. Field Parameters (Conductivity, Dissolved Oxygen, Temperature, pH,) are required for all sampling.

b. Ecoregion samples require specific analyses.

c. Waters on the 303(d) List must minimally be sampled every watershed cycle, for the cause that they were placed on the 303(d).

d. Consult the TMDL monitoring guidelines (Appendix C) for general TMDL monitoring requirements. Contact the TMDL manager prior to monitoring to determine specific monitoring stations, sampling periods and data needs.

e. Watershed sampling needs will vary by site.

f. Compliance or enforcement monitoring should be done according to permit specifications.

g. In non-scheduled monitoring such as complaints, spills, and other emergencies, the sampling objective will determine what parameters need to be analyzed. For assistance with determining what analyses are needed, consult the EFO DWR Manager or other experienced staff for site-by-site analyses determinations.

Table 5: Recommended Parameter List for Surface Water Samples

Parameter	**TMDLs**				**Ref. Sites**	**303(d)***	**Long Term Trend Stations**	**Watershed Sites**	**Landfills**	**Trip and Field Blanks**
	Metals† /pH	DO	Nutrients	Pathogens	**ECO, FECO & SEMN**					
Acidity, Total	X (pH)							O		
Alkalinity, Total	X (pH)				X	O	X	O		
Aluminum, Al	X†					O	X	O	X	O
Ammonia Nitrogen as N		X	X		X	O	X	O	X	O
Arsenic, As	X†				X	O	X	O	X	O
Cadmium, Cd	X†				X	O	X	O	X	O
Chloride					X		X		X	
Chromium, Cr	X†				X	O	X	O	X	O
$CBOD_5$		X				O		O		
Color, Apparent					X		X			
Color, True					X		X			
Conductivity (field)	X	X	X	X	X	X	X	X	X	
Copper, Cu	X†				X	O	X	O	X	O
Dissolved Oxygen (field)	X	X	X	X	X	X	X	X	X	
Diurnal DO		X	X							
E. Coli				X	O	O	X	O		
Flow	O	O	O	O	O, X SEMN	O	O	O		
Iron, Fe	X†				X	O	X	O	X	O
Lead, Pb	X†				X	O	X	O	X	O
Manganese, Mn	X†				X	O	X	O	X	O
Mercury, Hg	X†					O	X	O	X	O
Nickel, Ni	X†					O	X	O	X	O
Nitrogen NO_3 & NO_2		X	X		X	O	X	O	X	O
pH (field)	X	X	X	X	X	X	X	X	X	
Residue, Dissolved					X	O	X	O	X	
Residue, Settleable						O	O	O		
Residue, Suspended	X		X	X	X	O	X	O	X	
Residue, Total						O	X	O	X	
Selenium, Se	X				X	O	X	O	X	O
Sulfates					X(68a,69de), SEMN	O	X(68a,69de)	O		O
Temperature (field)	X	X	X	X	X	X	X	X	X	
Hardness ($CaCO_3$) by calculation	X				X	O	X	O	X	O
Total Kjeldahl Nitrogen		X	X		X	O	X	O	X	O
Total Organic Carbon	X		X		X	O	X	O		
Total Phosphorus (Total Phosphate)		X	X		X	O	X	O	X	O
Turbidity (field or lab)			X	X	X	O	X	O		
Zinc, Zn	X†				X	O	X	O	X	O

Parameter	**TMDLs**				**Ref. Sites ECO, FECO & SEMN**	**303(d)***	**Long Term Trend Stations**	**Watershed Sites**	**Landfills**	**Trip and Field Blanks**
	Metals† /pH	DO	Nutrients	Pathogens						
Biorecon					X			X (or SQSH)		
SQSH			X(or biorecon)		X	X (or biorecon) unless listed for pathogens				
Habitat Assessment					X	X		X		
Chlorophyll *a* (Non-wadeable)		R	X							
Diatom (Wadeable)		R	X		X	R for nutrients in wadeable				

Optional (O) – Collected if waterbody has been previously assessed as impacted by that substance or if there are known or probable sources of the substance. Field blanks every 10th time parameter is collected, Trip blanks every 10th trip that includes parameter
R – Recommended if time allows. † – Sample for pollutant on 303(d) List.
* These analyses are required for Ecosites and established FECO sites, not for candidate FECO sites.
** These QC blanks need to be analyzed if parameter is collected within the QC set.

The following parameters are never requested unless there is specific reason to do so: **antimony, barium, beryllium, calcium, magnesium, potassium, silver, sodium, boron, silica, total coliform, fecal coliform, enterococcus, fecal strep, cyanide, ortho-phosphorus and $CBOD_5$**

Nitrogen (nitrate) and nitrogen (nitrite) should only be collected at waterbodies with designated use of drinking water unless other specific reason to do so.

It is recommended that turbidity be measured in the field instead of collecting a sample for lab analysis if a calibrated meter is available.

QC samples (trip and field blank) are only collected for parameters requested at other sites in the same sample trip. Only parameters marked with an O (optional) in Table 5 should be run on blanks.

Table 6: Sample Containers for Surface Water Samples

Sample Container	Collect for Ambient	Collect for Reference sites (ECO & FECO)	Collect for Watershed
250mL or 1L Certified Clean single-use Routine**	X	X	X
Lab provided bottle for Bacteriological*	X	X	X
1L Certified Clean single-use Metal	X	X	X[m]
1-500 mL Certified Clean single-use Nutrient	X	X	X

* Only 1 bottle is required if *E. coli* is the only analysis needed. Various sized bottles used by different *E. coli* testing labs.

[m] Metals should not be routinely sampled at watershed sites. Only request analyses if these are a pollutant of concern.

** Refer to Table 3 for number of bottles needed. Number of bottles is based on tests requested.

E. coli is the preferred analysis for bacteriological sampling. If the bacteriological sample is collected for TMDL development, check with the WPU manager for any needed additional analyses. Unless required by study objectives, avoid collecting bacteriological samples during or immediately after storm events.

For geometric mean (geomean) collect five samples in a 30 consecutive day period. The samples must be taken at least 24 hours apart and not during a rain event. None of the analyses, can be reported as greater than or less than the test detection limit. To determine the likely detection limit needed for proper *E. coli* analysis, check the historical data for existing sites. Waterlog, maintained by WPU houses chemical and bacteriological analyses results. Contact the Watershed Planning Unit if assistance is needed in locating or using this database.

After historical *E. coli* readings have been determined for a given sampling station, the sampler should determine if a dilution needs to be requested (Table 7). If historical *E. coli* readings are greater than 2,419 colonies/100mL, the sampler should request a 1:10 dilution on the sample tags and the sample request form. A 1:100 dilution should be requested if historical readings are greater than 24,190 colonies/100mL. You may also want to request a 1:100 dilution if sewage overflow is observed or suspected. If historical readings are less than 2,419, no dilution is required, and no specific notations need to be made on the sample tags or sample request form. The goal is to try and get a real number for the most accurate calculations and assessments but results of < 100 are less informative than results of > 2419.

When collecting at a new site, the sampler should determine the likely upstream contamination level. If a waterbody is located in an undisturbed area, then an undiluted *E. coli* sample should be sufficient.

The sampler should call TDH laboratory or contract labs and request the data if *E. coli* results are not received before the next sampling trip so the correct dilution can be requested on subsequent sampling events. If the sampling objective is to compare the geometric mean to the criterion and any of the five measurements are reported as greater than or less than the count range, then additional samples must be collected until five measurements in a 30-day period, 24 hours apart, are achieved.

Table 7: Detection Limit of *E. coli* Test (Quanti-Tray/2000)

Dilution	Factor	Count Range
None	1X	1 to 2,419
1:10	10X	10 to 24,190
1:100	100X	100 to 241,900

2. Site Selection

Site selection is dependent on the study objectives. After determining the specific objectives of the study and clearly defining what information is needed, select the sampling site in a specific reach of the waterbody. Reconnaissance of the waterway is very important.

Note possible sources of pollution, access points, substrate types, flow characteristics, and other physical characteristics that will need to be considered in selecting the sampling sites. The number and location of sampling stations will vary with each individual study.

Choose a sample location with the greatest degree of cross-sectional homogeneity. The selected sampling location should be well mixed both vertically and horizontally. Since mixing occurs by flow and turbulence, an area downstream of a riffle will ensure adequate mixing. In slower moving waters, the mixing zone will extend some distance downstream. It is advisable to avoid confluence areas due to incomplete mixing and changes in flow patterns.

a. For **watershed screenings**, sites are located near the mouth of each tributary if representative of the stream as a whole. If impairment is observed, the watershed is inspected to see if the impairment is consistent. Additional monitoring is not needed if the impairment is consistent. However, if the impairment originates in a particular area, additional monitoring, if time allows, will help pinpoint the extent of the impairment.

b. For monitoring **point source** pollution, stations are located both upstream and downstream (below the mixing zone) of the source of pollution. Unless the waterbody is extremely small or turbulent, an effluent discharge will usually flow parallel to the bank with limited lateral mixing for some distance. If complete mixing of the discharge does not occur immediately, left bank, mid-channel and right bank stations may be established to determine the extent of possible impact. Stations are established at various distances downstream from the discharge. Collection stations are spaced farther apart going downstream from the pollution source to determine the extent of the recovery zone.

c. For **targeted monitoring**, avoid locations immediately above, or below the confluence of two streams/rivers, or immediately below point/non-point source discharges. Unless the waterbody is very small or extremely turbulent, an inflow will usually hug the stream bank, for some distance from which it was discharged, with little lateral mixing. This may result in very different chemical analyses and an inaccurate assessment of water conditions. This can be avoided by sampling after mixing has occurred.

d. If macroinvertebrate samples are also collected from the same access point, locate sampling stations for chemical, bacteriological, and physical parameters within the same reach (200 meters) as the macroinvertebrate sampling station and assign the same Station ID.

e. If a planned sampling location becomes inaccessible due to flooding, closed roads, or other temporary setbacks, if possible, reschedule sampling during normal flow and when the sampling location is accessible. If a site is permanently inaccessible, move the sampling location upstream or downstream to the nearest accessible location.

Protocol B – Assigning DWR Station ID

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

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

If new stations are created, they should be uploaded to the stations staging table in Waterlog/Hydra as soon after the sample collection as possible. They must be uploaded before samples are analyzed by the lab. An e-Form (see Appendix A) has been developed for submitting new stations. The form and guidance documents for completion and Waterlog upload Stream Parameter Electronic Reporting Tutorial (SPERT) are available on the DWR publications page or by contacting WPU QC staff.

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

It is very important that Station ID**s 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 or downstream, they are still the same station.)

Chemical and biological stations collected more than 200 yards apart can still be considered the same station if there are no tributaries, discharges, construction, agriculture, road crossing or other

activities that would influence the stream between sampling points. **It is very important for biological and chemical samplers to coordinate naming of station locations to avoid confusion.**
The official waterbody name is the one published on the USGS 1:24,000 scale (7.5 minute) USGS topographical map or equivalent GIS layer. Do not use other sources such as gazetteer, 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 using the USGS 1: 24,000 scale (7.5 minute) USGS topographical map and correspond to the latitude and longitude for easy comparison between multiple stations on the same waterbody. There are several options that can be used for measuring river miles:

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

2. USGS Streamstats https://streamstats.usgs.gov/ss/ . Use the National Map Base Layer. Do not use the National Geographic layer which uses flow lines which may cut off meanders and not all small tributaries are visible.

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

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

When measuring river miles for streams that enter an embayment, begin measurement from the confluence with the original channel of the main stem (not from where the stream becomes an embayment). For example, in Figure 1, river mile 0 for Bearden Creek would start at the confluence with the original channel of the Clinch River as marked on the 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 WPU to have the stations reassigned.

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

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

1. **Named streams/rivers**

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

a. The first five digits will be the first five letters of the stream name (capitalized). If the stream name has more than one word, use the first letter of each word finishing out the five letters with the last word. For example, South Fork Forked Deer River would be SFFDE. Do not use the words River, Creek Branch etc. (Fork is only used if the stream is also designated river, creek, branch etc.) For example, Dry Fork would be DRY but Dry Fork Creek would be DFORK. **The stream name will be one designated on the 1:24,000 scale (7.5 minute) USGS topographical map or GIS layer. (Do not use the Gazetteer, local name, 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). Measure the river miles from the confluence with the next waterbody downstream to the sampling location.

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

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

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

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

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

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

For example for 3 sites on the Cumberland River at mile 102.5:
CUMBE102.5ST-RDB
CUMBE102.5ST-LDB
CUMBE102.5ST-MC

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

LOOSA010.1SH = Loosahatchie River at river mile 10.1LOOSA1C40.5FA = 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 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 0.2 on an unnamed trib 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 0.2 on an unnamed tributary that flows into a second unnamed tributary at river mile 0.1 which, in turn flows into Cosby Creek at river mile 6.9 in Cocke County would be COSBY6.9T0.1T0.2CO (Figure 2).

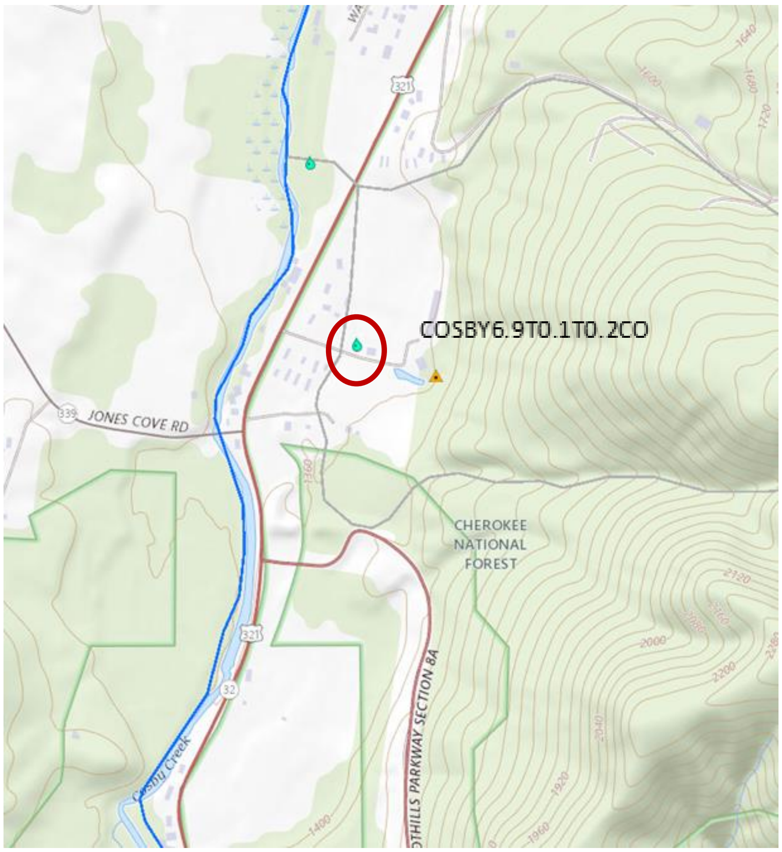

Figure 2: Naming Scheme for Stations Located on Unnamed Tributaries to Unnamed Tributaries. Station ID **COSBY6.9T0.1T0.2CO.**

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

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

Hollow, Gulch, Gulf, or Valley. If the feature name has fewer than five letters use the entire name.

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

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

(4) Use the two-letter county or state abbreviation from Appendix A. If the station is not in Tennesee, 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, river (or embayment).

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

c. Use the appropriate two-letter county or state abbreviation from Appendix 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 Waterlog/Hydra) 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 – General Collection Procedures

The primary objective of surface water sampling is to collect a representative sample that does not deteriorate or become contaminated before it is delivered to the laboratory. Generally, a sub-surface grab sample collected mid-channel is sufficient to document water quality for the space and time it was collected. Multiple or composite samples may more accurately represent water quality in large or slow flowing waterbodies.

For streams and rivers shallow enough to safely wade, samples should ideally be collected directly into the sample container from mid-channel or the middle of the thalweg if the main channel is not the middle of the stream (Protocol D). Samples should be collected 100 yards upstream from any bridges. If you are wading and it becomes too deep to safely wade to the thalweg, sampling outside the thalweg is acceptable as long as the location is in the channel and has sufficient flow. If a sample is taken outside the thalweg, comments that describe the location need to be recorded on the sample request form. Samples should never be collected from banks or docks unless the thalweg or the middle of the channel can be reached from this point. Do not sample if reduced to isolated pools. If drought conditions are suspected to affect stream data, flag with a D (similar to R flag for rain events). If a river, stream, or reservoir is too deep to wade or has dangerous current, mid-channel samples may be collected from a boat (Protocol E) or bridge (Protocol F). For large streams and rivers, combined grab samples collected at quarter-points (¼, ½ and ¾ width of channel) may result in more precise representation of water conditions.

Composite samples are a series of discrete, equal samples collected either at equal intervals of time (time composite) or relative to flow (flow proportional). Most commonly, composite samples are collected as part of NPDES compliance monitoring. Composite samples are usually collected with the use of an automatic sampler. See Protocol G for specific information on use of automatic samplers.

If possible, collect samples directly into the appropriate containers (Table 8). If the bottle contains a preservative, do not displace it while filling the container and leave adequate space in the sample bottle for mixing the preservative and the sample. To reduce the risk of bottle contamination, do not open the bottle until the sample is collected.

It is required that powder-free nitrile gloves be worn when collecting metal samples to avoid contamination of the sample. Either powder-free nitrile or latex gloves can be used for other sampling. Latex gloves may provide more protection from pathogens.

To avoid possible cross-contamination, it is recommended that tagged bottles be placed in unused colorless plastic zip-type bag. Store the sample on wet ice in a clean cooler until it is delivered to the lab. Each cooler must contain a temperature blank, used to measure cooler temperature upon arrival in the lab. Unless samples were collected within 2 hours of delivery to the lab, chemical samples warmer than 6°C are flagged, and bacteriological samples warmer than 10°C are flagged (Section II.B, # 4).

Table 8: Surface Water Sample Specifications With Holding Time

Sample Type	Bottle Type	Preservative	Holding Time
Bacteriological	Lab provided bottle (If sampling for just ***E. coli***, only **one** bottle is needed)	Sodium thiosulfate ($Na_2S_2O_3$)	8 hours***
Routine	1 liter or 250mL plastic depending on required analyses**	None	48 hours-28 days depending on required analyses**
Nutrient	500 mL plastic	1 mL sulfuric acid (H_2SO_4)*	48 hours -28 days depending on required analyses**
Metals[m]	1L plastic	None, preserved in lab with nitric acid	Once preserved; 180 days to analyze
Mercury[m]	1L plastic	None, Preserved in lab with 1.25mLs UHP hydrochloric acid	Once preserved; 28 days to analyze
Cyanide	1L plastic	pH >12; 5 mL of 50% sodium hydroxide (NaOH) at collection. If KI paper indicates chlorine, add 0.6g ascorbic acid ($C_6H_8O_6$) before adding NaOH. If sulfides are detected by lead acetate paper, add 1g of Cadmium Chloride ($CdCl_2$) after adding NaOH.	14 days
Oil & Grease	1 liter glass, wide mouth with Teflon® lid	2 mL sulfuric acid (H_2SO_4)*	28 days
Phenols, total	1L glass, amber	2 mL sulfuric acid (H_2SO_4)*	28 days
Sulfide	500 mL glass.	2 mL zinc acetate (ZnAc) in lab. 5 mL 50% sodium hydroxide (NaOH) in field	7 days
Flash Point	16 ounce glass jar with Teflon® lid	None	None
TCLP	16-ounce glass jar	None	28 days
TOC	One 250 mL plastic	0.1mL phosphoric acid (H_3PO_4)*	None specified
NPDES Extractables	Pace Outsourced: Two – 1L Amber Glass	None	7 days to extract; 365 days to analyze
Pesticides/PCBs			
TAL Extract.			
Nitrobodies			
Semivolatiles			

Sample Type	Bottle Type	Preservative	Holding Time
NPDES Volatiles TAL Volatiles	Three, 40-mL amber vials, Teflon®-lined septa caps, no headspace	1:1 hydrochloric acid (HCl)*	14 days
BTEX GRO	Three, 40-mL amber vials, Teflon®-lined septa caps, no headspace	1:1 hydrochloric acid (HCl)*	14 days
EPH	One 4L amber jug with Teflon® lined lid	1:1 hydrochloric acid (HCl)*	14 days

Store all samples on wet ice after collection.
*In very hot weather, store empty pre-preserved containers on ice to avoid vaporization.
**The specific parameters that can be analyzed from each sample are listed in Appendix B. Refer to Table 3 for number of bottles needed.
*** *E. coli* has 8 hour holding time but should arrive at lab within 6 hours.
[m]Metals and Mercury have no set time to make it to the lab for preservation but should be done so in a timely manner. Metals and Mercury will come out of the same 1 Liter unpreserved bottle.

Note that all holding times listed as less than seven (7) days by the EPA will be interpreted strictly to the minute and holding times greater than seven (7) days will be enforced after midnight on the 7th day after sampling.

Sample Request Sheet and Chain of Custody Information

Following the sample collection, complete the sample tag (Protocol H) and the Sample Request Form (Protocol I). When collecting scheduled samples, much of this form should be completed before arrival at the sampling location. Pre-printed forms and labels expedite the scheduled sampling. In the header information, take note that the primary sampler's name, field log number, collection date and time (military) after the sample is collected are completed. Each sample will have a different time including duplicates. Field water parameters are not recorded on the chain of custody. Staff directly upload field water parameters to Waterlog.

From the time of collection until analyses, custody of the sample must be traceable to assure integrity of the sample. A sample is considered to be in the custody of the primary sampler if it is in the sampler's possession or secured in a tamper-proof way in a restricted area. Make sure the doors are locked, if the sample is left unattended in a vehicle.

The primary sampler signs the "Collected by" line under chain of custody and fills in the date and military time of collection (Section II.D). The entire chain of custody must be completed (Protocol I). If the sample is given to anyone else (TDEC staff, courier, etc.) for transport to the laboratory, then they are responsible for the integrity of the sample and must sign the chain of custody on the Sample Request Form when taking custody of the sample.

Custody Seal

A custody seal assures the sample integrity has not been compromised. It is recommended that once samples have been placed on ice in the cooler, a signed and dated custody seal be attached to the cooler in such a way that it must be broken to open the cooler. A signed and dated custody seal (Figure 3) is only required if the sample is transferred from the primary sampler's custody (i.e. other TDEC staff, bus, courier, etc.) before reaching the laboratory. Any signed and dated custody seal may be used.

"The use of custody seals may be waived if field investigators keep the samples in their custody as defined from the time of collection until the samples are delivered to the laboratory analyzing the samples." (*Ecological Assessment Standard Operating Procedures and Quality Assurance Manual.* USEPA Region 4, 2002).

1. It is in the actual possession of an investigator;
2. It is in the view of an investigator, after being in their physical possession;
3. It was in the physical possession of an investigator and then it was secured to prevent loss or tampering; and/or;
4. It is placed in a designated secure area.

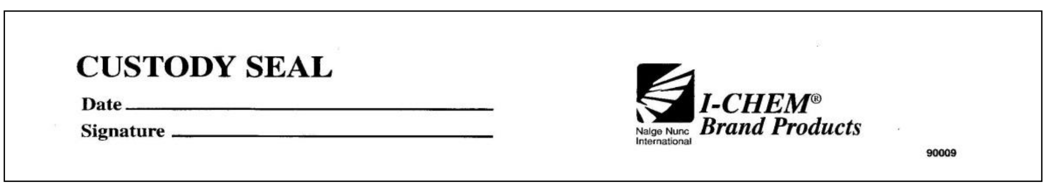

Figure 3: Custody Seal Example.

Delivery to the State Laboratory

All non-organic samples are to be delivered or shipped to the state laboratory, Tennessee Department of Health, in Nashville or Knoxville (for pathogen parameters only). Samplers must print the completed sample request forms and include them in the shipment with the samples after having sent the lab a copy of the forms. Contact the laboratory if samples cannot be delivered during normal hours of operation 7:00 – 4:30 (2:30 for bacteriological samples) Monday through Friday (Monday – Thursday for bacteriological samples). If samples cannot be delivered during normal hours of operation and **<u>holding times are not an issue</u>**, secure the samples in a locked area in the EFO and deliver them to the laboratory the next day. The samples must be stored at ≤

6ºC. If holding times are an issue, and the sample cannot be delivered during normal working hours, contact the laboratory by 12:00 pm to inform the lab of late delivery.

Organics (semi volatiles, PCB, pesticides, herbicides, dioxin/furans, PFOs/PFA and volatiles) are shipped directly to PACE with **PRIORITY OVERNIGHT SHIPPING.** (Note this does not apply to NEFO which can still take the samples to the state lab for shipping)

Attn: Sample Receiving
Pace Analytical Services
1241 Bellevue St, Suite 9
Green Bay, WI 54302
(920) 469-2436

Steps:

1. Use the same sample request/COC e-form that is used for samples you use for TDH lab.
2. Select the EFO contact from the dropdown box below send report to populate the chemical QC officer's contact information so PACE may contact the EFO if there is a question about the sample. The form is then completed as usual including speed chart.
3. Include signed/dated sample request/COC with the samples going to PACE and email a copy to Bill.Moore@tn.gov, Sakshi.Sawrkar@tn.gov and Patrick.Leathers@tn.gov before or when the sample is shipped. They will contact PACE and let them know the samples are coming.
4. Use the TDH shipping account.
5. Clearly mark coolers to be shipped back to the EFO.

Results are reported through the TDH lab for review/QC before being released. Reports will be generated from the state lab and included in monthly EDDs for upload to Waterlog.

Nashville Central Laboratory
630 Hart Lane
Nashville, TN 37247
Environmental Sample Coordinator: 615-262-6358

Microbiological Sample Coordinator: 615-262-6337

Knoxville Regional Laboratory
2101 Medical Center Way
Knoxville, TN 37912
(865) 549-5203

After hours emergency (all labs): 615-262-6300

Field Equipment Cleaning

All reusable equipment that comes in direct contact with sample water must be cleaned between uses. If it is not possible to return to the EFO lab to clean sampling equipment between uses, the equipment may be field-cleaned. Replace any contaminated tubing between sites. All contaminated wastes or suspected contaminated wastes must be contained in a bucket with a snap or screw-on lid. Document any deviation from this procedure.

1. **Soap Wash** – Wash the equipment with laboratory detergent such as phosphate-free Sparkleen® and tap water. The soapy water can be dispensed from a squeeze bottle. Use a clean scrub pad to remove any surface film or particulate matter. The wash water can be disposed in the sanitary drain in the washroom, or while in the field, washed onto pervious ground without recovery.

2. **Tap Water Rinse** – Rinse the equipment thoroughly with tap water from a squeeze bottle or other appropriate bottle. Store tap water in any clean and covered tank or bottle. The rinse water can be disposed in the sanitary drain in the washroom, or while in the field, washed onto pervious ground without recovery.

3. **Deionized Water Rinse** – Rinse equipment thoroughly with deionized water using a squeeze bottle. Store deionized water in a labeled, clean covered glass or plastic tank or bottle. If the sampling equipment is being cleaned for the collection of organic samples, rinse with organic-free reagent-grade water dispensed from Teflon® squeeze bottle. The rinse water can be disposed in the sanitary drain in the washroom, or while in the field, washed onto pervious ground without recovery.

4. **Storage –** Store equipment in a maintained and clean work area until used.

5. **Sample Water Rinse -** At the site before collecting the sample, rinse the sampling equipment at least once in the creek, river, or reservoir water.

Sample Types

The specific type of chemical or bacteriological sample that needs to be collected will vary with the sampling objectives and funding priorities. The most common sample types are discussed below. If additional samples are collected, contact the receiving laboratory for collection instructions. All samples should be collected sub surface with the exception of Oil and Grease.

1. Bacteriological Sample Collection

When collecting *E. coli* samples to calculate a geometric mean for comparison to water quality criteria; five samples must be collected within a 30-day period with samples being at least 24 hours apart. Ideally samples should be collected between March and November. Rain events should be avoided. Additional samples must be collected, with dilutions requested if any samples are reported as “less than” or “greater than” to achieve 5 measurable samples in 30 days.

Powder free gloves should be worn to avoid contamination of bacteriological samples. It is recommended that shoulder length gloves be worn in waters known or suspected to have high pathogen levels to protect the sampler from possible health risks. Do not use any equipment that has not been sterilized to collect bacteriological samples. If only analyzing for E. coli collect one sterilized pre-preserved bottle provided by the analyzing laboratory. If requesting multiple microbiological species analyses, collect two sterilized pre-preserved bottles to ensure an adequate sample volume is available for analyses. If only collecting *E. Coli* one bottle will suffice. Do not open the sterilized bottle until the sample is collected. When handling the sample container take care not to contaminate the lid or the inside of the bottle. When the sample is collected, leave ample air space in the bottle (about an inch) to facilitate mixing by shaking. Do not overfill the bottle and displace the preservative. After filling the bottle, carefully replace the lid and shake the bottle to assure adequate mixing of the sodium thiosulfate.

After the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler’s name must be on the sample tag. If collecting two bottles, the two bottles are considered one sample, so write the same collection time on both tags.

Collection of split samples will occur when the E. coli contract lab is not drinking water certified. The split sample will need to be collected quarterly by the EFO, providing one sample to the contract lab and the other to a drinking water certified lab for comparison of results. The split sample will be collected following the same method as duplicate samples (Protocol II.B). Split samples should be within 20% RPD of each other and results should be reported to CO QC officer for documentation. If split samples are out of range, E. coli must be sampled again within 7 days. If second split sample fails, EFO QC officer and CO QC officer will work together to identify the issue.

If chemical analyses are also requested, the microbiologists may not receive their copy of the Sample Request Form before the sample is analyzed; therefore write the needed analyses (i.e. *E. coli*, fecal coliform, and/or fecal strep.) and if dilution is requested in the remarks box on the sample tag.

If an *E. coli* value > 2400 is suspected a dilution should be requested. If in doubt (for example levels used to be high but may have improved) request both a diluted and undiluted sample (but don't over-use this as it incurs a double charge.) The goal is to try and get a real number for the most accurate calculations and assessments but results of < 100 are less informative than results of > 2419. Do not ask for dilutions when there is no history of data > 2400 (1:10 dilution) or >240,000 (1:100 dilution) and no obvious potential source such as bypassing, animal operations, leakage etc. Refer to Protocol A for additional guidelines for determining if diluted sample analysis should be requested.

To avoid cross-contamination, it is recommended that tagged bottles be placed in a colorless zip-type plastic bag and then stored on ice in a sealed cooler until delivered to the lab. Make sure each cooler contains a temperature blank, which is used to measure cooler temperature upon arrival in the lab. Bacteriological samples should be no warmer than 10°C, unless they are collected within two hours of delivery to the laboratory. Bacteriological samples must be delivered to TDH Microbiology Laboratory or any other TDEC contract laboratory within 6 hours of the collection time. If samples cannot be delivered by 2:30 PM, the laboratory must be notified by noon. If another TDEC contract laboratory is used, check with them on the days and times samples are accepted.

2. Inorganic Sample Collections

a. Routine Sample Collection

Routine samples require no preservative and are collected in certified pre-cleaned single-use 250mL or 1-L plastic bottles. See Table 3 for the volume of sample required for various routine analyses. If multiple analyses are requested, collect sample water in the appropriate bottles. Contact the receiving laboratory if there is a question about the volume of sample needed to collect for proper analyses and QC.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out; Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. For Routines, the preservative in the drop-down box that should have been completed is "4°C". Attach the completed Routine tag to the filled sample bottle, place it in a zip-type plastic bag (optional) and store on ice until delivery to the laboratory.

b. Nutrient Sample Collection

Nutrient samples are collected in certified pre-cleaned single-use 500-mL plastic bottles preserved with 1-mL sulfuric acid. In hot weather, store acid pre-preserved bottles on ice until needed to avoid vaporization and a potentially hazardous situation. Use only phosphate-free soap for hand washing or sampling equipment cleaning prior to obtaining nutrient samples. Always wear powder-free gloves when collecting nutrient samples. Fill the sample bottle with sample water, but do not overfill the bottle and displace the preservative. Note that nitrite and orthophosphate samples are analyzed from the routine sample bottle and are not preserved.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out; Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach the completed Nutrient tag to the filled sample bottle and place it in a zip-type bag (optional). Store the sample on ice until delivery to the laboratory.

When collecting Ammonia (NH_3) it is critical that field pH measurements be taken to determine toxicity.

c. Routine Metals Sample Collection

Routine metal and mercury samples are collected in certified pre-cleaned single-use 1-liter plastic bottles which are non-preserved. They will be preserved in the laboratory. Metals and Mercury will not require ice during shipment. Collect a Field Blank at the station that requests the Mercury. If more than one station requires Mercury collection, only sample one Field Blank for the whole run.

Most metal samples may be collected using the same collection techniques used to collect other chemical samples. Wear powder-free nitrile gloves when sampling. If sampling for dissolved metals, the sample water will need to be filtered through a 0.45µ pore diameter membrane filter in the field prior to preservation. EPA has recommended that any intermediate sampling devices used to collect mercury samples be constructed of Teflon®. If trace metals are a concern, collect samples using the modified clean technique specified in 2-d.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out; Field Log Number Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. For metals and mercury, the preservative in the dropdown box that should have been completed is "4°C". Attach the completed Metals tag to the filled sample bottle and place it in a zip-type bag (optional). Store the sample on ice until delivery to the laboratory.

It is critical that hardness and TSS (total suspended solids) be collected with metals for comparison to metal's criteria.

Generally, only the metal of concern(s) will be sampled. However, to screen for unknown metals the 106 priority pollutant list found in section 106 of the Clean Water Act is recommended: Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Selenium, Zinc.

d. Trace Metals Sample Collection
Modified Clean Technique

This sampling method is adapted from U.S. Environmental Protection Agency. 1996. *Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels.* Office of Water Engineering and Analysis Division (4303). Washington, DC.

The modified clean technique is used for trace metal collections. This method is not intended for collection of metals to be analyzed at minimum detection levels (MDL) available at most environmental laboratories including the TDH Environmental Laboratories. Only ultra-clean laboratories are able to obtain MDL necessary to analyze samples for trace metals.

It cannot be overemphasized how easily samples can be contaminated with trace metals. The detection levels for most metals are parts-per-billion (ug/l) or parts-per-trillion range. The modified clean sampling method is designed to reduce the probability of contamination when collecting a sample to be analyzed for trace metals.

Many lotions, sunscreens, perfumes, nail polish and insecticides contain trace amounts of metals and should not be worn when collecting trace metal samples. Atmospheric metals from automobile exhaust, cigarette smoke, bridges, wires or poles can also contaminate the sample. To avoid possible contamination, collect trace metal and low-level mercury samples at least 100 yards upstream of bridges, wires, poles, or roads.

Wear powder-free nitrile gloves when handling sample containers. Other gloves contain high levels of zinc and are likely to contaminate the sample and must not be used. If more than one sample is collected on the same waterbody, collect in the area believed to have the lowest metal contamination level first and the area with the highest metal concentration last.

Contact lab for specific low-level kits and instructions.

Designate one sampler as “clean hands” and the other as “dirty hands”. The “clean hands” designee conducts any activities involving the sample container and inner storage bag. The “dirty hands” designee is responsible for all other activities. The “clean hands” designee wears shoulder length powder-free gloves during the sampling event. The “dirty hands” designee may wear short powder-free gloves.

The “dirty hands” designee removes the sample containers from the cooler and opens the outer bag. The “clean hands” designee opens the inner bag, removes the sample container and moves to the appropriate sampling area. Then the “clean hands” designee removes the container lid and fills the sample container(s) upstream of all water movement, being careful not to displace the preservative. After the sample bottle is filled, the “clean hands” designee replaces the lid tightly, shakes the bottle to mix the preservative and returns it to the sample staging area.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the tag to the sample. “Clean hands” designee then places the sample in the inner zip bag and seals it. The “Dirty Hands” designee seals the outer zip bag and places the sample on wet ice in a clean non-metallic cooler with a temperature blank.

Trace metal samples cannot be collected from a bridge or pier due to likely contamination from the structure. In non-wadeable rivers or reservoirs, if possible collect metal and mercury samples from a boat constructed of a non-metal material like plastic or fiberglass. When feasible, paddling or electric motors are preferable to gasoline motors, since gasoline is a potential source of contamination. If the waterbody is too large to gain access to the sampling location without the use of a gasoline motor, turn off the motor a sufficient distance from the sampling location to avoid contamination and paddle the remainder of the way to the sample location.

Always approach the sampling location from downstream. The “clean hands” designee may collect subsurface grab samples from the bow of the boat. If the study objective requires a mid-depth sample in non-wadeable waterbodies, collect the sample with the use of a properly cleaned (Section I.H) discrete depth sampler (Kemmerer) constructed of Teflon® with no metal parts. Only the "clean hands" designee is to handle the Kemmerer, sample bottles and the inner zip bag. The "dirty hands" designee controls the boat location and handles all non-sample contact duties.

e. Cyanide Sample Collection

Cyanide analysis requires a 1-liter sample collected in a certified pre-cleaned single-use plastic bottle. Be sure to contact lab ahead of time for the specific kits as soon as you know you are sampling for Cyanide, refer to bottle request section. Test the sample for the presence of chlorine by placing a drop of sample on Potassium Iodine (KI) paper moistened with acetate buffer. If the KI paper turns blue indicating the presence of chlorine, neutralize the chlorine with 0.6 grams of ascorbic acid. If sulfides are suspected, test for the presence of sulfides by placing a drop of sample on acidified lead acetate test paper (gray indicates sulfides are present). Field preserve cyanide samples to a pH greater than 12 by adding 5-mL's of 50 percent sodium hydroxide to the sample. If sulfides were present, add 1g of Cadmium Chloride ($CdCl_2$) for each liter of sample after the pH has been raised.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the tag to the sample. Tighten the lid on the sample bottle and attach the completed Cyanide tag to the sample bottle, place in a zip-type bag (optional) and store on ice until delivery to the lab.

f. Oil and Grease Sample Collection

Oil and Grease analyses require at least 1-L sample collected in a wide mouth glass jar with a Teflon® lined lid and preserved with 2-mL's sulfuric acid. Consult the receiving laboratory to determine if more than 1-L sample is needed to achieve a homogeneous sample. Do not displace the preservative while filling the jar. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the tag to the sample. The primary sampler's name must be on the sample tag. Place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

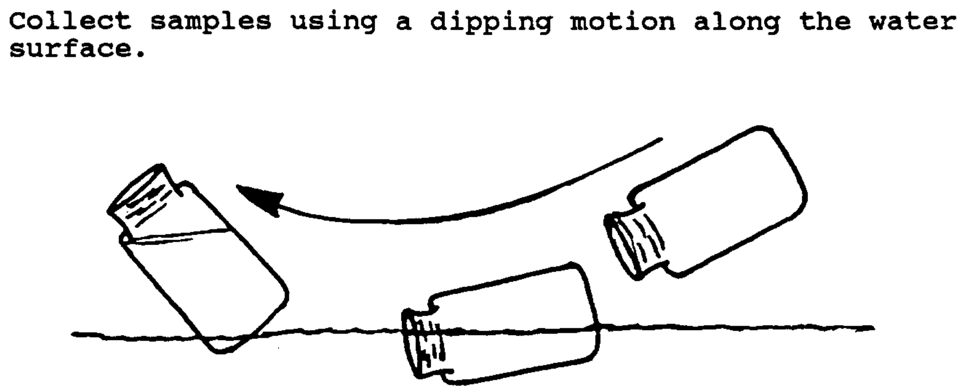

Figure 4: Proper way to collect Oil and Grease samples.

h. Phenols Sample Collection

Phenol analysis requires 1-L of sample collected in an amber glass jar preserved with 2-mL's of sulfuric acid. Do not displace the preservative while filling the jar. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the tag to the sample. The primary sampler's name must be on the sample tag. Place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

i. Sulfide Sample Collection

Sulfide analysis requires 500-mL's of sample collected in a glass jar. Sulfide samples are preserved in the laboratory with 2-mL's of zinc acetate and in the field with 5-mL's of 50 percent sodium hydroxide. Do not displace the preservative while filling the jar. Be sure to contact lab for kits. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the tag to the sample. The primary sampler's name must be on the sample tag. Place the sample in a zip-type bag (optional) and store on ice until delivery to the lab.

j. Flash Point Sample Collection

Flash point is a regulatory test to determine if a substance is flammable at temperature below 60^{o}C. Therefore, do not subject any suspected substance to heat or possible ignition source. Flash point analysis requires collection in a 16-ounce glass jar with a Teflon® lined lid. No preservative is needed.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the tag to the sample. The primary sampler's name must be on the sample tag. Place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

k. TCLP Sample Collection

Toxicity Characteristic Leaching Procedure (TCLP) test is used to simulate the mobility of analytes from wastes. This is most commonly a regulatory test performed on wastes and soils collected from landfills (Solid Waste) or superfund sites. This test has specific requirements. If the sample contains less than 0.5 percent solids, the liquid is classified as TCLP extract. If the sample contains more than 0.5 percent solids, enough sample must be filtered to get at least 100 grams of solids to perform the extraction. It could take copious amounts of sample to obtain 100 grams of solids.

Collect TCLP samples in a clean 16-ounce glass jar with no preservative. A great deal more sample may be required if more than 0.5 percent solids are found in the initial analysis. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach the completed TCLP tag to the sample bottle, place it in a zip-type bag (optional) and store on ice until delivery to the laboratory.

l. Total Organic Carbon Sample Collection

TOC samples are collected in one 250-mL plastic bottle with 1-mL of Phosphoric acid. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach one completed TOC tag to the sample vials and place them in one zip-type bag, and store on ice until delivery to the laboratory. In hot weather, store acid pre-preserved vials on ice until needed to avoid vaporization and a potentially hazardous situation.

3. Organic Sample Collections

a. Base/Neutral/Acid Extractable Compounds

(1). NPDES Extractable Sample Collection

NPDES Extractable analyses require either 2-1L (Pace) sample collected in an acetone-rinsed amber glass bottle with a Teflon® lined lid. No preservative is needed. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach the tag to the bottle and place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

(2). Pesticides/PCBs Sample Collection

Pesticide and PCBs analyses requires either 2-1L (Pace) sample collected in an acetone-rinsed amber glass bottle with a Teflon® lined lid. No preservative is needed. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach the sample tag to the bottle and place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

Generally the suspected source of contamination will be collected. However, if unknown, the following 106 priority pollutants are recommended:

Aldrin
Alpha-BHC
Gamma-BHC (Lindane)
Chlordane (Technical)
Alpha-Chlordane

Gamma-Chlordane
Cis-Nonachlor
2,4-DDD
4,4-DDD
2-4-DDE
4-4-DDE
2-4-DDT
4-4-DDT
Dieldrin
Endrin
Endrin Aldehyde
Endrin Ketone
Heptachlor
Heptachlor Epoxide
Hexachlorobenzene
Methoxychlor
Trans-Nonachlor
Oxychlordane
Toxaphene
PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB1254
PCB1260
PCB Total

(3). Target Analyte List Sample Collection

Target Analyte List (TAL) analyses require either 2-1L (PACE) sample collected in an acetone-rinsed amber glass bottle with a Teflon® lined lid. No preservative is needed. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the sample tag to the bottle and place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

(4). Nitrobodies Sample Collection

Nitrobodies tests are run to analyze for six explosive compounds, so handle these samples very carefully and protect the sample from heat sources. Nitrobodies analyses requires either 2-1L (PACE) sample collected in an acetone-rinsed amber glass bottle with a Teflon® lined lid. No preservative is needed.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach the sample tag to the bottle and place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

(5). Semivolatiles Sample Collection

Semivolatiles analyses require either 2-1L (PACE) sample collected in an acetone-rinsed amber glass bottle with a Teflon® lined lid. No preservative is needed. If unsure of what specifically is to be targeted, use SVOA 8270 list which include all analytes. If a lower detection limit is needed and the specific analyte is known, use the PAH method for detection. Although PAH analytes are a part of the 8270 method list, PAHs' are harder to detect as some overlap making it necessary to use the PAH method if the analyte in question is known.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach the sample tag to the bottle and place the sample in a zip-type bag (optional) and store on ice until delivery to the laboratory.

b. Volatile and Petroleum Hydrocarbon Compounds

Since volatile organic compounds may be present in concentrations of micrograms per liter, they may be lost when improperly handled. Avoid sampling in turbulent areas. Collect volatile organic samples directly into the appropriate pre-preserved amber vial or bottle (Table 8). All lids used for volatile organic samples must be Teflon® lined. Pour the sample slowly down the side of the container to avoid turbulence that could produce volatilization. There will always need to be a Trip Blank sampled for along with the Sample-Routine.

Slightly overfill bottles and vials to produce a convex meniscus without losing the preservative. The lid may be used to capture a small amount of sample to help produce the convex meniscus. A small amount of overflow should occur when the lid is tightened down. After placing the lid tightly on the bottle or vial, invert it and tap on the container while watching for air bubbles. If any bubbles are present, repeat the process with another clean preserved bottle or vial.

(1). NPDES and TAL Volatile Sample Collection

To collect a NPDES or TAL volatile sample, fill 3 40-mL amber pre-preserved vials with Teflon® lined septa caps. Each vial is pre-preserved with 1:1 hydrochloric acid. To keep the sample together, place a rubber band around the five vials. Fill out one tag and attach it to all five vials. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. While at the site be sure to fill out; Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Place all five rubber banded vials in a zip-type colorless plastic bag and store on ice in a clean cooler until delivery to the laboratory for analyses.

(2). BTEX and GRO Volatile Sample Collection

To collect a BTEX or GRO volatile sample, fill 3 40-mL's amber pre-preserved vials with Teflon® lined septa caps. Each vial is pre-preserved with 1:1 hydrochloric acid. To keep the samples together place a rubber band around the five vials. Fill out one tag and attach it to all five vials.

Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. Attach the tag to the sample. The primary sampler's name must be on the sample tag. Place all five rubber banded vials in a zip-type colorless plastic bag and store on ice in a clean cooler until delivery to the laboratory for analysis.

(3). EPH Sample Collection

To collect EPH sample, fill one 4L pre-preserved amber bottle with a Teflon® lined lid. The bottle is pre-preserved with 1:1 hydrochloric acid. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station No., Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out the following: Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Attach the sample tag to the bottle and place the sample in a zip-type bag (optional_ and store the sample on ice in a clean cooler until delivery to the laboratory for analysis.

Protocol D – Surface Water Collections in Wadeable Rivers and Streams

In streams and rivers shallow enough to wade (generally less than 4 feet, unless there is a strong current)**,** submerge the sample container directly in the water column (grab sample) to collect the sample. When a stream is very shallow, the sample container does not have to be completely submerged. Use a disposable beaker to fill the bottle. If multiple sample containers are going to be filled at the same station, fill the unpreserved sample (routine) first, then the bacteriological, nutrients, and the metal samples last. Collect subsequent samples upstream of the previous sample to avoid possible contamination from the substrate or previous preservatives.

Before collecting the sample attach a completed sample tag to the bottle. To collect a surface water sample using the sample container, wade to the thalweg, face upstream and collect the sample without disturbing the sediment. If sediment disturbance is unavoidable collect the sample upstream of the sediment plume or wait until the disturbed sediment moves downstream. If it becomes too deep to wade to the thalweg, sampling outside the thalweg is acceptable as long as the location is in the channel and has sufficient flow. Never collect samples from bank, dock, pier etc. unless thalweg can be reached from this point. If a sample is taken outside the thalweg, comments that describe the location need to be recorded on the sample request form. Remove the lid without contaminating the lid or the inside of the sample container. Grasp the bottle near the base and dip it midway in the water column. Collect samples in one arching motion to avoid losing the preservative. If the sample bottle contains a preservative, do not overfill it and displace the preservative. Tightly replace the lid and shake preserved bottles to assure adequate mixing of the preservative.

Return to the sample staging area on shore and place the sample inside a zip-type bag (optional) and store on ice until delivery to the laboratory. See Protocol C for general collection techniques and additional precautions when collecting trace metal or low-level mercury samples. Protocols H and I describe the procedure for completing sample tags and Sample Request Forms.

Field parameters (dissolved oxygen, temperature, conductivity and pH) are required in conjunction with all surface water sampling. It is recommended that turbidity be measured in the field instead of collecting a sample for lab analysis if a calibrated meter is available.

Protocol E – Surface Water Collections from a Boat

In streams, rivers, reservoirs, or lakes too deep for wading the best means of obtaining water samples is from a boat either directly into the sample container or with the use of a discrete depth sampler. Make all collections from the bow of the boat while the boat is facing upstream. Collect the samples upstream of the boat's movement. If multiple sample containers are going to be filled at the same station, fill the unpreserved sample (routine) first, then the bacteriological, nutrients, and the metal samples last. Collect subsequent samples upstream of the previous samples to avoid possible contamination from prior preservatives.

Collect subsurface grab water samples from the bow of the boat while the boat is facing upstream. Remove the lid without contaminating the lid or the inside of the sample container. Grasp the bottle near the base and dip it in the water column with a forward upstream motion. If the sample bottle contains a preservative, do not overfill it and displace the preservative. Tightly replace the lid and shake preserved bottles to assure adequate mixing of the preservative.

To collect mid-depth samples, use a discrete depth sampler, such as a Kemmerer. Any equivalent discrete depth sampler may be used as long as it samples from the desired depth, is constructed of a material that will not contaminate the sample, such as Teflon®, and is easily cleanable. Reusable discrete depth samplers cannot be sterilized; therefore, bacteriological samples cannot be collected with this equipment.

The location and number of samples will vary depending on the purpose of the sample. In reservoirs and lakes with little flow, multiple samples may be required to accurately represent water conditions. Composite samples collected at quarter-points (¼, ½, ¾) may more accurately represent water conditions for large bodies of water.

A Kemmerer is a cylinder, with Teflon® or silicone stoppers on each end, attached to a rope. The rubber stoppers can be closed remotely with a weighted messenger. Lock the stoppers in the open position to allow water to flow through the device as it is lowered to the correct depth.

When the Kemmerer reaches the proper depth (usually mid-depth), slide the messenger down the rope to close the stoppers and capture a water sample. Raise the Kemmerer out of the water by the rope. Open the valve on the Kemmerer to fill the appropriate sample bottles. Repeat this process as many times as necessary to collect a sufficient volume of water to fill all sample bottles.

Collect an equipment blank (Section II.B), before the sample is collected, on the clean discrete sampling device at every tenth site the equipment is used to assure the sample is not being contaminated by collection equipment. Before reusable equipment such as a Kemmerer can be used, it must be properly cleaned to avoid the possibility of cross-contamination. See Section I.H for laboratory cleaning procedures. If it is not possible to return to the EFO lab between uses, discrete or intermediate sampling devices may be field cleaned between sites using field cleaning procedures in Protocol C.

Measure water quality parameters (DO, pH, temperature, and conductivity) at each sample site. Rinse the probes with surface water prior to measurement. If the cord on the water parameter probe is long enough to reach mid-depth in waters 10 feet deep or less, lower the probe to the mid-depth and allow it to equilibrate. For sampling in waters deeper than 10 feet, measure the water parameters at a depth of 5 feet, unless a different depth is specified in the criteria or by the study objectives. Some studies may require additional readings to measure water quality profiles. When possible, submerge the sonde in the stream. Tie down the meter and other sampling equipment in the boat so it won't be dropped and potentially lost.

Protocol F – Surface Water Collections from a Bridge

The primary concerns when sampling from a bridge is the safety of personnel and the integrity of the water sample. For the safety of staff as well as motorists, follow OSHA precautions from *Manual on Uniform Traffic Control Devices* (2009) outlined in Procedure I.D. If the stream is wadeable, it is recommended that samples not be collected from the bridge. Generally, the sample should be collected in the thalweg. The location, depth, and number of samples will vary depending on the purpose of the study.

Collect the samples from the upstream side of the bridge. Handle the sampler carefully to avoid dislodging dirt and other contaminants from the bridge into the sample container or sampling device.

1. Subsurface sample collection

Subsurface samples may be collected from a bridge directly into the appropriate sample container with the use of a bottle holder connected to a long handle, a rope and bottle holder, or an intermediate sampling device. If an intermediate device is used, collect an equipment blank (Section II.B) at every tenth sample after the equipment is cleaned and before samples are collected to ensure they are not being contaminated by the collection method.

Due to likely contamination, chemical samples may not be collected from a PVC plastic bucket or bailer. A properly cleaned (Protocol C) Teflon® or High-Density Polyethylene (Nalgene®) bucket or bailer may be used to collect metals (other than trace level metal or mercury), nutrient, and routine samples. EPA recommends use of a Teflon® bucket or bailer to collect mercury samples. Samples for trace metal analyses must be collected using the modified clean technique (Protocol C).

Subsurface organic samples may be collected with the use of a properly cleaned stainless steel bucket or bailer. Bacteria samples must be collected using a sterile container. Subsurface bacteria samples may be collected from a bridge, pier, or bank directly into a sterile sampling container using a bottle holder connected to a long handle, a rope and bottle holder, or into a sterile intermediate sample container. Sterile disposable containers or intermediate samplers that can be sterilized without being damaged by autoclaving may also be used to collect bacteriological samples. If multiple sample containers are going to be filled at the same station, fill the unpreserved sample (routine) first, then the bacteriological, nutrients, and the metal samples last. Bacteriological samples may only be collected with sterile sampling device.

2. Mid-depth sample collection

If the study objective requires mid-depth chemical sample collection, a discrete depth sampler may be used to collect mid-depth samples. See Protocol C for specifications, use, and field cleaning procedures of discrete depth samplers. Protocol I.H discusses lab-cleaning procedures for sampling equipment. Collect an equipment blank (Section II.B) at every tenth sample collected using a discrete depth sampler to assure the sample is not being contaminated by collection equipment.

A peristaltic pump may also be used to collect chemical water samples if the bridge is no more than 25 feet above the water surface. A weighted line attached to the tubing may be lowered into the water to any depth. The pump can pull a surface water sample through the tubing approximately 25 vertical feet. The appropriate sample containers may be filled directly from the outlet tubing attached to the pump. Check the outlet tubing periodically for contamination and replace as necessary.

Since neither the discrete depth sampler nor the peristaltic pump can be sterilized, bacteriological samples cannot be collected using these devices.

3. Water Parameter Measurements

If the cord on the water parameter probe is not long enough to reach from the bridge to the water, a plastic (PVC or high density polyethylene is acceptable for this use) bucket attached to a rope may be used to collect water for reading water parameters. Rinse the bucket (Section I.H) two-three times with surface water before the water is collected for the water parameter readings. If the bucket gets visibly dirty, muddy or oily, clean the bucket according to the field cleaning procedure in Protocol C. Rinse the probe with surface water from the site before placing it in the bucket to read water parameters.

Fill the bucket with surface water and retrieve it with the rope. If water parameters will be taken from the same bucket used to collect chemical surface water samples, fill chemical sample container before taking water parameter readings. Place calibrated instantaneous water parameter meter(s) in the bucket of surface water, when measuring dissolved oxygen turn on the circulator (if applicable) and allow the probe to equilibrate before recording results. For duplicate readings, dump the water from the initial reading and refill the bucket with surface water. Record the results and rinse the probes with rinse water (tap water) after use at each site.

Protocol G –Composite Sample Collection

This method is a standardized way of collecting a representative composite sample, ensuring that it does not deteriorate or become contaminated before delivery to the laboratory. Composite samples are most commonly collected as part of NPDES compliance monitoring although it may be appropriate for other types of studies. When collecting a compliance sample, most aspects of monitoring, including sample location and collection method, will be specified in the NPDES permit. If the sample location is not specified in the permit, collect the sample between the last discharge and the receiving water. Generally, mid-depth, center of the flow, in an area with the highest turbulence is the best location for the intake line.

A composite sample is a combined or composited series of discrete, equal samples collected over a temporal or spatial range. Time (temporal) composite samples are made up of a number of discrete samples of equal size collected at equal time intervals into one container. Flow proportional (spatial) composite samples are composed of a number of samples sized relative to the flow. Automatic samplers may be used to collect composite samples either for collecting several aliquots at frequent intervals or to collect continuous samples. Flow proportional samplers are activated and paced by a compatible flow meter. The choice of time composite or flow proportional depends on permit requirements, variability of flow and concentration of pollutants. The composite sampler environment for the sample collection must be maintained at less than or equal to 6ºC.

Any automatic sampler meeting the following specifications may be used to collect composite samples. It is preferable to use one of TDEC's automatic samplers. However, if field conditions do not allow for the installation of TDECs automatic sampler and the facility's automatic sampler meets these specifications, the facility's sampler may be used.

Automatic Sampler Specifications:

- Automatic sampler must provide refrigeration either by mechanical means or ice.
- Automatic sampler shall be capable of collecting a large enough sample for all parameter analyses (each aliquot must be at least 100-mL's).
- Automatic sampler must have adjustable sample volume.
- Automatic sampler must provide at least 20 feet of lift.
- Pumping velocity must be at least two feet/second.
- Minimum inside diameter of intake line is ¼ inch.
- No PVC plastic or metal parts may come in contact with the sample water if it is being analyzed for organics or metals.
- The composite sampler environment for the sample collection must be maintained at less than or equal to 6ºC.

1. **Cleaning and Maintenance**

Remove contaminated tubing before cleaning and replace with new tubing before the next sample collection. Thoroughly clean the automatic sampler between uses, (Section I.H) and check for any damage or needed repairs. Inspect the desiccant and batteries and replace if necessary. Test the manual and automatic operation of the automatic sampler to make sure it is operating correctly. Check the pumps function in forward, reverse, automatic, and run the automatic sampler through at least one purge-pump-purge cycle. Compare function against manufacturer's specifications.

Follow manufacturer's instructions to make any needed repairs or calibration changes. Develop calibration and use SOPs for each brand and/or model of automatic sampler used in each EFO. Keep all calibration and repair records stored at minimum in a bound logbook.

2. **Safety**

Powder-free nitrile gloves must be worn when installing sampling equipment or collecting samples to avoid contamination of the sample and to provide protection from possible health risks. Nitrile gloves should not be assumed to provide adequate protection from acids or hazardous materials.

3. **Installation of Automatic Sampler**

Power must be available for the entire sampling event. If accessible, the facility's power may be used. If the facility's power is not available, then generator or battery power must be used. Install new tubing (Silastic®, or equal, in the pump and Tygon®, Teflon®, or equal in the sample train) in the automatic sampler before deployment. Collect an equipment blank on the automatic sampler at ten percent of the sites.

Before installation, test the rinse, purge-pump-purge cycle at least once. Also, check the pump volume at least twice using a graduated cylinder. Each aliquot must be at least 100-mL's. Test flow proportional automatic sampler operation with the flow meter to make certain it is operating properly.

After the automatic sampler and tubing is placed in the proper location, program the sampler. For time composite samples, program the automatic sampler to collect at least 100-mL aliquots at the permit specified frequency. For flow proportional samples, program the automatic sampler to collect at least 100-mL aliquots at intervals based on the flow.

The final total volume must be sufficient to conduct all required analyses, for either collection method. If possible, install the automatic sampler where specified in the permit. Position the intake to draw wastewater from the mid-channel at mid-depth. If a facility disinfects with chlorine, install the automatic sampler upstream of chlorination.

3. Special Precautions for Metal and Organic Samples

If metal samples are to be collected, rinse the entire automatic sampler with reagent-grade water. Pump about a half a gallon of reagent-grade rinse water through the system and discard. For organic samples, use organic-free reagent-grade water for rinsing and flushing. Pump about one and a half gallons of organic-free reagent-grade water into the composite sample container for distribution into the appropriate blank container.

For metal samples, add nitric acid to the metals blank container for preservation. If the automatic sampler tubing is attached to a metal conduit pipe, install the intake tubing upstream. Wrap the submerged portion of the conduit pipe with a protective barrier such as duct tape.

4. Securing Automatic Sampler

Secure the automatic sampler in such a way as to prevent tampering with the sample. At a minimum, place a lock and signed and dated custody seal on the automatic sampler housing. Some locations may require additional security measures. Custody seals may also be placed on sampling pole and tubing line.

5. Retrieving the Automatic Sampler

When the compositing period has ended, remove the sample from the automatic sampler and thoroughly mix the composite sample. After the sample is well mixed, pour the composite sample into the appropriate, properly preserved sample container(s). Attach a completed sample tag to each sample bottle and complete the Sample Request Form. Before the sample container is filled, attach pre completed tags to the corresponding bottles making sure the following is filled out; Station ID, Station Name, Description, Activity Type, Preservative, and Samples (Tests Requested). While at the site be sure to fill out; Field Log Number, Date, Military Time, and Samplers. The primary sampler's name must be on the sample tag. Write "Composite (Comp.)" on the tag. Place the labeled sample bottle in a zip-type bag (optional) and store in a cooler on ice until delivery to the laboratory.

For routine inspections, offer the permittee a split sample. Collect all sampling equipment and perform appropriate cleaning and maintenance on the automatic sampler upon return to the EFO.

Protocol H - Sample Identification Tags

Each sample must be correctly identified as to where, when, and by whom it was collected, how it was preserved and what analyses are needed. TDH Environmental Laboratory provides sample tags that have been approved by EPA. However, the LabReq form will generate auto populated sample tags that can be printed on Weatherproof© labels with a laser ink printer. These will also work for use if using another TDEC contract laboratory. Use only non-erasable ink on the sample tags. It is recommended to use waterproof ink or ballpoint pens. If mistakes are ever made on the printing of the tag, draw one line through any mistake. Do not use white out. If a sticker label is attached to the sample tag, it must adhere well enough that it cannot be removed without damaging the tag to a dry bottle. Clear packaging tape may be applied over a completed sample tag to assure the sticker will adhere and prevent the ink from smudging. Always write legibly. All tags or stickers must include the following identification information.

1. **Activity Type-** This will appear when the appropriate information is filled out in the Events Tab. Double check for accuracy. This will indicate if the sample is a routine sample or a QC sample.

2. **Station (No) ID-** This will appear when the appropriate information is filled out in the Events Tab. Double check for accuracy. This indicates your location.

3. **Name (of Waterbody)** – This will appear when the appropriate information is filled out in the Events Tab. Double check for accuracy.

4. **Month/Day/Year** –This will be filled in the field as sample is collected.

5. **Time** – This will be filled in the field as sample is collected. Record the sample collection time in military time (24-hour clock) without colons.

6. **Description** – This will appear when the appropriate information is filled out in the Events Tab. Double check for accuracy.

7. **Samplers** – The primary sampler must write their full name. The other samplers should initial.

8. **Preservative Samples (analyses)** – Next to samples, use the drop-down box to select the type of sample.

Protocol I - Sample Request Forms

When using the TDH laboratories complete the sample request form using e-forms.. Always use the most recent version of the LabReq workbook. An example of a properly completed sample request form is provided in Appendix A. For technical instructions, refer to the SPERT.

If using a TDEC contract laboratory for *E. coli*, fill out form as usual and check the box “Check if *E. coli* will be delivered to Contract Lab” in the Event tab in LabReq if that site has an *E. coli* that was sampled. All sample request forms must include the following information

If using another TDEC contract laboratory for chemical analysis, obtain the appropriate sample request sheets from the contract laboratory. Write legibly and complete all information on the Sample Request Forms. Draw one line through any mistake written on the form. Do not use white out Complete a separate Chain of Custody (Appendix A) if any sample request sheet other than those provided by TDH Environmental Laboratory is used.

1. Header Information

Completely fill out the yellow portion of cells of the LabReq form in the Events tab. This will then populate the corresponding information into the upper left hand corner of the TDH Environmental Laboratory Sample Request Form (Figure 5).

2	PLEASE PRINT LEGIBLY					
3	PROJECT NAME:	303(d)	PROJECT ID:	TNPR0080		
4	STATION NUMBER:	ADAIR001.1MN	WATERBODY NAME:	Adair Branch		
5	STREAM MILE:	1.1	COUNTY:	Madison		
6	DESCRIPTION	U/S Hwy 412 Nears Bells Hwy				
7	LATITUDE:	35.67505	LONGITUDE:	-88.94907		
8	Matrix:	Water	Activity Type:	Sample-Routine	Depth:	
9	COLLECTED: DATE	7/5/2017	TIME:			
10	SAMPLER'S FULL NAME (printed)	Amy Fritz				
11	SAMPLING AGENCY:	Jackson EFO	FIELD LOG NUMBER:	AJF0705201701C		
12	IF PRIORITY, DATE		BILLING CODE:	EN00019121		
13	SEND REPORT TO:	G. Denton DWR/PAS/CO		Brad Smith/JEFO/DWR		

Figure 5: Completed Sample Request Form Header Information

a. Field Log Number. This is the unique sample identifier that will act as an EPA recommended ‘Chain of Custody’ number that will follow the sample from collection to disposal. This number will auto populate into the sample request form when all specified information is entered within the events tab. Refer to SPERT for technical details on this process.

b. Project ID: This will auto populate when a Project Name is selected. This must be an approved 'TNPR' number or the lab will not report the data electronically and it will not be uploaded to Waterlog.

c. Activity Type: This will be the indication of the type of sample. The sample is specified as "Sample Routine, Field Replicate, Field Blank, Trip Blank or Equipment Blank".

d. Project Name – The specific project name or focus of the field investigation must be entered in this field.

e. Station Number – The Station ID number uniquely identifies the location where the sample was collected. Using the dropdown box fill in the Station ID into the specified cell. The Station ID number must be completed. (For example CUMBE381.1CY. See Protocol B for assigning station numbers.)

f. County – After selecting the Station ID in the events tab, the County will populate into the Sample Request Form. See Appendix A for a complete county list. Do not use the DWR letter designation.

g. Description – This is connected to the Station ID so this will populate into the form. The description should match the description recorded for that station in Waterlog.

h. Stream Mile – This is connected to the Station ID so this will populate into the form.

i. Depth – Write the depth at which the water sample was collected if a discrete depth sampler was used to collect the sample. This line may be left blank for subsurface samples.

j. Matrix – Since most samples are water the matrix is auto-populated. If sediment or another medium is sampled change the matrix accordingly.

k. Collection Date – This is the date the sample was collected. This will populate into the form from the Events Tab.

l. Time – Write the time the sample was collected recorded in military time (24-hour clock without colon). Each sample will have a different time of collection to meet the requirements of the sample logger.

m. Sampler's Name – The samplers names are populated from the Events Tab. Print legibly the first and last name of the primary sampler. The Sampler's Name must be the same name as the "Collected By" signature on the chain of custody and the sample identification tags.

n. Sampling Agency – The sampling agency is auto-completed from the events tab. (For example: Nashville EFO.) ....

o. Billing Code – For 106 monitoring the billing code is auto-completed. For other sampling select the billing code from the drop-down box. Write the TDEC billing code or cost center assigned to various TDEC programs, for purchase of laboratory services if not using the LabReq workbook. (For example: EN00018347 or EN00018344.) Use the same billing code for QC samples as the other samples. Contact Debbie Arnwine Debbie.Arnwine@tn.gov if uncertain of appropriate billing code.

p. If Priority, Date Needed – Only fill out if the analytical results are needed by a particular date such as a program-determined priority or health effect emergency. ASAP is never appropriate. Do not designate a priority date for routine sample collections (the agreed upon turn-around time is 25 business days for chemical sample and 7 business days for bacteriological samples).

q. Send Report To – is auto-completed from the Events tab. Include the lead sampler's name, EFO or unit and DWR. Write in the Events Tab the person's email address where the sample report is to be sent.

r. Contact Hazard – List any known hazards related to the sample (radiological, chemical, or biological). If there are no known hazards write "unknown" or "none known." Do not write none since there is always the possibility of an unknown hazard.

2. Requested Analyses

Designate which analyses need to be performed on the sample by marking an "X" in the box left of the requested analysis (Protocol A) on the Sample Request Form(s) (Appendix A). Choose the needed analyses, but carefully consider cost. Write any special notations, such as requested dilution or low-level analysis, beside the needed analysis.

Minimally sample any 303(d) listed waterbody for the cause(s) for which it was listed. Ecoregion, ambient, and watershed monitoring stations have a set parameter list (Table 5). Appendix C lists the needed analyses for metal, organic enrichment/DO, nutrient, and pathogen TMDL development. Contact the WPU manager for additional analyses for TMDL development that may be needed. Consult DWR annual Water Quality Monitoring and Planning Workplan for specific details on planned sampling objectives. The LabReq workbook will complete the parameters from the annual 106 Water Quality Monitoring Plan. Double check that the correct parameters where populated.

3. Field Determinations

Collect the surface water samples and measure water parameters upstream of the chemical and bacteriological sample area. Use calibrated instantaneous water parameter meters for all field measurements of water parameters (Protocol J). The readings for each parameter are recorded in the appropriate boxes labeled Field Parameters in the Events Tab in the LabReq workbook. Field parameters are not to be hand written onto the printed sample request form as the lab will no longer be entering these.

Specific conductivity must be recorded in micromhos per centimeter or microsiemens per centimeter (µmhos/cm or uS/cm), dissolved oxygen in parts per million (ppm), which is equivalent to milligram per liter (mg/l), and temperature in degrees Centigrade (^{o}C). If meter readings are in other units, record the exact readings in the field survey form or field book. If a temperature correction factor must be applied, record the exact readings in the field sheet or book along with the correction factor and record the corrected value into the field parameter section for that sample for the associated field parameter within the Events tab of the LabReq workbook. Record the converted readings in the field parameter box. Record any additional field parameters such as turbidity or suspended solids under the other category and include units.

Once the field parameters are entered, they are ready for upload into the Waterlog Production database. (See Appendix A and SPERT for technical assistance).

If, after the drift check, the meter was found to be off by more than 0.2 units for pH, temperature or dissolved oxygen calibrated in mg/L or more than 10% for conductivity or dissolved oxygen calibrated to 100 % air saturation, do not upload them into Waterlog. If one parameter is out, make a note on the existing parameters that did not fail. For example, if pH failed the drift check but Temperature did not, do not upload any pH values for that run and document the pH failure in the Temperature “Meter Problem” box.

It is ideal to upload field parameters within 48 hours. It is the responsibility of the EFO to ensure that these are captured and uploaded to Waterlog Production. In the LabReq workbook on the ‘Waterlog’ tab, there is a hyperlink for “Water Parameters for Upload to Waterlog” that is linked to the SPERT. This section gives a detailed technical explanation on how to upload field parameters.

4. Chain of Custody

TDEC's Office of General Counsel requires that the chain of custody (Figure 6) be completed for any sample that has the potential of being used in court, reviewed by the Water Quality Control Board, or involved in state hearings. Therefore, all samples are potentially legal and the integrity of the sample must be beyond question. It is required that the chain of custody be completely filled out and maintained in the project file. See Section II.D for additional information on the chain of custody.

The entire right column of TDH Environmental Laboratories' Chemical and Biological Analysis Request Form(s) is TDEC's official chain of custody. TDEC's Office of General Counsel (OGC) has approved these forms. If using a TDEC contract laboratory other than TDH Environmental Laboratory, a separate chain of custody must be completed (Appendix A).

The chain of custody follows the sample through collection, transfer, storage, analyses, quality assurance and disposal. Each person responsible for the sample signs, dates, and records the time when samples are transferred into their custody. The TDH Environmental Laboratory maintains the chain of custody as well as a separate Sample Control Log and Manifest and internal Chain of Custodies for samples going between different lab departments.

a. Chain of Custody (Required)

The following is a row by row description of what is to be filled out in the top portion of the Chain of Custody. The sequenced numbers correspond to the respective section on the chain of custody. For a visual reference, refer to Figure 6.

(1) This section will ALWAYS be filled in. The sampler will sign their name in collected by and delivered to will be filled in no matter if it is going to the 'State Lab', contract lab, handing it off to another TDEC staff or a courier.

Collected by – The primary sampler must sign the first line (first and last name) followed by the date and military time of collection. If using the LabReq workbook be sure that the date and the time are correctly populated however a signature is still required.

Delivered to – Write the name of the person or place where the sample was delivered and the date and military time it arrived. There are three correct options for completing this section:

(a) If the sample is delivered directly to the laboratory, write the lab's name and/or the name of the lab personnel who received the sample in this blank (e.g. State Lab).
(b) If another staff member takes custody of the sample, write their name in this blank (e.g. John Smith).
(c) If a mail, bus, or courier service is used to transport the samples to the laboratory, write the transportation service's name in this blank (e.g. FedEx). The shipping receipt becomes part of the chain of custody documentation and must remain with the chain of custody paperwork.

(2). For example if this section is needed; for example, if the primary sampler gave the sample to a coworker to drive it to the lab. This person would put their name in the box above (1) 'Delivered to' and in this sections' 'Received by'. In this section, only those transporting the sample will sign their names. Lab staff does NOT sign this portion.

Received by – If the sample is transferred to someone else for delivery to the laboratory, including mail, bus, courier service, or TDEC staff, the recipient must sign their first and last name followed by the date and military time of receipt of the sample.

Delivered to – Write the name of the person or place where the sample was delivered and the date and military time it arrived.

(3). If this section, is needed hose transporting the sample will sign their names. Lab staff does NOT sign this portion.

Received by – If the recipient of the sample gives the sample to a third person for transport to the laboratory, the receiver must sign their first and last name on this line and fill in the date and military time of receipt of the sample.

Delivered to - Write the name of the person or place where the sample was delivered and the date and military time it arrived. See (1).

(4-6). These sections are for if more than one lab person is picking up samples from the samplers. Samplers and Couriers names should NOT be in this section.

Received in Lab by – The person in the lab who receives the sample signs their full name followed by the date and military time the sample was received in the lab.

(7) This section is for the lab employee who logs in the samples.

Logged in by – The person in the laboratory who logs in the sample signs their full name followed by the date and military time the sample is logged in.

b. Chain of Custody Additional Information (Required per OGC)

(1). Others present at collection – List all people (other than the primary sampler) present when the sample was collected.

(2). Number of other samples collected at same time at this point – Write the total number of additional bacteriological, chemical, biological, algal, or fish samples collected at this station during this sampling event. All analyses requested on the same Sample Request Form are considered one sample. For example, if bacteriological, routine, nutrient, and metals were the only bottles filled at a given site and the Inorganic Analysis Sample Request Form is the only form completed then these bottles are all considered the same sample. However, if organic volatile and biological samples were also collected at the same time the answer would be two additional samples.

(3). Mode of transportation to lab – Record the sample's method of transport to the laboratory (i.e. State vehicle, Greyhound bus, courier etc).

(4). Sample/cooler sealed by – If a custody seal is required (see Protocol C), sign the primary sampler's full name after the cooler has been sealed with a signed and dated custody seal.

(5). Date sample/cooler sealed – Write the date the sample or cooler was sealed with a signed and dated custody seal.

(6). Remarks – Write any special notations here. Include any stream description notes that may affect the sample such as heavy rains, algae, silt etc.

(c). E. coli Contract Lab Analysis Request (see figure in Appendix A)

In the Events Tab of the LabReq workbook, be sure to check the box next to 'E. coli sample collected for analysis by Contract Lab?'. This will ensure that all the event information such as Station ID, Time, Field Log Number etc. will be populated into the Contract Lab form that will be given to the contract lab.

In the Contract Lab tab of the LabReq eform be sure to use the drop-down menu to select the name of the correct contract lab. Be sure to enter a phone number, billing code and who to send the report to (these cells will all be in blue).

1. Printing Analysis Request

If printing the E. coli Contract Lab Analysis Request, print in landscape and the 'For Lab Use Only' columns do not need to be printed. After samples are collected, record collection time, dilution, and sign relinquished by and write the date and time samples are delivered to the contract Lab and add any comments that are needed.

2. Emailing Analysis Request

If you have made an agreement with the contract lab to email them the workbook, do so as soon as possible so they may record and report the E. coli results in the LabReq workbook. Contract Labs may continue to report results using the previous EDD or report results directly to SharePoint using the LabReq workbook. Make sure everything is properly filled out.

For more technical assistance please refer to the SPERT.

Inorganic Analysis

Laboratory Number
Chain of Custody and Supplemental
Only one chain of custody form is required per sampleset or point (if all collected at the same
1. Collected By Amelia Pond
Date 6/21/2018 Time 906
Delivered to James T. Kirk
Date 6/21/2018 Time 1153
2. Received by James T. Kirk
Date 6/21/2018 Time 1153
Delivered to State Lab
Date 6/21/2018 Time 1416
3. Received by
Date Time
Delivered to
Date Time
4. Received in Lab by
Date Time
5. Received in Lab by
Date Time
6. Received in Lab by Marie Curie
Date 6/21/2018 Time 1416
7. Logged in by Marie Curie
Date 6/21/2018 Time 1500
Additional Information
1. Others present at collection
Rory Williams
2. Other samples collected
None
3. Mode of transportation to lab
State vehicle
4. Cooler sealed by
Rory Williams
5. Date cooler sealed
6/21/2018
6. Remarks
DO meter not working.

Figure 6: Sample Request Form Chain of Custody For TDH Labs

Protocol J – Instantaneous Field Parameters

Dissolved Oxygen, pH, temperature and conductivity measurements are to be recorded at each chemical monitoring station every time the site is sampled. Field parameters are to be entered on the field parameter data LabReq workbook and uploaded to Waterlog (SPERT). Multi-probe or individual meters meeting specifications in Table 9 can be used.

Measure dissolved oxygen, pH, temperature and conductivity before biological samples and after chemical samples are collected. Place the probe upstream of where surface water samples were collected. Allow sensors to equilibrate before recording measurements. This may take longer with older probes and in low conductivity waters. When possible, submerge the sonde in the stream. Document all measurements including duplicates on the field parameter electronic data sheets. Measurements should be recorded to the nearest tenth.

Table 9: Water Quality Probe Minimum Specifications

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

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

All waters with low conductivity (<100) and low pH (<6) readings need to collect a sample for low pH analysis, in an unpreserved 250mL bottle with no headspace, on ice, sent to the TDH (holding time 72 hours). Make sure all appropriate workbooks and sample bottles have specifically been filled out for lab pH as these do not auto populate. Continue to load regular field parameters to Waterlog as normal.

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.

Drift check should be completed before probes are cleaned/gently washed. 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.

   Record routine maintenance and repairs in the logbook as well as upload to Waterlog Production's Equipment and Assets Inventory module. Some instruments must be sent to the manufacturer for servicing if they are covered under warranties, i.e. Bench Service Plan (BSP) for OTT Hydromet instruments. Other probes must be replaced when they no longer maintain their calibration. In these cases, refer to manufacturer's instructions.

   Meters should be calibrated in the following order; Conductivity, DO, pH.

Date	Meter	Project	Init.	Parameter	Standard	Reading	Adj	Comments
3/6/22	YSI-A	Davis Ck	JEB	Conductivity	142	120	142	Cleaned contacts
3/6/22	YSI-A	Davis Ck	JEB	Conductivity	142	140	NA	Drift Check

Figure 7: Meter Calibration Log

   a. **Frequency**: To ensure the most accurate data it is desirable that meters be calibrated each morning before use (or the afternoon during drift check.) **Calibrate DO probes each morning of use and at each site where necessary** (see # 2). Daily calibration is preferred for most defensible data, but when necessary c**onductivity and pH probes can be calibrated weekly with a drift check performed daily upon return.** 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, 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. **Conductivity:** Calibrate at 0 and the highest expected conductivity value. When using meters where zero is assumed, a higher standard is used for the calibration. For the MS5 or other meters where 0 is not assumed, the flow-through cell must be dried and placed in a dry calibration cup for the zero standard. Then a higher standard is used to calibrate the upper range.

d. **Dissolved Oxygen: The DO probe must be calibrated using air calibration (% saturation) each morning prior to use.** Probes automatically compensate for temperature changes. Some probes also automatically compensate for pressure changes. An ASTM calibrated thermometer and/or a handheld barometer must be carried in the field if the probe does not compensate for temperature and/or pressure changes. It is only necessary to recalibrate the probe at sites where there is a significant elevation, pressure or temperature change and the meter does not automatically compensate. A significant change in elevation is 1000 feet. A significant change in pressure is ±20 mm Hg (higher or lower) or when a storm front comes through the area. A significant change in temperature includes any ±5ºC 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 9

2. **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 if possible, check user manual. Always perform at minimum a 2 point calibration with a check on the third point. Electrolyte and KCL pellets should be replaced monthly in most cases, every 2 weeks in low ionic strength environments. Buffer 7 always first then bracket with anticipated pH range (i.e. 4 for acidic streams and 10 for basic streams) and check with the other buffer. pH electrode should not be submerged during storage. Make sure the O ring is dry and there are no air bubbles. Use Simple Green on the electrode to clean it, fill it up halfway with the storage solution, and press it back on ensuring the O ring is dry, whenever the salt tablets are changed.

   All waters with low conductivity (<100) and low pH (<6) readings need to have a sample collected for low pH, in an unpreserved 250mL bottle with no headspace, on ice, sent to the TDH (holding time 72 hours). Make sure all appropriate workbooks and sample bottles have specifically been filled out for lab pH as these do not auto populate. Continue to load regular field parameters to Waterlog as normal. In low conductivity water the probe will take longer to equilibrate.

3. Probe Placement:

Ideally, measure the 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 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 horizontally 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 or riffle 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 and pH 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, bubbles, or tears. If the instrument has a Luminescent DO probe, check to see if the cap 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.

If you are having issues in very low ionic strength waters, swirl the sensor around in the water to help it reach equilibrium. If the sensor is just put in a stream, it could take up to an hour to stabilize but by swirling, it may only take 15-20 minutes.

4. **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 9. Rinse the probes with tap water after use at each site to avoid contamination.

5. **Record Field Parameters:**

   Document the field measurements on the field parameter datasheet. Specific conductivity must be measured in umhos/cm, dissolved oxygen in ppm (mg/l), and temperature in ^{o}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.

6. **Drift Check (Post Calibration):**

   Without post-calibration checks, the accuracy of the water parameter measurements cannot be demonstrated, and data are not defensible. 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 7). 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 10% (air saturation), all readings between the initial calibration and the drift check are questionable.

If any readings are criteria violations, and the data has been validated, be sure to put in the comments section if the drift check passed.

If one or more parameters have either instrument or drift check failure do not report that parameter but include a comment regarding the parameter that failed beside another parameter that will be reported. If you have complete instrument failure let WPU know.

7. 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. It is recommended that turbidity be measured in the field instead of collecting a sample for lab analysis if a calibrated meter is available. Perform check at the end of each day.

Protocol K – Continuous Monitoring Field Parameters

Some sampling objectives will require continuous monitoring of field parameters to document daily fluctuations. Continuous monitoring multi-parameter probes log water quality parameters at regular intervals up to several months. Current studies suggest that probes should be deployed for at least 2 weeks to accurately gauge water parameter fluctuations. The length of deployment will depend on the study objectives. Often diurnal probes are used to monitor water conditions in the low flow months during late summer and early fall. Continuous monitoring probes meeting the following specifications may be used (Table 10).

Table 10: Continuous Monitoring Probe Minimum Specifications

Parameter	Range	Accuracy	Resolution
Temperature	0°C to 50 °C	+/- 0.2 °C	0.01 °C
Specific Conductivity	0 – 100,000 umhos/cm* or to maximum study requirements	+/- 1% of full scale	4 digits
PH	0 to 14 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.

The continuous monitoring meter must be completely submerged in water throughout the study to record water parameters. At least 6 inches of water are required to submerge the probe. To produce manageable data, it is recommended that the probe be set to measure water parameter readings no more frequently than every 30 minutes. The sensors are very fragile, so be careful with the probe, especially when the sensor end cover is off for cleaning or maintenance.

Label all meters as property of the State of Tennessee, Department of Environment and Conservation. Assign each meter a distinct identifying number (i.e. serial number, letter, or number) for calibration, maintenance, and deployment records. Mark each meter with this designation.

1. **Pre-deployment calibration Check** – Many continuous monitoring multi-parameter probes are factory calibrated. It is necessary to check the meter's calibration to prove the accuracy has not drifted. The morning of the deployment or within 24 hours prior to deployment, at the EFO lab, check the meter's calibration, following manufacturer's directions. Maintain calibration and maintenance SOPs for each model and/or brand of meter. Keep all calibration check records in a bound logbook (Figure 7). Include the date, meter identification number, project name or number, initials of calibrator, parameter, standards used, meter reading, and adjustments.

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

2. **Initiate Logging** – Either in the EFO office or at the sampling site, follow manufacturer's instructions to connect the continuous monitoring probe to a programmed computer with the sensor cable. Follow the manufacturer's instructions to program the logger and turn on the probe. Change the file name to the Station ID. Check the time, date on the probe, and reset if necessary. Set the probe to record water parameters at regular time intervals according to study needs. Intervals no more frequent than every 30-minutes are recommended to produce a manageable data set and preserve battery life. After the probe has been programmed and the logger has been started, disconnect the sensor cable and prepare the sensors for deployment following the manufacturer's instructions.

3. **Probe Location** - To accurately measure water conditions choose an area of even, non-turbulent flow in which the probe will remain submerged even if the water recedes. At least six continuous inches of water are required for the sensors to read the water parameters accurately. If possible, to avoid vandalism, place the probe in an area out of sight from bridges and roads. Secure the instrument in a location that will give readings representative of ambient conditions.

   To check for maximum diurnal DO fluctuations associated with algae, secure the meter in an area with limited canopy cover. Be aware that if the probe is secured in direct sunlight, the daytime temperatures recorded may be higher than the actual water temperature due to radiant heating. If the study objective is to check diurnal DO swings in the most productive macroinvertebrate habitats, secure the probe in a canopied area. Avoid placing probe in a location that will receive full force of the floodwaters during storm activity (i.e. outside of bends, or bottleneck in streams).

4. **Probe Deployment** – Anchor the probe so it will remain stationary even if high water becomes a problem. Any means of securing the probe may be used, as the details to location are site dependent. In streams with firm substrate, but not bedrock, a good way to secure the probe is to drive a rebar stake into the streambed and attach the sensor to the rebar with stainless steel cable. In bedrock substrate, stabilize the probe with a stainless-steel cable or chain attached to a tree root, or boulder.

   Streams with silt and sand substrate pose an especially difficult challenge to avoid burying the probe in sediment. One solution that has been found is to place a concrete block on top of a wooden board and then attach the probe to the top of the concrete block. Another deployment method that works well in deeper waters is to attach the probe securely to a large float such as a boogie board. Then cable or chain the probe to a stable anchor point on the bank and to a weight to keep the floating probe in the channel.

After the probe is securely anchored, camouflage the body of the probe with rocks and branches, but do not cover the sensor end of the probe. Log the probe deployment in the field log (Figure 7) and make careful notes and drawings about where the probe is located. In several weeks, it may be difficult to remember where the probe was placed. It is possible someone else will need to retrieve the probe.

Continuous Monitoring Probe Field Deployment Log

Diurnal Field Log								
Logger Set Out					**Logger Retrieved**			
Station ID	**Probe#**	**Date**	**Time**	**Init.**	**Date**	**Time**	**Init.**	**Comments**
JONES000.1DA	B	7/07/21	0900	JRS	7/21/21	0830	JRS	Lots Algae

Figure 8: Diurnal Field Log

5. **QC Probe Readings –** At every 10th site, anchor a second continuous monitoring probe beside the first to serve as quality control. If time allows it is also recommended that at least one mid-deployment and a pick-up measurement be taken with a calibrated instantaneous probe. (See Section II for additional QC information.)

6. **Probe Retrieval** – After the probe has been deployed the designated time, return to the site where the probe is anchored. Note the probe's location and condition. Take instantaneous readings with a second calibrated probe for comparison. Carefully remove the probe from its anchor and stow it on the bank. Then retrieve the probe anchoring system and prepare the probe sensor for transport per manufacturer's instructions.

   Document probe condition on retrieval, and view readings with caution if the probe was covered in sediment or algae when it was retrieved. Disregard any questionable readings. Usually, the DO will drop markedly when the probe becomes buried. If the probe is not in the same location it was deployed make careful notes as to where the probe was found and its condition and view the readings with caution.

7. **Download Data** – Connect the continuous monitoring probe to the computer via the sensor cable. At the site, open the probe program on the laptop and turn the data logger off. If the probe will be redeployed immediately, download the recorded data onto the laptop computer. Data may be downloaded in transit to the next site. Back-up the data on the continuous monitoring central server. If the probe will be returned to the office before it is used again, the data may be downloaded to a programmed desktop computer.

8. **Post Deployment Drift Check** – Check the meter's calibration within 24 hours of returning to the office. Record the post deployment check in a bound logbook. Include the date, meter identification number, project name/number, and initials of the person performing the calibration, parameter, and meter reading. Include any duplicate measurements made with an instantaneous probe.

   Record any maintenance or repairs in the logbook as well as upload to Waterlog Production's Equipment and Assets Inventory module. Notify supervisor if conductivity measurements are off by more than 10% or if dissolved oxygen (mg/l), pH or temperature are off by more than 0.2 units. Note that if mid-deployment checks with an instantaneous probe were within acceptable ranges, only those measurements taken between the last duplicate reading and the post-calibration need to be flagged. Follow manufacturer's instructions for re-calibration if necessary.

9. **Clean Probe** – After the post calibration check, clean the sensors very carefully. (The sensors are fragile.) Follow the manufacturer's instructions for cleaning, maintenance, or repairs of the sensors.

10. **Data Interpretation** – Determine which readings reflect water quality. Due to set up time and the reading delay, disregard the initial readings. Review readings for all parameters and check for anomalies. It is possible for the water level to drop and rise back up during the time of deployment. If the probe was not in the same location it was left, carefully review data to determine if it has been removed from the water. Retain original files.

Protocol L – Flow Measurement

Flow measurements are only required at the Southeast Monitoring sites (SEMN).

In wadeable waters, measure the flow with an electromagnetic current meter after bacteriological and chemical samples are collected, physical water parameters are measured and before leaving the site. In waters too shallow for use of an electromagnetic current meter or too deep to safely wade, flow may be estimated. For non-wadeable waterbodies, vertical-axis rotor cup type meters may also be used to measure flow. Follow manufacturer's instructions for use, calibration, and maintenance of all flow meters. Record all measurements in tenths of feet.

1. Flow Measurement with Electromagnetic Current Meter

Label each flow meter as property of the State of Tennessee, Department of Environment and Conservation. Assign each meter a unique identification letter or number (i.e. A, B, 1,2, or a portion of the serial number). Mark each meter with this meter identification number. Electromagnetic current meters meeting the following specifications (Table 11) may be used:

Table 11: Electromagnetic Flow Meter Minimum Specifications

Range	Accuracy	Resolution
-0.5 to 20 ft./sec.	+/- 2% of the reading + Zero stability (+/- 0.05 ft./sec.)	0.1 ft./sec.

a. **Calibrate Meter** - Calibrate the flow meter at the EFO lab, per manufacturer's instructions each week the meter is used. Maintain calibration and maintenance SOPs for each brand and/or model of flow meter. Keep all calibration records in a bound logbook. Include date, meter identification number, project name or number, initials of calibrator, flow measurement, adjustments, and maintenance or repair records in the logbook. Upload any calibration issues to Waterlog Production's Equipment and Assets Inventory module.

Check to be certain the meter is reading in feet per seconds. A zero adjustment is the suggested method to calibrate flow meters. Place the sensor in a five-gallon plastic bucket of tap water. Keep it at least three inches away from the sides and bottom of the bucket. To make sure the water is not moving, wait 10-15 minutes after you have positioned the sensor before taking any zero readings. Adjust to zero according to manufacturer's instructions.

b. **Select Transect -** At the site, select a safely wadeable transect to measure velocity. If possible, the transect should be in a straight area with measurable linear flow. The water surface should be flat, not riffling, with no large obstructions to disrupt the smooth current.

The ideal (usually not possible) would be a flat, straight channel with a linear current at an even depth and velocity across the whole channel.

One of the best areas to consider is a run just before a riffle. Avoid braided areas next to large, wet gravel bars, stagnant water, eddies, and bridges. Some channel modifications may make a more uniform channel and be appropriate for measuring flow. Stretch a surveyor's tape (English measurements, marked in tenths of feet), on the selected transect from the left descending bank (LDB) to the right descending bank (RDB) perpendicular to the flow direction. Clamp the ends of the surveyor's tape at the top of each bank to trees and/or stakes. Make sure the surveyor's tape is straight, taut, and close to the water at an even height across the creek.

Record the meter identification number and document where flow measurements were taken. Remove large stones or logs that may interfere with flow and the placement of the wading rod before flow is measured.

c. **Measure Flow -** Attach the sensor probe to the sensor mount on the wading rod and the sensor cable to the display unit. Turn on the flow meter and make sure it is reading in feet/second (Ft/S). Record all flow information on the Field Flow Measurement Sheet in the Flow 1 tab in the LabReq workbook or in a field notebook.

(1) Record Tape Reading – Record the tape measurement (in tenths of feet) at the left edge of water (LEW). Make the first velocity reading as soon as the water depth is adequate to cover the sensor. Place the wading rod's weighted base flat on the streambed below the surveyor's tape and hold it vertically (make sure it is straight). Record the precise tape measurement in the tape-reading column located on the left column (tape reading) of field flow measurement sheet or in the field book. Actual distance measures can be calculated at the office.

(2) Measure Water Depth - Follow the manufacturer's instructions for measuring water depth and placing the sensor at the proper depth in the water column. Record the water depth (in tenths of feet) at this location in the depth column of field flow measurement sheet or in the field book.

(3) Measure Velocity – Adjust the sensor on the wading rod to the proper water depth and point the sensor perpendicular to transect tape. If the water is less than 2.5 feet deep, measure velocity at 0.6 of the total depth. For water deeper than 2.5 feet, measure velocity at both 0.2 and 0.8 of the total water depth and average the reading. Stand downstream and slightly to one side so as not to affect the flow of the current. Allow the readings to equilibrate and then record the average velocity reading in the velocity column on the field flow measurement sheet or in the field book.

(4) Repeat Velocity Measurement – To choose the appropriate spacing of the velocity readings consider the entire stream flow. Ideally, there should be no more than 5 to 10 percent of the total stream flow between each velocity reading. In areas with faster flow, readings will be spaced closer together. Velocity readings may be spaced further apart in areas with slower flow. Readings do not have to be at even increments, however, it is important to accurately record distances and depths.

At the left edge of water (LEW) record the tape reading, water depth and velocity on the next line of the field flow measurement sheet or field notebook. Repeat this procedure for 20 – 30 readings across the stream channel. For streams less than 5 feet wide, take readings at six-inch intervals. The number of measurements necessary for flow is dependent upon the size of the stream. Take the final reading near the right edge of water (REW) at the last place the water is deep enough to cover the sensor. Record the tape reading at the right edge of water (REW). Use additional sheets if more than 30 readings are necessary.

d. QC Flow Measurement - At every 10th site, take a second flow reading in the same transect. Measure QC flow on the same day as the original flow is measured.

If holding times are a constraint, flow and/or QC flow measurements may be taken later the same day if there has been no precipitation or change in flow. After flow has been calculated, if there is more than 10 percent difference between the original and QC flow calculations. Indicate that there was an issue with the probe the electronic field parameter section next to a passing field measurement.

e. Post-Calibration Check – Check the flow meter calibration at the end of each use (minimally once a week) in the EFO lab, according to manufacturer's instruction. Do not clean the sensor before performing post trip calibration check. Record the post trip calibration check in logbook. Do not upload flow if the check is off by more than ±0.05 Ft/S. After the post calibration drift check, adjust the calibration as needed following manufacturer's instructions.

f. Calculate Flow - The excel worksheet in the LabReq can quickly and accurately calculate total flow. An example of the flow measurement sheet with excel formulas is included in Appendix A. Contact the Watershed Planning Unit if a more recent electronic version of this flow calculation spreadsheet is needed.

Translate the tape readings from the field flow measurement sheet to distance from the LDB on the flow measurement sheet. Do not round off tape readings, water depth, or velocity readings. After flow has been calculated, round the total flow to the appropriate significant digit (generally 2 decimal places).

To calculate total flow of the stream or river, use the following formula:

1. Determine the cell width. Each cell width is composed of half of the distance between the previous and the next flow reading, $(W_c-W_a)/2$.
2. Determine the cell area. The cell area is made up of cell width, $(W_c-W_a)/2$, multiplied by the center depth measurement (D_b) of each cell.
3. Calculate cell flow by multiplying the cell area, $D_b[(W_c-W_a)/2]$, times the center velocity reading (V_b) of each cell.
4. Sum all the cell flow readings, $D_b[(W_c-W_a)/2]V_b$, to calculate total flow of the stream or river. This value is the total flow of the stream or river in cubic feet per second (CFS).

$$\Sigma = D_1[(W_2-W_1)/2]V_1 + D_2[(W_3-W_1)/2]V_2 + D_3[(W_4-W_2)/2]V_3 + \ldots + D_{25}[(W_{25}-W_{24})/2]V_{25}$$

g. QC Data Entry – Have the QC Quality Team Member (Section II.A) or their designee QC data entry and flow calculation before reporting the flow data. Send final flow calculation to WPU.

2. Flow Estimation Float Method

In waters too shallow for use of a current meter or too deep to safely wade, flow may be estimated by the float method. The only items needed to estimate flow are a watch (with seconds reading) or stopwatch, a measurement tool such as a yardstick or tape measure (English units), and something that floats like an orange, cork or piece of wood. Do not use non-biodegradable objects such as plastic bottles.

a. Measure and record the stream width and the stream depth in at least five places. Average the stream depth readings.
b. Multiply the average depth times the stream width to estimate the cross-sectional area.
c. To estimate water velocity, mark a given distance and time how long it takes the floating object to float the measured distance. The object should only take 10-30 seconds to float the given distance.
d. Repeat the velocity estimation at least three times and average the readings to determine mean velocity. When the float times are significantly different from one another, the floating object may be waterlogged. Check the object each time it is used.
e. Since water flows fastest at the surface, multiply the mean velocity by 0.8.
f. To estimate flow, multiply the mean velocity (times 0.8) times the cross-sectional area (average depth times width). Record flow in cubic feet per second (CFS).

Estimated Flow = [Mean Velocity (0.8)] (Avg. Depth) (Width)

3. **Flow Estimation Bucket Method**

In very small waterways, too small for an object to float, a graduated bucket or cylinder and a watch (with second readings) or a stopwatch may be used to estimate flow. A small temporary dam must be built to channel all flow to a weir or pipe. Capture all of the flow into a graduated bucket or cylinder over a given period of time and measure the amount of water captured. For example if 1.7 liters were captured in 10 seconds, the flow would be 0.17L/Sec. Repeat this measurement at least three times and report the average as the estimated flow. Calculate the flow in CFS. One liter is equivalent to 0.0353 cubic feet. If the average flow was 0.17L/Sec, when calculated into CFS it would be (0.17 x 0.0353) and reported as 0.006CFS.

4. **Staff Gage Flow Measurement**

If a staff gage is installed at a site, record the water height on the gage. Later plot the staff height on the established flow curve to determine flow or contact the USGS office responsible for the gage and request the flow in cubic feet per second for the corresponding gage height. See USGS protocol for methods and additional information (Buchanan and Somers, 1976). USGS also has real time flow on-line for some gauging stations.

5. **Dye tracers (dilution for "direct" flow measurement in some TMDLs**) – continuous, steady state release of known concentration of dye solution at known release (flow) rate – measure concentration at downstream point in stream at which complete mixing has occurred:

$$Q*C_0 + q*C_1 = (Q + q)*C_2$$

and $Q = q*(C_1 – C_2)/(C_2 – C_0)$

where q = injection rate

C_1 = tracer concentration

C_0 = initial in-stream concentration

C_2 = final concentration

6. **Gauging Station** - A calibrated gauging station (such as USGS) may be used to measure flow if there are no tributaries between the gauge and the sampling point.

Protocol M – Bacteriological (Pathogen) Analyses

Adapted from Standard Methods 9223B

Due to short holding times and long distances to the laboratory, it a may be more convenient for some EFOs to analyze the bacteriological water samples themselves. EPA has approved the use of the Colilert Method, which utilizes the IDEXX Quanti-Tray®/2000 for total coliform and *E. coli* testing. This method is reproducible but requires certain equipment such as a tray sealer, incubator. If the bacteriological water samples are analyzed at the EFO lab, the results must be within the limits of the method. When the results are outside the limits of the method, the EFO will take corrective action. When the problem cannot be resolved, the EFO must send future bacteriological water samples to the closest TDH or contract lab until the problem is resolved.

The Colilert method detects the presence of enzymes produced by total coliform bacteria and *E. coli*. Enzymes produced by total coliform will hydrolyze the substrate and produce a yellow color. If enzymes produced by *E. coli* bacteria are present, they will hydrolyze the substrate and cause the sample to fluoresce under a long-wavelength ultraviolet light. The IDEXX Quanti-Tray®/2000 quantifies the Most Probable Number (MPN) of bacteria detected using the Colilert method.

The media used in this test must be purchased from a commercially available source. Store Colilert media at room temperature and protect it from light. Colilert reagent media have a shelf life of one year. Do not use expired or discolored reagents. Some media lots have been found to auto fluoresce. Whenever a new lot is received, check it for fluorescence under the 366-nm ultraviolet light with a 6-watt bulb and do not use if the media fluoresces.

1. Log Pathogen Sample

Maintain a logbook of all bacteriological and quality control samples analyzed at the EFO (Figure 9). The logbook must minimally contain the following information:

- Date sample collected - Formatted: Month-Date-Year (MM-DD-YYYY)
- Time sample collected
- Station ID number or appropriate QC designation
- Field log number
- Media reagent lot number
- If sample is a QC note it as trip blank, field blank, equipment blank or duplicate into the QC column on the Pathogen Log
- Initials of the person who inoculated the sample
- Date sample was inoculated and placed in the incubator - Formatted: Month-Date-Year (MM-DD-YYYY)

- Time sample was inoculated
- Temperature of incubator
- Date sample was removed from the incubator and analyzed - Formatted: Month-Date-Year (MM-DD-YYYY)
- Time sample was analyzed
- Initials of the person who read the test results (analyzed the sample)
- Number of large and small wells that turned a yellow color equal to or darker than the comparator
- Number of large and small wells that fluoresce under a UV lamp equal to or darker than the comparator
- Record the most probable number Total coliform results from the Quanti-Tray®/2000 MPN table (Table 12)
- Record the most probable number *E. coli* results from the Quanti-Tray®/2000 MPN table (Table 12)
- Record any comments, cautions, QC results or maintenance. Additional comments can be recorded on the following rows.

Pathogen Log

Col. Date	Col. Time	Station ID/ QC ID	EFO Pathogen Log #	Reagent lot #	QC	Inoc. Init.	Date Inoc.	Time inoc	Incub .temp. (ºC)	Anal. date	Anal time	Anal .Init.	# yellow Lg/Sm wells (+Total Colif.)	# fluor. Lg/Sm wells (+ *E. coli*)	MPN Total Colif.	MPN *E. coli*	Comments/ Maintenance
05-29-2021	0830	BAKER 008.9WA	CFW0529202101	472HY		JAL	05-29-2021	1400	34.8	05-30-2021	1405	JKR	46/48	26/40	533	101	
05-29-2021	1000	BWAR 007.4HK	CFW0529202102	472HY		JAL	05-29-2021	1410	34.8	05-30-2021	1415	JKR	31/48	11/33	142	51	
05-29-2021	1200	RIPLEY 000.1HK	CFW0529202103	472HY		JAL	05-29-2021	1415	34.8	05-30-2021	1425	JKR	49/44	49/31	1553	649	
05-29-2021	0800	PUNCH 001.5GE	CFW0529202104	472HY		JAL	05-29-2021	1330	35.2	05-30-2021	1300	JKR	49/40	40/24	1120	140	
06-02-2021	NA	PUNCH 001.5GE	CFW0529202105	472HY	QC-*P. aerug.*	JAL	06-02-2021	1340	35.2	06-03-2021	1310	JKR	0/0	0/0	0	0	*P.aeruginosa* QC -PASS
05-29-2021	NA	PUNCH 001.5GE	CFW0529202106	472HY	QC-*K. pneum*.	JAL	05-29-2021	1345	35.2	06-03-2021	1315	JKR	49/36	0/0	866	0	*K.pneumoniae* QC-PASS
06-02-2021	NA	PUNCH 001.5GE	CFW0529202107	472HY	QC-*E. coli*	JAL	06-02-2021	1350	35.2	06-03-2021	1320	JKR	47/46	40/39	640	198	*E. coli* QC-PASS
05-29-2021	NA	PUNCH 001.5GE	CFW0529202108	NA	QC-Quanti-Tray sealer	JAL	05-29-2021	1400	NA	06-02-2021	1415	JKR	NA	NA	NA	NA	Quanti-Tray sealer QC-PASS

Figure 9: Pathogen Analyses Log

2. Use of the Colilert 18 or 24 Method Quanti-Tray®/2000

a. Add reagent media to sample. Colilert snap pack reagents are sized for specific volumes of water. Measure the amount of sample water appropriate for the reagent pack. Open the snap pack of media reagent and pour it into the sample water. Place lid on the sterile container and shake it until completely dissolved. Allow any foam to subside before pouring.

a. Carefully pour sample reagent mixture into the Quanti-Tray® without touching the foil tab. Tap tray to remove air bubbles before sealing.

b. Seal Quanti-Tray® according to manufacturer's instructions.

c. Incubate the sample at 35°C +/- 0.5°C for 18 or 24 hours, depending on the Colilert Method.

d. Read test results at 18 or 24 hours. There is a 4-hour period following the 18 or 24-hour incubation period within which the samples may be read.

   1. If no yellow color is observed, the test is negative for total coliform.

   2. If a yellow color lighter than the comparator yellow color is observed incubate the sample for an additional 4 hours, then check the color. If the color has intensified, the sample is positive. If it has not, the test is negative.

   3. If the sample has a yellow color equal to or greater than the comparator, the sample is positive for total coliform. Count the number of yellow large and small wells.

   4. Samples positive for total coliform can be checked for the presence of *E. coli* by placing the Quanti-Tray® in a 6-watt, 365 nm UV lamp and checking for fluorescence. If the fluorescence is equal to or greater than the comparator the sample is positive for *E. coli*. Count the number of large and small fluorescent wells.

e. To determine the coliform and *E. coli* density, compare the number of yellow and/or fluorescing wells to the Most Probable Number (MPN) table provided by the manufacturer (Table 12).

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

Table 12: Quanti-Tray®/2000 Most Probable Number Table

IDEXX Quanti-Tray®/2000 MPN Table *(per 100ml)*

# Large Wells Positive	# Small Wells Positive																								
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0	<1	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.1	15.1	16.1	17.1	18.1	19.1	20.2	21.2	22.2	23.3	24.3
1	1.0	2.0	3.0	4.0	5.0	6.0	7.1	8.1	9.1	10.1	11.1	12.1	13.2	14.2	15.2	16.2	17.3	18.3	19.3	20.4	21.4	22.4	23.5	24.5	25.6
2	2.0	3.0	4.1	5.1	6.1	7.1	8.1	9.2	10.2	11.2	12.2	13.3	14.3	15.4	16.4	17.4	18.5	19.5	20.6	21.6	22.7	23.7	24.8	25.8	26.9
3	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.3	11.3	12.4	13.4	14.5	15.5	16.5	17.6	18.6	19.7	20.8	21.8	22.9	23.9	25.0	26.1	27.1	28.2
4	4.1	5.2	6.2	7.2	8.3	9.3	10.4	11.4	12.5	13.5	14.6	15.6	16.7	17.8	18.8	19.9	21.0	22.0	23.1	24.2	25.3	26.3	27.4	28.5	29.6
5	5.2	6.3	7.3	8.4	9.4	10.5	11.5	12.6	13.7	14.7	15.8	16.9	17.9	19.0	20.1	21.2	22.2	23.3	24.4	25.5	26.6	27.7	28.8	29.9	31.0
6	6.3	7.4	8.4	9.5	10.6	11.6	12.7	13.8	14.9	16.0	17.0	18.1	19.2	20.3	21.4	22.5	23.6	24.7	25.8	26.9	28.0	29.1	30.2	31.3	32.4
7	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.1	17.2	18.3	19.4	20.5	21.6	22.7	23.8	24.9	26.0	27.1	28.3	29.4	30.5	31.6	32.8	33.9
8	8.6	9.7	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5	19.6	20.7	21.8	22.9	24.1	25.2	26.3	27.4	28.6	29.7	30.8	32.0	33.1	34.3	35.4
9	9.8	10.9	12.0	13.1	14.2	15.3	16.4	17.6	18.7	19.8	20.9	22.0	23.2	24.3	25.4	26.6	27.7	28.9	30.0	31.2	32.3	33.5	34.6	35.8	37.0
10	11.0	12.1	13.2	14.4	15.5	16.6	17.7	18.9	20.0	21.1	22.3	23.4	24.6	25.7	26.9	28.0	29.2	30.3	31.5	32.7	33.8	35.0	36.2	37.4	38.6
11	12.2	13.4	14.5	15.6	16.8	17.9	19.1	20.2	21.4	22.5	23.7	24.8	26.0	27.2	28.3	29.5	30.7	31.9	33.0	34.2	35.4	36.6	37.8	39.0	40.2
12	13.5	14.6	15.8	16.9	18.1	19.3	20.4	21.6	22.8	23.9	25.1	26.3	27.5	28.6	29.8	31.0	32.2	33.4	34.6	35.8	37.0	38.2	39.5	40.7	41.9
13	14.8	16.0	17.1	18.3	19.5	20.6	21.8	23.0	24.2	25.4	26.6	27.8	29.0	30.2	31.4	32.6	33.8	35.0	36.2	37.5	38.7	39.9	41.2	42.4	43.6
14	16.1	17.3	18.5	19.7	20.9	22.1	23.3	24.5	25.7	26.9	28.1	29.3	30.5	31.7	33.0	34.2	35.4	36.7	37.9	39.1	40.4	41.6	42.9	44.2	45.4
15	17.5	18.7	19.9	21.1	22.3	23.5	24.7	25.9	27.2	28.4	29.6	30.9	32.1	33.3	34.6	35.8	37.1	38.4	39.6	40.9	42.2	43.4	44.7	46.0	47.3
16	18.9	20.1	21.3	22.6	23.8	25.0	26.2	27.5	28.7	30.0	31.2	32.5	33.7	35.0	36.3	37.5	38.8	40.1	41.4	42.7	44.0	45.3	46.6	47.9	49.2
17	20.3	21.6	22.8	24.1	25.3	26.6	27.8	29.1	30.3	31.6	32.9	34.1	35.4	36.7	38.0	39.3	40.6	41.9	43.2	44.5	45.9	47.2	48.5	49.8	51.2
18	21.8	23.1	24.3	25.6	26.9	28.1	29.4	30.7	32.0	33.3	34.6	35.9	37.2	38.5	39.8	41.1	42.4	43.8	45.1	46.5	47.8	49.2	50.5	51.9	53.2
19	23.3	24.6	25.9	27.2	28.5	29.8	31.1	32.4	33.7	35.0	36.3	37.6	39.0	40.3	41.6	43.0	44.3	45.7	47.1	48.4	49.8	51.2	52.6	54.0	55.4
20	24.9	26.2	27.5	28.8	30.1	31.5	32.8	34.1	35.4	36.8	38.1	39.5	40.8	42.2	43.6	44.9	46.3	47.7	49.1	50.5	51.9	53.3	54.7	56.1	57.6
21	26.5	27.9	29.2	30.5	31.8	33.2	34.5	35.9	37.3	38.6	40.0	41.4	42.8	44.1	45.5	46.9	48.4	49.8	51.2	52.6	54.1	55.5	56.9	58.4	59.9
22	28.2	29.5	30.9	32.3	33.6	35.0	36.4	37.7	39.1	40.5	41.9	43.3	44.8	46.2	47.6	49.0	50.5	51.9	53.4	54.8	56.3	57.8	59.3	60.8	62.3
23	29.9	31.3	32.7	34.1	35.5	36.8	38.3	39.7	41.1	42.5	43.9	45.4	46.8	48.3	49.7	51.2	52.7	54.2	55.6	57.1	58.6	60.2	61.7	63.2	64.7
24	31.7	33.1	34.5	35.9	37.3	38.8	40.2	41.7	43.1	44.6	46.0	47.5	49.0	50.5	52.0	53.5	55.0	56.5	58.0	59.5	61.1	62.6	64.2	65.8	67.3
25	33.6	35.0	36.4	37.9	39.3	40.8	42.2	43.7	45.2	46.7	48.2	49.7	51.2	52.7	54.3	55.8	57.3	58.9	60.5	62.0	63.6	65.2	66.8	68.4	70.0
26	35.5	36.9	38.4	39.9	41.4	42.8	44.3	45.9	47.4	48.9	50.4	52.0	53.5	55.1	56.7	58.2	59.8	61.4	63.0	64.7	66.3	67.9	69.6	71.2	72.9
27	37.4	38.9	40.4	42.0	43.5	45.0	46.5	48.1	49.6	51.2	52.8	54.4	56.0	57.6	59.2	60.8	62.4	64.1	65.7	67.4	69.1	70.8	72.5	74.2	75.9
28	39.5	41.0	42.6	44.1	45.7	47.3	48.8	50.4	52.0	53.6	55.2	56.9	58.5	60.2	61.8	63.5	65.2	66.9	68.6	70.3	72.0	73.7	75.5	77.3	79.0
29	41.7	43.2	44.8	46.4	48.0	49.6	51.2	52.8	54.5	56.1	57.8	59.5	61.2	62.9	64.6	66.3	68.0	69.8	71.5	73.3	75.1	76.9	78.7	80.5	82.4
30	43.9	45.5	47.1	48.7	50.4	52.0	53.7	55.4	57.1	58.8	60.5	62.2	64.0	65.7	67.5	69.3	71.0	72.9	74.7	76.5	78.3	80.2	82.1	84.0	85.9
31	46.2	47.9	49.5	51.2	52.9	54.6	56.3	58.1	59.8	61.6	63.3	65.1	66.9	68.7	70.5	72.4	74.2	76.1	78.0	79.9	81.8	83.7	85.7	87.6	89.6
32	48.7	50.4	52.1	53.8	55.6	57.3	59.1	60.9	62.7	64.5	66.3	68.2	70.0	71.9	73.8	75.7	77.6	79.5	81.5	83.5	85.4	87.5	89.5	91.5	93.6
33	51.2	53.0	54.8	56.5	58.3	60.2	62.0	63.8	65.7	67.6	69.5	71.4	73.3	75.2	77.2	79.2	81.2	83.2	85.2	87.3	89.3	91.4	93.6	95.7	97.8
34	53.9	55.7	57.6	59.4	61.3	63.1	65.0	67.0	68.9	70.8	72.8	74.8	76.8	78.8	80.8	82.9	85.0	87.1	89.2	91.4	93.5	95.7	97.9	100.2	102.4
35	56.8	58.6	60.5	62.4	64.4	66.3	68.3	70.3	72.3	74.3	76.3	78.4	80.5	82.6	84.7	86.9	89.1	91.3	93.5	95.7	98.0	100.3	102.6	105.0	107.3
36	59.8	61.7	63.7	65.7	67.7	69.7	71.7	73.8	75.9	78.0	80.1	82.3	84.5	86.7	88.9	91.2	93.5	95.8	98.1	100.5	102.9	105.3	107.7	110.2	112.7
37	62.9	65.0	67.0	69.1	71.2	73.3	75.4	77.6	79.8	82.0	84.2	86.5	88.8	91.1	93.4	95.8	98.2	100.6	103.1	105.6	108.1	110.7	113.3	115.9	118.6
38	66.3	68.4	70.6	72.7	74.9	77.1	79.4	81.6	83.9	86.2	88.6	91.0	93.4	95.8	98.3	100.8	103.4	105.9	108.6	111.2	113.9	116.6	119.4	122.2	125.0
39	70.0	72.2	74.4	76.7	78.9	81.3	83.6	86.0	88.4	90.9	93.4	95.9	98.4	101.0	103.6	106.3	109.0	111.8	114.6	117.4	120.3	123.2	126.1	129.2	132.2
40	73.8	76.2	78.5	80.9	83.3	85.7	88.2	90.8	93.3	95.9	98.5	101.2	103.9	106.7	109.5	112.4	115.3	118.2	121.2	124.3	127.4	130.5	133.7	137.0	140.3
41	78.0	80.5	83.0	85.5	88.0	90.6	93.3	95.9	98.7	101.4	104.3	107.1	110.0	113.0	116.0	119.1	122.2	125.4	128.7	132.0	135.4	138.8	142.3	145.9	149.5
42	82.6	85.2	87.8	90.5	93.2	96.0	98.8	101.7	104.6	107.6	110.6	113.7	116.9	120.1	123.4	126.7	130.1	133.6	137.2	140.8	144.5	148.3	152.2	156.1	160.2
43	87.6	90.4	93.2	96.0	99.0	101.9	105.0	108.1	111.2	114.5	117.8	121.1	124.6	128.1	131.7	135.4	139.1	143.0	147.0	151.0	155.2	159.4	163.8	168.2	172.8
44	93.1	96.1	99.1	102.2	105.4	108.6	111.9	115.3	118.7	122.3	125.9	129.6	133.4	137.4	141.4	145.5	149.7	154.1	158.5	163.1	167.9	172.7	177.7	182.9	188.2
45	99.3	102.5	105.8	109.2	112.6	116.2	119.8	123.6	127.4	131.4	135.4	139.6	143.9	148.3	152.9	157.6	162.4	167.4	172.6	178.0	183.5	189.2	195.1	201.2	207.5
46	106.3	109.8	113.4	117.2	121.0	125.0	129.1	133.3	137.6	142.1	146.7	151.5	156.5	161.6	167.0	172.5	178.2	184.2	190.4	196.8	203.5	210.5	217.8	225.4	233.3
47	114.3	118.3	122.4	126.6	130.9	135.4	140.1	145.0	150.0	155.3	160.7	166.4	172.3	178.5	185.0	191.8	198.9	206.4	214.2	222.4	231.0	240.0	249.5	259.5	270.0
48	123.9	128.4	133.1	137.9	143.0	148.3	153.9	159.7	165.8	172.2	178.9	186.0	193.5	201.4	209.8	218.7	228.2	238.2	248.9	260.3	272.3	285.1	298.7	313.0	328.2
49	135.5	140.8	146.4	152.3	158.5	165.0	172.0	179.3	187.2	195.6	204.6	214.3	224.7	235.9	248.1	261.3	275.5	290.9	307.6	325.5	344.8	365.4	387.3	410.6	435.2

09-63235-01

Table 12 continued: Quanti-Tray®/2000 Most Probable Number Table

IDEXX Quanti-Tray®/2000 MPN Table *(per 100ml)*

# Large Wells Positive	# Small Wells Positive: 25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
0	25.3	26.4	27.4	28.4	29.5	30.5	31.5	32.6	33.6	34.7	35.7	36.8	37.8	38.9	40.0	41.0	42.1	43.1	44.2	45.3	46.3	47.4	48.5	49.5
1	26.6	27.7	28.7	29.8	30.8	31.9	32.9	34.0	35.0	36.1	37.2	38.2	39.3	40.4	41.4	42.5	43.6	44.7	45.7	46.8	47.9	49.0	50.1	51.2
2	27.9	29.0	30.0	31.1	32.2	33.2	34.3	35.4	36.5	37.5	38.6	39.7	40.8	41.9	43.0	44.0	45.1	46.2	47.3	48.4	49.5	50.6	51.7	52.8
3	29.3	30.4	31.4	32.5	33.6	34.7	35.8	36.8	37.9	39.0	40.1	41.2	42.3	43.4	44.5	45.6	46.7	47.8	48.9	50.0	51.2	52.3	53.4	54.5
4	30.7	31.8	32.8	33.9	35.0	36.1	37.2	38.3	39.4	40.5	41.6	42.8	43.9	45.0	46.1	47.2	48.3	49.5	50.6	51.7	52.9	54.0	55.1	56.3
5	32.1	33.2	34.3	35.4	36.5	37.6	38.7	39.9	41.0	42.1	43.2	44.4	45.5	46.6	47.7	48.9	50.0	51.2	52.3	53.5	54.6	55.8	56.9	58.1
6	33.5	34.7	35.8	36.9	38.0	39.2	40.3	41.4	42.6	43.7	44.8	46.0	47.1	48.3	49.4	50.6	51.7	52.9	54.1	55.2	56.4	57.6	58.7	59.9
7	35.0	36.2	37.3	38.4	39.6	40.7	41.9	43.0	44.2	45.3	46.5	47.7	48.8	50.0	51.2	52.3	53.5	54.7	55.9	57.1	58.3	59.4	60.6	61.8
8	36.6	37.7	38.9	40.0	41.2	42.3	43.5	44.7	45.9	47.0	48.2	49.4	50.6	51.8	53.0	54.1	55.3	56.5	57.7	59.0	60.2	61.4	62.6	63.8
9	38.1	39.3	40.5	41.6	42.8	44.0	45.2	46.4	47.6	48.8	50.0	51.2	52.4	53.6	54.8	56.0	57.2	58.4	59.7	60.9	62.1	63.4	64.6	65.8
10	39.7	40.9	42.1	43.3	44.5	45.7	46.9	48.1	49.3	50.6	51.8	53.0	54.2	55.5	56.7	57.9	59.2	60.4	61.7	62.9	64.2	65.4	66.7	67.9
11	41.4	42.6	43.8	45.0	46.3	47.5	48.7	49.9	51.2	52.4	53.7	54.9	56.1	57.4	58.6	59.9	61.2	62.4	63.7	65.0	66.3	67.5	68.8	70.1
12	43.1	44.3	45.6	46.8	48.1	49.3	50.6	51.8	53.1	54.3	55.6	56.8	58.1	59.4	60.7	62.0	63.2	64.5	65.8	67.1	68.4	69.7	71.0	72.4
13	44.9	46.1	47.4	48.6	49.9	51.2	52.5	53.7	55.0	56.3	57.6	58.9	60.2	61.5	62.8	64.1	65.4	66.7	68.0	69.3	70.7	72.0	73.3	74.7
14	46.7	48.0	49.3	50.5	51.8	53.1	54.4	55.7	57.0	58.3	59.6	60.9	62.3	63.6	64.9	66.3	67.6	68.9	70.3	71.6	73.0	74.4	75.7	77.1
15	48.6	49.9	51.2	52.5	53.8	55.1	56.4	57.8	59.1	60.4	61.8	63.1	64.5	65.8	67.2	68.5	69.9	71.3	72.6	74.0	75.4	76.8	78.2	79.6
16	50.5	51.8	53.2	54.5	55.8	57.2	58.5	59.9	61.2	62.6	64.0	65.3	66.7	68.1	69.5	70.9	72.3	73.7	75.1	76.5	77.9	79.3	80.8	82.2
17	52.5	53.9	55.2	56.6	58.0	59.3	60.7	62.1	63.5	64.9	66.3	67.7	69.1	70.5	71.9	73.3	74.8	76.2	77.6	79.1	80.5	82.0	83.5	84.9
18	54.6	56.0	57.4	58.8	60.2	61.6	63.0	64.4	65.8	67.2	68.6	70.1	71.5	73.0	74.4	75.9	77.3	78.8	80.3	81.8	83.3	84.8	86.3	87.8
19	56.8	58.2	59.6	61.0	62.4	63.9	65.3	66.8	68.2	69.7	71.1	72.6	74.1	75.5	77.0	78.5	80.0	81.5	83.1	84.6	86.1	87.6	89.2	90.7
20	59.0	60.4	61.9	63.3	64.8	66.3	67.7	69.2	70.7	72.2	73.7	75.2	76.7	78.2	79.8	81.3	82.8	84.4	85.9	87.5	89.1	90.7	92.2	93.8
21	61.3	62.8	64.3	65.8	67.3	68.8	70.3	71.8	73.3	74.9	76.4	77.9	79.5	81.1	82.6	84.2	85.8	87.4	89.0	90.6	92.2	93.8	95.4	97.1
22	63.8	65.3	66.8	68.3	69.8	71.4	72.9	74.5	76.1	77.6	79.2	80.8	82.4	84.0	85.6	87.2	88.9	90.5	92.1	93.8	95.5	97.1	98.8	100.5
23	66.3	67.8	69.4	71.0	72.5	74.1	75.7	77.3	78.9	80.5	82.2	83.8	85.4	87.1	88.7	90.4	92.1	93.8	95.5	97.2	98.9	100.6	102.4	104.1
24	68.9	70.5	72.1	73.7	75.3	77.0	78.6	80.3	81.9	83.6	85.2	86.9	88.6	90.3	92.0	93.8	95.5	97.2	99.0	100.7	102.5	104.3	106.1	107.9
25	71.7	73.3	75.0	76.6	78.3	80.0	81.7	83.3	85.1	86.8	88.5	90.2	92.0	93.7	95.5	97.3	99.1	100.9	102.7	104.5	106.3	108.2	110.0	111.9
26	74.6	76.3	78.0	79.7	81.4	83.1	84.8	86.6	88.4	90.1	91.9	93.7	95.5	97.3	99.2	101.0	102.9	104.7	106.6	108.5	110.4	112.3	114.2	116.2
27	77.6	79.4	81.1	82.9	84.6	86.4	88.2	90.0	91.9	93.7	95.5	97.4	99.3	101.2	103.1	105.0	106.9	108.8	110.8	112.7	114.7	116.7	118.7	120.7
28	80.8	82.6	84.4	86.3	88.1	89.9	91.8	93.7	95.6	97.5	99.4	101.3	103.3	105.2	107.2	109.2	111.2	113.2	115.2	117.3	119.3	121.4	123.5	125.6
29	84.2	86.1	87.9	89.8	91.7	93.7	95.6	97.5	99.5	101.5	103.5	105.5	107.5	109.5	111.6	113.7	115.7	117.8	120.0	122.1	124.2	126.4	128.6	130.8
30	87.8	89.7	91.7	93.6	95.6	97.6	99.6	101.6	103.7	105.7	107.8	109.9	112.0	114.2	116.3	118.5	120.6	122.8	125.1	127.3	129.5	131.8	134.1	136.4
31	91.6	93.6	95.6	97.7	99.7	101.8	103.9	106.0	108.2	110.3	112.5	114.7	116.9	119.1	121.4	123.6	125.9	128.2	130.5	132.9	135.3	137.7	140.1	142.5
32	95.7	97.8	99.9	102.0	104.2	106.3	108.5	110.7	113.0	115.2	117.5	119.8	122.1	124.5	126.8	129.2	131.6	134.0	136.5	139.0	141.5	144.0	146.6	149.1
33	100.0	102.2	104.4	106.6	108.9	111.2	113.5	115.8	118.2	120.5	122.9	125.4	127.8	130.3	132.8	135.3	137.8	140.4	143.0	145.6	148.3	150.9	153.7	156.4
34	104.7	107.0	109.3	111.7	114.0	116.4	118.9	121.3	123.8	126.3	128.8	131.4	134.0	136.6	139.2	141.9	144.6	147.4	150.1	152.9	155.7	158.6	161.5	164.4
35	109.7	112.2	114.6	117.1	119.6	122.2	124.7	127.3	129.9	132.6	135.3	138.0	140.8	143.6	146.4	149.2	152.1	155.0	158.0	161.0	164.0	167.1	170.2	173.3
36	115.2	117.8	120.4	123.0	125.7	128.4	131.1	133.9	136.7	139.5	142.4	145.3	148.3	151.3	154.3	157.3	160.5	163.6	166.8	170.0	173.3	176.6	179.9	183.3
37	121.3	124.0	126.8	129.6	132.4	135.3	138.2	141.2	144.2	147.3	150.3	153.5	156.7	159.9	163.1	166.5	169.8	173.2	176.7	180.2	183.7	187.3	191.0	194.7
38	127.9	130.8	133.8	136.8	139.9	143.0	146.2	149.4	152.6	155.9	159.2	162.6	166.1	169.6	173.2	176.8	180.4	184.2	188.0	191.8	195.7	199.7	203.7	207.7
39	135.3	138.5	141.7	145.0	148.3	151.7	155.1	158.6	162.1	165.7	169.4	173.1	176.9	180.7	184.7	188.7	192.7	196.8	201.0	205.3	209.6	214.0	218.5	223.0
40	143.7	147.1	150.6	154.2	157.8	161.5	165.3	169.1	173.0	177.0	181.1	185.2	189.4	193.7	198.1	202.5	207.1	211.7	216.4	221.1	226.0	231.0	236.0	241.1
41	153.2	157.0	160.9	164.8	168.9	173.0	177.2	181.5	185.8	190.3	194.8	199.5	204.2	209.1	214.0	219.1	224.2	229.4	234.8	240.2	245.8	251.5	257.2	263.1
42	164.3	168.6	172.9	177.3	181.9	186.5	191.3	196.1	201.1	206.2	211.4	216.7	222.2	227.7	233.4	239.2	245.2	251.3	257.5	263.8	270.3	276.9	283.6	290.5
43	177.5	182.3	187.3	192.4	197.6	202.9	208.4	214.0	219.8	225.8	231.8	238.1	244.5	251.0	257.7	264.6	271.7	278.9	286.3	293.8	301.5	309.4	317.4	325.7
44	193.6	199.3	205.1	211.0	217.2	223.5	230.0	236.7	243.6	250.8	258.1	265.6	273.3	281.2	289.4	297.8	306.3	315.1	324.1	333.3	342.8	352.4	362.3	372.4
45	214.1	220.9	227.9	235.2	242.7	250.4	258.4	266.7	275.3	284.1	293.3	302.6	312.3	322.3	332.5	343.0	353.8	364.9	376.2	387.9	399.8	412.0	424.5	437.4
46	241.5	250.0	258.9	268.2	277.8	287.8	298.1	308.8	319.9	331.4	343.3	355.5	368.1	381.1	394.5	408.3	422.5	437.1	452.0	467.4	483.3	499.6	516.3	533.5
47	280.9	292.4	304.4	316.9	330.0	343.6	357.8	372.5	387.7	403.4	419.8	436.6	454.1	472.1	490.7	509.9	529.8	550.4	571.7	593.8	616.7	640.5	665.3	691.0
48	344.1	360.9	378.4	396.8	416.0	436.0	456.9	478.6	501.2	524.7	549.3	574.8	601.5	629.4	658.6	689.3	721.5	755.6	791.5	829.7	870.4	913.9	960.6	1011.2
49	461.1	488.4	517.2	547.5	579.4	613.1	648.8	686.7	727.0	770.1	816.4	866.4	920.8	980.4	1046.2	1119.9	1203.3	1299.7	1413.6	1553.1	1732.9	1986.3	2419.6	>2419.6

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3. Colilert Test Dilutions

If the first time the sample is analyzed, and all of the wells turn yellow and fluoresce, then the *E. coli* and total coliform readings are higher than the maximum undiluted detection limit. The next time the bacteriological sample is collected, dilute the sample with sterile water. Sterilize the appropriate amount of Type I reagent-grade organic-free water in an autoclave and allow it to cool before inoculation or purchase sterilized water.

If an autoclave is not available, sterilized water may be purchased from commercial sources or obtained from TDH Central Laboratory. Water is only sterile until the bottle is opened. Do not store and reuse sterile water after the bottle has been opened.

Use a sterile disposable pipette or other sterile measuring container to measure the volume of sample and appropriate amount of sterile water to produce the proper dilution (Table 13). Then add reagent media and incubate as above (steps 1-5). Compare the number of yellow and/or fluorescing wells to the MPN table and multiply by the dilution factor to determine the total count.

Table 13: *E. coli* Detection Limit of Colilert Test

Dilution	Factor	Count Range
None	1X	1 to 2,419
1:10	10X	1 to 24,190
1:100	100X	1 to 241,900

5. Colilert Test Quality Control

Perform quality control check on each new lot of media reagent. The manufacturer sells three Quanti-Cult™ or American Type Culture Collection (ATCC) pathogen standards (Table 14) that are used for quality control checks of the reagent media and testing methods. To perform the quality control check, inoculate sterile water with the appropriate Quanti-Cult or ATCC pathogen standards and add the reagent media. Incubate and analyze the sample using the Colilert method. Compare test results to the expected results supplied by the manufacturer.

The analyses are being done correctly if the test results are similar to the expected results. If the results are significantly different, review the testing process and determine the probable origin of the problem. Correct any noted problems and repeat the QC test. For 10 percent of the samples analyzed, run a quality control sample to ensure the samples are being run and interpreted correctly.

Table 14: Quality Control Organisms for Colilert Analyses

Quanti-Cult Organism	ATCC#	Observation	Result
E. coli	25922 or 11775	Yellow, fluorescence	+ Total coliform + *E. coli*
Kiebsiella pneumoniae	31488	Yellow, No fluorescence	+ Total coliform - *E. coli*
Pseudomonas aeruginosa	10145 or 27853	Clear, No Fluorescence	- Total Coliform - *E. coli*

Once a month check the Quanti-Tray® sealer by adding dye to a sample and sealing it. Commercially available dye, bromcresol purple, or 2-3 drops per 100 mL of food coloring may be added to a blank sample and poured into the Quanti-Tray®. Seal the Quanti-Tray® as usual. If dye is observed outside the wells, the seal is leaking, and a new sealer should be used.

I.J. Data and Records Management

Data

Minimally all analysis results should be sent to the EFO that collected the samples and the DWR Watershed Planning Unit. The EFOs should keep sampling data for five years if the data was also sent to the Central Office. If the data is only housed at the EFO, it can be archived after five years. WPU will keep all electronic copies of reports. Chemical and bacteriological monitoring data and station location information can be found in Waterlog. Contact DWR, WPU if assistance is needed in using this database. Waterlog is maintained by WPU.

Records

The Quality Team member (Section II.A) or their designee in each EFO checks that all chemical, bacteriological, and biological stations have been entered with complete information. Chemical and biological stations collected within 0.1 miles of each other where there is no outfall, tributaries or other potential changes to the water quality, will be considered the same station and therefore will have the same Station ID. If errors are found or stations are missing from Waterlog please notify WPU in writing (email) of the errors so they can be corrected. If stations are missing from the database, upload the new station information to Waterlog, see SPERT for complete instructions. If errors are found in the database entries, please include the Field Log Number, Activity ID/lab number, Station ID, sample date, and parameter in question. If any analyses results appear incongruent contact the analyzing laboratory and copy WPU for verification of the readings, include laboratory number, Station ID, and parameter result in question.

Note, if new stations are set up that will have chemical or bacteriological monitoring, upload the station information to the stations table in Waterlog before chemical and bacteriological results are received. It usually takes about a month from the time samples are collected for the results to be received.

II. QUALITY CONTROL AND QUALITY ASSURANCE

The U.S. EPA requires that a centrally planned, directed, and coordinated quality assurance and quality control program be applied to efforts supported by EPA through grants, contracts or other formalized agreements. This time allocation is an essential component of chemical and bacteriological sampling and analyses and is included in the annual work plan. This is not an optional or "as time allows" activity. The validity of all samples hinges on proving that neither the collection method nor the transport contaminated the samples.

II. A. General QC Practices

1. **Quality Team Leader (QC coordinator)** - A centralized chemical and bacteriological QC coordinator is designated with the responsibility of ensuring that all QC protocols are met. This person will be an experienced water quality professional who participates in QC training and planning. Major responsibilities 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. The Watershed Planning Unit will be responsible for these activities.
2. **Quality Team Member (In-house QC officer)** - One DWR staff member in each EFO will be designated as the Quality Team Member (in-house QC officer) by the DWR Manager. The in-house QC officer should be an experienced water quality professional who participates in QC training and planning. 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. Ensure all staff are aware of updates to protocols when received from central QC coordinator or state laboratory
    2. Maintain QSSOP and QAPP updates and make sure all staff are aware of changes
    3. Informing WPU/CO QC coordinator of any RPD's out of range
    4. Ensure all staff have appropriate training
    5. Ensure samplers upload field parameters weekly
    6. Coordinate maintenance and repair of sampling equipment. (Coordinate with Barbara Loudermilk (Barbara.Loudermilk@tn.gov).
    7. Make sure meter calibration and QC logs are maintained
    8. Review and track blanks and duplicates. Resolve source of contamination and take corrective action (See Section II.C)
    9. Inform CO QC coordinator of split sample results. Work with CO QC coordinator if split samples are out of RPD range.

3. **Training** – There is no substitute for field experience. All samplers should have at least six months of field experience before selecting sampling sites. For on-the-job training, new employees should accompany experienced staff for as many different studies and sampling situations as possible. During this training period, the new employee needs to perform all tasks involved in sample collection under the supervision of experienced staff.

II.B. Quality Control Samples

Field blanks, and duplicate samples must be collected at a minimum of ten percent of sampling events, defined as every 10th site sampled (this is per EFO not per team). Trip blanks should be collected on every 10th trip. Equipment blanks are needed at every tenth station where an intermediate sampling device such as bucket, bailer, peristaltic pump or Kemmerer is used. A temperature blank to measure cooler temperature must be placed in each cooler if it arrives at the lab more than two hours after collection.

Only the parameters collected for that run should be included with the trip and field blank. Only the parameters requested for the same site should be included in the duplicates or equipment blanks. Turbidity, BOD/CBOD, COD, TOC, Alkalinity, Color, Acidity, solids of any kind are not necessary in trip or field blanks.

All trip, field, and equipment blank water must be Type I organic-free reagent-grade water. The TDH laboratory has Type I water filtration systems. This is not the DI tap. Request assistance if needed in locating or using the Type I water filtration system. Wash hands with phosphate-free soap before filling blank water containers and always wear powder-free nitrile gloves while filling the blank containers. Allow the Type I water filtration system to flush at least three minutes before obtaining blank water.

Store blank water for inorganic analysis in unused, pre-cleaned, single-use plastic bottles. For organic analysis, store blank water in glass bottles. Specify organic or inorganic when requesting blank water from the lab. Always keep an ample supply of fresh blank water on hand. The Environmental Laboratory recommends that blank water not be stored more than 28 days. Do not refill old bottles. Obtain a new bottle when replenishing blank water. Never top off stored water even within the 28-day period. Obtain Type I organic-free reagent-grade blank water as close to the sampling event as possible. It is recommended that fresh blank water be obtained weekly. Refrigerate blank water when storing at the EFO and put on ice during transport/sample run.

It is not necessary to sterilize the Type I DI water for bacteriological field and trip blanks. The use of sterilized blank water is recommended as a resolution step if any field office receives lab reports with measurable results in field or trip blanks.

1. **Trip Blanks** – The Trip Blank is used to determine if samples were contaminated during storage or transportation to the laboratory. To be sampled every 10th TRIP, not every 10th sample site within one trip. In the EFO lab, immediately before departing for a sampling trip, fill the appropriate QC sample containers with Type I organic-free reagent-grade water. Wear powder-free nitrile gloves when filling Trip Blanks. Open a new bottle, one that has not been opened prior, of Type I organic-free reagent-grade water in the office and fill the trip blank bottle. Reseal the bottle and carry the jug into the field to prepare the field blank from this same bottle. Any left-over water can be used for equipment blanks or rinse water.

   The tags and Sample Request Forms should be labeled with the county, date, military time, sampler, preservative, cost code/billing ID, project name, activity type, field log number, the tests requested and Station ID. In this case it would be, "TRIPBLANK", followed by the EFO abbreviation without any spaces between. For example, the Station ID for a trip blank sampled by the Nashville EFO would be "TRIPBLANKNEFO" as well as indicating activity type as "Quality Control Sample-Trip Blank". Specify on the Sample Request Form what parameters need to be analyzed on the blank. Attach a completed sample tag to each sample container and place the trip blank samples in a zip-type colorless plastic bag (optional). Store the Trip Blank QC sample on ice in a clean cooler. The sample is to remain closed the remainder of the trip.

2. **Field Blanks** – The Field Blank is used to determine if contamination originated from sources at the sampling site not associated with the surface water conditions. Near the sampling location, before collecting surface water samples, pour Type I organic-free reagent-grade water from the storage container the trip blank was filled from into the sample container(s). Wear powder-free nitrile gloves when filling Field Blanks. Any left-over water can be used for equipment blanks or rinse water. To be sampled every 10th sample site or 10 percent of the sample sites.

   The tags and Sample Request Forms should be labeled with the county, date, military time, sampler, preservative, cost code/billing ID, project name, activity type, field log number, the tests requested and Station ID. In this case it would be, "FIELDBLANK", followed by the EFO abbreviation without any spaces between. For example, the Station ID for a field blank sampled by the Nashville EFO would be "FIELDBLANKNEFO" as well as indicating activity type as "Quality Control Sample-Field Blank". Specify on the Sample Request Form what parameters need to be analyzed on the blank. Before collecting sample attach a completed sample tag to each sample container and place the trip blank samples in a zip-type colorless plastic bag (optional). Store the Field Blank QC sample on ice in a clean cooler. The sample is to remain closed the remainder of the trip.

3. **Duplicate Sample** – The purpose of the duplicate sample is to determine variability of contaminant in surface water samples. Immediately after collecting a sample, fill a second sample container using the same technique. These are to be sampled every 10th sample site or

10 percent of the sample sites. The tags and Sample Request Forms should be labeled with the county, date, military time, sampler, preservative, cost code/billing ID, project name, activity type, field log number, the tests requested and Station ID. pe. The time recorded for the duplicate sample should be **after** the time recorded for the routine sample. The Station ID will be exactly as the original sample however, the activity type should indicate this sample as "Quality Control Sample-Field Replicate". Specify on the Sample Request Form what parameters need to be analyzed on the duplicate sample. Before collecting sample attach a completed sample tag to the sample container and place it in a zip-type colorless plastic bag (optional) and store on ice in a clean cooler until delivery to the lab.

4. **Temperature Blank** – A temperature blank is a small bottle filled with water that is placed inside each cooler at the time the samples are stored in the cooler. When the samples are delivered to the laboratory, the temperature of the sample cooler is measured in the temperature blank to ensure it is 6^{o}C or less. Samples maintained at higher temperatures are flagged. (Note: If samples are delivered to the laboratory within 2 hours of collection, then temperatures greater than 6^{o}C are acceptable.)

5. **Equipment Field Blank** – After reusable equipment such as buckets, bailers, discrete depth samplers, or automatic samplers are cleaned, it is necessary to demonstrate that it is contaminant free. Collect equipment blanks at every 10^{th} sample site where the equipment is used. In the field before collecting the first sample, collect equipment blank by pouring organic-free reagent-grade water into the equipment and collecting the sample into the appropriate sample container.

   The tags and Sample Request Forms should be labeled with the, date, military time, sampler, preservative, cost code/billing ID, project name, activity type, field log number, the tests requested and Station ID. In this case it would be, "EQUIPLANK", followed by the EFO abbreviation without any spaces between. For example, the Station ID for an equipment blank sampled by the Nashville EFO would be "EQUIPBLANKNEFO" as well as indicating activity type as "Quality Control Sample-Equipment Blank". Attach the tag to the sample, place the sample in a colorless zip-type plastic bag (optional), and store on ice in a clean cooler until delivery to the laboratory.

6. **Instantaneous Field Water Parameter QC** – Calibrate all probes each week or day before use, depending on which field parameters are to be measured. (If overnight travel is involved, the probes may be calibrated at the beginning of the trip.) Take duplicate water parameter readings at each site. If time is a constraint, duplicate readings may be reduced to the first and last site each day. To take a duplicate reading, lift the probe completely out of the water, then place it upstream of the original reading and allow the meter to equilibrate before recording results. If the readings are off by more than 0.2 units for pH, temperature, or DO measured in

mg/L (or 10% for conductivity or DO measured in % saturation), repeat the procedure until reproducible results are obtained.

Upon return to the EFO, perform a QC drift check on each meter at the end of the day (or at the end of the trip on multiple night trips). If the meter calibration is off by more than 0.2 for pH, DO measured in mg/L or temperature or by more than 10% for conductivity and DO measured in % saturation, all readings between the initial calibration and the drift check are questionable. In this case, do not upload the field parameters. If only one parameter failed, make note of the failed parameter in the uploading of the acceptable parameters.

The probes have difficultly reading the low pH accurately in low conductivity waters. Therefore in low pH (<6) and low conductivity (<100) conditions the low pH must be verified by the TDH laboratory using a low pH test analysis.

7. **Continuous Water Parameter QC** – At every 10th site, anchor a second continuous monitoring probe beside the first. Upload to TNCON for consistency and QC checks. (For parameters other than temperature and water-depth, data review data and flag spreadsheet for any duplicates that do not meet drift check requirements (0.2 for pH, DO measured in mg/L or temperature or by more than 10% for conductivity and DO measured in % saturation,)

8. **Flow Measurement QC –** Take a second flow measurement at every 10th site. The readings must be taken on the same day and in the same transect. If the original and the QC flow measurements differ by more than 10 percent, note but do not upload to Waterlog. See Protocol L for additional information.

II.C. Contaminants Detected in Blank Samples.

When contaminants (values above the MDL) are detected in trip, field, or equipment blanks it is important to investigate the cause of the contamination and initiate corrective action as soon as possible. The QC officer in each EFO is responsible for reviewing the A list of QC officers is provided in Table 55 of the 106 monitoring QAPP (TDEC, 2021).

The state laboratory will re-analyze DWR and DOE-O trip, field and equipment blanks with measurable and verifiable values above the MQL (i.e. within the calibration curve) and note as such in the comments field below the results entry. The laboratory does not consider estimated values between the MDL and MQL as contaminants and these samples are not routinely re-analyzed prior to reporting.

However, 40 CFR, Part 136 (Appendix B) defines the MDL (minimum detection limit) as 99% confidence that the concentration is > 0 (even though the amount cannot be quantified). Therefore, DWR will treat any blank results above the MDL as potential contamination. If the cause of the contamination cannot be isolated to the blank sample, all samples associated with the blank for the parameter of concern will be flagged with SCF- Suspected Contamination Field.

EFO QC Responsibilities (EFO QC officer)

1. The field office QC officer should review blank data as soon as it is received from the lab so decisions can be made about corrective action or the need for resampling. If contaminants (results above the MDL) are found the officer should verify that there were no deviations from protocol including (but not limited to):

    a. Source water for blank was from an approved source (Type 1 from Nashville TDH Environmental Lab).
    b. Nitrile gloves were worn when collecting source water for blanks.
    c. Nitrile gloves were worn when pouring blank water into sample bottles.
    d. Cooler was clean and free of contaminants.
    e. Bottle used to store source water was in a new, previous unopened, certified clean container from an approved source.
    f. Source water container was stored in a clean area free of dust and dirt. Trip blanks were poured in the same area.
    g. Source water had been stored less than 28 days.

2. If deviations from protocol were discovered, take corrective action to avoid potential contamination of future samples, document corrective action in QC.

3. Within 1 week of receipt of contaminated blank results, notify WPU of Field Log Number, any deviations from field protocol and corrective action (or that all protocols were followed).

4. Determine if contamination was isolated to blank; out of date blank water, inappropriate storage of blank water, physical contamination of blank water, etc. then notify WPU. WPU will review and discard data and this will not count as part of the 10% QC requirements. EFO will need to collect additional QA set to prove the problem has been solved and to complete the 10% QC requirement.

5. If contaminated blank resulted in flagged data, determine if more accurate or more defensible data are needed. If so, sampling may need to be repeated. Factors to take into consideration include:

   a. Are flagged parameters slightly above the criterion for that parameter which may result in a determination of impairment? (If it is well above the criterion flag would not affect assessment).
   b. Was sample collected for enforcement, 303(d), reference, or other purpose where questionable data are unacceptable?

6. The EFO QC officer is responsible for checking that QC logs are maintained and that equipment is in serviced and in good working order.

WPU QC responsibilities (Central QC Coordinator)

1. Data will be reviewed as received from laboratory. When values above the MDL are observed in any blank, the coordinator will review the information sent by the EFO QC officer to verify that proper procedures were followed and there were no potential sources of field contamination. Coordinator will contact EFO QC officer to obtain information if not received within one week.

2. If potential field contamination was identified, the QC coordinator will flag SCF (Suspected Contamination, Field) the parameter where the contaminant was observed for all samples associated with the blank. The source of contamination will be identified in the comment field of the database.

3. If no potential field contamination source was identified, the QC coordinator will contact the laboratory section manager, director and QC officer to verify results, and determine if there were any problems with the analysis. The QC coordinator will also request results from the laboratory instrument blanks for the parameter of concern associated with that sample set to determine if measurements between the MDL and MQL were also found in the laboratory blanks. If so, the QC officer will flag (B) the parameter where the contaminant was observed for all samples associated with the blank. Lab instrument blank values for the parameter of concern will be kept on file with the data report sheet.

4. If neither a lab nor field source of contamination can be determined, the parameter where the contaminant was observed for all samples associated with the blank will be flagged with an SCX (suspected contamination, unknown). Unknown contamination will be entered in the comment field of Waterlog.

5. If it was determined that the contamination was restricted to the blank sample and would not affect other samples, the blank data will be discarded, and samples will be associated with the next blank QC set collected.

6. A running record of all contaminated blanks, potential sources of contamination and corrective action will be maintained (Figure 10).

7. Once per month the QC coordinator will review all QC data statewide for each parameter. Any parameter where values above the mdl are found more in more of 10% of blanks or resulted in more than 10% of samples being flagged for that parameter will be investigated by coordination with laboratory and field office QC officers.

8. If any RPD’s are out of range work with EFO to determine issue.

Field Log Number	Parameter (TOC and SULFATE are ok)	Activity ID	Activity Type	Station ID	Date Collected	Collected By	EFO	Value	Qualifier	MDL	MQL	Lab Response/ Analyzed By	EFO Response	Potential Contaminant Source	Corrective Action
CFW0708202017	Nitrite	N2007062-03-02	Quality Control Sample-Field Blank	FIELD BLANKCHEFO	7/8/2020	CFW/ NRG	CHEFO	0.01 mg/l	SCX	0.01 mg/l	0.05 mg/l	Contamination not from Lab. Patrick Leathers	Samplers followed all protocols. Jessica Rader 9.21.2020	Unknown	Continue to follow SOP
NRG0803202011	Zinc	N2008009-03-02	Quality Control Sample-Field Blank	FIELD BLANKCHEFO	8/3/2020	NRG/ CFW	CHEFO	10.7 ug/l	SCX	3.47 ug/l	5 ug/l	Contamination not from Lab. Anthony Wilson	Samplers followed all protocols. Jessica Rader 9.21.2020	Unknown	Continue to follow SOP
NRG0803202011	Calcium	N2008009-03-02	Quality Control Sample-Field Blank	FIELD BLANKCHEFO	8/3/2020	NRG/ CFW	CHEFO	0.051 mg/l	SCX	0.05 mg/l	0.1 mg/l	Contamination not from Lab. Anthony Wilson	Samplers followed all protocols. Jessica Rader 9.21.2020	Unknown	Continue to follow SOP

Figure 10: Record of blank water contamination and corrective action.
Activity Type = field, trip or equipment blank
Collected by = initials
Potential Contaminant source = cause of problem, i.e., sampler did not wear gloves, water not stored properly at EFO, unknown, instrument error, contaminant in lab instrument blank etc.
Corrective Action = what was done to prevent this from happening again, i.e., retrain field staff, update QSSOP, change water storage location, etc.

II.D.

Chain of Custody

TDEC's Office of General Counsel requires that the chain of custody (Figure 6) be completed for any sample that has the potential of being used in court, reviewed by the Water Quality Control Board, or involved in state hearings. Therefore, all samples are potentially legal, and the integrity of the sample must be beyond question. The chain of custody is located in the right column of the TDH Environmental Laboratory's Chemical Analyses Forms (Appendix A). If using another TDEC contract lab, a separate chain of custody must be completed (Appendix A). See Protocol I for additional details on completing the Chemical Request Forms.

The chain of custody follows the sample through collection, transfer, storage, analyses, quality assurance, and disposal. The primary sampler must sign (do not print or initial) first and last name in the "Collected By" space followed by date and military time of collection. When the sample is transferred to the next sample custodian, write the name of the person or place receiving the sample and the date and military time of custody transfer. Each custodian of the sample must sign their full name on the "Received By" space with the date and military time the sample was received and complete the "Delivered To" section when it is transferred from their custody. Upon arrival at the laboratory, the person who receives the sample, signs the Received In The Lab By line followed by the date and military time of receipt. When the sample is logged into the LIMS system, the person who logs in the sample, signs and dates the Logged In By line.

Contact the laboratory if samples cannot be delivered during normal hours of operation. If holding times are not an issue, it may be best to secure the samples in a locked area in the EFO and deliver them to the laboratory the next day. It also may be possible to arrange for someone at the laboratory to receive the sample after hours. In either of these scenarios, the laboratory personnel will sign the chain-of-custody. The final and least desirable option for after hour delivery is to have the security guard sign the chain-of-custody and secure the samples.

The second half of the chain of custody titled Additional Information is equally important. Complete the bottom half of the right column of the Sample Request Form. Fill out approximate volume of sample, nearest town or city, others present at collection, number of other samples collected at same time at this point, field collection procedure, handling and/or preservation of this sample, and mode of transportation to lab. Sign and date the sample sealed by line and write any remarks or special notations about the sample on the last line.

II.E. Laboratory Detection Limits

In most cases, samples will be sent to the TDH Environmental Laboratory for analyses or subcontract to a private lab. This laboratory and subcontractors meet required detection limits for DWR. In special instances (short holding times, grants or collections performed by non- DWR individuals) another TDEC contract laboratory may be used. It is required that the sampler verify that specified detection limits (Appendix B) will be met and that results will be reported in the designated units. The sampler must also ensure that the electronic reports will be sent to WPU.

III. REFERENCES

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IV. APPENDICES

APPENDIX A

FORMS AND DATA SHEETS

County and State Abbreviations and Code Numbers
TDH Environmental Laboratories Sample Container Request Form
TDH Inorganic Analysis Sample Request Form
TDH Organic Analysis; Base/Neutral/Acid Extractable Sample Request Form
TDH Organic Analysis; Volatiles and Petroleum Hydrocarbons Sample Request Form
Chain of Custody
Field Flow Measurement Sheet
Flow Measurement Sheet (Excel Formulas)

COUNTY AND STATE – Abbreviations and Code Numbers

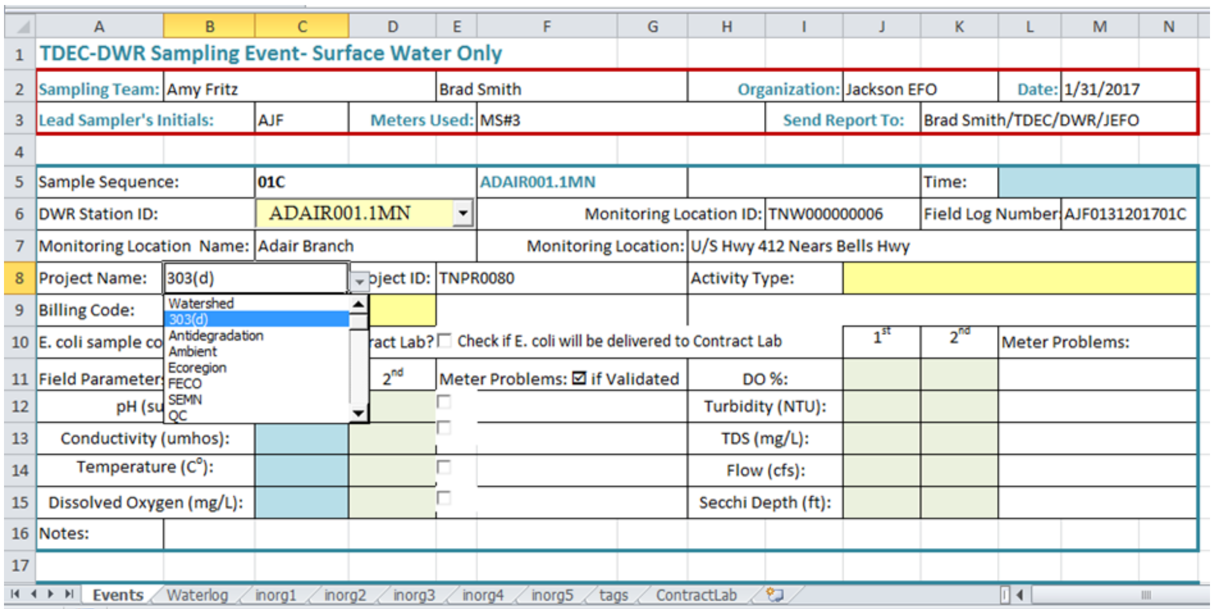
COUNTY NAME	DWR CO ABBR	TN CO NO	NATIONAL TN FIPS	COUNTY NAME	DWR CO ABBR	TN CO NO	NATIONAL TN FIPS
ANDERSON	**AN**	01	001	LAUDERDALE	**LE**	49	097
BEDFORD	**BE**	02	003	LAWRENCE	**LW**	50	099
BENTON	**BN**	03	005	LEWIS	**LS**	51	101
BLEDSOE	**BL**	04	007	LINCOLN	**LI**	52	103
BLOUNT	**BT**	05	009	LOUDON	**LO**	53	105
BRADLEY	**BR**	06	011	MCMINN	**MM**	54	107
CAMPBELL	**CA**	07	013	MCNAIRY	**MC**	55	109
CANNON	**CN**	08	015	MACON	**MA**	56	111
CARROLL	**CR**	09	017	MADISON	**MN**	57	113
CARTER	**CT**	10	019	MARION	**MI**	58	115
CHEATHAM	**CH**	11	021	MARSHALL	**ML**	59	117
CHESTER	**CS**	12	023	MAURY	**MY**	60	119
CLAIBORNE	**CL**	13	025	MEIGS	**ME**	61	121
CLAY	**CY**	14	027	MONROE	**MO**	62	123
COCKE	**CO**	15	029	MONTGOMERY	**MT**	63	125
COFFEE	**CE**	16	031	MOORE	**MR**	64	127
CROCKETT	**CK**	17	033	MORGAN	**MG**	65	129
CUMBERLAND	**CU**	18	035	OBION	**OB**	66	131
DAVIDSON	**DA**	19	037	OVERTON	**OV**	67	133
DECATUR	**DE**	20	039	PERRY	**PE**	68	135
DE KALB	**DB**	21	041	PICKETT	**PI**	69	137
DICKSON	**DI**	22	043	POLK	**PO**	70	139
DYER	**DY**	23	045	PUTNAM	**PU**	71	141
FAYETTE	**FA**	24	047	RHEA	**RH**	72	143
FENTRESS	**FE**	25	049	ROANE	**RO**	73	145
FRANKLIN	**FR**	26	051	ROBERTSON	**RN**	74	147
GIBSON	**GI**	27	053	RUTHERFORD	**RU**	75	149
GILES	**GS**	28	055	SCOTT	**SC**	76	151
GRAINGER	**GR**	29	057	SEQUATCHIE	**SE**	77	153
GREENE	**GE**	30	059	SEVIER	**SV**	78	155
GRUNDY	**GY**	31	061	SHELBY	**SH**	79	157
HAMBLEN	**HA**	32	063	SMITH	**SM**	80	159
HAMILTON	**HM**	33	065	STEWART	**ST**	81	161
HANCOCK	**HK**	34	067	SULLIVAN	**SU**	82	163

COUNTY NAME	DWR CO ABBR	TN CO NO	NATIONAL TN FIPS	COUNTY NAME	DWR CO ABBR	TN CO NO	NATIONAL TN FIPS
HARDEMAN	**HR**	35	069	SUMNER	**SR**	83	165
HARDIN	**HD**	36	071	TIPTON	**TI**	84	167
HAWKINS	**HS**	37	073	TROUSDALE	**TR**	85	169
HAYWOOD	**HY**	38	075	UNICOI	**UC**	86	171
HENDERSON	**HE**	39	077	UNION	**UN**	87	173
HENRY	**HN**	40	079	VAN BUREN	**VA**	88	175
HICKMAN	**HI**	41	081	WARREN	**WA**	89	177
HOUSTON	**HO**	42	083	WASHINGTON	**WN**	90	179
HUMPHREYS	**HU**	43	085	WAYNE	**WE**	91	181
JACKSON	**JA**	44	087	WEAKLEY	**WY**	92	183
JEFFERSON	**JE**	45	089	WHITE	**WH**	93	185
JOHNSON	**JO**	46	091	WILLIAMSON	**WI**	94	187
KNOX	**KN**	47	093	WILSON	**WS**	95	189
LAKE	**LA**	48	095				
STATE NAME	DWR **ABBR**			**STATE NAME**	DWR **ABBR**		
ALABAMA	**_AL**			MISSISSIPPI	**_MS**		
ARKANSAS	**_AR**			MISSOURI	**_MO**		
GEORGIA	**_GA**			NORTH CAROLINA	**_NC**		
KENTUCKY	**_KY**			VIRGINIA	**_VA**		

Department of Environment & Conservation

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

Header Information for sampling run



Row					
1	TDEC-DWR Sampling Event- Surface Water Only				
2	Sampling Team: Amy Fritz	Brad Smith	Organization: Jackson EFO	Date: 1/31/2017	
3	Lead Sampler's Initials: AJF	Meters Used: MS#3	Send Report To: Brad Smith/TDEC/DWR/JEFO		
4					
5	Sample Sequence: 01C	ADAIR001.1MN		Time:	
6	DWR Station ID: ADAIR001.1MN	Monitoring Location ID: TNW000000006	Field Log Number: AJF0131201701C		
7	Monitoring Location Name: Adair Branch	Monitoring Location: U/S Hwy 412 Nears Bells Hwy			
8	Project Name: 303(d)	[Pr]oject ID: TNPR0080	Activity Type:		
9	Billing Code:				
10	E. coli sample co[...]	[Contr]act Lab? Check if E. coli will be delivered to Contract Lab	1st	2nd	Meter Problems:
11	Field Parameter[s]	2nd	Meter Problems: ☑ if Validated	DO %:	
12	pH (su[...])			Turbidity (NTU):	
13	Conductivity (umhos):			TDS (mg/L):	
14	Temperature (C°):			Flow (cfs):	
15	Dissolved Oxygen (mg/L):			Secchi Depth (ft):	
16	Notes:				
17					

Project Name drop-down list: Watershed, 303(d), Antidegradation, Ambient, Ecoregion, FECO, SEMN, QC

Sheet tabs: Events, Waterlog, inorg1, inorg2, inorg3, inorg4, inorg5, tags, ContractLab

TN Department of Environment & Conservation

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

5	Sample Sequence:	01C		ECO66G12			Time:	815
6	DWR Station ID:	ECO66G12		Monitoring Location ID:	TNW000001991		Field Log Number:	JKR0201201801C
7	Monitoring Location Name:	Sheeds Creek		Monitoring Location:	0.25 Mi U/S Sheeds Creek Road Crossing.			
8	Project Name: SEMN	Project ID: TNPR0039			Activity Type:	Sample-Routine		
9	Billing Code: EN000023458							
10	E. coli sample collected for analysis by Contract Lab?	☐ Check if E. coli will be delivered to Contract Lab				1st	2nd	Meter Problems:
11	Field Parameters:	1st	2nd	Meter Problems: ☑ if Validated	DO %:			
12	pH (su):	6.8		☑ Mining	Turbidity (NTU):			
13	Conductivity (umhos):	98		☐	TDS (mg/L):			
14	Temperature (C°):	13.5		☐	Flow (cfs):	5.13		
15	Dissolved Oxygen (mg/L):	10.5		☐	Secchi Depth (ft):			
16	Notes:							

*Note: flow must be manually entered from flow calculation sheet into ‘Flow’ parameter cell.

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

State of Tennessee – Environmental
PLEASE PRINT LEGIBLY

Inorganic Analysis

PROJECT NAME:	303(d)	**PROJECT ID:**	TNPR0080
STATION NUMBER:	SULPH000.1RN	**WATERBODY NAME:**	Sulphur Fork
STREAM MILE:	0.1	**COUNTY:**	Robertson
DESCRIPTION:	Port Royal State Park - West of Hwy 238(Port Royal Road) and Old Clarksville		
LATITUDE:	36.55417	**LONGITUDE:**	-87.14028
Matrix:	Water	Activity Type: Sample-Routine	**Depth:**
COLLECTED: DATE	6/17/2018	**TIME:**	730
SAMPLER'S FULL NAME (printed)	Amelia Pond		
SAMPLING AGENCY:	Nashville EFO	**FIELD LOG NUMBER:**	AJP0617201801
IF PRIORITY, DATE NEEDED:		**BILLING CODE:**	EN000123456
SEND REPORT TO:	N. L. Moore DWR/PAS/CO	Melody.Pond@tn.gov	

*	Env. Microbiology	*	Gen. Inorganics (con't)	Other General
	coliform, fecal*		ortho-phosphate	
	coliform, total*		silica*	
	strep, fecal*	X	sulfate*	
X	E. Coli*	X	turbidity*	
	Enterococcus*		**Preserved, Nutrient**	
			COD*	
*	**General Inorganics**	X	nitrogen, ammonia	
	Not Preserved	X	nitrogen, NO_3 & NO_2	
	acidity as $CaCO_3$*	X	nitrogen, total Kjeldahl	
X	alkalinity as $CaCO_3$*		nitrogen, total organic	
	BOD, 5-day*	X	phosphate, total	
	CBOD, 5-day*			
	chloride*		**SPECIAL PRESERVATION**	
	chromium, hexavalent		cyanide	
X	color		oil and grease	
	conductivity*		phenols, total	**Metals Digestion type:**
	fluoride*		sulfide, total*	Normal
	MBAS*	X	TOC*	Dissolved
	nitrogen, nitrate*			TCLP
	nitrogen, nitrite*			Other:______________
	pH			
X	residue, dissolved*		**Asbestos**	
X	residue, settleable*		bulk asbestos	
X	residue, suspended*		other microscopic	
X	residue, total*			

*	Metals
X	aluminum, Al
	antimony, Sb
X	arsenic, As
	barium, Ba
	beryllium, Be
	boron, B
X	cadmium, Cd
	calcium, Ca
X	chromium, Cr
	cobalt, Co
X	copper, Cu
X	iron, Fe
	lithium, Li
X	lead, Pb
	magnesium, Mg
X	manganese, Mn
X	mercury, Hg
X	nickel, Ni
	potassium, K
X	selenium, Se
	silver, Ag
	sodium, Na
	strontium, Sr
	thallium, Tl
	vanadium, V
X	zinc, Zn
	hardness, Ca as $CaCO_3$*
X	hardness, total as
	Other Metals:

** denotes analyses performed only on water*

Laboratory Number			
Chain of Custody and Supplemental			
Only one chain of custody form is required			
per sampleset or point (if all collected at			
1. Collected By			
Date	6/17/2018	Time	730
Delivered to			
Date		Time	
2. Received by			
Date		Time	
Delivered to			
Date		Time	
3. Received by			
Date		Time	
Delivered to			
Date		Time	
4. Received in Lab by			
Date		Time	
5. Received in Lab by			
Date		Time	
6. Received in Lab by			
Date		Time	
7. Logged in by			
Date		Time	
Additional Information			
1. Others present at collection			
2. Other samples collected			
3. Mode of transportation to lab			
4. Cooler sealed by			
5. Date cooler sealed			
6. Remarks			
DO meter not working			

FIELD DETERMINATIONS

Conductivity,		Chlorine, residual		**Other Field Parameters:**
Dissolved Oxygen,		Turbidity, (NTU)		
Temperature, (°C)		ORP, (mv)		
pH		Flow Rate		

State of Tennessee – Environmental PLEASE PRINT LEGIBLY						Inorganic Analysis	
PROJECT NAME:		PROJECT ID:		*	Metals	Laboratory Number	
STATION NUMBER:		WATERBODY NAME:			aluminum, Al		
STREAM MILE:		COUNTY:			antimony, Sb		
DESCRIPTION:					arsenic, As	Chain of Custody and Supplemental	
LATITUDE:		LONGITUDE:			barium, Ba	*Only one chain of custody form is required*	
Matrix:	Water	Activity Type:	Depth:		beryllium, Be	*per sampleset or point (if all collected at*	
COLLECTED:	DATE	TIME:			boron, B	1. Collected By	
SAMPLER'S FULL NAME (printed)					cadmium, Cd	Date	Time
SAMPLING AGENCY:		FIELD LOG NUMBER:			calcium, Ca	Delivered to	
IF PRIORITY, DATE NEEDED:		BILLING CODE:			chromium, Cr	Date	Time
SEND REPORT TO:	N. L. Moore DWR/PAS/CO				cobalt, Co	2. Received by	

*	Env. Microbiology	*	Gen. Inorganics (con't)	Other General		copper, Cu	Date	Time
	coliform, fecal*		ortho-phosphate			iron, Fe	Delivered to	
	coliform, total*		silica*			lithium, Li	Date	Time
	strep, fecal*		sulfate*			lead, Pb	3. Received by	
	E. Coli*		turbidity*			magnesium, Mg	Date	Time
	Enterococcus*		Preserved, Nutrient			manganese, Mn	Delivered to	
			COD*			mercury, Hg	Date	Time
*	General Inorganics		nitrogen, ammonia			nickel, Ni	4. Received in Lab by	
	Not Preserved		nitrogen, NO_3 & NO_2			potassium, K	Date	Time
	acidity as $CaCO_3$*		nitrogen, total Kjeldahl			selenium, Se	5. Received in Lab by	
	alkalinity as $CaCO_3$*		nitrogen, total organic			silver, Ag	Date	Time
	BOD, 5-day*		phosphate, total			sodium, Na	6. Received in Lab by	
	CBOD, 5-day*					strontium, Sr	Date	Time
	chloride*		SPECIAL PRESERVATION			thallium, Tl	7. Logged in by	
	chromium, hexavalent		cyanide			vanadium, V	Date	Time
	color		oil and grease			zinc, Zn		
	conductivity*		phenols, total	Metals Digestion type:		hardness, Ca as $CaCO_3$*		
	fluoride*		sulfide, total*	Normal		hardness, total as		
	MBAS*		TOC*	Dissolved			Additional Information	
	nitrogen, nitrate*			TCLP				
	nitrogen, nitrite*			Other:______________		Other Metals:	1. Others present at collection	
	pH							
	residue, dissolved*		Asbestos				2. Other samples collected	
	residue, settleable*		bulk asbestos					
	residue, suspended*		other microscopic				3. Mode of transportation to lab	
	residue, total*							

** denotes analyses performed only on water*					4. Cooler sealed by
FIELD DETERMINATIONS					
Conductivity,		Chlorine, residual		Other Field Parameters:	5. Date cooler sealed
Dissolved Oxygen,		Turbidity, (NTU)			
Temperature, (°C)		ORP, (mv)			6. Remarks
pH		Flow Rate			

State of Tennessee - Environmental Laboratories

PLEASE PRINT LEGIBLY

Organic Analysis
Base/Neutral/Acid Extractables

PROJECT/SITE NO.	**PROJECT NAME**
STATION NUMBER	**COUNTY**
DESCRIPTION	
STREAM MILE	**DEPTH** **MATRIX**
COLLECTED: DATE	**TIME**
SAMPLER'S NAME(printed)	
SAMPLING AGENCY	**BILLING CODE**
IF PRIORITY, DATE NEEDED	
SEND REPORT TO:	
CONTACT HAZARD	

Laboratory Number

Branch Lab Number

*	**NPDES** Extractables	*	**NPDES** Extractables(con't)	*	**TCL** Semivolatiles
	butylbenzylphthalate		2-chlorophenol		dimethylphthalate
	bis(2-ethylhexyl)phthalate		2,4-dichlorophenol		4,6-dinitro-2-methylphenol
	di-n-butylphthalate		2,4-dimethylphenol		2,4-dinitrophenol
	di-n-octylphthalate		2,4-dinitrophenol		2,4-dinitrotoluene
	diethylphthalate		4,6-dinitro-o-cresol		2,6-dinitrotoluene
	dimethylphthalate		2-nitrophenol		fluoranthene
	n-nitrosodimethylamine		4-nitrophenol		fluorene
	n-nitrosodiphenylamine		pentachlorophenol		hexachlorobenzene
	n-nitrosodi-n-propylamine		phenol		hexachlorobutadiene
	isophorone		2,4,6-trichlorophenol		hexachlorocyclopentadiene
	nitrobenzene	*	**TCL** Semivolatiles		hexachloroethane
	2,4-dinitrotoluene		acenaphthene		indeno(1,2,3-cd)pyrene
	acenaphthene		acenaphthylene		isophorone
	acenaphthylene		anthracene		2-methylnaphthalene
	anthracene		benzo(a)anthracene		2-methylphenol
	benzo(a)anthracene		benzo(a)pyrene		4-methylphenol
	benzo(a)pyrene		benzo(b)fluoranthene		n-nitrosodiphenylamine
	benzo(b)fluoranthene		benzo(g,h,i)perylene		n-nitroso-n-dipropylamine
	benzo(g,h,i)perylene		benzo(k)fluoranthene		naphthalene
	benzo(k)fluoranthene		benzoic acid		2-nitroaniline
	chrysene		benzyl alcohol		3-nitroaniline
	dibenzo(a,h)anthracene		bis(2-chloroethoxy)methane		4-nitroaniline
	fluoranthene		bis(2-chloroethyl) ether		nitrobenzene
	fluorene		bis(2-chloroisopropyl)ether		2-nitrophenol
	indeno(1,2,3-c,d)pyrene		bis(2-ethylhexyl)phthalate		4-nitrophenol
	naphthalene		4-bromophenylphenylether		pentachlorophenol
	phenanthrene		butylbenzylphthalate		phenanthrene
	pyrene		4-chloroaniline		phenol
	bis(2-chloroethyl)ether		4-chloro-3-methyl phenol		pyrene
	bis(2-chloroethoxy)methane		2-chloronaphthalene		1,2,4-trichlorobenzene
	bis(2-chloroisopropyl)ether		4-chlorophenylphenylether		2,4,5-trichlorophenol
	4-bromophenylphenylether		chrysene		2,4,6-trichlorophenol
	4-chlorophenylphenylether		di-n-butylphthalate	*	**Nitrobodies**
	hexachlorocyclopentadiene		di-n-octylphthalate		RDX
	hexachlorobutadiene		dibenzo(a,h)anthracene		2,4,6-TNT
	hexachlorobenzene		dibenzofuran		2,4-dinitrotoluene
	hexachloroethane		3,3'-dichlorobenzidine		2,6-dinitrotoluene
	1,2,4-trichlorobenzene		2,4-dichlorophenol		nitrobenzene
	2-chloronaphthalene		diethylphthalate		1,3,5-TNB
	4-chloro-3-methyl phenol		2,4-dimethylphenol		

*	**TCLP** Semivolatiles
	chlordane
	o-cresol
	m-cresol
	p-cresol
	cresol
	2,4-D
	2,4-dinitrotoluene
	endrin
	heptachlor
	heptachlor epoxide
	hexachlorobenzene
	hexachlorobutadiene
	hexachloroethane
	lindane
	methoxychlor
	nitrobenzene
	pentachlorophenol
	pyridine
	toxaphene
	2,4,5-trichlorophenol
	2,4,6-trichlorophenol
	2,4,5-TP (Silvex)
*	**Pesticides/PCBs**
	aldrin
	alpha-BHC
	beta-BHC
	delta-BHC
	gamma-BHC (lindane)
	technical chlordane
	alpha-chlordane
	gamma-chlordane
	4,4'-DDD
	4,4'-DDE
	4,4'-DDT
	dieldrin
	endosulfan I
	endosulfan II
	endosulfan sulfate
	endrin
	endrin aldehyde
	endrin ketone
	heptachlor
	heptachlor epoxide
	toxaphene
	methoxychlor
	PCB 1016/1242
	PCB 1221
	PCB 1232
	PCB 1248
	PCB 1254
	PCB 1260
	PCB 1262

Chain of Custody and Supplemental Information

Only one chain of custody form is required per sample set or point (if all collected at the same time)

1. Collected by
   Date Time
   Delivered to
   Date Time
2. Received by
   Date Time
   Delivered to
   Date Time
3. Received by
   Date Time
   Delivered to
   Date Time
4. Received in Lab by
   Date Time
   Logged in by
   Date Time

Additional Information

1. Approximate volume of sample
2. Nearest town or city
3. Others present at collection
4. Number of other samples collected at same time at this point
5. Field collection procedure, handling and/or preservation of this sample
6. Mode of transportation to lab
7. Sample sealed by
8. Date sample sealed
9. Remarks

PH-3014 (rev 1/96) RDA 1527

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

State of Tennessee - Environmental Laboratories			**Volatiles**
PLEASE PRINT LEGIBLY			**and Petroleum Hydrocarbons**
PROJECT ID:		**PROJECT NAME:**	
STATION NUMBER		**COUNTY:**	**Branch Lab Number**
DESCRIPTION			**Chain of Custody and Supplemental Information**
STREAM MILE	**DEPTH**	**MATRIX** Water	*Only one chain of custody form is required per sample*
COLLECTED: DATE		**TIME**	*set or point (if all collected at the same time)*
SAMPLER'S NAME (printec		**ACTIVITY:**	1. Collected by
SAMPLING AGENCY		**BILLING CODE**	Date Time
IF PRIORITY, DATE NEEDED		**FIELD LOG NO.**	Delivered to
SEND REPORT TO: N. L. Moore DWR/WPU/CO			Date Time
			2. Received by
CONTACT HAZARD			Date Time
* **NPDES** Volatiles - 624	* **TCL** Volatiles - 8260A	* **TCLP** Volatiles	Delivered to
Bromoform	Chloromethane	Benzene	Date Time
Bromodichloromethane	Bromomethane	Carbon tetrachloride	3. Received by
Carbon Tetrachloride	Vinyl chloride	Chlorobenzene	Date Time
Chlorobenzene	Chloroethane	Chloroform	Delivered to
Chloroethane	Methylene chloride	1,2-Dichloroethane	Date Time
2-Chloroethylvinyl ether	Acetone	1,1-Dichloroethane	4. Received in Lab by
Chloroform	Carbon disulfide	Methyl ethyl ketone	Date Time
Chloromethane	1,1-Dichloroethene	Tetrachloroethene	Logged in by
Dibromochloromethane	1,1-Dichloroethane	Trichloroethene	Date Time
1,2-Dichlorobenzene	Cis-1,2-dichloroethene	Vinyl chloride	
1,3-Dichlorobenzene	Trans-1,2-dichloroethene	* **BTEX - 8260A** - UST	**Additional Information**
1,4-Dichlorobenzene	1,2-Dichloroethane	Benzene	1. Approximate volume of sample
Dichlorodifluoromethane	Chloroform	Toluene	
1,1-Dichloroethane	2-Butanone	Ethyl benzene	
1,2-Dichloroethane	1,1,1-Trichloroethane	o-Xylene	2. Nearest town or city
1,1-Dichloroethene	Carbon tetrachloride	m-Xylene	3. Others present at collection
Cis-1,2-dichloroethene	Vinyl acetate	p-Xylene	
Trans-1,2-dichloroethene	Bromodichloromethane	Methyl t-butyl ether	4. Number of other samples collected at same time at
1,2-Dichloropropane	1,2-Dichloropropane	Diisopropyl ether	this point
Cis-1,3-dichloropropene	Cis-1,3-dichloropropene	* **TPH by GC**	
Trans-1,2-dichloroethene	Trichloroethene	Gasoline Range Organics	
Methylene chloride	Dibromochloromethane	Diesel Range Organics	5. Field collection procedure, handling and/or
1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	* **TPH by IR** (418.1)	preservation of this sample
Tetrachloroethene	Benzene	418.1 - Waste Oil	
1,1,1-Trichloroethane	Trans-1,3-dichloropropene	* **Other**	
1,1,2-Trichloroethane	Bromoform		
Trichloroethene	4-Methyl-2-pentanone		6. Mode of transportation to lab
Trichlorofluoromethane	2-Hexanone		
Vinyl chloride	Tetrachloroethene		
Benzene	Toluene		7. Sample sealed by
Ethylbenzene	1,1,2,2-Tetrachloroethane		8. Date sample sealed
Toluene	Chlorobenzene		9. Remarks
o-Xylene	Ethyl benzene		
m-Xylene	Styrene		
p-Xylene	o-Xylene		
	m-Xylene		
	p-Xylene		
PH-3013 (rev 1/96)			**RDA 1527**

Chain of Custody

Inorganic Analysis

Laboratory Number

Chain of Custody and Supplemental

Only one chain of custody form is required per sampleset or point (if all collected at the same

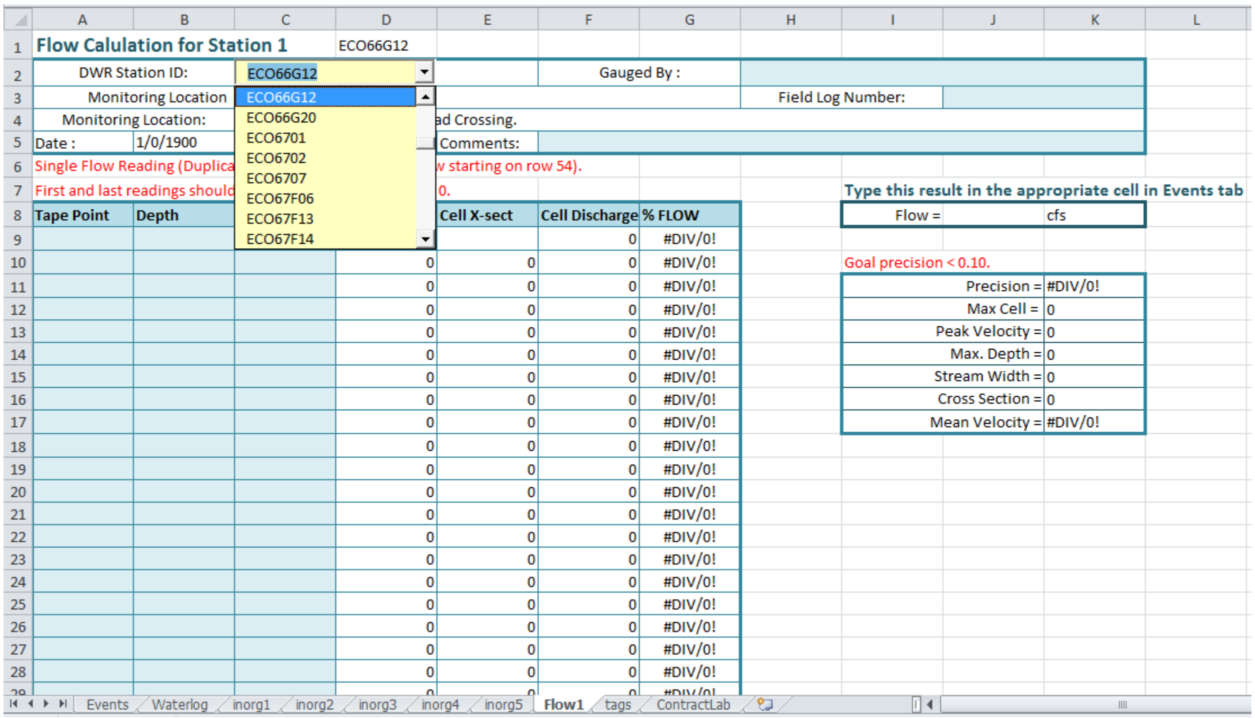
1. Collected By Amelia Pond
   Date 6/21/2018 Time 906
   Delivered to James T. Kirk
   Date 6/21/2018 Time 1153
2. Received by James T. Kirk
   Date 6/21/2018 Time 1153
   Delivered to State Lab
   Date 6/21/2018 Time 1416
3. Received by
   Date Time
   Delivered to
   Date Time
4. Received in Lab by
   Date Time
5. Received in Lab by
   Date Time
6. Received in Lab by Marie Curie
   Date 6/21/2018 Time 1416
7. Logged in by Marie Curie
   Date 6/21/2018 Time 1500

Additional Information

1. Others present at collection
   Rory Williams
2. Other samples collected
   None
3. Mode of transportation to lab
   State vehicle
4. Cooler sealed by
   Rory Williams
5. Date cooler sealed
   6/21/2018
6. Remarks
   DO meter not working.

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

Flow Calculation Sheet



	A	B	C	D	E	F	G	H	I	J	K	L
1	Flow Calulation for Station 1			ECO66G12								
2	DWR Station ID:		ECO66G12			Gauged By :						
3	Monitoring Location		ECO66G12					Field Log Number:				
4	Monitoring Location:		ECO66G20	ad Crossing.								
5	Date :	1/0/1900	ECO6701		Comments:							
6	Single Flow Reading (Duplica		ECO6702	w starting on row 54).								
7	First and last readings should		ECO6707	0.					Type this result in the appropriate cell in Events tab			
8	Tape Point	Depth	ECO67F06		Cell X-sect	Cell Discharge	% FLOW		Flow =		cfs	
9			ECO67F13			0	#DIV/0!					
10			ECO67F14	0	0	0	#DIV/0!		Goal precision < 0.10.			
11				0	0	0	#DIV/0!		Precision =		#DIV/0!	
12				0	0	0	#DIV/0!		Max Cell =		0	
13				0	0	0	#DIV/0!		Peak Velocity =		0	
14				0	0	0	#DIV/0!		Max. Depth =		0	
15				0	0	0	#DIV/0!		Stream Width =		0	
16				0	0	0	#DIV/0!		Cross Section =		0	
17				0	0	0	#DIV/0!		Mean Velocity =		#DIV/0!	
18				0	0	0	#DIV/0!					
19				0	0	0	#DIV/0!					
20				0	0	0	#DIV/0!					
21				0	0	0	#DIV/0!					
22				0	0	0	#DIV/0!					
23				0	0	0	#DIV/0!					
24				0	0	0	#DIV/0!					
25				0	0	0	#DIV/0!					
26				0	0	0	#DIV/0!					
27				0	0	0	#DIV/0!					
28				0	0	0	#DIV/0!					

Events / Waterlog / inorg1 / inorg2 / inorg3 / inorg4 / inorg5 / Flow1 / tags / ContractLab

	A	B	C	D	E	F	G	H	I	J	K
1	Flow Calulation for Station 1			ECO66G20							
2	DWR Station ID:		ECO66G20			Gauged By :		Chip Walton			
3	Monitoring Location		Name:	Rough Creek					Field Log Number:	CFW0701202001	
4	Monitoring Location:		National Forest Road 221 Stream Crossing								
5	Date :	7/1/2020			Comments:						
6	Single Flow Reading (Duplicate readings are entered below starting on row 54).										
7	First and last readings should have a depth and velcoity of 0.							Type this result in the appropriate cell in Events tab			
8	Tape Point	Depth	Velocity	Cell Width	Cell X-sect	Cell Discharge	% FLOW		Flow =	6.13 cfs	
9	3.6	0	0			0	0				
10	4.5	0.1	0.2	0.95	0.095	0.019	0.30993842		Goal precision < 0.10.		
11	5.5	0.25	0.35	1	0.25	0.0875	1.427347987		Precision =	0.093797153	
12	6.5	0.4	0.4	1	0.4	0.16	2.610007748		Max Cell =	0.575	
13	7.5	0.5	0.45	0.95	0.475	0.21375	3.486807226		Peak Velocity =	1	
14	8.4	0.55	0.5	1	0.55	0.275	4.485950818		Max. Depth =	1.15	
15	9.5	0.6	0.55	0.8	0.48	0.264	4.306512785		Stream Width =	15.7	
16	10	0.65	0.62	0.5	0.325	0.2015	3.286978508		Cross Section =	8.68	
17	10.5	0.65	0.66	0.5	0.325	0.2145	3.499041638		Mean Velocity =	0.70625	
18	11	0.7	0.7	0.5	0.35	0.245	3.996574365				
19	11.5	0.75	0.8	0.5	0.375	0.3	4.893764528				
20	12	0.8	0.85	0.5	0.4	0.34	5.546266465				
21	12.5	0.9	0.88	0.5	0.45	0.396	6.459769177				
22	13	0.9	0.9	0.5	0.45	0.405	6.606582113				
23	13.5	1.1	0.92	0.5	0.55	0.506	8.254149505				
24	14	1	0.95	0.5	0.5	0.475	7.748460503				
25	14.5	1.1	0.9	0.5	0.55	0.495	8.074711472				
26	15	1.15	1	0.5	0.575	0.575	9.379715346				
27	15.5	0.8	0.8	0.5	0.4	0.32	5.220015497				
28	16	0.6	0.7	0.75	0.45	0.315	5.138452755				
29	17	0.5	0.6	1	0.5	0.3	4.893764528				
30	18	0.2	0.1	1.15	0.23	0.023	0.375188614				
31	19.3	0	0	9	0	0	0				

Empty Field Parameter Section

TDEC-DWR Sampling Event- Surface Water Only — Version 5.0 for FY 2021-2022 106 Workplan (revised 6/11/2021)

Sampling Team:	Christie Renfro/Josh Frazier			Organization:	Knoxville EFO	Date:	7/7/2021
Lead Sampler's Initials:	CVR	Meters Used:	R2D2		Send Report To:	Christie Renfro/TDEC/KEFO/DWR	

Inorganic Analyses — Stations were last updated 6/2/2021. Add new stations at the bottom of this worksheet.

Sample Sequence:	01		FBROA095.9CO			Time:	830
DWR Station ID:	FBROA095.9CO		Monitoring Location ID:	TNW000002287		Field Log Number	CVR0707202101
Monitoring Location Name:	French Broad River		Monitoring Location:	USFS Canoe Access off Hwy 25/70			
Project Name:	Ambient	Project ID:	TNPR0003	Activity Type:	Sample-Routine		
Billing Code:	EN00018344						
E. coli sample collected for analysis by Contract Lab?		☐ Check if E. coli will be delivered to Contract Lab			1st	2nd	Meter Problems:
Field Parameters:	1st	2nd	Meter Problems: ☑ if Validated	DO %:			
Conductivity (umhos):	253.00		☐	Turbidity (NTU):			
Dissolved Oxygen (mg/L):	8.50		☐	TDS (mg/L):			
Temperature (C°):	20.30		☐	Flow (cfs):			
pH (su):	7.80		☐	Secchi Depth (ft):			
Notes:							

Field Parameters Completed & Ready For Uploading

Water Parameters for Upload to Waterlog

DWR_STATION_ID	ACTIVITY_START_DATE	PROJECT_ID	PROJECT_NAME	MONITORING_LOCATION_ID	ACTIVITY_ID	FIELD_LOG_NUMBE	ACTIVITY_TYPE	ACTIVITY_START_	ACTIVITY_START_	SAMPLE_COLLECTION_N	SAMPLE_COLLE	CHARACTERISTIC_NA	METHOD_SPECIATION	RESULT_DETECT	RESULT_VALUE	RESULT_UNIT
FBROA095.9CO	7/7/2021	TNPR0003	Ambient	TNW000002287	CVR0707202101F	CVR0707202101	Field Msr/Obs	830	EST			Conductivity			253.00	umho/cm
FBROA095.9CO	7/7/2021	TNPR0003	Ambient	TNW000002287	CVR0707202101F	CVR0707202101	Field Msr/Obs	830	EST			Dissolved oxygen (DO)			8.50	mg/l
FBROA095.9CO	7/7/2021	TNPR0003	Ambient	TNW000002287	CVR0707202101F	CVR0707202101	Field Msr/Obs	830	EST			Temperature, water			20.30	deg C
FBROA095.9CO	7/7/2021	TNPR0003	Ambient	TNW000002287	CVR0707202101F	CVR0707202101	Field Msr/Obs	830	EST			pH			7.80	None

Tennessee Department of Health
Environmental Laboratories TDOH-ENVLogin.Health@tn.gov
Sample Container Request Form

		Environmental Laboratory Contact Information		
Enivironmental Field Office (EFO):		Craig Edwards	(615)262-6345	Craig.Edwards@tn.gov
EFO Contact Person:		Patrick Leathers	(615)262-6487	Patrick. Leathers@tn.gov
Contact Phone #:		Sakshi Sawarkar	(615)262-6321	Sakshi.Sawarkar@tn.gov
Contact Email:		sample receiving	(615)262-6358	
Request Date:				
Sent Date:				

The bottles listed below are kept on hand by TDH Lab Services

Test Description	Container Description	Unit of Measure	Quantity per UOM	Request Amount (in case)
Inorganic Routines	1 gallon HDPE Bleach Style Jug, Pre-Cleaned	**Case**	**6**	
Inorganic Routines/ Metals/ Regular Mercury	1000 mL HDPE Oblong Wide Mouth, Pre-Cleaned and Certified	**Case**	**12**	
Inorganic Routines	250 mL HDPE Wide Mouth Plastic Bottle, Pre-cleaned and certified	**Case**	**72**	
Inorganic Routines	500 mL HDPE Oblong Wide Mouth, Pre-Cleaned and Certified	**Case**	**24**	
Nutrients	500 mL HDPE Oblong Wide Mouth with 1 mL Concentrated Sulfuric Acid, Pre-Cleaned and Certified	**Case**	**24**	
Low Level Mercury	250 mL Clear Boston Round Glass Bottles with 1.25 mL Optima Grade HCl, Pre-cleaned and Certified	**Case**	**12**	
Oil and Grease	**Pace**: 32 oz (1000 mL) Clear Straight-Sided Glass Jar with 2 mL Concentrated Sulfuric Acid	**Case**	**12**	
Total Organic Carbon (TOC)	250 mL Natural HDPE Wide Mouthed Nalgene Bottle with 3 mL 1:1 Phosphoric Acid, Pre-Cleaned and	**Case**	**24**	
Volatile Organics (VOA) Water	40 mL Glass Vial, Amber with 1 mL 1:1 Hydrochloric Acid, Pre-Cleaned and Certified	**Case (Packaged in small bags, 3 to a bag)**	**72**	
Radiochemistry Radon in Water	60 mL Glass Vial, Clear or Amber, Pre-Cleaned and Certified (No Preservative	**Case**	**144**	
Bacteriological	290 mL Plastic Bottles with Sodium Thiosulfate, Pre-Cleaned and Certified	**Case**	**100**	
Nanopure Water				

The bottles listed below are for special projects and should be requested from the lab that will be doing the analysis.

Test Description	Container Description	Unit of Measure	Quantity per UOM	Request Amount (in case)
Ext. Waters (SVOA's) Pest/PCB's	**Pace**: 1000 mL Amber Boston Round Glass Container	**Case**	**12**	
Extractable Soils and Metals Soils	16 oz Amber Wide Mouth Glass Jar (Straight-side/Short with Cap size approx 89 mm), Pre-Cleaned and Certified	**Case**	**12**	
Ext. Pet. Hydrocarbons (EPH)	**Pace**: 4 L Amber Glass Jug with 20 mL 1:1 Hydrochloric Acid (Needs to be pre-ordered from pace, Pre-Cleaned and Certified	**Case**	**12**	
Glyphosate and Carbamates	40 mL Glass Vial, Amber, Pre-Cleaned and Certified (No Preservative)	**Case**	**144**	
Haloacetic Acids, Herbicides and Chloral Hydrate	60 mL Glass Vial, Amber, Pre-Cleaned and Certified (No Preservative)	**Case**	**144**	
Paraquat and Diquat	1000 mL HDPE, Amber Wide Mouth, Pre-cleaned and Certified (No Preservative)	**Case**	**24**	
Total Phenol	1000 mL Amber Boston Round with 2 ML Concentrated Sulfuric Acid, Pre-Cleaned and Certified	**Case**	**12**	
Volatile Organics (VOA) Soil	4 oz Amber Wide mouth Glass Jar with Septum cap, Pre-Cleaned and Certified	**Case**	**24**	

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

TDEC Division of Water Resources

E. coli Sample Request

Laboratory:								
Samplers Name:			EFO:			Phone Number:		
Date Collected:			Billing Code:					
Send Report to:	Natalie.L.Moore@tn.gov	and						
Date Report Needed:	Standard (5 days) or		Priority (date):			Cooler Temp:		
Project ID	Project Name	DWR Station ID	Monitor. Loc. ID	Field Log No.	Activity ID #	Activity Type	Time	D

Chain of Custody

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

APPENDIX B

TESTS, CONTAINERS, HOLDING TIMES, and LABORATORY MDLs

TDH Bacteriological Analyses Available
TDH Routine Analyses Available
TDH Nutrient Analyses Available
TDH Metal Analyses Available
TDH Miscellaneous Inorganic Analyses Available
TDH Organic Analyses Available
Laboratory MDLs for Metals
Laboratory MDLs for Non-Metals (Inorganics)
Laboratory MDLs for Pesticides
Laboratory MDLs for PCBs
Laboratory MDLs for PAHs
Laboratory MDLs for Semivolatiles
Laboratory MDLs for Volatiles

TDH Bacteriological Analyses Available

Test	Holding Time	Container	Preservative
Coliform, fecal	6 hours	Lab provided bacti bottles	20 mg of Sodium Thiosulfate ($Na_2S_2O_3$). Bottles are labeled with preparation date and expiration date. Do not use expired bottles.
Coliform, total	6 hours		
*E. coli**	6 hours		
Strep, fecal	6 hours		

*Only **one** bottle is needed if *E. coli* is the analysis requested.
Store on ice at ≤10°C.

Routine Analyses Available

Test	Holding Time	Container	Preservative
Acidity	14 days	1 L plastic	None
Alkalinity	14 days	1 L plastic	
Alkalinity, phen.	14 days	1L plastic,	
BOD, 5-day	48 hours	1 L plastic, separate, outsourced	
CBOD, 5-day	48 hours	1 L plastic, separate, outsourced	
Chloride	28 days	250mL plastic	
Chromium, hexavalent	24 hours	250mL plastic, outsourced	
Fluoride	28 days	250mL plastic	
Nitrogen, nitrate	48 hours	250mL plastic	
Nitrogen, nitrite	48 hours	250mL plastic	
Orthophosphate, total	48 hours	250mL plastic	None
Silica	28 days	250mL plastic	
Sulfate	28 days	250mL plastic	
Turbidity	48 hours	250mL plastic	
MBAS	48 hours	Contact TDH for current bottle requirement	
Color, apparent	48 hours	250mL plastic	
Color, true	48 hours	250mL plastic	
Residue, dissolved	7 days	1L plastic	
Residue, suspended	7 days	1L, plastic	

Routine Analyses Available

Residue, settleable	48 hours	1L, plastic, separate,	None
Residue, total	7 days	1L plastic outsourced	

All plastics are single-use. Store on ice at ≤6ºC.
No preservative is needed for Routine Samples.
* If a test needs a separate 1L container then that test will consume all of the 1Lvolume. If the test does not need a 'separate' 1L, then all "1 liter" tests (that do not need a separate container) can be obtained from, one-1L container. Contact TDH Lab if assistance is needed to determine how much sample to collect.
** All "250 mL" analyses can be obtained from one bottle with exception of Hexavalent Chromium.

Nutrient Analyses Available

Test	Holding Time	Container	Preservative
COD	28 days	500 mL plastic	1 mL sulfuric acid (H_2SO_4)
Nitrogen, ammonia	28 days	500mL Plastic	1 mL sulfuric acid (H_2SO_4)
Nitrogen, (NO_3 & NO_2)	28 days		
Nitrogen, total kjeldahl (TKN)	28 days		
Nitrogen, total organic	28 days		
Phosphorus, total (phosphate, total on request sheet)	28 days		

All plastics are single-use. Store on ice at ≤6ºC.
*COD should be collected in a separate bottle.
Powder-free gloves must be worn when collecting nutrients.

Metals Analyses Available

Test	Holding Time	Container	Preservative
Aluminum, Al	6 months	1 L plastic	None, preserved in lab with 5 mL 70% Nitric Acid (HNO_3)
Antimony, Sb			
Arsenic, As			
Barium, Ba			
Beryllium, Be			
Boron, B			
Cadmium, Cd			
Calcium, Ca			
Chromium, Cr			
Cobalt, Co			
Copper, Cu			
Iron, Fe			
Lead, Pb			
Magnesium, Mg			
Manganese, Mn			
Nickel, Ni			
Potassium, K			
Selenium, Se			
Silver, Ag			
Sodium, Na			
Thallium, Tl			
Vanadium, V			
Zinc, Zn			
Mercury, Hg	28 days		
Total Hardness by Calculation	6 months		
Mercury, Low Level Hg	120 days	250 mL glass	1.25mL Optima grade HCL

All plastics are single-use. Metals and mercury do not need ice during shipment. All metals and mercury can be sampled in ONE bottle.
Trace metals and low-level mercury samples must be collected using the modified clean technique.

Miscellaneous Inorganic Analyses Available

Test	Holding Time	Container	Preservative
Cyanide	14 days	1 L plastic	pH>12; 5 mL of 50% sodium hydroxide (NaOH) at collection. If KI paper indicates chlorine, add 0.6g ascorbic acid ($C_6H_8O_6$) before adding NaOH. If sulfides are detected by lead acetate paper, add 1g of Cadmium Chloride ($CdCl_2$) after adding NaOH.
Oil & Grease	28 days	1 L glass, wide mouth with Teflon® lined lid	2 mL sulfuric acid (H_2SO_4)
Phenols, total	28 days	1L glass, amber	2 mL sulfuric acid (H_2SO_4)
Sulfide	7 days	500 mL glass	2 mL zinc acetate (ZnAc) in laboratory. 5 mL 50% sodium hydroxide (NaOH) in field.
Flash Point	None specified	16-ounce glass Teflon® lined lid	None
TCLP	28 days	16-ounce glass jar*	None
TOC	28 days	1-250 mL plastic	1 mL phosphoric acid (H_3PO_4)

All plastics are single-use. Store on ice at ≤6ºC.
*Due to analysis requirements, this could require much more sample. (See Section II, Protocol C)

Organic Analyses Available

Test	Holding Time	Container	Preservative
Base/Neutral/Acid Extractables			
NPDES Extrac. Pesticides/PCBs TAL Extrac. Nitrobodies Semivolatiles	7 days to extract; (then 365 days to analyze for PCB test ONLY)	2 - 1L Amber Glass	None
Volatiles and Petroleum Hydrocarbons			
NPDES Volatiles TAL Volatiles	14 days	3 40-mL amber vials, Teflon®-lined septa caps, no headspace.	1:1 hydrochloric acid (HCl)
BTEX GRO	14 days	3 40-mL amber vials, Teflon®-lined septa caps, no headspace	1:1 hydrochloric acid (HCl)
EPH	14 days	One 4 L amber bottle with Teflon® lined lid	1:1 Hydrochloric Acid (HCl)

Store on ice ≤6ºC.
Contact the TDH Environmental Laboratory for collection instruction for other types of analyses.

Laboratory MDLs for Metals

Parameter	Units	Nashville TDH Lab		PACE Lab	
		MQL	MDL	MQL	MDL
Aluminum - Al	ug/L	10	6.51	x	x
Antimony - Sb	ug/L	1	0.48	x	x
Arsenic - As	ug/L	5	1.35	x	x
Barium - Ba	ug/L	5	0.198	x	x
Beryllium - Be	ug/L	1	0.243	x	x
Boron	ug/L	10	3.71	x	x
Cadmium - Cd	ug/L	1	0.274	x	x
Calcium - Ca	mg/L	0.1	0.0483	x	x
Chromium - Cr	ug/L	5	3.11	x	x
Cobalt - Co	ug/L	1	0.182	x	x
Copper - Cu	ug/L	1	0.583	x	x
Iron - Fe	ug/L	10	4.27	x	x
Lead - Pb	ug/L	1	0.144	x	x
Lithium - Li	ug/L	1	0.384	x	x
Magnesium - Mg	mg/L	0.1	0.03	x	x
Manganese - Mn	ug/L	1	0.813	x	x
Mercury - Hg	ug/L	0.2	0.0405	0.0002 mg/L	0.000049 mg/L
Mercury-Low Level	ug/L	0.005	0.00176	x	x
Molybdenum - Mo	ug/L	1	0.442	x	x
Nickel - Ni	ug/L	1	0.27	x	x
Potassium - K	mg/L	0.1	0.0507	x	x
Selenium - Se	ug/L	5	2.22	x	x
Silver - Ag	ug/L	0.25	0.195	x	x
Sodium - Na	mg/L	0.1	0.027	x	x
Thallium - Tl	ug/L	1	1.53	x	x
Uranium - U	ug/L	1	0.154	x	x
Vanadium - V	ug/L	5	4.65	x	x
Zinc - Zn	ug/L	5	3.47	x	x
Hardness (Total)	mg/L	0.25	0.115	x	x
Hardness, Calcium	mg/L	0.25	0.152	x	x

x = Not Performed by Lab
* = MDL not required

Laboratory MDLs for Non-Metals (Inorganics)

Parameter	Units	Nashville TDH Lab		PACE Lab	
		MQL	MDL	MQL	MDL
Ammonia	mg/L	0.1	0.01937	0.1	0.0317
TKN	mg/L	0.5	0.362	x	x
Nitrate/Nitrite	mg/L	0.1	0.01389	0.1	0.0197
Nitrate	mg/L	0.05	0.0221	0.1	0.0227
Nitrite	mg/L	0.05	0.01814	0.1	0.0277
Orthophosphate	mg/L	0.025	0.0046	0.025	0.00466
Total Phosphorus	mg/L	0.05	0.0100^	x	x
TOC	mg/L	0.5	0.34482	1	0.102
COD	mg/L	x	x	10	3
Sulfate	mg/L	2.5	1.348	5	0.0774
Phenol	mg/L	x	x	0.04	0.0083
Fluoride	mg/L	0.1	0.0224	0.1	0.0099
Cyanide	mg/L	x	x	x	x
Alkalinity	mg/L	10	10	20	2.71
Acidity	mg/L	x	x	10	3.63
BOD/CBOD	mg/L	3.33	3.33	3.33	3.33
Color	Color Units	5	5	1	1
MBAS	mg/L	x	x	x	x
Turbidity	NTU	1	1	0.1	0.031
Settleable Solids	mg/L	0.2	0.2	0.1	0.033
Suspended Residue	mg/L	10	10	2.5	0.35
Dissolved Residue	mg/L	10	10	10	2.82
Total Residue	mg/L	10	10	10	10
Sulfide	mg/L	x	x	x	x
Chloride	mg/L	2.5	1.1091	1	0.0519
Hexavalent Chromium	mg/L	x	x	0.0005	0.00002
Silica	mg/L	100	25	x	x
Conductivity	µmohms/cm	10	10	x	x
Residual Free Chlorine	mg/L	0.25	0.053	x	x

TBD = To Be Determined
x = Not Performed by Lab
*** = MDL not required**
^ = MDL is being reviewed by TDH lab

Laboratory MDLs for Pesticides

Analyte	Units	PACE Lab	
		MDL	MQL
2,4'-DDD	µg/L	X	X
2,4'-DDE	µg/L	X	X
2,4'-DDT	µg/L	X	X
4,4'-DDD	µg/L	0.0298	0.10
4,4'-DDE	µg/L	0.0118	0.10
4-4'-DDT	µg/L	0.0305	0.10
a-BHC	µg/L	0.00894	0.05
a-Chlordane	µg/L	0.00676	0.05
a-Endosulfan / Endosulfan I	µg/L	0.00719	0.05
Aldrin	µg/L	0.0141	0.05
b-BHC	µg/L	0.0138	0.05
b-Endosulfan / Endosulfan II	µg/L	0.0148	0.10
Chlordane	µg/L	0.211	0.50
cis-Nonachlor	µg/L	0.231	1.67
d-BHC	µg/L	0.0165	0.05
Dieldrin	µg/L	0.0157	0.10
Endrin	µg/L	0.0290	0.10
Endrin Aldehyde	µg/L	0.0255	0.10
Endrin Ketone	µg/L	0.0293	0.10
Endosulfin sulfate	µg/L	0.0136	0.10
g-Chlordane	µg/L	0.00697	0.05
Heptachlor	µg/L	0.00793	0.05
Heptachlor epoxide	µg/L	0.00641	0.05
Hexachlorobenzene	µg/L	X	X
Hexachlorocyclopentadiene	µg/L	x	x
Lindane / g-BHC	µg/L	0.00657	0.05
Methoxychlor	µg/L	0.163	0.50
o,p'-DDD	µg/L	x	x
o,p'-DDE	µg/L	x	x
o,p'-DDT	µg/L	x	x
Oxychlordne	µg/L	X	X
p,p'-DDD	µg/L	x	x
p.p'-DDE	µg/L	x	x
p,p'-DDT	µg/L	x	x

Propachlor	µg/L	x	x
Toxaphene	µg/L	0.454	1.5
trans-Nonachlor	µg/L	X	X
Trifluralin	µg/L	x	x

Laboratory MDLs for PCBs

Analyte	Units	PACE Lab	
		MDL	MQL
PCB-1016	µg/L	0.112	0.5
PCB-1221	µg/L	0.112	0.5
PCB-1232	µg/L	0.112	0.5
PCB-1242	µg/L	0.112	0.5
PCB-1248	µg/L	0.112	0.5
PCB-1254	µg/L	0.112	0.5
PCB-1260	µg/L	0.112	0.5

Laboratory MDLs for PAHs

Analyte	Units	PACE Lab	
		MDL	MQL
Acenaphthene	ug/L	0.01390	0.0500
Acenaphthylene	ug/L	0.01260	0.0500
Anthracene	ug/L	0.01855	0.0500
Benzo(a)anthracene	ug/L	0.01362	0.0500
Benzo(a)pyrene	ug/L	0.01960	0.0500
Benzo(b)fluoranthene	ug/L	0.01950	0.0500
Benzo(g,h,i)perylene	ug/L	0.02330	0.0500
Benzo(k)fluoranthene	ug/L	0.02227	0.0500
Chrysene	ug/L	0.02662	0.0500
Dibenzo(a,h)anthracene	ug/L	0.01780	0.0500
Fluoranthene	ug/L	0.02614	0.0500
Fluorene	ug/L	0.02350	0.0500
Indeno(1,2,3-cd)pyrene	ug/L	0.01550	0.0500
Naphthalene	ug/L	0.01990	0.0500
Phenanthrene	ug/L	0.02564	0.0500
Pyrene	ug/L	0.02258	0.0500

Laboratory MDLs for Semivolatiles

Analyte	PACE		Units
	MDL	MQL	
1,1'-Biphenyl	1.453	5.00	µg/L
1,2,4,5 Tetrachlorobenzene	0.999	5.00	µg/L
1,2,4-Trichlorobenzene	1.570	5.23	µg/L
2,4,5-Trichlorophenol	0.645	5.00	µg/L
2,4,6-Tribromophenol	x	x	µg/L
2,4,6-Trichlorophenol	0.797	5.00	µg/L
2,4-Dichlorophenol	0.896	5.00	µg/L
2,4-Dimethylphenol	1.159	5.00	µg/L
2,4-Dinitrophenol	2.451	8.17	µg/L
2,4-Dinitrotoluene	1.059	5.00	µg/L
2,6-Dinitrotoluene	0.773	5.00	µg/L
2-Chloronaphthalene	0.829	5.00	µg/L
2-Chlorophenol	0.828	5.00	µg/L
2-Fluorobiphenyl	x	x	µg/L
2-Fluorophenol	x	x	µg/L
2-Methylnaphthalene	1.164	5.00	µg/L
2-Methylphenol	0.931	5.00	µg/L
2-Nitroaniline	0.948	5.00	µg/L
2-Nitrophenol	0.826	5.00	µg/L
3,3'-Dichlorobenzidine	1.345	5.00	µg/L
3-Nitroaniline	1.364	5.00	µg/L
4,6-Dinitro-2-methylphenol	3.114	10.4	µg/L
4-Bromophenyl-phenylether	0.956	5.00	µg/L
4-Chloro-3-methylphenol	0.683	5.00	µg/L
4-Chloroaniline	1.787	5.96	µg/L
4-Chlorophenyl-phenylether	0.828	5.00	µg/L
4-Methylphenol	0.613	5.00	µg/L
4-Nitroaniline	2.998	9.99	µg/L
4-Nitrophenol	3.055	10.2	µg/L
Acenaphthene	0.763	5.00	µg/L
Acenaphthylene	0.730	5.00	µg/L
Acetophenone	2.199	7.33	µg/L
Anthracene	0.810	5.00	µg/L
Atrazine	3.554	11.8	µg/L
Azobenzene	x	x	µg/L

Analyte	PACE		Units
	MDL	MQL	
Benzaldehyde	2.382	7.94	µg/L
Benzidine	15.623	52.1	µg/L
Benzo(k)fluoranthene	1.124	5.00	µg/L
Benzo[a]anthracene	0.847	5.00	µg/L
Benzo[a]pyrene	1.272	5.00	µg/L
Benzo[b]fluoranthene	1.035	5.00	µg/L
Benzo[g,h,i}Perylene	1.379	5.00	µg/L
Benzoic Acid	16.5	55.1	µg/L
Benzyl Alcohol	0.648	5.00	µg/L
Bis(2-chloroethoxy)methane	1.307	5.00	µg/L
Bis(2-chloroethyl)ether	1.167	5.00	µg/L
Bis(2-chloroisopropyl)ether	1.233	5.00	µg/L
Bis(2-ethylhexyl)phthalate	2.880	9.60	µg/L
Butylbenzylphthalate	1.298	5.00	µg/L
Caprolactam	4.841	16.1	µg/L
Carbazole	0.913	5.00	µg/L
Chyrsene	1.269	5.00	µg/L
Dibenzo[a,h]anthracene	1.105	5.00	µg/L
Dibenzofuran	0.848	5.00	µg/L
Diethylphthalate	0.775	5.00	µg/L
Dimethylphenthalate	0.720	5.00	µg/L
Di-n-butylphthalate	1.229	5.00	µg/L
Di-n-octylphthalate	4.765	15.9	µg/L
Fluoranthene	0.988	5.00	µg/L
Fluorene	0.906	5.00	µg/L
Hexachlorobenzene	1.652	5.51	µg/L
Hexachlorobutadiene	1.148	5.00	µg/L
Hexachlorocyclopentadiene	1.008	5.00	µg/L
Hexachloroethane	1.420	5.00	µg/L
Indeno[1,2,3-cd]pyrene	1.216	5.00	µg/L
Isophorone	0.774	5.00	µg/L
Naphthalene	1.218	5.00	µg/L
Nitrobenzene	1.075	5.00	µg/L
N-Nitrosodimethylamine	0.730	10.00	µg/L
N-Nitroso-di-n-propylamine	1.135	5.00	µg/L
N-Nitrosodiphenylamine	3.449	11.5	µg/L

Analyte	PACE		Units
	MDL	MQL	
Pentachlorophenol	4.555	15.2	µg/L
Phenanthrene	0.953	5.00	µg/L
Phenol	0.321	5.00	µg/L
Pyrene	1.201	5.00	µg/L
Pyridine	1.511	5.04	µg/L
Quinolin	x	x	µg/L
Resorcinol	x	x	µg/L

Laboratory MDLs for Volatiles

Analyte	PACE Lab		Units
	MDL	MQL	
1,1,1,2-Tetrachloroethane	0.36	1.00	µg/L
1,1,1-Trichloroethane	0.30	1.00	µg/L
1,1,2,2-Tetrachloroethane	0.38	1.00	µg/L
1,1,2-Trichloro-1,1,2-trifluoroethane	0.38	5.00	µg/L
1,1,2-Trichloroethane	0.34	5.00	µg/L
1,1-Dichloroethane	0.30	1.00	µg/L
1,1-Dichloroethene	0.58	1.00	µg/L
1,1-Dichloropropene	0.41	1.00	µg/L
1,2,3-Trichlorobenzene	1.02	5.00	µg/L
1,2,3-Trichloropropane	0.56	5.00	µg/L
1,2,4-Trichlorobenzene	0.95	5.00	µg/L
1,2,4-Trimethylbenzene	0.45	1.00	µg/L
1,2-Dibromo-3-chloropropane	2.37	5.00	µg/L
1,2-Dibromoethane	0.31	1.00	µg/L
1,2-Dichlorobenzene	0.33	1.00	µg/L
1,2-Dichloroethane	0.29	1.00	µg/L
1,2-Dichloropropane	0.45	1.00	µg/L
1,3,5-Trimethylbenzene	0.36	1.00	µg/L
1,3-Dichlorobenzene	0.35	1.00	µg/L
1,3-Dichloropropane	0.30	1.00	µg/L
1,4-Dichlorobenzene	0.89	1.00	µg/L
2,2-Dichloropropane	4.18	5.00	µg/L
2-Butanone (MEK)	6.52	25.00	µg/L
2-chloroethyl vinyl ether	2.48	10.00	µg/L

Analyte	PACE Lab		Units
	MDL	MQL	
2-Chlorotoluene	0.89	5.00	µg/L
2-Hexanone	6.28	25.00	µg/L
4-Chlorotoluene	0.89	5.00	µg/L
4-Methyl-2-pentanone	5.95	25.00	µg/L
Acetone	8.64	25.00	µg/L
Acrolein	3.82	5.00	µg/L
Acrylonitrile	6.50	25.00	µg/L
Benzene	0.30	1.00	µg/L
Bromobenzene	0.36	1.00	µg/L
Bromochloromethane	0.36	5.00	µg/L
Bromodichloromethane	0.42	1.00	µg/L
Bromoform	3.80	5.00	µg/L
Bromomethane	1.19	5.00	µg/L
Carbon disulfide	1.10	5.00	µg/L
Carbon tetrachloride	0.37	1.00	µg/L
Chlorobenzene	0.86	1.00	µg/L
Chloroethane	1.38	5.00	µg/L
Chloroform	1.18	5.00	µg/L
Chloromethane	1.64	5.00	µg/L
cis-1,2-Dichloroethene	0.47	1.00	µg/L
cis-1,3-Dichloropropene	0.36	1.00	µg/L
Cyclohexane	1.29	5.00	µg/L
Dibromochloromethane	2.64	5.00	µg/L
Dibromomethane	0.99	5.00	µg/L
Dichlorodifluoromethane	0.46	5.00	µg/L
Diisopropyl ether	1.10	5.00	µg/L
Ethylbenzene	0.33	1.00	µg/L
Hexachlorobutadiene	2.74	5.00	µg/L
Isopropylbenzene	1.00	5.00	µg/L
m & *p*-xylene	0.70	2.00	µg/L
Methyl acetate	6.30	25.00	µg/L
Methylcyclohexane	1.19	5.00	µg/L
Methylene chloride	0.32	5.00	µg/L
Methyl-*t*-butyl ether	1.13	5.00	µg/L
Naphthalene	1.13	5.00	µg/L
n-Butylbenzene	0.86	1.00	µg/L

Analyte	PACE Lab		Units
	MDL	MQL	
n-Propylbenzene	0.35	1.00	µg/L
o-Xylene	0.35	1.00	µg/L
p-isopropyl toluene	1.04	5.00	µg/L
sec-Butylbenzene	0.42	1.00	µg/L
Styrene	0.36	1.00	µg/L
tert-Butylbenzene	0.59	1.00	µg/L
Tetrachloroethene	0.41	1.00	µg/L
Toluene	0.29	1.00	µg/L
trans-1,2-Dichloroethene	0.53	1.00	µg/L
trans-1,3-Dichloropropene	3.46	5.00	µg/L
Trichloroethene	0.32	1.00	µg/L
Trichlorofluoromethane	0.42	1.00	µg/L
Vinyl acetate	1.33	5.00	µg/L
Vinyl chloride	0.17	1.00	µg/L

APPENDIX C

Monitoring to Support TMDL Development

TMDL: Monitoring to support pollutant specific TMDL development depends on the TMDL type. Coordinate TMDL monitoring with the Watershed Management Section.

a. Metal TMDLs (Minimum number of data points at each site is 12, some data points are obtained at low flow conditions).

- Critical: Flow, Hardness as $CaCO_3$, TSS, TOC, Metal(s) on 303(d) List, Selenium, pH, temperature, conductivity, and DO.
- Noncritical: Dissolved Metals (Cd, Cu, Pb, Ni, Ag, Zn).

b. pH TMDL (Minimum number of data points at each site is 12, some data points are obtained at low flow conditions).

- Critical: Acidity, Alkalinity, Flow, Hardness as $CaCO_3$, TSS, TOC, pH, temperature, conductivity, and DO.

c. DO TMDLs (Minimum number of data points at each site is 12, some data points are obtained at low flow conditions).

- Critical: Flow, pH, temperature (water), conductivity, DO, diurnal DO (minimum 2 weeks during growing season), $CBOD_5$, NH_3, NO_2/NO_3, Total Phosphorus (Total Phosphate on lab request sheet), Total Kjeldahl Nitrogen, and channel cross-section (transect profile, width, and depth).
- Noncritical: Velocity (dye study), temperature (air), CBOD decay rate, $CBOD_{ultimate}$, re-aeration rate, SOD, chlorophyll *a*, field notes (weather conditions, presence of algae, point source discharge, etc.).

d. Nutrient TMDLs (Minimum of 12 monthly samples, minimum of four high-flow samples).

- Critical: Flow, NH_3, NO_2/NO_3, Total Phosphorus (listed as total phosphate on lab request sheet), Orthophosphate, Total Kjeldahl Nitrogen, TSS, Turbidity, TOC, periphyton (wadeable) or chlorophyll *a* (non-wadeable), pH, temperature, conductivity, DO, and Diurnal DO (minimum 2 weeks during growing season).
- Noncritical: Project specific and weather conditions.

e. Pathogen TMDLs (Minimum of 12 monthly samples, minimum of four high-flow samples)

- Critical: Fecal coliform, *E. coli*, TSS, Turbidity, pH, temperature, conductivity, and DO, and comments describing flow conditions.
- Noncritical: Flow measurements, weather conditions.

Guidelines for collection of high-flow samples:

During wet season (January to March): ≥ 0.25 inches of rain in last 24 hours prior to sample collection.

During dry season (August to October): ≥ 0.5 inches of rain in last 24 hours prior to sample collection.

Storm Event Characterization

Level I:

Collect a minimum of 3 samples during each storm event with the objective of collecting at least one sample during each phase of the storm hydrograph: rising limb, near the peak, and on the recession.

Level II:

Collect 6-10 samples during each storm with the objective of fully representing the storm hydrograph: 2-3 samples on the rising limb, 1-2 at or near the peak, and 3-5 on the recession of the hydrograph.

Characterize storms during seasonal wet (January-March) and dry (August-October) periods (at least one storm each) in order to differentiate seasonal characteristics.

Wet season storm events tend to be longer duration (days) and may require more samples, on average, than dry season storm events with shorter duration (hours).

General storm event characterization guidelines:

During wet season (January to March): ≥ 0.25 inches of rain in last 24 hours prior to sample collection.

During dry season (August to October): ≥0.5 inches of rain in last 24 hours prior to sample collection.

Note: Many factors (antecedent moisture conditions, drainage area, rainfall intensity, land use, soil permeability, ground cover, etc.) can affect the stormflow runoff potential and dynamics in a watershed. The above are guidelines only; best professional judgment should be used.

APPENDIX D

NOTICE OF REVISIONS 2004-2021

NOTICE OF REVISIONS RECORD 2004

This revision(s) has been reviewed and approved. It becomes effective on: March 01, 2004.

C T Cole
Signature
Cheryl Cole
TDEC-BOE Quality Assurance Manager

3/1/2004
Date

Paul E. Davis
Signature
Paul E. Davis
Director
TN Division of Water Pollution Control

2/27/04
Date

Kimberly J. Sparks
Signature
Kimberly J. Sparks
Project Manager for Chemical and Bacteriological Sampling of Surface Water
TN Division of Water Pollution Control

02/27/2004
Date

Kimberly J Sparks — 02/27/2004

Signature — Date

Kimberly J. Sparks
Biologist III
TN Division of Water Pollution Control

Deborah H. Arnwine — 2-27-2004

Signature — Date

Deborah Arnwine
Environmental Specialist V
TN Division of Water Pollution Control

Gregory M. Denton — 3/1/04

Signature — Date

Gregory Denton
Environmental Program Manager I
TN Division of Water Pollution Control

Garland P. Wiggins — 2/27/04

Signature — Date

Garland Wiggins
Deputy Director
TN Division of Water Pollution Control

NOTICE OF REVISIONS RECORD 2008

Date	Specific Section or Page	Revision Type (major or minor)	Revision Description
06/05/08	Throughout Document	Minor	Numerous employee, positions and titles were updated.
06/05/08	Throughout Document	Minor	Change Environmental Assistance Center (EAC) to Environmental Field Office (EFO)
06/05/08	I.A	Minor	Clarified Tennessee Statutory Authority.
06/05/08	I.C.	Minor	Added and revised definitions.
06/05/08	I.D	Minor	Clarified health and safety warnings
06/05/08	I.E.	Minor	Clarified Cautions
06/05/08	I.F.	Minor	Clarified Interferences, added atmospheric metals.
06/05/08	I.H.	Minor	Added field barometer, boat safety equipment and automatic sampling equipment to equipment lists
06/05/08	I.H	Major	Revised sample container acquisition procedure.
06/05/08	I.H.	Minor	Clarified sample container descriptions.
06/05/08	I.H. Table 2	Major	Revised TOC bottle requirements.
06/05/08	I.H. Table 3	Major	Increased number of required volatile vials from four to five.
06/05/08	1.H.	Major	Removed bottle preparation procedure.
06/05/08	1.H.	Minor	Clarified cooler and bucket cleaning procedures.
06/05/08	I.I. Table 4	Major	Updated recommended parameter list for Surface Water Samples.
06/05/08	I.I. Table 5	Minor	Specified Certified Clean single use sample containers.

06/05/08	I.I Protocol A	Minor	Clarified decision making process for requesting E. coli dilutions.
06/05/08	I.I Protocol A	Minor	Provided more detail for site selection process.
06/05/08	I.I Protocol B	Minor	Added clarification for determining river mile.

NOTICE OF REVISIONS RECORD 2008

06/05/08	I.I Protocol B	Major	Added protocol for assigning Station IDs to unnamed tributaries of unnamed tributaries, wetlands, sinking streams, reservoirs, lakes and QC samples.
06/05/08	I.I Protocol C	Minor	Clarified sample procedures for isolated pools, drought and large rivers/streams.
06/05/08	I.I. Protocol C	Major	Changed sample temperature requirements.
06/05/08	I.I Protocol C Table 7	Major	Revised holding time for routine and TCLP samples. Revised TOC sample container requirements. Increased number of volatile vials required.
06/05/08	I.I Protocol C	Minor	Added custody seal information.
06/05/08	I.I Protocol C	Major	Added state laboratory requirements for sample delivery.
06/05/08	I.I Protocol C	Minor	Added primary sampler requirement to sample tag.
06/05/08	I.I Protocol C	Major	Clarified bacteriological sample collection procedure including dilution requests and air space requirements.
06/05/08	I.I Protocol C	Major	Added TOC sampling protocol.
06/05/08	I.I Protocol C	Major	Revised Volatile sample collection procedure.
06/05/08	I.I Protocol D	Minor	Refined field cleaning procedures for sampling equipment.
06/05/08	I.I Protocol H	Minor	Added more details to sample identification tag procedure.
06/05/08	I.I Protocol I	Minor	Added more details to sample request form procedure.

06/05/08	I.I Protocol J	Major	Revised protocol for Instantaneous Field Parameters including minimum probe specifications, meter calibration and drift checks.
06/05/08	I.I Protocol K	Major	Revised protocol for Continuous Monitoring Field parameters including minimum probe specifications and drift checks.
06/05/08	I.I Protocol L	Minor	Added detail to flow measurement procedure and added dye tracer flow measurement method for use in some TMDLs.

NOTICE OF REVISIONS RECORD 2008

06/05/08	I.I Protocol M	Minor	Added clarification to bacteriological analyses conducted by EFO.
06/05/08	II.A.	Major	Added responsibilities for In-house QC officer including problem resolution.
06/05/08	II.B	Minor	Added detail on collection of trip blank and field blanks.
06/05/08	II B	Minor	Added more detail on how to complete the sample request form for QC samples.
06/05/08	II B	Minor	Added sterilization of water for field and trip blanks as a step in resolving sample contamination.
06/05/08	II.C	Minor	Specified the primary sampler must sign chain of custody.
06/05/08	III	Minor	Updated references.
06/05/08	Appendix A	Major	Replaced TDH Environmental Laboratories Sample Container Request Form.
06/05/08	Appendix A	Minor	Added example of completed sample request form.
06/05/08	Appendix B	Major	Revised sample temperature requirements for TDH bacteriological Analyses
06/05/08	Appendix B	Major	Revised TDH Available Routine Analyses.

06/05/08	Appendix B	Major	Revised TDH Available Nutrient Analyses.
06/05/08	Appendix B	Major	Revised TDH Available Metals Analyses.
06/05/08	Appendix B	Major	Revised TDH Available Miscellaneous Inorganic Analyses.
06/05/08	Appendix B	Major	Revised TDH Available Organic Analyses
06/05/08	Appendix C	Major	Revised TMDL monitoring sample list.
06/05/08	Appendix C	Major	Added protocol for storm event characterization.

This revision(s) has been reviewed and approved. It becomes effective on: July 1, 2008.

Deborah H. Arnwine 6-12-08

Deborah Arnwine **Date**
Project Manager
WPC QSSOP for Chemical and Bacteriological Sampling of Surface Water

Paul E. Davis 6/12/08

Paul E. Davis **Date**
Director
Division of Water Pollution Control

Charles L. Head 6/12/08

Charles Head **Date**
TDEC Quality Assurance Manager

NOTICE OF REVISIONS RECORD 2009

11/17/09	Throughout Document	Minor	Numerous employees, positions and titles were updated.
11/17/09	I. C.	Major	Revised storage time for organic-free reagent water (blank water).
11/17/09	I. D.	Minor	Replaced the words "Life Jacket" with the acronym "PDF".
11/17/09	I. D.	Minor	Added info pertaining to law enforcement and listed THP phone numbers
11/17/09	I. E.	Major	Added that meters should minimally be calibrated once a week.
11/17/09	I. E.	Major	Added caution to collect chemical and biological samples on same day if possible.
11/17/09	I.F.	Major	Changed post-trip drift check for D.O. from 5% to 10%.
11/17/09	I.F.	Minor	Reworded Interferences # 9 and 10.
11/17/09	I.H.	Minor	Changed to recommend ordering bottles two weeks prior to sampling, not one week.
11/17/09	I.H.	Major	Changed calibration of meters from "morning of sampling" to "prior to sampling (minimally once a week."
11/17/09	I.H.	Minor	Added Extra bottles and State I.D. to general field equipment list.
11/17/09	I.H.	Minor	Changed custody seal from "necessary" to "if required"
11/17/09	I.H.	Minor	Changed to recommend ordering bottles two weeks prior to sampling, not one week.
11/17/09	I.H.	Major	Reverted sample container acquisition procedure back to the 2007 version.
11/17/09	I.H.	Minor	Added that multiple buckets may be taken in the field to avoid cleaning between sites.
11/17/09	I.H.	Minor	Corrected reference to a procedure in another section.
11/17/09	I.H. Table 3	Major	Revised TOC bottle requirements.
11/17/09	I.I. Protocol A, Table 5	Major	Revised flow requirements for TMDL monitoring of pathogens.
11/17/09	I.I. Protocol A, Table 5	Major	Added Selenium as a requirement for TMDLs and reference (Eco & Feco) sites.

11/17/09	I.I. Protocol A, Table 5	Major	Added multiple parameters as optional for 303(d) monitoring.
11/17/09	I.I. Protocol A,	Major	Changed the E. coli dilution requirement based on historical data to match the count ranges for the Colilert test method.
11/17/09	I.I. Protocol A	Major	Revised protocol for assigning Station IDs when sampling for chemicals and biology the same location.
11/17/09	I.I. Protocol B	Major	Revised protocol for assigning Station IDs when sampling chemicals and biology the same location.
11/17/09	I.I. Protocol B	Major	Added protocol to use the stream name from a USGS topo map when assigning Station IDs.
11/17/09	I.I. Protocol B	Minor	Added comment about measuring river miles.
11/17/09	I.I. Protocol B	Minor	Added abbreviations and underscore _ to Station IDs that are out-of-state
11/17/09	I.I. Protocol B	Major	Added protocol for naming unnamed streams within a geographical feature.
11/17/09	I.I. Protocol B	Minor	Corrected example on naming unnamed sinking streams.
11/17/09	I.I. Protocol B	Minor	Changed wording of Number 8, Example 2
11/17/09	I.I. Protocol C	Minor	Changed wording of sentence regarding drought conditions.
11/17/09	I.I. Protocol C	Major	Revised sampling protocol regarding the thalweg and collecting samples from banks or docks.
11/17/09	I.I. Protocol C	Major	Added sampling protocol for the collection of dissolved metals.
11/17/09	I.I. Protocol C Table 8	Major	Revised TOC bottle requirements.
11/17/09	I.I. Protocol C	Minor	Removed rubber band requirement for TOC vials.
11/17/09	I.I. Protocol D	Major	Added information about sampling outside of the thalweg.
11/17/09	I.I. Protocol D	Major	Added protocol for sampling order.
11/17/09	I.I. Protocol E	Major	Added protocol for sampling order.
11/17/09	I.I. Protocol E	Major	Removed sentence: "Rinse the probes with water (tap water) after use at each site to decrease the chance of contamination."

11/17/09	I.I. Protocol F	Minor	Removed repeated information.
11/17/09	I.I. Protocol F	Major	Added a rope and bottle holder as a sampling device from a bridge.
11/17/09	I.I. Protocol F	Major	Added protocol for sampling order.
11/17/09	I.I. Protocol G	Minor	Added safety precaution relating to latex gloves.
11/17/09	I.I. Protocol H	Major	Added to write the name of the waterbody in the "Station Location" field on the sample I.D. tag
11/17/09	I.I. Protocol H	Minor	Changed that samplers must write (not sign) their full name in the "Samplers" field on the sample I.D. tag.
11/17/09	I.I. Protocol I	Minor	Added that pre-printed and copied forms can be used as a sample request form.
11/17/09	I.I. Protocol I	Major	Added to write the name of the waterbody in the "Description" field on the sample request form.
11/17/09	I.I. Protocol I	Major	Added protocol to record temperature reading if a temperature correction factor was applied.
11/17/09	I.I. Protocol I	Minor	Added to #4. b. (7) "If a custody seal is required"
11/17/09	I.I. Protocol I	Major	Removed sentence: "Rinse the probes with water (tap water) after use at each site to decrease the chance of contamination."
11/17/09	I.I. Protocol J	Major	Added that drift checks can be done in the field.
11/17/09	I.I. Protocol K	Minor	Reworded #10. Data Interpretation.
11/17/09	I.I. Protocol L	Major	Revised flow requirements for TMDL monitoring of pathogens.
11/17/09	I.I. Protocol L	Major	Added that calibrated gauging stations may be used to measure flow.
11/17/09	I.I. Protocol M	Major	Revised pathogen log number assignments.
11/17/09	I.I. Protocol M	Minor	Added formatting for dates when logging pathogen samples.
11/17/09	I.J.	Minor	Revised storage times for sampling data.
11/17/09	II. B	Major	Added protocol for blank water containers for organic analysis.
11/17/09	II. B	Major	Added storage information for blank water.

11/17/09	II. B	Major	Added information on recording time for duplicates.
11/17/09	References	Minor	Added reference for IDEXX Laboratories procedure.
11/17/09	Appendix A	Major	Added abbreviations for samples collected out-of-state
11/17/09	Appendix B	Major	Changed bottle requirements for hardness from 1-L routine to 500 mL nutrient.
11/17/09	Appendix B	Major	Revised holding time for total coliform.
11/17/09	Appendix B	Major	Revised holding time for conductivity.
11/17/09	Appendix B	Major	Revised holding time and MDL for nitrate.
11/17/09	Appendix B	Major	Revised holding time and MDL for nitrite.
11/17/09	Appendix B	Major	Revised holding time for silica.
11/17/09	Appendix B	Major	Revised MDL for sulfate.
11/17/09	Appendix B	Major	Revised MDL for apparent color.
11/17/09	Appendix B	Major	Revised MDL for true color.
11/17/09	Appendix B	Major	Revised MDL for COD.
11/17/09	Appendix B	Major	Revised MDL for nitrogen, ammonia.

TN Department of Environment & Conservation

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

This revision(s) has been reviewed and approved. It becomes effective December 2009.

11-4-09

Deborah Arnwine
Project Manager
WPC QSSOP for Chemical and Bacteriological Sampling of Surface Water

Date

11/9/09

Paul E. Davis
Director
Division of Water Pollution Control

Date

11/4/09

Charles Head
TDEC Quality Assurance Manager

Date

NOTICE OF REVISIONS RECORD 2011

6/2/11	I.F. and I.H.	Minor	Added that gloves are required for routine metals and mercury sampling.
6/2/11	I.I. Protocol A (Table 5)	Minor	Clarified that the parameters marked with an asterisk are for established FECO sites.
6/2/11	I.I. Protocol B	Major	Revised protocol for assigning Station ID numbers and added two figures.
6/2/11	I.I. Protocol B	Major	Clarifications on how to measure river miles, specifically ones that flow through an embayment.
6/2/11	I.I. Protocol C	Minor	Added that gloves are required for routine metals and mercury sampling.
6/2/11	I.I. Protocol J	Major	Added procedure on what to do if field parameter equipment fails in the field.
6/2/11	I.I. Protocol J	Minor	Changed how often the WQ database is sent from WPU to EFOs and Lab. Monthly instead of quarterly.
6/2/11	I.I. Protocol L	Major	Added that flow need to be measured at Ecoregion and FECO reference sites.
6/2/11	II.C.	Major	Added procedure to determine potential contamination of blank results.
6/2/11	Appendix A (Flow Sheet)	Minor	Added that the final flow measurement needs to be rounded to two decimal places.
6/2/11	Appendix B	Minor	Revised MDLs for Sodium, Vanadium, and Zinc.
6/8/11	I.H. I.I., Protocol C Appendix B	Major	Corrected cyanide preservative technique.
7/19/11	Throughout	Major	Required the use of nitrile gloves for metals sampling.
7/19/11	Throughout	Major	Revised Cyanide preservation procedure.
7/19/11	I.I. Protocol A	Major	Added QC blank parameter list to Table 5.
7/19/11	I.I. Protocol C	Minor	Added that if Mercury samples are sent to the Jackson Lab, collect in a 500mL plastic bottle.
7/19/11	I.I. Protocol I	Minor	Added to include Central Office QC Coordinator on Sample Request Form under "Send Report To".
7/19/11	II. B	Major	Added clarification on QC Samples.
7/19/11	Appendix C	Minor	Broke out the current Laboratory MDLs into separate tables from the "Analyses Available" tables.

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

This revision(s) has been reviewed and approved. It becomes effective August 2011.

7-21-11

Deborah Arnwine
Project Manager
WPC QSSOP for Chemical and Bacteriological Sampling of Surface Water

Date

7/21/11

Paul E. Davis
Director
Division of Water Pollution Control

Date

7/22/11

Charles Head
TDEC Quality Assurance Manager

Date

NOTICE OF REVISIONS RECORD 2018

02/26/18	Throughout	Major	Revised operational Dept of Health Laboratories.
02/26/18	Throughout	Minor	Revised Mercury bottle requirements
02/26/18	Throughout	Major	Changed Division of Water Pollution Control to Division of Water Resources.
02/26/18	Throughout	Major	Revised pre preserved bottle expiration dates.
02/26/18	Throughout	Major	Revised DWR central office location from L&C Annex to Rosa Parks Ave.
02/26/18	Throughout	Minor	Added Division Program Names
02/26/18	Throughout	Major	Update Sample Identification tags for all appropriate sections.
02/26/18	Throughout	Minor	Update to specify to contact lab for bottle kits when necessary.
02/27/18	Throughout	Major	Clarified/Updated what to do for failed field parameter probe drift checks.
02/27/18	Throughout	Minor	Updated “database” to “Waterlog”
02/27/18	Throughout	Major	Updated Knoxville Regional Lab address
02/27/18	Throughout	Major	Added: For non-routine testing such as Cyanide and Sulfide, must contact lab for specific kits.
03/01/18	Throughout	Major	Update all bottle containers in text (non table)
05/16/18	Throughout	Major	Clarify snodes to be submerged in stream when possible
03/01/18	Cover Page	Major	Added Disclaimer
03/02/18		Major	Added Document Revision History

03/02/18	Table of Contents	Minor	Updated table of contents to reflect addition of Appendix D
03/07/18	Table of Contents	Minor	Updated Table of Contents' figures and tables.
02/27/18	Title and Approval page	Major	Updated the names
	Reviewers	Major	Added names of reviewers/commenters
02/26/18	Evaluation Procedure	Major	Revised SOP central office contact as Natalie Moore
02/26/18	Document distribution list	Major	Revised QS-SOP Document distribution recipients.
03/02/18	Document distribution list	Major	Added navigation to electronic versions of this SOP
02/27/18	Preface	Minor	Clarifying; all LabReq eform technical assistance should refer to the SPERT
03/02/18	Preface	Major	Added navigation to electronic versions of SPERT and LabReq forms.
03/02/18	Preface	Minor	Clarify importance of SOP for outside agencies and public
02/26/18	I.C.	Major	Added DWR and SPERT to acronyms
02/26/18	I.D.	Minor	Terminology changed from MSDS to SDS
05/16/18	I.D.	Minor	Recommendation for replenishing first aid kits
05/16/18	I.D.	Minor	Removed comment about Latex gloves providing more protection from pathogens
05/16/18	I.D.	Minor	Clarified how to set up traffic cones
02/26/18	I.H.	Major	Updated Table 3 with new bottle volumes and containers
02/26/18	I.H.	Major	Revised Nashville TDH Laboratory Sample Coordinator

02/26/18	I.H.	Minor	Added “Toughbooks” to General Field Equipment

02/26/18	I.H	Major	Update Table 3: Boron no longer needs special sampling. Can be done out of Metals bottle.
03/01/18	I.H.	Major	Updated bottle containers in Table 3
03/01/18	I.H.	Major	Updated bottle containers in Table 4
04/12/18	I.H.	Minor	Added COD to Table 3
03/01/18	I.J.	Minor	Update the way with in which hard copies are now saved as electronic documents
02/26/18	I.I. Protocol A	Major	Removed Turbidity and TOC from requested tests on QC blanks.
02/28/18	I.I. Protocol A	Major	Updated table 5.
02/28/18	I.I. Protocol A	Major	Clarification for tests no longer performed
03/01/18	I.I. Protocol A	Major	Updated bottle containers in Table 6
04/12/18	I.I. Protocol A	Major	Updated Table 5 to make Settleable Residue to “O” for ‘Long Term Trend Stations’
02/26/18	I.I. Protocol B	Major	Updated: Assigning A New DWR Station ID
02/26/18	I.I. Protocol C	Major	Updated Table 8 updated bottle volumes and containers
02/26/18	I.I. Protocol C	Major	Update Table 8: Removed Boron from table.
02/26/18	I.I. Protocol C	Major	Update PCB holding time from 40 days to 1 year.
02/26/18	I.I. Protocol C	Major	Remove Boron Sampling technique; no longer applies
02/26/18	I.I. Protocol C	Major	Change the bottle requirements for TOC collection from pre-preserved vials to 250mL pre-preserved bottles

02/27/18	I.I. Protocol C	Major	Changing of sampling technique no longer requires beakers since vials are no longer used
03/01/18	I.I. Protocol C	Major	Table 8: Updated bottle containers

03/01/18	I.I. Protocol C	Major	Clarify *E. coli* holding time
04/12/18	I.I. Protocol C	Major	Updated: Metals do not need ice for shipment but
05/16/18	I.I. Protocol C	Major	Clarified all samples to be collected sub surface except Oil and Grease
06/11/18	I.I. Protocol C	Major	Clarified PAH and SVOA requests
02/26/18	I.I. Protocol H	Major	Revised Sample Identification Tags.
02/27/18	I.I. Protocol H	Major	Updated sample tag needs.
06/28/18	I.I. Protocol I	Major	Updated Chemical Analysis Request/ COC Form
06/28/18	I.I. Protocol I	Major	Added *E. coli* Contract lab analysis request
02/27/18	I.I. Protocol J	Major	Update how Sample Request Form is to be filled out.
02/2718	I.I. Protocol J	Minor	Deleted Project/Site No.
02/27/18	I.I. Protocol J	Minor	Added Project ID.
06/11/18	I.I. Protocol J	Major	Updated Figure 8.
03/27/18	I.I. Protocol J	Major	Revised Instantaneous Field Parameters
06/11/18	I.I. Protocol J	Major	Updated Figure 6.
06/11/18	I.I. Protocol J	Major	Updated Figure 5.
06/11/18	I.I. Protocol J	Major	Updated Figure 7.
06/11/18	I.I. Protocol J	Major	Updated Figure 9.
06/11/18	I.I. Protocol J	Major	Updated Figure 10.
02/27/18	I.I. Protocol M	Minor	Clarified how to indicate a QC sample in Pathogen Log

05/16/18	I.I.C.	Minor	Clarified flags to be used for contamination
06/28/18	Appendix A	Minor	Updated COC figure
06/28/18	Appendix A	Major	Added *E. coli* contract lab Sample Request Form
03/01/18	Appendix B	Major	Update bottle containers
04/12/18	Appendix B	Major	Update ALL MDL's
04/12/18	Appendix B	Major	Added Contract Labs to MDL table
04/12/18	Appendix B	Major	Updated: Metals do not need ice for shipment but Mercury will require ice storage of <6^{o}C.
02/27/18	Appendix C	Major	Updated MDLs for associated tests
03/01/18	Appendix C	Major	Update location and phone number for Office of General Council
03/01/18	Appendix C.	Major	Update location and phone number for Human Resource Department
03/02/18	Appendix D	Major	Added Appendix D for revision history

This revision(s) has been reviewed and approved. It becomes effective August 2018.

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

Jennifer Dodd
Director
TN Division of Water Resources

Barry Brawley
Reviewer
TDEC Quality Assurance Manager

Natalie Moore
Preparer
TN Division of Water Resources-Planning and Standards

NOTICE OF REVISIONS RECORD 2021

03/22/19	Revisions Table	Minor	Moved 2018 revisions record to Appendix D
03/22/19	Approval signatures	Minor	Moved approval signatures to appendix D
03/22/19	I.H.	Minor	Updated TDH Lab contacts
03/22/19	QSSOP Distribution List	Minor	Updated SOP Distribution list
03/25/19	QCQA	Minor	Changed spelling of Barbara Loudermilks name
03/25/19	Throughout	Minor	Changed PAS to WPU
03/25/19	Table 3	Minor	Clarified bottle requirements
03/26/19	Title and Approval Page	Minor	Updated commissioner name
03/26/19	Reviewers Page	Minor	Updated names
03/26/19	Throughout	Minor	Changed ‘Planning and Standards Section’ to ‘Watershed Planning Unit’
06/11/19	Table 5	Minor	Clarified the Trip and Field Blank sample requests
06/11/19	Table 5	Minor	Added SEMN into the table
06/11/19	I.D.	Minor	Added Safety
06/11/19	I.I.	Minor	Tie Down Meter to Boat
06/11/19	Appendix B	Minor	Add amount of preservative for Bacti bottles
9/17/19	Appendix B	Minor	Updated MDLs for Nashville TDH Lab
11/18/19	Table 9	Major	Updated Meter Calibration Order
11/18/19	Protocol J	Minor	Clarify the pH buffers orders.
5/15/20	Table 3	Major	Bottle clarification for TSS
5/15/20	Appendix B	Major	Updated outsourced bottles
5/20/20	Protocol I	Major	Add Lab Certification

09/28/20	Throughout	Major	Low pH in low conductivity dictates TDH low pH lab test request
03/11/21	Throughout	Major	Organics sent to contract labs by EFO's not TDH anymore (except NEFO)
3/12/21	Protocol I.H.2	Major	Update contacts for sample receiving
3/16/21	Protocol G, J, K	Major	Update stored central location for maintenance and repair logs on field probes
3/16/21	Throughout	Minor	Remove retired employees
3/23/21	Throughout	Major	Clarify what to do with low pH bottles, workbooks, and sampling protocol
3/24/21	Table 5	Major	Chloride added for reference and ambient sites
4/1/21	Protocol C	Major	How to ship out Organic samples to PACE
4/26/21	Appendix A	Minor	Update Bottle Order Form
4/27/21	Appendix B	Major	Update MDL's for TDH lab
5/5/21	Protocol J	Minor	Clarify how to handle probes in low ionic strength waters
11/1/21	Throughout	Minor	Update personnel changes
11/30/21	Protocol C	Major	Introduce E. coli split sampling for non-drinking water certified contract labs
11/30/21	Throughout	Minor	Updated references
12/01/21	Table 5	Major	Updated Mercury from optional to required for long term trend sites
12/14/21	Throughout	Major	Updated *E. coli* bottle sizes from "290mL" to "testing lab provided" bottles to be inclusive as all contract labs have different sized bottles they provide for analysis
12/27/21	Throughout	Major	Remove ESC as an outsourced lab

DWR-WQP-P-01-QSSOP-Chem-Bact-082918
Quality System Standard Operating Procedure For
Chemical and Bacteriological Sampling of Surface Water

To reach your local
ENVIRONMENTAL FIELD OFFICE
Call 1-888-891-8332 OR 1-888-891-TDEC