Tennessee's Consolidated Assessment and Listing Methodology (CALM)

Revised January, 2018

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I. Water Quality Monitoring Philosophy

The water quality program in Tennessee was established by the Water Quality Control Act(the Act), a landmark state legislation that actually predated the federal Clean Water Act. The Act identifies the duties and authority of both the commissioner of the Tennessee Department of Environment and Conservation (TDEC or "the Department") and the Board of Water Quality, Oil and Gas (Board). Additionally, the Act defines many of the important terms and concepts in water pollution control.

Important responsibilities of the TDEC commissioner include: investigating water quality statewide and developing water quality assessment reports, maintaining a permitting system for discharges to or alterations of waterbodies, and having a process to ensure compliance of permit conditions. The duties of the board include hearing appeals of permits and enforcement actions, and establishing the appropriate uses of waters along with criteria to protect the level of water quality needed to maintain those uses.

The Tennessee Division of Water Resources (DWR or "the division") within TDEC is composed of central office units and eight field offices in Memphis, Jackson, Nashville, Columbia, Cookeville, Chattanooga, Knoxville, and Johnson City. Water quality sampling is primarily done from the field offices. Water quality standards development and data management are performed in the central office. Water quality assessment is a shared responsibility between central and field offices.

So that water quality monitoring and assessment activities are accomplished consistently across the state, this Consolidated Assessment and Listing Methodology (CALM) policy document has been developed to help train new employees and maintain consistency within the agency. These procedures have previously existed in the form of multiple SOP and QAPP documents, the annual monitoring workplan, and public reports such as the 303(d) List and 305(b) Report. The CALM document consolidates some of these concepts into a single reference.

a. Important Concepts and Definitions

The department has formally differentiated between documents that are either guidance or policy in nature. In general, guidance documents are designed to be used by the public or the regulated community to help them understand how to interact with the department. An example would be instructions on how to submit data required by permit conditions. Guidance documents are reviewed internally and also have a public review period.

Policy documents are designed to train, instruct and/or direct departmental staff how to conduct and document activities related to statutory and other responsibilities. Examples of policy documents include SOPs. Policy documents are reviewed internally by staff and often by the Environmental Protection Agency (EPA).

The CALM is a policy document designed to be used by monitoring and assessment staff. While the document has an important place in providing public transparency regarding how water quality assessments are done, the writing is technical in nature as the target audience are staff.

Definitions of important water quality assessment concepts are provided below. Those that are direct quotes from either state laws or regulations are presented in italics. Additionally a citation is provided. The Tennessee Water Quality Control Act preceded the federal Clean Water Act so it may be that some definitions are slightly different. In the event that a state definition differs from a federal one, we have only presented the state point of view. EPA should be contacted for the federal perspective regarding these definitions.

"Pollutant" means sewage, industrial wastes, or other wastes; TCA 69-3-103(27)

"Pollution" means such alteration of the physical, chemical, biological, bacteriological, or radiological properties of the waters of this state, including, but not limited to, changes in temperature, taste, color, turbidity, or odor of the waters that will:

> ***(A)*** *Result or will likely result in harm, potential harm or detriment to the public health, safety, or welfare;*
>
> ***(B)*** *Result or will likely result in harm, potential harm or detriment to the health of animals, birds, fish, or aquatic life;*
>
> ***(C)*** *Render or will likely render the waters substantially less useful for domestic, municipal, industrial, agricultural, recreational, or other reasonable uses; or*
>
> ***(D)*** *Leave or likely leave the waters in such condition as to violate any standards of water quality established by the board;* TCA 69-3-103(28)

"Waters" means any and all water, public or private, on or beneath the surface of the ground, that are contained within, flow through, or border upon Tennessee or any portion thereof, except those bodies of water confined to and retained within the limits of private property in single ownership that do not combine or effect a junction with natural surface or underground waters; and TCA 69-3-103(44)

"Wet weather conveyance" means, notwithstanding any other law or rule to the contrary, man-made or natural watercourses, including natural watercourses that have been modified by channelization:

> ***(A)*** *That flow only in direct response to precipitation runoff in their immediate locality;*
>
> ***(B)*** *Whose channels are at all times above the groundwater table;*
>
> ***(C)*** *That are not suitable for drinking water supplies; and*
>
> ***(D)*** *In which hydrological and biological analyses indicate that, under normal weather conditions, due to naturally occurring ephemeral or low flow there is not sufficient water to support fish, or multiple populations of obligate lotic aquatic organisms whose life cycle includes an aquatic phase of at least two (2) months.*
> TCA 69-3-103(45)

Parameter – A biological, chemical, radiological, bacteriological, or physical property of water that can be directly measured. Some criteria are expressed in terms of a single parameter; others, such as habitat, nutrients, and biological integrity are not directly measured, but are derived from measurements of parameters. Chapter 0400-40-03-.04(16)

Reference condition - A parameter-specific set of data from regional reference sites that establish the statistical range of values for that particular substance at least-impacted streams. Chapter 0400-40-03-.04(19)

Reference Site - Least impacted waters within an ecoregion that have been monitored to establish a baseline to which alterations of other waters can be compared. Chapter 0400-40-03-.04(20)

Response Variable – a characteristic of water quality that can be measured and changes as a result of an alteration of habitat, water withdrawal, or discharge of pollutants, as distinguished from agents that cause changes in aquatic systems. Chapter 0400-40-03-.04(21)

Wadeable streams - Streams that can be sampled using a hand held, one meter square or smaller kick net without water and materials escaping over the top of the net. Chapter 0400-40-03-.04(26)

Condition of Impairment – Excursions from water quality criteria of a magnitude, frequency, and/or duration such that a specific use classification is no longer supported by existing water quality. With the exception of pathogens, those excursions caused by natural conditions (not anthropogenic in nature) will not be considered impairment. Examples of natural conditions include alterations caused by beaver dams, non-construction related rockslides of pyritic materials, groundwater with naturally elevated metals, and phosphate-bearing rock formations.

b. TDEC Watershed Approach

In the early 1970's, the USGS delineated 55 hydrologic watershed boundaries within Tennessee. A watershed is the entire land area that drains into a particular watercourse or body of water. In 1996, the division adopted a watershed approach that reorganized existing programs and focused on integrated water quality management.

> The watershed approach is an organizational monitoring framework. Ecoregions serve as a geographical framework for establishing water quality expectations.

The watershed approach is a decision making process that reflects a common strategy for information collection and analysis as well as a common understanding of the roles, priorities and responsibilities of all stakeholders within a watershed. Traditional activities like permitting, planning and monitoring are coordinated. The watershed approach encourages integration of traditional regulatory (point source pollution) and non-regulatory (nonpoint source pollutant) programs. Stormwater runoff in some cities, counties, and other areas are regulated through Municipal Separate Storm Sewer Systems (MS4) permit requirements.

When all pollutant sources are considered together, agencies are better able to focus on those controls necessary to produce measurable improvements in water quality. This also results in a more efficient process. It encourages agencies to focus staff and financial resources on prioritized geographic location and makes it easier to coordinate between agencies and individuals with an interest in solving water quality problems.

Four main features are typical of the watershed approach:

- Identifying and prioritizing water quality problems in the watershed.
- Developing increased public involvement.
- Coordinating activities with other agencies.
- Measuring success through increased and more efficient monitoring and data gathering.

Figure 1

The 55 watersheds in Tennessee have been sorted into five groups based on the year of implementation in a five year cycle (Figure 1). Each group contains between 9 and 16 watersheds (Table 2 and Figure 2). In 2012, adjustments were made in five watersheds to more evenly distribute monitoring resources.

Activities for each group are based on its position in the cycle. One of the following six key activities is occurring in each of the five watershed group each year.

1. **Existing Data Review and Planning.** Existing data and reports from appropriate federal, state, and local agencies and citizen-based organizations are compiled and used to determine the current conditions and status of reservoirs, lakes, rivers and streams where known. Data review and comparison of agency workplans guide the development of an effective monitoring strategy.

2. **Monitoring.** Field data are collected from reservoirs, lakes, rivers and streams. Three standard operating procedures (SOPs) have been developed to guide sampling techniques and quality control for macroinvertebrate surveys (TDEC, 2017), chemical and bacteriological sampling (TDEC, 2011), and periphyton sampling (TDEC, 2010).

3. **Assessment.** Monitoring data are used to determine if the streams, rivers, lakes, reservoirs, and wetlands support their designated uses based on waterbody classifications and water quality criteria. The causes and most probable significant sources of impairment are identified for waterbodies that do not meet their designated uses.

4. **Total Maximum Daily Load (TMDL) Development/Load Allocation.** Section 303(d) of the Clean Water Act requires states to develop TMDLs for those waterbodies not attaining water quality standards. The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards can be achieved.

   The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollutant sources and instream water quality conditions. A TMDL can be expressed as the sum of all point source loads (waste load allocations), nonpoint source loads (load allocations) and an appropriate margin of safety, and is represented by this relationship:

   TMDL = Sum of Point Sources + Sum of Nonpoint Sources + Margin of Safety

5. **Permits.** Expiration and issuance of discharge and water withdrawal permits are synchronized to the five-year watershed cycle.

6. **Watershed Management Plans.** Each existing watershed plan contains a general description, management strategies, and information relevant to water quality. Future plans will focus on TMDL implementation.

More details may be found on the department's watershed management page.
http://tn.gov/environment/article/wr-ws-watershed-management-approach

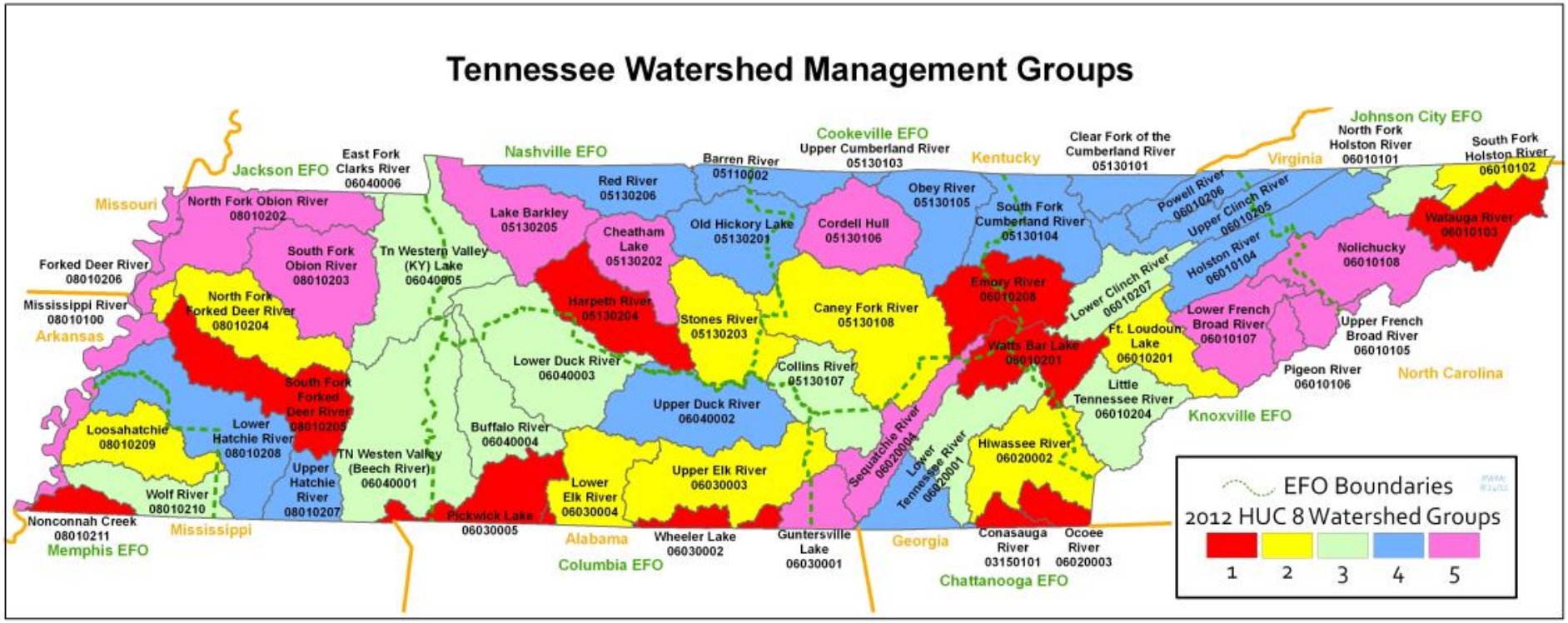
TABLE 1
WATERSHED GROUPS IN TENNESSEE

	Monitoring Years	West Tennessee	Middle Tennessee	East Tennessee
Group 1	1996 2001 2006 2011 2016	Nonconnah South Fork of the Forked Deer	Harpeth Wheeler Res.^ Pickwick Res.^	Upper Tennessee (Watts Bar Res.*)† Ocoee Emory* Watauga Conasauga
Group 2	1997 2002 2007 2012 2017	Loosahatchie North Fork Forked Deer Forked Deer	Stones Caney Fork Upper Elk Lower Elk	Hiwassee Upper Tennessee (Fort Loudoun Res.*)† South Fork Holston (part)†
Group 3	1998 2003 2008 2013 2018	Wolf Lower TN Western Valley Upper TN Western Valley Clarks	Collins ^ Lower Duck Buffalo	Chickamauga Reservoir† Little Tennessee* Lower Clinch* North Fork Holston South Fork Holston (part)†
Group 4	1999 2004 2009 2014 2019	Upper Hatchie Lower Hatchie	Red Barren Cumberland (Old Hickory) Obey Upper Duck^	South Fork Cumberland* Powell* Upper Clinch* Holston* Clear Fork Nickajack Reservoir†
Group 5	2000 2005 2010 2015 2020	Mississippi Obion, North Fork Obion South Fork Obion	Barkley Reservoir Cheatham Reservoir Guntersville Reservoir Upper Cumberland (Cordell Hull)^	Sequatchie Upper French Broad* Lower French Broad* Pigeon* Nolichucky

*These watersheds are monitored the following year.
†These watersheds have been split into two watershed groups.

^ These watersheds were moved into a different group in 2012.

FIGURE 2


Tennessee Watershed Management Groups
Jackson EFO
Nashville EFO
Cookeville EFO
Johnson City EFO
Knoxville EFO
Chattanooga EFO
Columbia EFO
Memphis EFO
Missouri
Arkansas
Mississippi
Alabama
Georgia
Kentucky
Virginia
North Carolina
East Fork Clarks River 06040006
North Fork Obion River 08010202
South Fork Obion River 08010203
Forked Deer River 08010206
Mississippi River 08010100
North Fork Forked Deer River 08010204
South Fork Forked Deer River 08010205
Loosahatchie 08010209
Lower Hatchie River 08010208
Upper Hatchie River 08010207
Wolf River 08010210
Nonconnah Creek 08010211
Tn Western Valley (KY) Lake 06040005
TN Westen Valley (Beech River) 06040001
Lake Barkley 05130205
Red River 05130206
Cheatham Lake 05130202
Harpeth River 05130204
Lower Duck River 06040003
Buffalo River 06040004
Pickwick Lake 06030005
Barren River 05110002
Old Hickory Lake 05130201
Stones River 05130203
Upper Duck River 06040002
Lower Elk River 06030004
Upper Elk River 06030003
Wheeler Lake 06030002
Guntersville Lake 06030001
Cordell Hull 05130106
Caney Fork River 05130108
Collins River 05130107
Sequatchie River 06020004
Lower Tennessee River 06020001
Obey River 05130105
South Fork Cumberland River 05130104
Clear Fork of the Cumberland River 05130101
Emory River 06010208
Watts Bar Lake 06010201
Hiwassee River 06020002
Conasauga River 03150101
Ocoee River 06020003
Powell River 06010206
Upper Clinch River 06010205
Lower Clinch River 06010207
Ft. Loudoun Lake 06010201
Little Tennessee River 06010204
Holston River 06010104
North Fork Holston River 06010101
South Fork Holston River 06010102
Watauga River 06010103
Nolichucky 06010108
Lower French Broad River 06010107
Upper French Broad River 06010105
Pigeon River 06010106
EFO Boundaries
2012 HUC 8 Watershed Groups
1
2
3
4
5

c. Monitoring Objectives

Tennessee has a wealth of water resources with over 60,000 miles of rivers and streams and more than 570,000 lake and reservoir acres. Monitoring data are used to not only assess streams, but also to inform permit decisions and to assist in the development of water quality criteria. Recent physical, chemical, or biological survey results are not the only form of data available to inform the assessment process. While recent stream sample data are the ideal, there are other valid information sources, such as GIS analysis of land use, recent aerial photographs, models, self-monitoring reports, compliance inspection results, and overflow reports. Stream assessment decisions are based on multiple sources of evidence and the agency must weigh all available information to arrive at a conclusion.

TDEC's watershed approach serves as an organizational framework for systematic assessment of the state's water quality. By viewing the entire drainage area or watershed as a whole, the department is better able to schedule water quality monitoring, assessment, permitting activities, and stream restoration efforts. This unified approach affords a more in-depth study of each watershed and encourages coordination of public and governmental organizations. The watersheds are assessed on a five-year cycle that coincides with permit issuance.

The purpose of the division's water quality monitoring program is to provide a measure of Tennessee's progress towards meeting the goals established in the federal Clean Water Act and the Tennessee Water Quality Control Act. To accomplish this task, data are collected and interpreted in order to:

1. Assess the overall condition of the state's waters, both geographically and temporally.

2. Identify specific problem areas where parameter values violate Tennessee numerical or narrative water quality standards.

3. Identify causes and the most probable and significant sources of water quality problems.

4. Document areas with potential human health threats from fish tissue contamination or elevated bacteria levels. Identify those areas where the public may need to be warned to avoid water contact or fish consumption.

5. Establish trends in water quality.

6. Gauge water quality conditions downstream of point source dischargers as an additional compliance check.

7. Document baseline conditions prior to a potential impact or as a reference stream for downstream or other sites within the same ecoregion and/or watershed.

8. Provide data for TMDL studies.

9. Assess water quality improvements based on site remediation, enforcement, Best Management Practices, TMDL implementation, and other restoration strategies.

10. Identify proper stream-use classification, plus assist in the application of the Antidegradation Statement.

11. Identify natural reference conditions on an ecoregion basis for refinement of water quality standards.

12. Identify and protect wetlands.

Guidance on how to do water quality monitoring appears in multiple SOP documents. These include:

1. Quality Assurance Project Plan (QAPP) for 106 Surface Water Monitoring. https://www.tn.gov/content/dam/tn/environment/water/documents/wr_wq_qapp-106monitoring.pdf

2. Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water https://www.tn.gov/content/dam/tn/environment/water/documents/ChemSOP03QUAP.pdf

3. Standard Operating Procedure for Macroinvertebrate Stream Surveys https://www.tn.gov/content/dam/tn/environment/water/documents/DWR-PAS-P-01-Quality_System_SOP_for_Macroinvertebrate_Stream_Surveys-081117.pdf

4. Standard Operating Procedure for Periphyton Stream Surveys https://www.tn.gov/content/dam/tn/environment/water/documents/periphyton_sop.pdf

5. Year 2016 303(d) List – Final Version https://www.tn.gov/content/dam/tn/environment/water/documents/wr_wq_303d-2016-final.pdf 2014 305(b) Report: The Status of Water Quality in Tennessee https://www.tn.gov/content/dam/tn/environment/water/documents/wr_wq_report-305b-2014.pdf

d. Prioritization of Waterbodies for Monitoring

The division maintains a statewide monitoring system consisting of approximately 7000 stations (Figure 4) sampled on a rotating basis. In addition, new stations are created every year to increase the number of assessed streams. Stations are sampled monthly, quarterly, semi-annually, or annually depending on the objectives of the project. Within each watershed cycle, the locations of monitoring stations are coordinated between the central office and staff in the eight Environmental Field Offices (EFOs) and the Mining Unit located across the state, based on the following priorities.

1. **Antidegradation Monitoring:** Before the division can authorize new or increased degradation in Tennessee waterbodies (some exceptions exist), the appropriate categories under the Antidegradation Policy must be determined. These categories are (1) Available Parameters or (2) Unavailable Parameters, (3) Exceptional Tennessee Waters, and (4) Outstanding National Resource Waters (ONRWs). ONRWs can only be established by promulgation by the Tennessee Board of Water Quality, Oil and Gas. Categories 1 and 2 are on a "parameter by parameter" basis considering the existing water quality of the stream. Exceptional Tennessee Waters (ETWs) must be identified by division staff based on 7 identifying characteristics established in Rule 0400-40-03-.06(4). Waterbodies can be in more than one category at a time, due to the parameter-specific nature of categories 1 and 2 above.

   Streams are evaluated as needed in response to requests for new or expanded National Pollutant Discharge Elimination System (NPDES) and Aquatic Resource Alteration Permit (ARAP) individual permits, including ARAP water withdrawal applications. When the waterbody requiring an antidegradation determination does not have recent water quality data from the last five years , surveys must be done by field office staff, unless the applicant is willing to provide the needed information in a timely manner. In some circumstances, older data may be used if the field staff believes they are still valid. Because the identification of antidegradation status must be determined prior to permit issuance, this work is done on the highest priority basis.

   Streams are evaluated for antidegradation status based on a standardized ETW and Waterbody Use Support evaluation process, which includes information on specialized recreation uses, scenic values, ecological consideration, biological integrity and attainment of water quality criteria. Since permit requests generally cannot be anticipated, these evaluations are generally not included in the workplan. The number of antidegradation evaluations conducted by the state is steadily increasing as the process becomes more refined and standardized.

2. **Posted Streams**: When the department issues advisories due to elevated public health risks from excessive pathogen or contaminant levels in fish, it accepts a responsibility to monitor changes in those streams. In the case of fishing advisories, in conjunction with the

monitoring cycle, field office staff should determine when tissue samples were last collected. If appropriate, the state lab is contracted to sample in the upcoming watershed year, unless another agency like TWRA or TVA are willing to do the collections. During review of field office monitoring plans for the upcoming watershed year, central office may also discuss needed tissue sampling with the field office.

For pathogen advisories, in conjunction with the monitoring cycle, monthly E. coli samples, plus a minimum of one geo mean sample (5 samples in 30 days) must be scheduled and accomplished. If another entity (such as an MS4 program) has already planned to collect samples, that effort can substitute for division sampling, if staff have confidence that the other entity can meet data quality objectives. However, field office staff must confirm that this sampling is taking place, remembering that the ultimate responsibility to ensure that sampling is done remains with the division.

Field office and central office staff review fish tissue and pathogen results and jointly decide if it appears that an advisory could be proposed for lifting. Additionally, field office staff have the primary responsibility to ensure that existing signs on posted waterbodies are inspected periodically (annually is preferred) and replaced if damaged or removed.

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

   Ambient Monitoring Sites are the division's longest existing trend stations and any disruption in sampling over time reduces our ability to make comparisons. Regardless of monitoring cycle, all ambient stations must be sampled quarterly according to the set list of parameters established for this sampling effort.

   Southeastern Monitoring Network Stations (SEMN): Like ambient stations, SEMN stations within each field office area must be sampled according to the project plan and grant for this project, regardless of watershed cycle.

4. **Impaired segments:** Water quality limited streams are those that have one or more properties that violate water quality standards. They are considered impaired by pollutants and not fully meeting designated uses. (Streams where water quality is exactly at criteria levels also have "unavailable parameters" and would be considered water quality limited, but as they are not impaired, are not appropriate for listing.)

Like posted streams, by identifying these streams as not meeting water quality standards, the division accepts responsibility to develop control strategies and to continue monitoring in order to track progress towards restoration.

Impaired waters are monitored, at a minimum, every five years coinciding with the watershed cycle. Waters that do not support fish and aquatic life are sampled once for macroinvertebrates (semi-quantitative sample preferred) and monthly for many of the listed pollutant(s). Streams with impacted recreational uses, such as those impaired due to pathogens are sampled monthly for *E. coli.* Another acceptable sampling strategy for *E. coli* is an approach in which an initial geometric mean is collected (5 samples within a 30-day period) in the first quarter. If the geomean is well over the existing water quality criterion of 126 colony forming units, the waterbody remains impaired with no additional *E. coli* sampling needed. If the geomean results meet the water quality criterion, staff will continue with monthly samples during the remainder of the monitoring cycle. If the geomean is not substantially over the criterion, field staff may at their discretion continue monthly monitoring in the hope that additional samples will indicate that the criterion is met.

For parameters other than pathogens, resource limitations or data results may sometimes justify fewer sample collections. For example, there are cases where pollutants are at high enough levels that sampling frequency may be reduced while still providing a statistically sound basis for assessments. In other unavoidable circumstances, such as dry streams, monitoring may be appropriately bypassed during a monitoring cycle.

When developing workplans prior to the next monitoring cycle, field office staff coordinate with the Division of Remediation (DoR) to confirm that any Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites currently on the 303(d) List are being monitored by either DoR or the permittee. These water quality data are reviewed to determine if the site continues to cause or contribute to violations of water quality standards. If data are not available, sampling should be designed to document water quality and provide a rationale for delisting if improvement is observed.

5. **Sampling downstream of Major Dischargers and CAFO's:** During each monitoring cycle, the major dischargers are identified in targeted watersheds. Stations are established at those waterbodies, if the facility does not currently have in-stream monitoring requirements built into their permit. The pollutant of concern and the effect it would have on the receiving stream may determine the location of the station. (Note: stations may not be required for dischargers into very large waterways such as the Mississippi River or large reservoirs.) Frequent collection (monthly recommended) of parameters should include those being discharged, plus a semi-quantitative single habitat (SQSH) survey if the stream is wadeable. Stations downstream of STPs or industries that discharge nutrients should include a SQSH, plus monthly nutrient monitoring.

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

6. **TMDL:** Effectiveness monitoring for completed TMDLs in the watershed group is coordinated between the Watershed Management Unit (WMU) manager and the EFOs to meet objectives for each TMDL. The frequency and parameters monitored for TMDL monitoring depends on the specific TMDL. Detailed information about TMDLs can be found in the department's 106 Monitoring QAPP, (TDEC 2017), and in the document *Monitoring to Support TMDL Development* (2001).

7. **Special Project Monitoring**: Occasionally, the division is given the opportunity to compete for special EPA grant resources for monitoring and other water quality research projects. If awarded, activities related to these grants become a high priority because the division is under contract to achieve the milestone set out in the workplan.

   Normally, monitoring activities related to these projects are contracted out to the state lab. However, if problems arise, field offices might be called upon if the lab is unable to fulfill the commitment. Examples of historical special studies include: sediment oxygen demand surveys, nutrient studies, ecoregion delineation, coalfield studies, air deposition surveys, reference stream monitoring, and various probabilistic monitoring designs.

8. **Watershed Monitoring**: In addition to the previous priorities, each EFO should monitor additional stations to confirm continued support of designated uses and to increase the number of assessed waterbodies. Macroinvertebrate biorecons, habitat assessments, and field measurements of DO, specific conductance, pH and temperature are conducted at the majority of these sites. These priorities include:

   - Previously assessed segments, particularly large ones, that would likely revert to Category 3 unassessed status. (Note that a single site per assessed segment is generally adequate if assessment was supporting and no changes are evident).

   - Sites below ARAP activities or extensive nonpoint source impacts in wadeable streams where biological impairment is suspected. Examples might be unpermitted activities, violations of permit conditions, failure to install or maintain BMPs, large-scale development, clusters of stormwater permits, or a dramatic increase in impervious surfaces.

   - Unassessed reaches especially in third order or larger streams or in disturbed headwaters.

- Pre-restoration or BMP monitoring. In most cases this sampling would be to document improvements, but might also be needed to confirm that the stream is a good candidate for such a project. This protects against the possibility that a good stream could be harmed by unnecessary restoration.

e. Data Quality Objectives

TDEC DWR has developed three Quality System Standard Operating Procedures (QSSOP) for use as guidance for collecting water pollution control data and appropriate quality control in the state. The QSSOP for Macroinvertebrate Stream Survey (TDEC, 2017) was first published in March of 2002 and was revised in October 2006 and June 2011. The QSSOP for Chemical and Bacteriological Sampling of Surface Waters was first published in March of 2004 and revised in 2009 and June 2011 (TDEC, 2011). The QSSOP for Periphyton Stream Surveys was completed in 2010 (TDEC, 2010).

Each year, the division submits a Quality Assurance Project Plan to EPA (TDEC, 2017). This document describes monitoring, analyses, quality control, and assessment procedures used by the division to develop TMDLs, 305(b) and 303(d) assessments. All documents are reviewed annually and revised as needed. A copy of any document revisions made during the year is sent to all appropriate stakeholders and posted on the website. A report is made to the Deputy Commissioner and Quality Assurance Manager of any changes that occur. Division staff are trained on field techniques outlined in the documents during the division's annual meeting and during biological workshops.

Biological (SQSH and some biorecons) and inorganic chemical samples are analyzed by the TDH Environmental Laboratories. Organic chemical samples and most bacteriological samples are analyzed by contract labs. The biological laboratory follows the QSSOP for macroinvertebrate (TDEC, 2017) and for periphyton (TDEC, 2010) sample analysis. The state and contract chemistry and bacteriological laboratories has standard operating procedures which follow approved EPA methodologies. EPA audits the state laboratories on a regular schedule.

II. WATER QUALITY ASSESSMENT APPROACH

a. How TDEC Assesses Water Quality

The water quality assessment process in Tennessee consists of four parts:

1. Development of clean water goals (water quality standards) either by promulgating national numeric criteria, statewide narrative criteria, or regional goals based on reference conditions.

2. Implementation of a statewide water quality monitoring program, based on a watershed cycle.

3. Comparison of data to water quality standards for each waterbody in order to assess water quality and categorize use support.

4. Geographic referencing of all water resources with the National Hydrography Dataset (NHD).

Monitoring data from individual waterbodies are compared to water quality criteria. Violations of water quality standards are identified and the degree to which each individual waterbody meets its designated uses is determined. Assessment categories recommended by EPA are used to characterize water quality.

Assessment results are compiled and reported to the public. The principal means of disseminating this water quality information are the 305(b) Report and the 303(d) List, plus various databases and mapping features maintained on the Department's website at http://www.tn.gov/environment/article/wr-water-resources-data-viewer

Almost half of the stream miles and nearly all the large reservoirs have been monitored and assessed. Waters without data collected within the last five years are usually identified as not assessed unless previously identified as impaired. About half of assessed streams and rivers and the majority of assessed reservoir acres are fully supporting of assigned designated uses. The remainder of assessed waterbodies are impaired to some degree and therefore, not supporting of all designated uses.

Once it has been determined that a stream, river, lake or reservoir is not fully supporting of its designated uses, it is necessary to determine what the pollutants are (causes) and where they

most likely are coming from (sources). The most common causes of impairment in rivers and streams are pathogens, habitat alteration, siltation, and nutrients. Common sources of these pollutants are agricultural runoff, physical and hydrologic modifications, urban runoff, and municipal dischargers.

The leading causes of impairment in reservoirs and lakes are toxic organics in fish such as PCBs and dioxins as well as mercury. The primary sources of problems in reservoirs and lakes are the historical discharge of pollutants that have accumulated in sediment and atmospheric deposition of mercury.

b. Consideration of Magnitude, Frequency, and/or Duration in Assessment Decisions

According to the definition of the Condition of Impairment provided earlier, the magnitude, frequency, and duration of criteria violations are important factors in assessment decisions. It would be handy if there were a formula for this determination. Thirty-five years ago, the Division experimented with just such a formula, a model called appropriately, the Water Quality Index.

However, use of the formula on ambient water quality data proved problematic. For example, the magnitude of each violation was established based on the current criterion for a parameter, the detection level, and the amount an ambient value exceeded both. Detection levels are seldom consistent, and in some parameters, the detection level could be much higher than the criterion. The model could not make these distinctions and generated erroneous and misleading results.

The Division rarely has information about the true duration of an excursion from criteria unless we have continuous monitoring of a physical property like dissolved oxygen or temperature. Because we collect mostly grab samples, sometimes we must substitute the frequency of violations to arrive at some judgment about the duration.

Regarding magnitude: clearly the greater the excursion, the more concerning. When evaluating magnitude, the division considers the relative toxicity or carcinogenicity of the pollutant in conjunction with the degree of exceedance above the criterion. For example, we would likely be more concerned if mercury was twice the criterion than if iron was ten times higher.

There are completely unavoidable data limitations on how the magnitude, frequency and/or duration provision is implemented. In the absence of standard equations that can be employed, a combination of statistical measures, scientific evidence, field observations and staff judgement is used to derive the most defensible assessment with the available data and supplemental information. The

agency implements this provision consistently statewide, which is one of the responsibilities of the central office assessment staff.

Additionally, all assessments are subject to review by EPA, the public, the board and perhaps even the legal system. The division must be mindful of the scientific and legal defensibility of assessments and must maintain the transparency of the decision process.

c. Use of Data Submitted by Other Agencies and Citizens

The division uses all reliable data that are readily available for the assessment of Tennessee's waterways. This includes data from TDEC, other state and federal agencies, universities, NPDES permit holders, citizens, and the private sector.

The division issues annual public notices requesting water quality data for use in the statewide water quality assessment. All submitted data are considered in the assessment process. If data reliability cannot be established, data are used to screen waters for future studies. In situations where data from the division and another source do not agree, more weight is given to the division's data unless the other data were significantly more recent.

Data collected by permittees as a requirement of NPDES permits are reviewed for accuracy and once accepted, are stored in appropriate databases. When data collected by permittees and the division disagree, more weight is given to the division's information.

d. Assessment of Causes and Sources

Water quality assessments are conducted by comparing water quality and other relevant data to the appropriate criteria to determine if waters are supportive of designated uses, and to determine the causes and most probable and significant sources of impairment. To facilitate this process, several provisions have been made:

- Criteria have been refined to help evaluate data. The ecoregion project has dramatically reduced the uncertainty associated with the application of statewide narrative and numerical criteria. Guidance documents have been developed to assist in the interpretation of biological, nutrient, habitat, and periphyton data. These documents are available on the division's webpage at https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/water-quality-reports---publications.html

- Critical periods have been determined for various criteria. Certain collection seasons and types of data have proven more important for the protection of specific water uses. For instance, the critical period for parameters like toxic metals or organics is the low flow season of late summer and early fall. Likewise, most recreational water contact occurs in the summer so pathogen results are considered most significant during that time.

- To ensure defensible assessments, data quality objectives have been set. For some parameters, a minimum number of observations are needed to assure confidence in the accuracy of the assessment. Other QA/QC requirements and staff qualifications are listed in Standard Operating Procedures in the publications link above.

- Provisions in the water quality criteria instruct staff to determine whether violations are caused by man-induced or natural conditions. Natural conditions are not considered the condition of impairment, except for pathogens.

- The magnitude, frequency, and duration of violations are considered in the assessment process.

- Streams and rivers in some ecoregions naturally go dry or historically have only subsurface flow during prolonged periods of low flow. Evaluations of biological integrity data include differentiating whether waters have been recently dry or are affected by man-induced conditions.

- Ecoregion reference sites are periodically re-evaluated and data are statistically analyzed. New sites are added when possible. Existing sites are dropped if data show the water quality has degraded, the site is not typical of the region, or does not reflect the best attainable conditions. Data from bordering states that share the same ecoregions are used to test suitability of reference sites and augment the dataset. Currently the state is reviewing river, lakes, headwaters, and reservoir data to identify reference conditions in these systems.

At watershed assessment meetings between central and field office staff, physical, chemical, habitat, and biological data are compared to water quality criteria. Where violations are of sufficient magnitude, frequency, and duration to be considered the condition of impairment, the specific pollutants are identified as the causes of impairment. Commonly, streams are impacted by more than one pollutant or in the case of removal of habitat, more than one kind of physical alteration.

In some cases, criteria are not parameters or single number, but rather a combined group of metrics. Examples of these criteria include groups of parameters like “nutrients,” or condition indexes such as habitat or biointegrity. In these cases, TDEC attempts to identify the actual parameter(s) causing the impact. For example, if the regional goal for the condition index habitat is not met, staff determine which components of habitat are the actual problem, such as lack of riparian vegetation. These aspects of habitat are then identified as the listed cause of impairment.

This “parameter by parameter” approach is also consistent with the Antidegradation Policy. The division, when issuing permit authorizations that result in the degradation of a water quality parameter, must identify whether or not the affected waterbody can receive additional loadings of that specific parameter

Additional information about interpretation of water quality criteria appears in the next chapter.

Once the causes of impairment have been identified, the next step is to list the most probable and significant sources of that parameter. Following are some general steps:

- If the parameter is associated with habitat loss, the activities causing the loss are identified, usually by a combination of watershed observations and a review of aerial photography. Commonly identified sources associated with habitat loss include crop production, pasture grazing, land development, and urban areas.

- If biological impairment is indicated, the distribution of genera can often provide an indication of the nature of the problem. For example, a lack of clean water indicators in the absence of excessive habitat alteration, sedimentation, or nutrients can suggest the presence of a toxicant. A review of discharge data from permitted facilities might help identify the source of specific pollutants.

- If excessive sedimentation is indicated, construction general permits and aquatic resource alteration permits can be reviewed to resolve whether or not the activities are in compliance with permit conditions. In areas of intensive agricultural activities, aerial photographs can be used to identify areas of riparian loss or direct cattle access that can cause excessive erosion.

- If pathogen levels are elevated downstream of urban areas, compliance reports are reviewed for documentation of overflows. In some severe cases, evidence of overflows can be noted in the stream (manhole covers dislodged, presence of paper and latex products, etc.) In agricultural areas, aerial photographs are used to look for evidence of concentrated livestock either with access to or in close proximity to streams.

- At times, the sources of a pollutant are general urban runoff from within a MS4 area. If a more specific source can be identified, such as an agricultural area or an collection system overflow point within the larger MS4 area, the more specific source is identified rather than the MS4. Otherwise, either urban runoff or the general MS4 area will be identified. Due to confusion regarding the regulatory ramifications of the identification of an MS4 area as a pollutant source, the division is currently evaluating whether or not it should go back to the previous method of only using "urban runoff" to identify these source areas.

d. Out of Cycle Assessment Requests

Water quality data will be used to assess/list/de-list waterbodies wherever possible within the existing watershed cycle. Occasionally there may be a reason to assess outside of the normal cycle. Examples might include: enforcement cases, emergency response/threats to public health, permit issues, TMDL studies, miscellaneous follow-up monitoring or post-BMP monitoring.

If these requests are due to an internal agency need, the manager of the field office or central office unit will contact the Planning and Standards Unit (PAS). In cases where compliance related factors are causing long-term impairment, the request will come to the central office as soon as possible so that the reassessment can be reflected accurately in the ADB in conjunction with any enforcement actions. In this way, our position regarding impairment will be consistent.

On occasion, requests for out-of-cycle reassessments come from the public or the regulated community. Whenever possible, EFO/Unit Managers or Deputy Directors should deal directly with external customers, providing technical assistance, screening requests, and properly documenting data submittals. Requests will then be forward to PAS.

All external reassessment requests and data submittals will be in writing. The request should be thoroughly explained. Data should be accompanied by maps or other locational

information. Data quality efforts should be detailed. Additionally, the request should explain why the data support the desired outcome.

These formal requests will receive a written response from PAS. An email acknowledgement is acceptable, unless the customer requests a letter. The response acknowledging receipt of the submittal will be accomplished within 10 working days and will offer the requester the option of a meeting with PAS. These reassessment meetings will be in Nashville, unless a meeting at the local field office is more desirable and can be arranged.

PAS will provide a written response with a rationale for TDEC's decision within 90 days of receipt of request. PAS will coordinate with appropriate EFO/Unit Managers on the assessment decision and rationale. In some complex situations, this may necessitate the creation of an assessment team of EFO, PAS and other staff.

In the event of a large number of requests for assessment/re-assessment out of the normal cycle, processing of requests will be prioritized as follows:

- Emergency response/public health threat.
- Providing a timely response to an external customer.
- Providing timely response and coordination to a sister agency.
- Enforcement-driven assessment.
- Permit decision-driven assessment.

III. Introduction to Water Quality Criteria

There are two types of criteria: numeric and narrative. Numeric criteria provide a specific level that should not be exceeded, while narrative criteria provide a description of the condition to be avoided. The water quality standards regulation instructs staff to consider the frequency, magnitude, and duration of criteria violations and to determine whether the appearance of pollution might be due to natural conditions.

Numeric criteria are specific levels of parameters that should not be exceeded. They are acute or chronic criteria based on degrees of toxicity to aquatic life, plus "organisms only" or "water and organisms" values based on human health. Additionally, Maximum Contaminant Levels (MCLs) are applied to some waterbodies to protect public drinking water supplies.

Narrative criteria are written descriptions of water quality. These descriptions generally state that the waters should be "free from" particular types or effects of pollutants. The division's long-standing position is that narrative criteria should have a regional basis for interpretation. To help provide regional information for narrative criteria, guidance documents based on reference stream data have been developed for biological integrity (Arnwine and Denton, 2001), habitat (Arnwine and Denton, 2001), and nutrients (Denton *et al*., 2001). Guidelines for biological criteria and habitat are re-calibrated periodically and are published in the department's QSSOP for Macroinvertebrate Stream Surveys (TDEC, 2011).

All streams in Tennessee are classified at a minimum for fish and aquatic life protection and recreation, so the most stringent of these criteria always apply to any stream. Waters are only classified for domestic water supply if they are large suitable waterbodies such as reservoirs, or other waterbodies currently used as a raw water source by public water suppliers. However, assessment staff should be aware that many small streams are used by private homeowners without access to public water, often with little treatment. Where these unofficial uses are noted by monitoring staff, assessments should be protective of human health.

It is important to note that water quality criteria are reviewed and may be revised each Triennial Review. While we will attempt to update this document to keep pace with revisions, the currently promulgated Chapter 0400-40-03-.03 should be considered the most accurate resource for information regarding criteria and their interpretation.

a. Flow Basis for Criteria

The general water quality criteria apply at any and all flows for waterbodies that are not wet weather conveyances. (Some criteria apply to wet weather conveyances, however they are not classified. This is explained further in the next section.)

The flow basis for application of criteria is found in Chapter 0400-40-03-.05(4):

Water quality criteria for fish and aquatic life and livestock watering and wildlife set forth shall generally be applied on the basis of the following stream flows: unregulated streams - stream flows equal to or exceeding the 7-day minimum, 10-year recurrence interval; regulated streams - all flows in excess of the minimum critical flow occurring once in ten years as determined by the Division. However, criteria that are wholly or partially based on measurements of ambient aquatic community health, such as the nutrient, biological integrity, and habitat criteria for the fish and aquatic life use, shall support the designated use. These criteria should be considered independent of a specified minimum flow duration and recurrence. All other criteria shall be applied on the basis of stream flows equal to or exceeding the 30 day minimum 5 year recurrence interval.

The awkward wording of the first sentence has led many outside the department to believe that fish and aquatic life or recreational criteria do not apply at flows below the 7Q10 or 30Q5 levels. Believing there are flow scenarios where “anything goes” for water quality simply cannot be the case, because it would present possibly acutely toxic conditions and direct threats to human health.

The flow basis rule cited above simply provides the flows used to apply criteria when calculating NPDES discharge permit limits. If a stream falls below the 7Q10 level and criteria are violated due to an NPDES discharge at permitted levels, that could be the condition of impairment in the stream. However, it would only be a permit violation if the conditions established in the permit were exceeded.

Some assessment methodologies may not be applicable at very high or low flows. For example, the SOP for performing macroinvertebrate surveys requires that flow be present when sampling. Should such a survey be done where flows are not present, the results would not be considered valid. In another example, dissolved oxygen criteria should not be applied to stagnant, non-flowing waters.

A discussion of application of the flow criteria under the fish and aquatic life and recreational criteria follows later in this Chapter.

b. Limited Application of Criteria to Wet Weather Conveyances (WWCs)

On rare occasions, such as spills or unpermitted discharges, staff may be required to determine whether or not a wet weather conveyance is in compliance with Tennessee's General Water Quality Criteria. As stated previously, wet weather conveyances are not classified. Here's what the Rule says about their protection level in Chapter 0400-40-03-.02(6):

Waters identified as wet weather conveyances according to the definition found in Rule 0400-40-03-.04, shall be protective of humans and wildlife that may come in contact with them and shall not adversely affect the quality of downstream waters. Applicable water quality standards will be maintained downstream of wet weather conveyances.

The task faced by staff is to determine which criteria and criteria levels apply to wet weather conveyances. Taking into consideration the lack of clarity in the Rule, following is some general guidance:

- Wet weather conveyances usually connect with classified waters some distance downstream. If the distance is short, and the receiving stream small, any criteria violations in the WWC should be assumed to negatively impact downstream water quality.

- The Act limits our ability to regulate physical alterations of wet weather conveyances. In theory, if physical alterations were not done in a way that was "protective of humans and wildlife" they could be deemed in violation of the general water quality criteria.

- For toxic substances, acute criteria should not be exceeded. If a WWC flows more than 4 consecutive days, chronic criteria should not be exceeded.

- Pathogen levels should not exceed the single sample maximum concentration under the recreational use.

- Wet weather conveyances should be generally free of bioaccumulative or radioactive substances, acidity, heavy metals, inorganic salts, oil and grease, color, or any other substance or condition that creates an environmental hazard or public nuisance.

Even if a WWC exceeds protection levels found in the General Water Quality Criteria, they are not suitable for inclusion in Tennessee's 303(d) List. Of course, if WWC alterations cause downstream impacts to a classified water, that impairment should be listed.

c. Interpretation of Numeric Water Quality Criteria

Toxic Substances (Numeric)

- For fish and aquatic life criteria, metals data are appropriately "translated" according to the water quality standards before comparison to criteria. For example, toxicity of certain metals can be altered by the waterbody's hardness and the amount of total suspended solids in the water. Widely accepted methodologies are used to translate toxicity data.

  This additional explanation appears in Chapter 0400-40-03-.02 (8):

  All fish and aquatic life metals criteria are expressed as total recoverable, except cadmium, copper, lead, nickel, silver, and zinc which are expressed as dissolved. Translators will be used to convert the dissolved fraction into a total recoverable permit limit. One of three approaches to metals translation will be used: (1) translator is the same as the conversion factor, (2) translator is based on relationships derived from STORET data, (3) a site-specific translator is developed. Where available, a site-specific translator is preferred. For assessing whether criteria for cadmium, copper, lead, nickel, silver, and zinc are exceeded by ambient water quality conditions, the dissolved criteria will also be translated in order to allow direct comparison to the ambient data, if total recoverable.

  Assessment staff use an Excel formula to calculate the allowable instream concentration of a hardness-based metal. Sample hardness and TSS levels are needed to accurately run the formula. In the absence of sample specific hardness and TSS values, carefully selected assumptions based on ecoregion historical ranges or similar nearby streams could be used.

- According to EPA guidance, numeric chronic fish and aquatic life protection criteria should not be exceeded more than once in a three year period. This time interval presents an implementation challenge to staff, as our chemical sampling normally is on a five year cycle. Where TDEC has multiple years of chemical data at a site - such as ambient and reference stations, or sites where dischargers collect and submit instream data - we will follow the one exceedance every three years guidance for establishing use impairment. In the more common occurrence where we have a year's worth of data very five year cycle, we will not List if only one exceedance, but will consider impaired if a chronic criterion is violated twice.

- A single violation of acute criteria for a toxic substance can provide the basis for an assessment of fish and aquatic life impairment.

- For protection of the Recreational use, ambient data are compared to either (1) Water and Organisms or (2) Organisms Only numeric criteria. Unless the waterbody is classified for, or actively being used for domestic water supply, the "Organisms Only" criteria apply. Since criteria for human health impacts are based on long-term exposure to a pollutant, either by drinking treated water or ingesting fish or other aquatic life, ambient levels over time are compared to criteria, unless the magnitude requires a more immediate response.

Pathogen Criteria (Numeric)

- Tennessee utilizes *E. coli* as the pathogen indicator since this group is generally considered more reflective of true risk than are fecal coliform data. Some waterbodies, such as Exceptional Tennessee Waters and lakes, have more stringent *E. coli* criteria which apply, due to the greater chance people will engage in recreation there.

- A minimum of ten samples, including geo means, are required to assess waterbodies as impaired due to high bacteria levels, unless the levels in a fewer number of samples or the geo mean are very elevated. Streams cannot be assessed as fully supporting with an equally few number of observations except as allowed under the evaluation framework in this guidance.

- The recreational criterion for pathogens does not specify whether or not the source is natural or anthropogenic. For that reason, the natural conditions provision does not apply to pathogens. Any stream that violates the criterion, regardless of source, should be evaluated for the condition of impairment. If impairment is confirmed, the waterbody should be listed.

- The seasonality of pathogens samples is critical, depending on the sources. Where cattle have access to streams and use them as lounging areas as a refuge from heat, or areas with failing septic tanks, low flow, dry season data are considered more meaningful than high flow, wet season data. Conversely, urban or agricultural runoff sources may be elevated and overflows from sewage treatment plants more likely in wet season samples. Assessment staff must consider the most likely sources of pathogens and be mindful of the appropriate season and proper timing of sample

collection to accurately gauge impacts.

- In the absence of flow data, samples collected in late summer and fall are considered low flow or dry season samples. It is important to note that wet season pathogen samples are not disregarded and data indicating point source contributions are never given less consideration due to elevated flows.

Dissolved Oxygen (Numeric)

- In order to be accurate, meters must be properly calibrated and meters can malfunction. While it does not happen often, assessment staff should watch for signs of faulty results, such as multiple streams indicating low or elevated oxygen on the same day, or values that seem out of place in the historical range of data at a site. Post calibration checks are required in the SOP and are especially critical when unexpected readings are obtained. Questionable data should be purged and never uploaded to databases.

- Dissolved oxygen levels in streams and rivers are measured in flowing water. In lakes and reservoirs, dissolved oxygen is measured at mid-depth or five feet if the water is deeper than ten feet. Data collected at extreme low flows must be interpreted with caution as any violations may be due to natural stagnation rather than pollution.

- There are subcategories under the criteria for dissolved oxygen for streams in the Mississippi delta [sub-ecoregion 73(a)], identified trout streams, streams with naturally reproducing trout, and streams within the Blue Ridge Mountain ecoregion (66). Criteria are higher in trout streams and the Blue Ridge, and lower in the Delta. Current criteria should be consulted prior to assessment of these waters.

- If the source of the low DO is a non-anthropogenic source such as ground water, spring, or wetland, then the low DO is considered natural and not the condition of impairment.

pH (Numeric)

- The pH criterion range for wadeable streams and rivers is 6.0 - 9.0 standard units. For nonwadeable rivers, streams, reservoirs, lakes, and wetlands, the pH range is 6.5 – 9.0 standard units.

- In order to be accurate, pH meters must be properly calibrated and the meters can malfunction. While it does not happen often, assessment staff should watch for signs of faulty results, such as multiple streams indicating low or elevated pH on the same day, or values that seem out of place in the historical range of data at a site. Post calibration checks are required in the SOP and are especially critical when unexpected readings are obtained. Questionable data should be purged and never uploaded to databases.

- Elevated pH is an importation factor elevating the toxicity of ammonia, so in these conditions, care should be taken to also collect and review ammonia data.

- Increased acidity causes some metals to become more available and therefore more toxic. In many waterbodies assessed as impaired by acidity, it is difficult to discern whether the harm was caused by the reduced pH or the resulting metal toxicity, especially in areas with historical or active mining present.

- Staff should be mindful that each unit of the pH scale going either up or down is an order of magnitude (tenfold) change in hydrogen ions rather than a simple linear change. That means that a pH level of 3 is ten times more acidic than a level of 4. Assessment decisions for pH need to consider this magnitude difference.

Temperature (Numeric)

- The temperature criteria can be violated in three different ways. A (1) temperature difference from downstream to upstream, (2) an elevated rate of change, and (3) exceedance of a maximum temperature. Temperature criteria are more stringent in trout streams.

- Where the maximum temperature criterion has been exceeded, assessment staff should determine whether heat has been added to the waterbody because of a discharge or withdrawal. If that is not the case, increased sun exposure due to the removal of habitat either through channelization or riparian loss can cause the temperature to be elevated. If the reason is riparian loss, that condition should also be identified as a cause of non-support.

- In lakes, the cause of elevated temperatures might be strong stratification due to the inability of light to penetrate because of excessive algae. In that case, nutrients should

be added as a cause.

- Elevated temperatures also cause ammonia to be more toxic, especially if combined with high pH levels. In eutrophic lakes, this combination of effects can be common. Assessors should be mindful of this connection.

- Large dischargers into normally cool mountain streams can cause an undesirable elevation in temperature. Where this is a strong possibility, assessors should ask that the discharger be required to monitor upstream and downstream of their outfall. Staff can use those data to assess the stream.

- Turbines and generation schedules at dams or other power facilities can cause temperature pulsing in tailwaters, dramatically impacting aquatic life. Where these conditions violate water quality criteria, the stream should be identified as impaired.

- Power plants or other facilities that have been issued a federal 316(a) permit are not required to meet state temperature criteria. The substituted requirement is that they must maintain a Balanced and Indigenous Population (BIP) of aquatic and other wildlife. There is very little guidance to states on how to interpret this provision. Generally, it has been Tennessee's interpretation that populations should be similar in makeup and community structure both upstream and downstream of the outfall. Since this is a federal rather than state provision, it is always best to get EPA's point of view.

  It is always important to note that a 316(a) federal permit does not shield the discharger from effects that might be related to heat, such as low dissolved oxygen, fish kills, or impacts to recreational uses. If these should occur, the waterbody should be assessed as impaired.

- In the absence of a 316(a) federal permit, state temperature criteria apply, even if biointegrity measures are met.

Human Health (Numeric)

- There are two types of human heath criteria: Water and Organisms and Organisms Only. Water and Organism criteria apply only where waterbodies are classified for domestic water supply. The Organisms Only criteria apply everywhere else.

- Normally, the criteria for metals are most stringent under the fish and aquatic life protection use because aquatic life tend to be more sensitive to these toxicants than people. However, there are exceptions. The criterion for mercury is lower under the human health (recreational) use. Mercury ambient water quality data should always be compared to the recreational criterion and attention should be given to detection levels to insure that they are near or below criteria levels.

  At present, the lowest criterion for arsenic is the recreational criterion. Particularly in West Tennessee, arsenic can be elevated and should always be sampled and assessed. For antimony and thallium, there is a numeric recreational criterion, but no equivalent fish and aquatic life criterion.

  The criterion for lead under the fish and aquatic life criterion is hardness dependent and the allowable instream concentration derived from the formula can be over 5 ug/L, the current domestic water supply criterion, which is not hardness dependent. Assessment staff should be mindful that where lead levels are above 5 ug/L, the waterbody should be checked to determine whether or not it is classified for domestic water supply.

- Since criteria for human health impacts are based on long-term exposure to a pollutant, either by drinking treated water or ingesting fish or other aquatic life for a lifetime, ambient levels over time are compared to criteria, unless the magnitude of excursions requires a more immediate response.

MCLs and Other Domestic Water Supply Criteria (Numeric)

- Domestic Water Supply criteria only apply where waterbodies are classified for domestic water supply and are designed to prevent a public water supplier from undue effort and costs to remove pollutants placed in a stream by others. Some of these pollutants are difficult to remove, but criteria apply even if a public water supplier is able to successfully remove the pollutant through treatment.

- In East and Middle Tennessee, lakes or rivers are commonly used as raw water sources, along with some springs or groundwater. In West Tennessee, sources are almost exclusively ground water, so few surface streams are classified for domestic water supply west of the Tennessee River.

- In Tennessee, the most common reason for rivers or lakes to be assessed as failing to support the domestic water supply use is nutrients. There is a numeric criterion for nitrate, 10 mg/L. If that level is exceeded, the stream is impaired. (It is unusual for lakes to have nitrate levels that high.) Phosphorus can also create treatment problems.

- Lake eutrophication and the resulting stratification caused by excessive nutrients in particular can impact water treatment in multiple ways. Excessive algae can elevate pH levels, interfering with treatment, and cause taste and odor problems. Additionally, increased concentration of organics can create disinfection byproducts that are carcinogenic.

- If more than ten percent of the observations of a domestic water supply is above the criterion or if a public water supplier has reported a significant issue related to the removal of pollutants, the waterbody is assessed as impaired by that substance. It is critical during the assessment process that staff familiar with public water suppliers within a watershed be consulted regarding treatment issues cause by pollutants.

- Some secondary MCLs are designed to prevent scaling in pipes or system corrosion. Assessment staff should exercise caution in assessing stream of lakes as impaired for those parameters. Fish and aquatic life or recreational criteria should be applied instead.

- There is a numeric criterion for beryllium under domestic water supply, but not one under fish and aquatic life or recreation. As noted in the previous segment, the domestic water supply criteria for certain metals are not hardness dependent like they are under fish and aquatic life protection. For metals such as cadmium, nickel, or lead, staff should be mindful the most stringent criterion might be under the domestic water supply use in situations of higher hardness values.

Nutrient Criteria (Numeric)

- A numeric nutrient response criterion based on chlorophyll *a* has been adopted for Pickwick Lake. The criterion of 18 ug/L is based on an average level during the growing season (April – September). Compliance is measured at the lake's deepest point, the forebay.

Total Dissolved Solids (Numeric)

- Assessment staff should be mindful that there is a total dissolved solids numeric criterion of 500 mg/L under both the domestic and industrial water supply classified uses. However, as this criterion is likely designed to prevent scaling of pipes, care should be taken in assessing streams as impaired for this parameter.

d. Interpretation of Narrative Criteria

Nutrient Criteria (Narrative)

- The primary designated uses that have narrative nutrient criteria are fish and aquatic life and recreation. As noted in a previous section, a numeric nutrient response criterion based on chlorophyll *a* has been adopted for, and applies to, Pickwick Lake.

- Regional numeric nutrient goals (Denton *et al*., 2001) are used as guidance regarding acceptable concentrations. At least four nutrient samples are needed for a valid assessment, in combination with the documentation of aesthetic or biological impairment.

- The NUTOL score, a component of the Tennessee Macroinvertebrate Index, is designed for sensitivity to nutrient impairment. In most bioregions, scores between 30 and 50% demonstrate some stress on the macroinvertebrate community while those higher than 50% may indicate impairment. However, the metric does not include all nutrient tolerant macroinvertebrates so low scores do not necessarily mean a biological response does not exist. Algae can be another important biological indicator when abundant growth is observed. The division is in the process of developing a diatom index in coordination with sister-states and EPA which will be incorporated in future nutrient assessments when developed.

- Waters are not assessed as impaired by nutrients unless biological impairment, aesthetic impacts such as excessive algae growth, or other downstream problems are also documented.

- In streams where continuous dissolved oxygen monitoring has occurred, wide swings in diurnal oxygen levels can be an indication of nutrient enrichment. The Division

monitored reference streams to determine what natural diurnal swings might occur in each ecoregion. These studies are most meaningful under low flow, elevated stress scenarios such as August or September.

- In lakes, strong oxygen and temperature stratification is an indication of nutrient enrichment. Where lake profile information is available, staff should watch for decreased light transmission, elevated temperatures in the upper portions (sometimes above the maximum temperature of 30.5 degrees), a strong thermocline (a rapid decrease in temperature at the depth light can no longer penetrate), and elevated pH due to algae as signs of excessive nutrients. Chlorophyll a samples can be used to document biomass.

  EPA and Division staff have traditionally used the Trophic State Index developed by Robert Carlson in 1977 as a way of gauging the eutrophication of lakes. Eutrophication is a natural process that can be accelerated by human activities in which lakes move from being nutrient poor (oligotrophic) to having excessive nutrients (eutrophic).

  Carlson's Index could be based on Chlorophyll *a* or total phosphorus levels, or the Secchi depth, as seen in the table below. A Secchi disk is a black and white metal disk that is lowered into a lake until it can no longer be seen by the observer. It is a simple, inexpensive way to measure light penetration.

  Chlorophyll a and phosphorus levels increase with eutrophication, Secchi depth decreases. Carlson Index scores over 50 are considered eutrophic. Scores over 70 are considered hypereutrophic (see Table 2 below).

Table 2
Carlson's Trophic State Index for Lakes

TI	Chl (ug/L)	P (ug/L)	SD (meters)	Trophic Class
<30—40	0—2.6	0—12	>8—4	Oligotrophic
40—50	2.6—20	12—24	4—2	Mesotrophic
50—70	20—56	24—96	2—0.5	Eutrophic
70—100+	56—155+	96—384+	0.5—<0.25	Hypereutrophic

There are some natural lakes in Tennessee, but most are actually reservoirs. Where lakes or reservoirs are determined by staff to be eutrophic or hypereutrophic, they should be watched for signs that use support has been impacted. Such signs include strong stratification, excessive algae, elevated temperatures, elevated pH levels, fish kills, public complaints about water contact issues, treatment problems for public water suppliers, taste and odor problems in finished water, and low dissolved and elevated metals in reservoir tailwaters.

Where loss of use support is documented, staff should determine whether the entire reservoir or just a portion is impacted. It is not uncommon for large reservoirs to display different water quality characteristics in the various parts of the waterbody. In some cases, problems might be restricted to an embayment. These smaller segments can be assessed differently than the main reservoir for 303(d) Listing purposes as appropriate.

Suspended Solids Criteria (Narrative)

- Historically, silt has been one of the primary pollutants in Tennessee waterways. The division has experimented with multiple ways to determine if a stream, river, lake or reservoir is impaired due to silt. These methods include visual observations, chemical analysis (total suspended solids), and macroinvertebrate/ habitat surveys.

- The most satisfactory method for identification of impairment due to silt in flowing water has been biological surveys that include habitat assessments. Regional guidelines based for habitat parameters associated with siltation (embeddedness and sediment deposition) have been estimated for each ecoregion (TDEC Macroinvertebrate QSSOP Appendix A, 2017).

- Ecoregions vary in the amount of silt that can be tolerated before aquatic life is impacted. Through work at reference streams, staff found that the appearance of excessive sediment/silt is often, but not always, associated with loss of biological integrity. Thus, for water quality assessment purposes, it is important to establish whether or not aquatic life is being impaired. For those waterbodies where loss of biological integrity can be documented, the habitat assessment can determine if this loss is due to excessive silt deposits.

- Identifying the sources of silt in waterways can be problematic because there may be so many potential candidates. In urban areas, construction issues can be spotted through aerial photographs, staff watershed observations, complaints, plus compliance and enforcement activities. In agricultural areas, aerial photographs can be used to spot erosion areas. Across the state, channelization and riparian vegetation loss speeds and worsens sediment transport.

Biological Integrity Criteria (Narrative)

- Biological integrity criteria are designed to protect fish and aquatic life.

- Biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing use support. Two standardized biological methods, biorecons and semi-quantitative single habitat (SQSH) samples, are used to produce a biological index score. These methods are described in *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys* (TDEC, 2011) and are referenced in the water quality criteria.

- A commonly utilized biological survey method is the biorecon. Biological scores are compared to the metric values obtained in ecoregion reference streams. Three metrics are examined: taxa richness, number of families or genera of caddisflies, mayflies, and stoneflies (EPT), and number of intolerant families or genera. This method only uses qualitative data and relies heavily on the expertise of the biologist.

- If a more definitive assessment is needed, a SQSH is collected. Organisms are identified to genus and an index based on seven biological metrics is used for comparison to reference streams. Waterbodies are considered impaired if the biological integrity falls below the target score for that region. This method provides quantified data that can be used to calculate metrics based on relative abundance as well as richness.

- If both biorecon and SQSH data are available and the results do not agree, generally more weight is given to the SQSH. However, SQSH results may be suspect if the amount of habitat was not adequate or not representative in that stream. In those scenarios more weight should be given to the biorecon, since it surveys more than one habitat.

- If biological data from the division and another agency do not agree, more weight is given to the state's data unless the other agency's data are considerably more recent.

- To be comparable to ecoregions guidance, streams must be similar size and drainage as the reference streams in the ecoregion and must have at least 80 percent of the upstream drainage within that ecoregion.

- The division is in the process of developing a diatom index to augment the macroinvertebrate surveys, especially in nutrient impaired streams. The division is working with sister states (AL, KY, GA) and EPA to develop a regional diatom index sensitive to nutrient impairment. The 4 states have combined databases and submitted a request for a N-Steps grant to have a contractor develop and calibrate an index. It is anticipated this index will be available for use in 2019.

Habitat Data (Narrative)

- Habitat alteration is one of the major causes in waterbody impairment in Tennessee. The criterion for habitat is an example of a condition index. That means that habitat is a measurement of the parameters associated with habitat.

- Division staff use a modified version of a standardized scoring system developed by EPA to rate the habitat in a stream (Barbour, *et al*., 1999). The *QSSOP for Macroinvertebrate Stream Surveys* (TDEC, 2011) provides guidance for completing a habitat assessment and evaluating the results.

- Habitat scores calculated by division biologists are compared to the ecoregion reference stream database. These regional goals are based on 75 percent of the median reference condition scores for the ecoregion.

- According to the narrative criterion, habitat should not be assessed as impaired unless biological harm can be established. In some drastic scenarios, this harm can be assumed, for example in recently relocations, channelization, encapsulation, or concrete lining of streams.

Color (Narrative)

- The criterion for color is based on the creation of objectionable conditions. Color is measured as true (dissolved) color or apparent (particulate and dissolved) color. The

type of measurement that is most relevant in a given situation is site-specific, and based on whether the color is dissolved or particulate.

- Color associated with sediment or algae can be objectionable, but should be generally assessed as excessive sediment or algae rather than as a violation of the color criterion.

- Naturally-occurring color, such as tannins in wetlands, falls under the "natural conditions" clause in water quality standards and should not be assessed as impairment.

- True or apparent color data can be compared to levels found in reference streams for that ecoregion.

- Other relevant information sources include discharge monitoring reports from upstream industries, contacts from other agencies, and public complaints.

Flow (Narrative)

- The criterion for flow under both recreation and fish and aquatic life is simply that flows should support the intended use.

- Like other criteria, the natural conditions provision applies. That means that assessors must ensure that alteration or removal of flow is caused by human activities such as dams, diversions, or withdrawals rather than natural conditions such as beaver dams, drought, or karst features.

e. Interpretation of Natural Conditions Provision

A previous chapter provided important definitions including one for the Condition of Impairment. A part of that definition addresses natural conditions when it says, *"With the exception of pathogens, those excursions caused by natural conditions (not anthropogenic in nature) will not be considered impairment."*

In a different part of the Rule, the General Water Quality Criteria provide additional guidance. Rule 0400-40-03-.05(7) sets out that while any exceedance of water quality criteria is a violation, violations caused by natural conditions should be treated differently.

> *Where naturally formed conditions (e.g., geologic formations) or background water quality conditions are substantial impediments to attainment of the water quality standards, these natural or background conditions shall be taken into consideration in establishing any effluent limitations or restrictions on discharges to such waters.* ***For purposes of water quality assessment, exceedances of water quality standards caused by natural conditions will not be considered the condition of pollution.*** *(Emphasis added.)*

Thus, when the magnitude, frequency and duration of water quality violations causes the loss of a use, that waterbody is considered to be impaired, unless the parameters are elevated entirely due to natural rather than anthropogenic sources. Table 3 provides examples of water quality criteria violations than might be viewed as natural in origin as opposed to those assessed as anthropogenic in origin.

Natural Conditions Parameter Specific Information

Metals

There are natural sources of most metals and they are often found to be elevated in ground water, rocks and soil. Metals found in ground water include but are not limited to iron and manganese. Other metals commonly found in native rock include iron, manganese, and aluminum. Lead and copper are components of soil that can cause water quality criteria violations in areas of erosion and low hardness water (hardness effects toxicity of some metals).

For metals with low toxicities, such as manganese and iron, background is considered to be the levels found in reference streams. These metals are often more likely to cause a habitat problem if they get to high enough levels to precipitate out on substrate.

For aluminum, the Division uses EPA's acute criterion for exceedances due to man-made sources such as mining or reclamation. The Division has not adopted a chronic criterion for aluminum. In 1988, EPA suggested a chronic criterion of 87 ug/l, but this suggested level is frequently exceeded at Division reference streams in several areas of the state, with no apparent impact to sensitive taxa, making this number difficult to defend legally. As with iron and manganese, aluminum levels found at reference streams are used to determine background (natural) levels.

Table 3
Examples of Natural Conditions vs Anthropogenic Causes

Parameter(s)	Nature of Issue	Example of Natural Conditions	Example of Anthropogenic Causes
Low DO and elevated metals	Groundwater with naturally suppressed DO levels or elevated metals.	Springs and natural groundwater connections. (Gaining reaches of streams.)	Oil, water, or gas well drilling mishaps.
Flow issues	Prolonged dryness	Drought. Losing reaches of streams.	Excessive water withdrawals or diversions. Streams in karst areas being "sunk" by construction activities. Failing or improper placement of pipes.
Flow issues	Stagnant or reduced flows due to impoundments.	Beaver dams.	Concrete, rock or earthen impoundments. Sand plugs caused by channelization.
Elevated biomass	Plant or algae response to nutrients	Wetlands or lakes in delta region of state without other nutrient sources in watershed.	Reservoirs with excessive inflows of nutrients from surrounding watershed.
Low pH	Elevated acidity	Landslide areas in acid-bearing rock formations.	Disturbance of acid-bearing rock formations by construction or mining.

It is unusual for copper and lead to exceed formula-based numeric criteria, but when they do, those events are considered violations, even if due to background soil concentrations, if those are due to man induced erosion. While there are background levels of mercury from rocks, those are generally insignificant in Tennessee compared to mercury from industrial dischargers and the burning of coal. Thus, criteria violations for mercury are always considered anthropogenic in origin.

Organic Contaminants

Pesticides, Herbicides, Other Man-Made Organic Contaminants – There are no natural sources of these contaminants.

Sediment

There are natural levels of sediment in streams. TDEC's guidance for habitat assessments is an ecoregion based approach that incorporates the natural variability in water quality statewide. When ambient sediment levels exceed reference condition there is a significant difference in sedimentation. When these levels cause biointegrity or habitat scores to fail to meet clean water goals, silt will be considered a cause of impairment.

Habitat and Nutrients

Similar to sediment, compared to reference condition.

Pathogens

There are natural sources of pathogens, however, since the human-health-based criterion does not differentiate between natural or background sources, whenever that criterion is exceeded, the stream will be considered impaired. The source will be identified as natural in origin, if we have determined this to be true.

Relationship of Water Quality Criteria Violations to the Antidegradation Policy

According to the Antidegradation Policy, when water quality for a specific parameter is at or not meeting appropriate water quality criteria, that waterbody is unavailable for additional measurable degradation of that parameter. (Or in the case of physical alterations, degradation above a *de minimis* level.) Although a stream that violates water quality standards due to natural sources is not considered to be polluted, it is still unavailable for additional measureable degradation.

The comment field on the Assessment Database (ADB) will be used to communicate that the waterbody exceeds water quality standards. The permitting staff have access to this information.

f. Interpretation of the Rain Event Provision

Tennessee's water quality standards contain a provision [Chapter 0400-40-03-.05(4)] specific to pathogen data that allows rain event samples to be counted as data outliers. Once identified, these samples can be given less weight than non-rain event samples.

Additionally, TDEC's monitoring SOP suggests that monitoring staff avoid sampling when streams are over "bank full" volume. However, this provision should not be interpreted as meaning that rain event samples are not violations if they exceed criteria or that the Division has somehow prohibited itself from sampling under any conditions.

IV. Listing and Prioritization

a. Framework for Establishing Evaluated Water Quality Assessments

A committee within the Division of Water Resources was created in 2015 to explore ways to slow or reverse the trend in water quality assessments towards the "two color map." The two color map is a projection of a possible outcome in which most waterbodies in Tennessee are assessed as either "impaired" or "not assessed," thus producing a map with only two colors, gray and red.

In the initial meeting of the committee, it was the consensus of the group that in order to reverse the two color map trend, a combination of techniques would have to be employed, including but not limited to: new technology, maximizing partnerships, and increasing sampling efficiency. As of this writing the creation of new staff positions dedicated to monitoring is unlikely at present.

An additional opportunity discussed was the enhanced use of "evaluated" assessments. Evaluated assessments would be based on information sources other than recently collected benthic or chemical data. Evaluated assessments have always been used to some degree, but in recent years, have fallen into disfavor.

This guidance is designed to not only assist the assessment process, but to also aid in the development of the annual monitoring workplan.

<u>Introduction</u>

- As a science agency, our credibility and professional ethics must be maintained at a high level and our decision processes must be above reproach. This proposal for expanded use of evaluated assessments is neither intended, nor should it be used, for the purpose of biasing Tennessee's water quality assessments in the direction of "fully supporting" waters. We should be as equally apt to use evaluation techniques to identify impaired waters as fully supporting ones.

- Recent physical, chemical, or biological survey results are not the only forms of data available to inform the assessment process. While recent stream sample data are the ideal, there are other valid information sources, such as GIS analysis of land use, recent aerial photographs, models, self-monitoring reports, compliance inspection results, and

overflow reports. Stream assessment decisions are based on multiple sources of evidence and the agency must weigh all available information to arrive at a conclusion.

- An important part of our scientific credibility as an agency is consistency. Once statewide guidance has been developed, it must be followed at every step of the assessment process. All methodologies evolve, but changes to this process must be preceded by a change in the guidance.

- Both field office and central office staff have critical roles and water quality assessments in Tennessee are created in partnership. Field Office staff have undisputed expertise in local conditions that form the basis of assessments. Central Office staff have the equally important task of ensuring that the assessment decision process is comprehensive, defensible, consistent throughout the state, and compliant with existing laws and regulations.

- Evaluated information can only be used in a limited set of circumstances (and for a limited amount of time in many cases) for fish and aquatic life assessments and an even more limited set of circumstances for recreational use assessments. The Domestic Water Supply use can only be assessed by using recent data. As we have done historically, assessment of the uses of irrigation and livestock and wildlife watering can be done with evaluated information, but only if either fish and aquatic use and/or recreation are also being assessed.

- Monitoring resources are not unlimited. The guidance will help us maximize the possibility of assessing waterbodies with data other than recent chemical or benthic surveys.

Evaluated Assessments Automatically Considered "Fully Supporting"

Waterbodies fully contained within the Great Smoky Mountains National Park:

- Can be assessed as "fully supporting" for fish and aquatic life provided they have not been recently altered and are at elevations below 5,000 feet. (At elevations above 5,000 feet, acidification due to atmospheric deposition may occur.)

- Can be assessed as “fully supporting” for recreation provided they do not contain herds of mammals (such as horse stables or congregations of elk), campgrounds, or permitted discharges.

- When developing the draft monitoring workplan, waterbodies that are proposed as candidates to be evaluated rather than monitored because they fall under this category should be specifically identified but may be compiled into a group for convenience. A brief rationale for not monitoring these waterbodies should be provided (e.g. no stables, less than 5000 feet in elevation, no private inholdings or campgrounds, etc.)

Waterbodies fully contained within Designated Wilderness Areas within the Cherokee National Forest:

- Can be assessed as “fully supporting” for fish and aquatic life provided they are at elevations below 5,000 feet.

- Can be assessed as “fully supporting” for recreation. (Assumes no herds of mammals.)

- When developing the draft monitoring workplan, waterbodies that are proposed as candidates to be evaluated rather than monitored because they fall under this category should be specifically identified but may be compiled into a group for convenience. A brief rationale for not monitoring these waterbodies should be provided.

Other Waterbodies fully contained within the Cherokee National Forest:

- Can be assessed as “fully supporting” for fish and aquatic life provided they have not been recently altered (including logging or mining), do not have significant private inholdings, and are at elevations below 5,000 feet.

- Can be assessed as “fully supporting” for recreation provided they do not contain potential sources of pathogens such as private inholdings of land, herds of mammals, permitted discharges, or developed campgrounds.

- When developing the draft monitoring workplan, waterbodies that are proposed as candidates to be evaluated rather than monitored because they fall under this category should be specifically identified but may be compiled into a group for convenience. A

brief rationale for not monitoring these waterbodies should be provided.

Waterbodies within the Big South Fork National River and Recreational Area:

- Can be assessed as “fully supporting” for fish and aquatic life provided they are fully contained within the park, have not been altered, have no public inholdings of land, and no history of mining.

- Can be assessed as “fully supporting” for recreation provided they are fully contained within the park, have no herds of mammals or campgrounds, and have no public inholdings of land.

- When developing the draft monitoring workplan, waterbodies that are proposed as candidates to be evaluated rather than monitored because they fall under this category should be specifically identified, but may be compiled into a group for convenience. A brief rationale for not monitoring these waterbodies should be provided.

Other Waterbodies:

- Small tributaries to waterbodies with data collected during the most recent watershed cycle can be assessed as “fully supporting” for fish and aquatic life or recreation provided it is the consensus judgement of assessment staff that the conditions in these waterbodies mirror those in the downstream water, that the distance between the monitoring station and the tributary is not too extreme and both waterbodies are within the same ecoregion. In most cases, the waterbodies in this type scenario will be included within the same waterbody segment.

- When developing the draft monitoring workplan, these waterbodies should not be proposed as candidates for evaluation, because their subsequent assessment is dependent on the results of nearby recent benthic or chemical data.

Evaluated Assessments Considered "Fully Supporting Based On Factors Other Than Recent Chemical or Benthic Data."

- Wadeable streams that scored either 36 or greater (or 26 or greater in Ecoregion 73a) on a SQSH or a 15 on a biorecon in the previous assessment cycle can be assessed as "Fully Supporting Based On Factors Other Than Recent Data" provided that it is the consensus judgement of assessment staff based on site visits, or other knowledge/data sources that the conditions in these streams have not changed. Stream assessed under this category can miss having data collected for one assessment cycle, but not for two.

- When developing the draft monitoring workplan, streams that are proposed as candidates to be evaluated rather than monitored because they fall under this category should be specifically identified. A brief rationale for not monitoring these streams should be provided which explains the basis for the belief that conditions have not changed (e.g. site visits). However, conditions should be presumed to have changed if the stream has a large watershed (>50 square miles), is being rapidly developed, is in an urbanized area, or an area with intensive agriculture.

Limitations Placed on the Category "Fully Supporting Based On Factors Other Than Recent Chemical or Benthic Data."

- This evaluation process is limited to the fish and aquatic life use, except as allowed in previous sections dealing with National Parks and Wilderness Areas.

- Waterbodies evaluated under this category will be differentiated from "fully supporting" (assessments based on recent data) and will be given a different color on assessment maps.

- Evaluated waterbodies cannot be expanded to incorporate more miles that the original assessment based on recent chemical or benthic data.

- Evaluated fully supporting assessments should not be used to establish the existence of available parameters for antidegradation purposes in NPDES permitting. These assessments should be only be used for antidegradation purposes by the Natural Resources Unit after careful consultation with knowledgeable Field Office staff.

Evaluated Assessments Considered "Not Supporting Based on Factors Other Than Recent Benthic Survey Data"

- Consistent with existing guidance, streams impacted due to flow or habitat alteration due to upstream impoundments, channelization, culverting, or hard armoring do not require new data be collected each cycle if the condition is still present. (A habitat assessment might be recommended in some situations.)

- Unassessed streams that are channelized or concrete lined can be presumed to be habitat impaired, especially if they are tributaries to habitat-impaired streams with recent data.

- Streams that scored either 20 or less (or 12 or less in Ecoregion 73a) on a SQSH, or a 5 or less on a biorecon in the previous assessment cycle can be assessed as "Not Supporting Based On Factors Other Than Recent Data" provided that it is the consensus judgement of assessment staff that the (1) conditions in these streams have not changed and (2) that it is not possible the previous low scores were due to natural conditions such as prolonged dryness, or beaver activity. Stream assessed under this category can miss having data collected for one assessment cycle, but not for two.

- When developing the draft monitoring workplan, waterbodies that are proposed as candidates to be evaluated rather than monitored because they fall under this category should be specifically identified. A brief rationale for not monitoring these waterbodies should be provided (e.g. hard armoring, upstream impoundment) that includes an explanation of why staff feel that conditions have not changed.

Evaluated Assessments Considered "Not Supporting Based on Factors Other Than Recent Chemical or Pathogen Survey Data"

- Waterbodies may be assessed as impacted by chemical parameters even in the absence of stream data if effluent quality data from dischargers indicate that at that volume and concentration of parameters, the discharge would cause the stream at critical flows to violate water quality standards. An example of this might be ammonia permit violations from a sewage treatment plant.

- Waterbodies may be assessed as impacted by pathogens based on factors other than recent in-stream data if in the professional judgement of the assessment staff, there is a high likelihood that the water quality standard is being violated. This type evidence might include the presence of sludge banks, failing animal waste lagoons, chronically inadequate treatment at domestic wastewater plants, and collection system overflow reports.

- Streams or lakes with legacy chemicals should be assessed as impacted for the recreational use if a fishing advisory is present, even if recent tissue data are not available. Parameters identified as impaired should be the ones upon which the advisory is based.

Limitations Placed on the Category "Evaluated Impaired Based On Factors Other Than Recent Chemical, Bacteriological, or Benthic Data."

- Generally, in the absence of data, waterbodies previously assessed as impacted must remain assessed as impacted. However, possible exceptions might be the moving of a discharge or bypass point from a stream or the closing of a diary that was the only pathogen source within a watershed. These situations will be considered on a case by case basis.

- Waterbodies evaluated as impacted by chemical parameters or pathogens one cycle must be a high priority future sampling location.

b. Identification of Threatened Waterbodies

When water quality data can be used to establish a trend that indicates that a water quality criterion is likely to be exceeded in the near future, that stream will be identified as threatened by the specific pollutants and included in the 303(d) List.

c. Identification of Assessment Category

Tennessee uses the process and categories recommended by EPA. Waterbodies impaired or threatened by one or more pollutant are placed in one of the following categories. Note that individual impaired streams can contain pollutants in more than one category (under Category 4 or 5), especially if a TMDL has been for some pollutants, but not others.

Category 1 waters are **fully supporting** of all designated uses. These streams, rivers, and reservoirs have been monitored and meet the most stringent water quality criteria for all designated uses for which they are classified. The biological integrity of Category 1 waters is favorably comparable with reference streams in the same subecoregion and pathogen concentrations are at acceptable levels.

Category 2 waters are **fully supporting** of some designated uses, but have not been assessed for all uses. In many cases, these waterbodies have been monitored and are fully supporting of fish and aquatic life, but have not been assessed for recreational use.

Category 3 waters are **not assessed** for any use due to insufficient or outdated data. However, streams previously identified as impaired are not moved to this category simply because data are old.

Category 4 waters are **impaired**, but a TMDL has been completed or is not required. Category 4 has been further subdivided into three subcategories.

Category 4a pollutants impaired waters have already had all necessary TMDLs developed and approved by EPA. (Note: if not all TMDLs have been completed for the impaired segment, the segment remains in Category 5.)

Category 4b specific pollutants in impaired waters do not require TMDL development since “other pollution control requirements required by local, State or Federal authority are expected to

address all water-quality pollutants" (EPA, 2003). An example of a 4b stream might be where a discharge point will be moved in the near future to another waterbody with more assimilative capacity.

Category 4c impaired waters in which the impacts are not caused by a pollutant (e.g., flow alterations).

Category 5 waters have been monitored and found to not meet one or more water quality standards. These waters have been identified as **not supporting** one or more designated uses. Category 5 waterbodies are moderately to highly impaired by pollutants and need to have TMDLs developed. Category 5-Alt is reserved for those Category 5 waters for which an alternative plan in advance of a TMDL has been accepted by EPA. All Category 5 waters are included in the 303(d) List. The current 303(d) list may be viewed at http://www.tn.gov/environment/article/wr-wq-water-quality-reports-publications

d. TMDL Prioritization

It should be noted that TMDL priorities are parameter specific and methodologies have not yet been developed for all substances or conditions. Thus a stream that has multiple causes of impairment may be high priority for one cause, but low priority for another.

HIGH (H) Tools are available to produce the TMDL and the stream is in one of the watersheds being studied in the next two years. The TMDL will be produced in the next two years.

MEDIUM (M) Tools are available to produce the TMDL, but the stream is not in a watershed being studied in the next two years. TMDL will be produced in the next five to eight years.

LOW (L)	Tools are not currently available to produce the TMDL and the stream is not in the watershed being studied in the next two years. TMDLs will be produced in the next 8-13 years. Alternatively, a Low Priority may indicate that the segment is a TMDL Vision priority and an alternative restoration strategy will be produced in advance of a TMDL.
NOT APPLICABLE (NA)	4a - A TMDL has already been completed, submitted to EPA, and approved by EPA. 4b - A TMDL is not needed because a different type of control strategy is in place which will bring about compliance with the criterion in a reasonable amount of time. 4c – The impact to the stream is not being caused by a pollutant.

e. Public Participation

Each year, prior to the start of the assessment process for that state fiscal year, the Division of Water Resources issues a public notice requesting that citizens, municipalities, the regulated community, academia, and other entities submit data they would like to have considered in the assessment process. The watersheds targeted for reassessment under the Watershed Approach are identified, but data from other watersheds are also accepted.

Potential submitters are reminded that the agency has data quality objectives. Submissions that do not meet these objectives may be used as a screening tool rather than to assess streams. Data are requested in electronic format and must provide location information so that we can tell where they were collected.

In the same time period, individual letters are sent to long-term cooperating agencies requesting data for the targeted watersheds. Agencies sent letters include the Tennessee Valley Authority and U.S. Army Corps of Engineers.

Odd-numbered year water quality reassessments are not published until the following even-numbered year. In even-numbered years, a draft List of Impaired Waters is published and a

public notice is issued to make the public aware of its availability to be reviewed. Individual 303(d) Listings, the identification of assessment category, and TMDL prioritization are all issues in which the public is invited to comment. Following the completion of the review period, comments will be addressed and the 303(d) List, assessment categories, and TMDL priorities will be revised as appropriate.

Even outside of the formal 303(d) review process, the division is always willing to discuss water quality assessments.

f. Resolution of Disputed Assessments

At times, entities submitting data will also provide their thoughts about what the assessment decision should be. The division appreciates the sharing of these thoughts, but cannot be bound by them, since our responsibility is to assess streams based on our analysis of the data and understanding of SOPs, policies, rules, and regulations.

When entities and the division have data in the same segment during the same time period, in many cases the data will agree. In cases in which they do not, more weight will be given to the division's data in assessment decisions. Additionally, the division reserves the right to wait for additional data or assessment cycles to make a change of a stream's existing assessment when data are borderline. Since short-term ambient conditions can sometimes give the false impression of a water quality trend, we risk having segments bounce on and off the List if we over-react to data outliers.

Unlike permit limits or enforcement actions, water quality monitoring, assessment, and data reporting results are responsibilities of the Commissioner not subject to appeal to the Tennessee Board of Water Quality, Oil and Gas. Since the List must be approved by EPA, disputes that cannot be resolved on the state level can be elevated to EPA for their impartial review. Following the publication of the Proposed Final Version of the List of Impaired Waters, EPA should be notified as soon as possible that their review of an assessment decision is being requested.

V. REFERENCES

American Public Health Association, American Waterworks Association, Water Environment Federation. 1995. Part 9000, Microbiological Examination in *19th Edition, Standard Methods for Examination of Water and Wastewater.* American Public Health Association. Washington, D.C.

Arnwine, D.H., J.I. Broach, L.K. Cartwright and G.M. Denton. 2000. *Tennessee Ecoregion Project.* Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Arnwine, D.H. and G.M. Denton. 2001. *Development of Regionally-Based Numeric Interpretations of Tennessee's Narrative Biological Integrity Criterion.* Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Arnwine, D.H. and G.M. Denton. 2001. *Habitat Quality of Least-Impacted Streams in Tennessee.* Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable River*s. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington D.C.

Denton, G.M., D.H. Arnwine and S.H. Wang. 2001. *Development of Regionally-Based Interpretations of Tennessee's Narrative Nutrient Criterion.* Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Tennessee Department of Environment and Conservation. 2001. *Monitoring to Support TMDL Development*. Division of Water Pollution Control, Watershed Management Section. Nashville, TN

Tennessee Department of Environment and Conservation. 2010. *Quality System Standard Operating Procedure for Periphyton Stream Surveys.* Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Tennessee Department of Environment and Conservation, Water Quality Control Board. 2013. *Rules of the Tennessee Department of Environment and Conservation*, Chapter 0400-40-03, General Water Quality Criteria. Tennessee Department of Environment and Conservation. Nashville, TN.

Tennessee Department of Environment and Conservation, Water Quality Control Board. 2013. *Rules of the Tennessee Department of Environment and Conservation,* Chapter 0400-40-04, Use Classifications for Surface Waters. Tennessee Department of Environment and Conservation. Nashville, TN.

Tennessee Department of Environment and Conservation. 2014. *2014 305(b) Report The Status of Water Quality in Tennessee.* Division of Water Resources. Nashville, TN.

Tennessee Department of Environment and Conservation. 2016. *2016 303(d) List.* Tennessee Department of Environment and Conservation, Division of Water Resources. Nashville, TN

Tennessee Department of Environment and Conservation. 2017. *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys.* Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, TN.

Tennessee Department of Environment and Conservation. 2017. *Tennessee Division of Water Resources Surface Water Monitoring and Assessment Program Plan.* Tennessee Department of Environment and Conservation, Division of Water Resources. Nashville, TN.

Tennessee Department of Health. 2017. *Environmental Sample Collection and Handling Information from the Tennessee Directory of Laboratory Services.* Tennessee Environmental Laboratories. Nashville, TN.

Tennessee Department of Health. 2017. *Laboratory Seminar for Field Environmentalists.* Tennessee Environmental Laboratories. Nashville, TN.

Tennessee Secretary of State. 1999. *The Tennessee Water Quality Control Act of 1977 including the 1998 amendments.* Nashville, TN.

United States Congress. 2000. *Federal Water Pollution Control Act As Amended Through P.L. 109-308.* 33 U.S.C. 1251 et. seq. Washington D.C.

United States Environmental Protection Agency. 2000. *Guidance for Data Quality Assessment Practical Methods for Data Analysis* (EPA QA/G-9, 2000)

United States Environmental Protection Agency. 2002. *Ecological Assessment Standard Operating Procedures and Quality Assurance Manual.* Region 4. Atlanta, Georgia.