2016 Guidance for Assessing and Reporting Surface Water Quality in Texas (August 6, 2019)

In Compliance with Sections 305(b) and 303(d) of the Federal Clean Water Act

Prepared by
Surface Water Quality Monitoring Program
Monitoring and Assessment Section
Water Quality Planning Division

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List of Abbreviations Used in the Guidance

ALM	aquatic life monitoring
ALU	aquatic life use
AU	assessment unit
AVS	acid volatile sulfide
BMP	Best Management Practices
BPJ	Best Professional Judgement
CFR	Code of Federal Regulation
CFS or ft^3/s	cubic feet per second
Chl-a	chlorophyll *a*
CI	confidence interval
CRP	Clean Rivers Program
CV	coefficient of variability
CWA	Clean Water Act
DMC	Drought Mitigation Center
DO	dissolved oxygen
DSHS	Texas Department of State Health Services
DSI	drought severity index
EPA	United States Environmental Protection Agency
GLO	Texas General Land Office
IBI	index of biotic integrity
IP	implementation plan
IR	integrated report
LOQ	limit of quantitation
LOS	Level of Support
LOE	line of evidence
m	meter
MCL	maximum contaminant level
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
mg/L	milligrams per liter
mL	milliliter
MTBE	methyl tert butyl ether
NDMC	National Drought Mitigation Center
NH_3-N	ammonia-nitrogen
NHD	National Hydrography Dataset
NELAP	National Environmental Laboratory Accreditation Program
OP	orthophosphorus
PAH	polycyclic aromatic hydrocarbin
PCB	polychlorinated biphenyl
PECs	probable effects concentrations
PELs	probable effects levels
PWS	public water supply
QAPP	quality assurance project plan

List of Abbreviations Used in the Guidance (continued)

7Q2	seven-day, two-year low flow
RBA	rapid bioassessment protocol
RUAA	recreational use attainability analysis
RWA	receiving water assessment
SEL	severe effects level
SSMD	single sample maximum density
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TIE	toxicity identification evaluation
TMDL	total maximum daily load
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSI	Trophic State Index
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWC	Texas Water Code
TWDB	Texas Water Development Board
USGS	United States Geological Survey
UAA	use attainability analysis
WAP	Watershed Action Planning
WPP	Watershed Protection Plan

Chapter 1

Summary of the Reporting Approach

Introduction

In compliance with Sections 305(b) and 303(d) of the Federal Clean Water Act (CWA), the Texas Commission on Environmental Quality (TCEQ) evaluates water bodies in the state and identifies those that do not meet uses and criteria defined in the *Texas Surface Water Quality Standards* (TSWQS). Guidance developed by the Environmental Protection Agency (EPA) directs each state to document and submit the results of its evaluation to the EPA biennially, in even-numbered years (CWA 306(b)(1)). The TCEQ publishes the results on its Web site as the *Texas Integrated Report of Surface Water Quality (Integrated Report)* prepared by the TCEQ and submitted biennially to the EPA.

The Integrated Report describes the status of water quality in all surface water bodies of the state that were evaluated for a given assessment period. The TCEQ uses data collected during the most recent seven to ten-year period. The data are gathered by many different organizations that all operate according to approved quality control guidelines and sample collection procedures. The quality of waters described in the Integrated Report represents a snapshot of conditions during the specific time period considered in the assessment.

Assessment Guidance

Water quality is evaluated according to this assessment guidance. The guidance is developed by staff of the TCEQ with input through an advisory stakeholder process. Individuals representing diverse organizations and interests are invited to participate in the revision of current guidance and to develop, review, and comment on new draft guidance every few years. The advisory group includes but is not limited to, state agencies, environmental consultants, river authorities, environmental groups, industry, agricultural interests, and municipalities. The TCEQ's guidance for assessing water bodies is documented in Chapter *2- General Assessment Methodology* and *Chapter 3 - Assessment of Beneficial Uses*.

After the evaluation is complete, all water bodies are placed into one of five categories. See Chapter 5 - *Categorizing Water Quality Conditions for Management Action* for details on the categories and the management strategies the state employs for each.

The categories indicate the status of water quality. Category 5 constitutes the 303(d) List of Impaired Waters, for which total maximum daily loads (TMDLs) or other management measures may be required. The TCEQ holds a public comment period to solicit input from the public and stakeholders on the Integrated Report, and then prepares a schedule that identifies the TMDLs the TCEQ expects to develop and submit to the EPA within the next two years. The TMDL schedule is submitted to the EPA as part of the Integrated Report.

Development of the Integrated Report and List

Development of the Integrated Report includes the following basic steps:

- Active solicitation and selection of acceptable data and information to develop the Integrated Report.
- Assessing the data and information to determine which water bodies are not meeting TSWQS (See Chapters 2 and 3).
- Preparing and categorizing the draft Integrated Report.
- Receiving public comment on the draft Integrated Report.
- Revising and finalizing the assessment and list based on new information and comments from the EPA and the public.
- Developing a schedule for TMDLs for Category 5 water bodies.

- Present draft Integrated Report at a TCEQ Agenda for Commission Approval.

Data and Information Used

As required by CWA Section 303(d) and CFR Section 130.7(b)(5), the TCEQ considers all existing and readily available water quality-related data and information during the development of the Integrated Report. The TCEQ solicits data and information primarily through established public outreach mechanisms of the Texas Clean Rivers Program (CRP), including steering committee meetings, public meetings, publications, and by posting drafts of the Integrated Report on the TCEQ website.

The TCEQ and the EPA recognize that there are some boundaries that must be established for the data and information ultimately used for listing. These boundaries are:

- **Time limitations**. In most circumstances, data collected prior to the most recent seven-to-ten-year assessment period do not adequately reflect current conditions.
- **Data quality**. Given the regulatory implications associated with the use of water quality data, the TCEQ requires the highest quality data feasible. Data collected using consistent and scientifically rigorous water quality sampling methods ensures a valid outcome.

Data must therefore meet minimum quality assurance and quality control requirements established by the TCEQ. Data that are not collected under a TCEQ-approved quality assurance plan, if submitted, must be accompanied by documentation of quality assurance for evaluation by TCEQ water quality staff. Data without appropriate quality assurance documentation will be considered as anecdotal evidence to support or refute assessment results, but will not be used in statistical evaluations.

On July 1, 2008 requirements regarding laboratory accreditation went into effect. Data analyzed after that must comply with the National Environmental Laboratory Accreditation Program (NELAP) standard to be used to generate the Integrated Report (See 30 TAC, Chapter 25).

- **Data format**. All data must be in a form that does not require extensive data format manipulation to be useable for assessment. TCEQ provides guidance and support to monitoring entities that allow them to submit data in an appropriate and consistent format.

In order to increase the data available to the TCEQ for water quality assessment purposes, TCEQ staff work closely with local and regional agencies and other interest groups to develop and implement data collection procedures under an established quality assurance and quality control program.

Readily Available Data and Information

Readily available data are defined for the purposes of the Integrated Report as:

- **Routine surface water quality data stored in the TCEQ Surface Water Quality Monitoring Information System (SWQMIS) database**. These data are used to conduct the assessment and to compile the draft Integrated Report. This database consists of water quality data collected by the TCEQ, the U.S. Geological Survey (USGS), the Texas Department of State Health Services (DSHS), the Texas Parks and Wildlife (TPWD), Texas State Soil and Water Conservation Board (TSSWCB), and CRP planning agencies and their associated partners.
- **Routine data and information obtained from other sources**.
  - Fish consumption advisories, aquatic life closures, and oyster waters closures issued by the DSHS.
  - Recreational beach advisory information provided by the Texas General Land Office (GLO).
  - Drought information from the National Drought Mitigation Center (DMC)

Other Data and Information

To refine the draft Integrated Report, the TCEQ relies on formal public comment to solicit additional data and information that support the listing process. These additional data and information can be used to support or refute results of the initial data assessment and to revise the category of water bodies. These data and information may also be used to direct future water quality monitoring activities. In all cases, the value and accuracy of these data are determined by TCEQ water quality staff.

Water Quality Data Collected for Watershed Protection Plans and TMDL Implementation Plans

By definition, a watershed represents an area, peripherally bounded by a divide which causes water to drain to a particular watercourse or body of water. Water quality in the lower reaches of a watershed is directly influenced by the physical characteristics and anthropogenic activities in the upstream portions. Hence, water quality impairments in downstream assessment units are influenced by conditions and activities that occur in the upper subwatershed and contributing tributaries. The TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB) recognize the importance of this connectivity and support the development and restoration plans (Watershed Protection Plans (WPP) and TMDLs/TMDL Implementation Plans), as a means to address water quality impairments identified in the Integrated Report. WPP's and TMDLs include detailed objectives, strategies, and measurable benchmarks designed to improve water quality in impaired assessment units (AUs). Typically, water quality monitoring in contributing tributaries is a critical component of a WPP or a TMDL and samples are collected to address a number of objectives, including:

- Quantifying concentrations of pollutants which can be used to support modeling activities;
- Identifying contributing sources of pollutants;
- Tracking the effectiveness of best management practices.

These data are an important component of effective implementation and are used to direct efforts designed to contribute to the overall restoration of water quality within watersheds (impaired AUs as well as contributing tributaries). Considering these objectives, the assessment of data collected in the contributing tributaries located in subwatersheds would be of limited utility for determining use attainment in the impaired AU(s). Identification of additional impairments in these contributing tributaries based on these data is not likely to lead to increased effectiveness of the overall restoration plan. Thus, water quality data collected from contributing tributaries as part of WPP and TMDL activities for source identification, model development or BMP effectiveness will typically be excluded from the assessment.

Categorizing Water Bodies

Chapter 5 provides an in-depth discussion of categories assigned to segments and the management strategies associated with each category. To summarize, one of five categories is assigned to each impairment parameter in each segment that affects the use of the water body as defined in the TSWQS. When a segment falls into more than one category because of different impairments, its overall category is the highest numbered category assigned to any one use.

- **Category 1**. Attaining all water quality standards and no use is threatened.
- **Category 2**. Attaining some water quality standards and no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.
- **Category 3**. Insufficient data and information are available to determine if any water quality standard is attained.
- **Category 4**. Water quality standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.
    - **Category 4a**. TMDL has been completed and approved by EPA.
    - **Category 4b**. Other pollution control requirements are reasonably expected to result in the

attainment of the water quality standard in the near future.
    - **Category 4c**. Nonsupport of the water quality standard is not caused by a pollutant.
- **Category 5**. The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.
    - **Category 5a**. A TMDL is underway, scheduled, or will be scheduled.
    - **Category 5b**. A review of the water quality standards for the water body will be conducted before a management strategy is selected.
    - **Category 5c**. Additional data and information will be collected or evaluated before a management strategy is selected.

Removing a Water Body from the 303(d) List

Water bodies are removed from the 303(d) List (Category 5) for any one on the following seven reasons:

- **Standards are met**. Additional monitoring data demonstrate that a water body meets applicable water quality standards.
- **Errors in listing**. Errors in the data or procedures used to list the water body invalidate the original basis for listing.
- **New procedures used**. Procedures used by the state to assess water quality monitoring data are routinely improved and revised. In the absence of recent data, the original data set for a listed water body may be reassessed with more accurate procedures and be found to attain the standard or criteria. The strength of the data set and quality of the water must also meet the requirement for delisting using revised methods.
- **Revised standards**. Water quality standards and criteria have been revised, and a listed water body attains the new standards or criteria.
- **TMDL approval**. The EPA approves a TMDL designed to attain water quality standards for a water body which is moved to Category 4a.
- **Water body expected to meet**. Based on water quality controls in place (other than a TMDL), attainment of the water quality standards is expected in the near future Category 4b.
- **Impairments not caused by a pollutant**. New information demonstrates that the impairment is not caused by a pollutant, and that water quality conditions cannot be changed by the allocation and control of pollutants through the TMDL process Category 4c.

Note that for Category 4 impairments, because there are water quality controls in place, or the non-support is not amenable to TMDL processes, impairments are removed from this category when water quality standards are attained.

Public Participation

The draft Integrated Report, including the 303(d) List, is posted on the TCEQ website. Stakeholders and the public are alerted of opportunities to comment through a notice of publication in the Texas Register. Through the CRP, the TCEQ has contracted with river authorities or other local water quality management entities in each major river basin to engage a diverse stake holder group. The TCEQ distributes notification of opportunities to comment through the stakeholder process.

Comments, data, and information must be submitted during the formal public comment period in written form, via letter, facsimile transmission, or e-mail, to ensure an accurate record of the concerns of the person or group submitting them. Comments received during the comment period are considered in the development of the draft Integrated Report. Those who comment will not be notified that their comments were received.

A summary of all comments received during the formal public comment period, along with the TCEQ's response to those comments, are published with the draft Integrated Report on the TCEQ website.

Preparation of the Schedule for TMDL Development

In compliance with CFR 130.7(b)(4), the TCEQ prepares a schedule for the TMDLs that TCEQ expects to develop and submit to the EPA within the next two years. The TMDL schedule is submitted to the EPA as part of the draft Integrated Report. Additional factors, not known at the time of the schedule development, may alter the time required to complete the TMDL and hence the date of submission to EPA. The two most significant factors are a change in funding availability, and a change in the degree of complexity of a TMDL.

Preparation of the Final 303(d) List

During the draft Integrated Report comments period, TCEQ staff evaluates the data and information received and responds to requests for information. TCEQ staff modify the Integrated Report, including the 303(d) List) as appropriate, considering applicable guidance and legal requirements. This may result in:

- Removal of a water body or a parameter from the 303(d) List.
- Addition to the 303(d) List of water bodies or parameters not on the draft list.
- Changes in category.

Upon Commission approval at a TCEQ agenda, the draft 303(d) List, the TMDL Schedule, and supporting materials and summary documents are submitted to the EPA. The supporting materials include, but are not limited to:

- The most recent Guidance for Assessing and Reporting Surface Water Quality in Texas.
- A list of water bodies or pollutants removed from the previous list, along with reasons for delisting.
- A list of water bodies or pollutants added to the 303(d) List.
- A summary of public comments on the draft 303(d) List, and the TCEQ=s response to the comments.
- A summary for each water body describing the status of use support and assessment information.
- A list of water bodies with Concerns for Use Attainment or Screening Levels.

The final submission is also available for public review on the TCEQ website, < **http://www.tceq.texas.gov/waterquality/assessment/305_303.html** > and upon request by telephone, mail, or e-mail.

Chapter 2

General Assessment Methodology

Introduction

The TCEQ administers water quality management programs with the goal of protecting, maintaining, and restoring Texas water resources including the support of aquatic life, recreation, fishing, and drinking water supplies. The *Texas Surface Water Quality Standards* (TSWQS) reflect the regional and geologic diversity of the state by dividing major river basins, bays, and estuaries into defined segments (referred to as classified segments). Appropriate water uses-such as aquatic life, recreation, or oyster waters-are designated for each of the classified segments. Site-specific criteria are developed for classified segments to evaluate general uses-water temperature, pH, chloride, sulfate, and total dissolved solids (TDS). For general uses, site specific criteria apply to classified segments but not to unclassified water bodies.

Numerical criteria (water quality parameter concentrations) established in the TSWQS provide a quantitative basis for evaluating use support and for managing point and nonpoint loadings in Texas surface waters. These criteria are used as maximum or minimum instream concentrations that may result from permitted discharges and nonpoint sources. Procedures for assessing instream water quality against numerical criteria are specified in the TSWQS in addition to this guidance. The implementation of this guidance and each assessment decision may at times involve best professional judgment in the application of the water quality standards. This will use expert opinion and decisions based on available data and site-specific conditions.

The TSWQS also contain narrative criteria (verbal descriptions) that apply to all waters of the state and are used to evaluate support of applicable uses. Narrative criteria include general descriptions, such as the existence of excessive aquatic plant growth, foaming of surface waters, taste- and odor-producing substances, sediment build-up, and toxic materials. Narrative criteria are evaluated with screening levels, if they are available, as well as other information, including water quality studies, existence of fish kills or contaminant spills, photographic evidence, and local knowledge. Narrative criteria, a form of general criteria, are applied to all classified and unclassified waters. The assessment methods for determining compliance with the narrative criteria are not based on adopted numeric criteria but rather an assessment practice prescribed in this guidance. All available lines of evidence must be considered when making listing decisions, including professional judgment.

Instream concentrations of some parameters such as nutrients and chlorophyll *a*, toxic substances in sediment, and toxic substances in fish tissue are useful in identifying water quality concerns and in evaluating the causes of nonsupport of the narrative standards. The screening levels (instream concentrations) for these parameters establish targets that can be directly compared to monitoring data. The screening levels are statistically derived from long-term monitoring data or published levels of concern. Recent monitoring data are compared to the screening levels to identify areas where elevated concentrations are causes of concern.

Summary of Method Changes for 2016

Nutrient Assessments

In 2013, the EPA approved 39 of 75 chlorophyll *a* criteria for reservoirs adopted by TCEQ in the 2010 revisions to the Texas Surface Water Quality Standards. The TCEQ have developed procedures to establish a consistent framework to evaluate reservoirs with or without EPA-approved chlorophyll *a* criteria. To accomplish this, TCEQ developed a protocol to assess

numeric nutrient criteria for chlorophyll *a*, and developed an alternative protocol to identify concerns for nutrients as part of the IR. Potential impacts to existing, designated, presumed or attainable uses from excessive nutrients are evaluated in accordance with the narrative and numeric criteria for nutrients in the TSWQS. These criteria are protective of multiple uses such as contact recreation, aquatic life, and public water supplies. To better assess whether a reservoir is meeting existing, designated, presumed or attainable uses in relation to nutrients, more parameters must be considered. Indicators of biological response include Secchi depth, dissolved oxygen, and the primary response variable of chlorophyll *a*. Causative parameters evaluated as potential stressors include TN and TP. For the 2016 IR the TCEQ is proposing a line of evidence approach for nutrient assessment in lakes and reservoirs involving the use of numeric translators of narrative criteria as "thresholds," in addition to numeric chlorophyll *a* criteria approved by EPA. Multiple lines of evidence corroborate adverse nutrient conditions before a water body will be identified as impacted, with chlorophyll *a* serving as a primary indicator. This methodology provides a more robust assessment of reservoir conditions, and increases certainty that elevated nutrients are impacting other factors like water clarity, increased algae biomass and dissolved oxygen attainment.

Consideration of Drought

Several provisions in the Texas Surface Water Quality Standards allow for the consideration of natural phenomena and representativeness when applying water quality standards and making attainment determinations. These provisions are as follows:

- §307.4(a): "General criteria do not apply to those instances when surface water, as a result of natural phenomena, exhibit characteristics beyond the limits established by this section."
- §307.6(a): "With the exception of numeric human health criteria, toxic criteria do not apply to those instances where surface water, solely as a result of natural phenomena, exhibit characteristics beyond the limits established by this section."
- §307.7(a): "Site-specific criteria do not apply to those instances when surface waters exceed criteria due to natural phenomena.", and
- §307.9(b): "Samples to determine standards attainment in ambient water must be representative in terms of location, seasonal variations, and hydrologic conditions."

The TCEQ and stakeholders have previously considered the impact of drought on water quality in monitoring and assessment activities. In large portions of Texas, the period of record for the 2016 IR was in some category of drought status according to the National Drought Mitigation Center. For the 2016 IR, the TCEQ is proposing a framework to consider information reported by the U.S. Drought Monitor and hydrologic data to evaluate impacts from the drought on water quality in reservoirs.

Spatially Representative Data

Geographic Areas for Assessment

The term "water body" is used in a non-specific way to refer to a stream, reservoir, or estuary. A water body is generally divided into one or more segments. The Brazos River, for example, is divided into 48 segments. Classified segments are "water bodies" defined in Appendix A of the TSWQS. These segments have designated uses and water quality criteria. Each segment is given a number which identifies the river basin and segment. For example, the Brazos River Tidal segment number (SEG_ID) is 1201. The next most upstream Segment is 1202.

Water bodies not defined in Appendix A of the TSWQS are considered unclassified segments. For the purpose of the assessment, unclassified segments not in the TSWQS will be referenced to the classified segments described in the Appendix A. Each unclassified water body is given a number

which associates it to the classified segment with a letter designation. For example, 1201A, is a small stream which flows into Segment 1201 of the Brazos River. This also applies to certain unclassified water bodies given site specific descriptions and criteria and listed in Appendix D of the TSWQS. These water bodies follow the same naming convention of other unclassified water bodies. The site-specific descriptions often make up only a portion of a water body. Further delineation of these Appendix D water bodies for the assessment is defined in the section on *assessment units (AUs)*.

Considering the Representativeness of Stations

Water quality standards and criteria are set to protect the attainable uses for each water body. Sample sites used for ambient water quality monitoring are located in areas determined to be reasonably characteristic of major hydrologic portions of the water body and where the criteria are expected to be attained. Representative sites for stream sample collection should be placed in areas of good flow or circulation. For reservoirs, sites should be located downstream of headwaters and away from shorelines and isolated coves. Reservoir arm sites should be located nearer the main body of the water body than the riverine tributary areas. For biological sampling, all habitat types are sampled for characteristics of the fish community, while optimal available habitat, for example cobble substrate riffles, are sampled for benthic macroinvertebrates. The assessor can use judgment in determining if sites are representative of an assessment area and if it is appropriate to apply criteria to the data. Note that the TSWQS 307.9(b) states, "Representative samples to determine standards attainment will be collected at locations approved by the Agency. Samples collected at non-approved locations may be accepted at the discretion of the Agency."

Assessment Units

For the purpose of the assessment, use support is reported at both the segment and sub-area levels. Each assessment sub-area is known as an AU which is defined as the smallest geographic area of use support reported in the assessment. Support of criteria and uses are evaluated for each AU. To address water quality regulatory activity such as permitting, standards development, and remediation, use support information applies to the AU level. The 303(d) List is reported at the level of the AU for each water body.

An AU often consists of a single representative station used to characterize standards attainment. The data from multiple stations in a single AU can be used in the assessment based on assessor judgment.

Each AU within a water body segment is given a number such as AU_01. A segment may consist of one or more AUs.

There are two general types of AUs:

- **Primary segment AUs**. AUs which are hydrologically defined: They can be the entire segment or parts of the segment, but the cumulative size of the entire primary segment AUs must add up to the total size of the segment. The numbering convention consists of the segment number followed by the AU number (0101_01, 0101_02).
- **Special purpose AUs**. AUs which are defined by available information such as oyster water maps, fish advisories, or special assessments (such as sediment or fish surveys) and may cover all or part of the segment. Numbering convention for special purpose AUs are,
  - Oyster waters—2439OW_01, 2439OW_02
  - Fish advisory—2451FA_01
  - Special assessments (sediment, fish survey)—2422SA_01, 2422SA_02
- The special purpose AUs assigned to swimming beaches designated by the Texas Beach Watch Program do not follow the convention of the other special purpose AUs. Recreational beach AUs are assigned by segment number and beach name within the segment. For example, 2501BC is the segment identifier for Brazoria County beaches located in Segment 2501. Each

beach is also assigned an AU number. For example, 2501BC_01 is Follets Island, 2501BC_02 is Quintana, and 2501BC_03 is Surfside. Since these AUs are linear, they do not add up to the entire segment size.

All assessment methods and use attainment status are reported for each of the primary segment AUs. In some instances, the use and assessment method summary statistics will be calculated across the entire segment, for example, some general uses (chloride, sulfate, TDS). This same information will be reported for each of the primary AUs (the results will be the same for each of the AUs).

More than one AU type can describe the same parts of a segment. For example, the entire segment can be made up of four smaller AUs—AU_01, AU_02, AU_03, and AU_04. Or, 1403SA_01 can be a sediment survey that applies to the lower part of the segment and includes primary AU 1403_03 and 1403_04. The results of the sediment survey will be repeated for each of these primary AUs (_03 and _04).

AUs do not have to be contiguous; for example, the various marshy fringe areas of a lake can make up one of the primary AUs.

For fish consumption and oyster water assessments, the stream length or area defined as the AU are determined by the information made available by the responsible regulatory entity rather than hydrology. Such information may include oyster water maps, beach advisory days, or fish consumption advisories.

Defining Assessment Units

An AU may have one station, several stations, or no stations if it is in an unmonitored part of the segment. Stations are typically assigned to only one AU within the primary AU type, and do not have to be grouped the same way for special AU types.

An AU can be assessed using only one station that is selected as most representative, or using data combined from several stations.

Improvements have been made to redefine AUs to better represent hydrologically distinct areas of streams, reservoirs, and estuaries. To provide consistency from year to year, the numbering of AUs will be unchanged if boundaries are shifted a little, even if a station is reassigned to an adjacent AU. However, when AUs are combined (because they are not hydrologically distinct areas) or when AUs are split, the description and AU numbering will be changed to better represent the updated assessment area. The National Hydrography Dataset (NHD) is used to georeference the assessment results. In many cases stream paths extend into the upper portions of the watershed. Because TCEQ assesses “water in the state,” as defined in the TSWQS, the TCEQ water programs will identify a regulatory need to define an AU within the context of “waters in the state.”

Stream AUs. The upstream boundary of the most upstream primary AU is based on yield of the upstream watershed or the flow, which may be calculated from watershed size. For classified water bodies, the upper and lower boundaries are defined in the TSWQS. For unclassified water bodies, the upper and lower boundaries are generally based on the NHD. Certain water bodies, or portions of water bodies, are defined in Appendix D of the TSWQS. For streams described in Appendix D, the entire length typically constitutes one AU (see Figure 2.1).

However, if it is evident that hydrology and water quality conditions are different within the area described in Appendix D, based on water quality sampling and flow information, the segment can be split into more than one AU, with the same criteria applied to all AUs (See Figure 2.2).

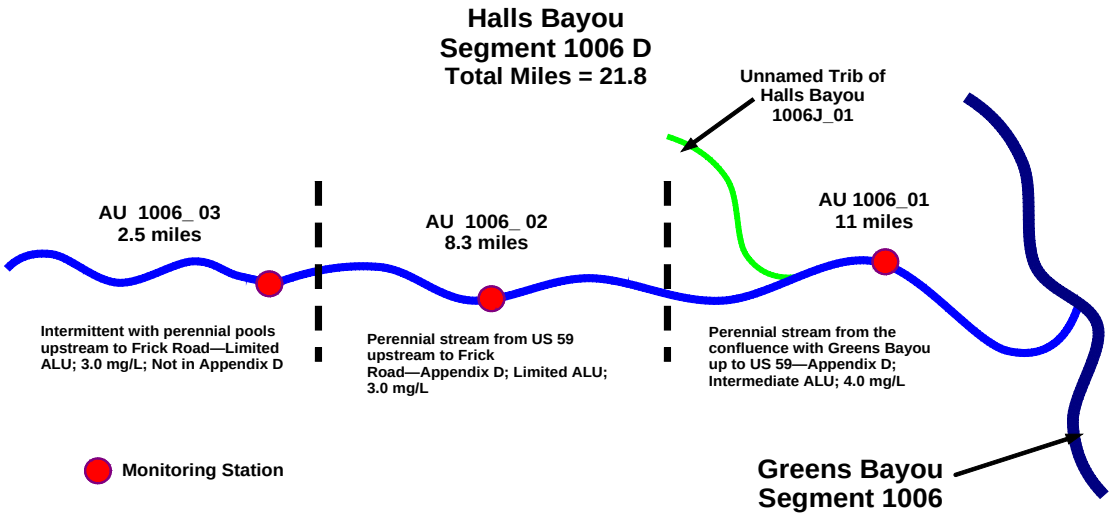

Figure 2.1. A water body divided into three AUs with two defined in Appendix D and one with a presumed Aquatic Life Use (ALU).

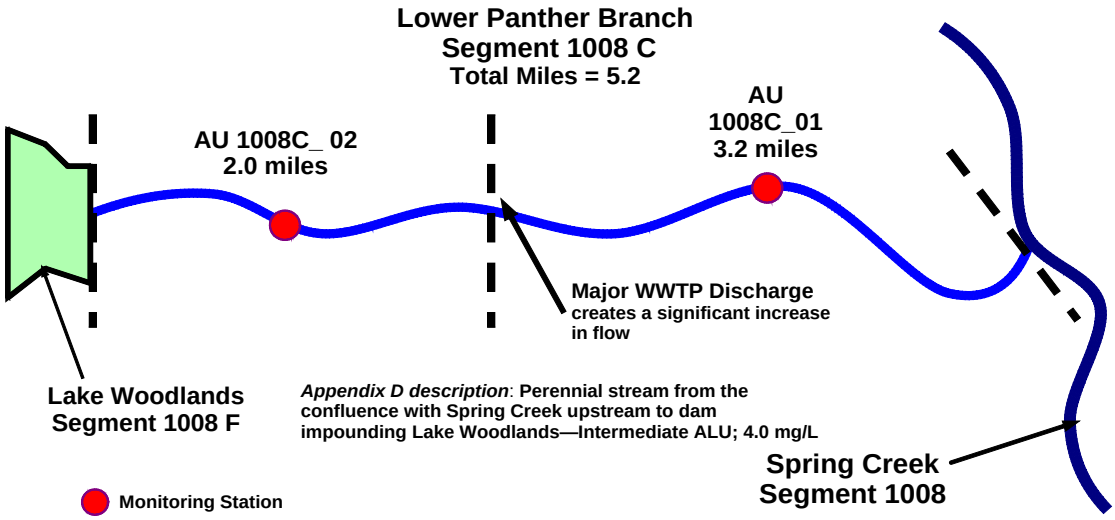

Figure 2.2. Appendix D defined water body divided into two AUs to reflect a significant change in flow.

As a rule of thumb, the boundary of one AU and start of another AU is the point where the flow increases due to a confluence with a tributary or wastewater outfall since that can impact water quality. Tributary inflows that have the potential to influence water quality in the parent segment are typically used to define an AU boundary (see Figure 2.3).

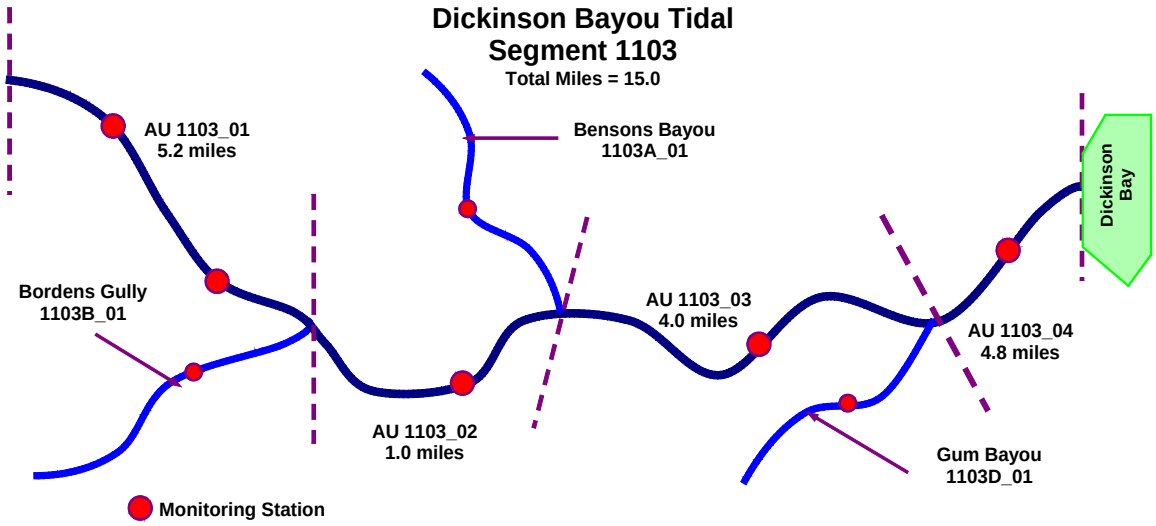

Figure 2.3. Water body divided into four AUs to reflect inflow from water bodies with the potential to influence water quality in the parent segment.

Note: The examples used in Figures 2.1 to 2.3 are based on actual water bodies included in the assessment but may have been modified to illustrate various AU selection scenarios.

As a rule of thumb, stream AUs are no more than 25 miles in length. Because an AU represents an area of similar hydrology, a station located anywhere in the AU ideally represents water quality conditions in the entire AU. Stream stations generally characterize a length of stream both upstream and downstream of the station. This length is about 12.5 miles or half the 25 miles typically represented by an AU. A station can also be located at the lower end of an AU characterizing 25 miles upstream of that point. An AU that includes a station located near the upper end of the boundary is typically avoided. Based on assessor judgment an AU can be longer than 25 miles. This is generally limited to areas where there are no wastewater discharges or tributary inflow and water quality is similar throughout the AU.

Reservoir and Estuary AUs. Primary AUs are defined as hydrologically distinct arms or areas of a reservoir. For most reservoirs distinct AUs will represent the main body near the dam, and in each major arm or the upper part of the reservoir.

To meet the goals of the monitoring program, a reservoir or estuary with more than one AU has at least one AU representing the central area of the water body and one AU for each major tributary arm. The reservoir or estuary can also be divided into AUs at hydrologic constrictions that form distinct coves or sub-bays.

Ideally, each station is at the center of a concentric AU. Tables 2.1 and 2.2 describe the assessment by AUs on reservoirs and estuaries derived from historical practices. Linear distances described for stations may be more or less if there are other stations representing hydrologically distinct areas.

Table 2.1. Assessment Units for Reservoirs

Size (acres)*	Number of AUs	Typical Linear distance described by station (miles)**
3000 or less	1 or more	1
3000 - 6000	2 or more	2
6000 - 10000	3 or more	3
10000 or greater	4 or more	3

* 3000 acres/640 equals 4.7 sq mi; ** radius of the assessment area

Table 2.2. Assessment Units for Estuaries

Size (square miles)	Number of AUs	Typical Linear distance described by station (miles)**
< 3	1 or more	1
3- 10	2 or more	2
10 - 50	4 or more	3
> 50	5 or more	3

** radius of the assessment area

Depth of Water Quality Measurements

Surface measurements—typically collected at a depth of 0.3m from the water surface—are considered the most appropriate for consistency with water quality standards and are generally used for assessing the following: water temperature, chloride, sulfate, TDS (or specific conductance), dissolved oxygen, nutrients, chlorophyll *a*, *E. coli*, and Enterococci. Samples collected by the USGS that are *composited* over depth (using equal-discharge-increment or equal-width-increment methods) may also be utilized in an assessment. In deep streams, reservoirs, estuaries, and the Gulf of Mexico, dissolved oxygen (DO) and pH measurements made in profile over the entire *mixed surface layer* may also be used with the exception of bacteria and temperature. For toxic substances in water, individual surface grab samples are evaluated. If samples are available for the same day at multiple depths, criteria expressed as averages are evaluated as surface-to-bottom composite samples.

Determination of the Surface Sample, Profiles, and Mixed Surface Layer

The surface sample is typically collected at 0.3m, or is the shallowest sample, not deeper than 1.5 m. Water column profiles are required in water bodies with depths greater than 1.5 meters and are taken at consistent depth intervals (depth intervals determined by the total water depth). The profile measurements should be made within one hour of the collection time of the water sample. Procedures for measuring depth or vertical profiles in reservoirs, deep rivers, bays, and barge and ship channels greater than 1.5 m in depth are outlined in the most recent version of Chapter 3 of the *SWQM Procedures Volume 1: Physical and Chemical Monitoring Methods*.

If the mixed surface layer is used, the following guidelines exist for each water body type: For reservoirs, the *mixed surface layer* in a water column profile is defined as the portion of the water column from the surface to the depth at which water temperature decreases more than 0.5 degrees

Celsius. DO (mean of measurements) and pH (median of measurements) criteria apply to the entire mixed water column when a profile of measurements is reported and the water column is not stratified, or only to measurements made in the mixed surface layer if the water column is stratified. In rare instances, large declines in DO or pH may occur with depth within the mixed surface layer defined by water temperature, or a superheated layer at the surface may constrict the mixed surface layer by this definition. Best professional judgment may then be used to determine which DO and/or pH measurements are assessed from the mixed surface layer. The information considered for this decision will be recorded and made available in the assessment files.

The mixed surface layer for tidally influenced water bodies is defined as the portion of the water column from the surface to the depth at which the specific conductance is 6,000 µmhos/cm greater than the conductance at the surface. DO and pH criteria apply to the entire mixed water column when the water column is not stratified, or only to measurements made in the mixed surface layer if the water column is stratified. On occasion, tidal areas may temporarily have fresh water, and the mixed surface layer is determined by considering temperature.

Monitoring personnel often make vertical field measurement profiles in deep freshwater and tidal streams. In these cases, the surface sample and profile are determined using the same method described above for reservoirs and estuaries.

Determining the Extent of Tidal Influence

In most cases, the extent of tidal influence in freshwater streams that drain to tidal streams, estuaries, or the Gulf of Mexico, is determined by making field measurements (specific conductance and salinity), collecting water samples (TDS and chloride), and observing level recorders sequentially upstream from the streams' mouth over several complete tidal cycles. A water body is considered *tidally influenced* when there is observed tidal activity, TDS is greater than or equal to 2,000 mg/L, salinity is greater than or equal to 2 parts per thousand, or specific conductance is greater than or equal to approximately 3,000 micro Siemen per centimeter (µS/cm). In the absence of monitoring data, the tidal limit in a freshwater stream is approximated as the point where the 5-foot contour line (5 feet above average sea level) on a USGS topographic map crosses the stream. Marine criteria developed in the TSWQS apply to all tidally influenced streams (classified and unclassified), estuaries, and the Gulf of Mexico.

Temporally Representative Data

Frequency and Duration of Sampling

The assessment must use a sample set that is temporally representative of conditions within the period of record. Optimally, sampling should be routinely scheduled over several years and at a minimum of two years, with approximately the same intervals of time between sampling events. This routine sampling plan results in monthly or quarterly sample data sets which are considered temporally representative of long-term conditions.

In some instances where water quality data indicates dramatic improvements or declines and there is good cause to believe the change will be persistent, the assessor may determine it is appropriate to use only the more recent and representative dataset. These changes in water quality could be due to identified permanent changes in pollutant loadings, such as a new treatment facility, implementation of best management practices, or hydrologic changes.

Sediment and fish tissue samples generally do not vary greatly over time and are considered useful integrators of water quality over time and space. Fish and sediment samples collected as part of a one-time special monitoring event may be used in the assessment. For example, ten fish samples or ten sediment samples collected on the same day from an AU would meet the minimum sample requirement.

The most recent advisory or closure issued by the DSHS is used to determine support of the fish consumption use; although, sometimes these may have been issued in years prior to the period of record for the assessment.

Considering the Representativeness of Sample Events

To provide a temporally balanced dataset, water sampling events should be collected on a routine frequency, for example each week, month, or quarter. Such a sampling regime will assess a range of flow and temperature conditions. An exception is sediment and tissue samples which have no such temporal requirements.

Monitoring projects collect data determined to bias the dataset will be excluded. These may include data collected as part of a complaint investigation, equipment test, or a focused short term special study targeting specific conditions. Sampling projects targeted to high or low flow conditions may generate biased datasets. Such data can be used to add to a narrative for the water body assessment and may be useful for planning follow-up monitoring, but, in general, are not used in the calculation for determining use support, listing, or delisting. Routine data collected during high flows or storm events will be considered as part of the assessment dataset. Special study data that is determined to be routine by design, e.g., monthly TMDL monitoring, may be used in assessment.

Other sources of data and information, for example volunteer monitoring, compliance monitoring and complaint investigations can be used to plan future monitoring and to document sources of pollutants.

Samples from the same day or month will be used from different stations, or from different routine programs at the same station, if they comprise a routine data set or were collected at a consistent frequency that independently meets temporal requirements for number of years and seasonality.

When samples that temporally bias the data set must be removed, samples in the remaining temporally representative data set will be those collected earliest, provided that they are collected after 8:00 am. The samples that are not used, however, may be considered by the assessor to determine if they, in fact, identify a water quality concern.

For criteria expressed as a 24-hour average, a time-weighted average will be calculated (see SWQM Volume 1 Manual for the method). This calculated value will be available as a parameter value (assigned to a reported STORET code).

As an alternative to using more than one station, only the single, most representative site in an AU could be used to characterize standards attainment. The assessment at the other stations can be reported in the Integrated Report, but based on assessor judgment, not used to determine use support or concerns for the AU.

Seasonal Requirements

- Sample data must be collected over a minimum of two years (though not necessarily consecutive).
- No more than two thirds of the samples can be collected in any one year (defined as approximately 12 consecutive months).
- No more than one-third of the sample data are from any one of the four seasons
- If most of the samples are collected twice yearly, samples must represent the warm half of the year (approximately March 15 thru October 15) and cool half of the year (approximately October 16 thru March 14) of both years. No more than two-thirds of the samples should be from one of these two distinct parts of the year.
- If more samples are collected than needed for any particular time period, sample data from the routine monitoring program or those with the earliest collection date (for each week, month, or half year, dependent on routine sampling frequency) will be used as a systematic and unbiased

method to select a representative data set for assessment. The samples that are not used, however, may be considered by the assessor to determine if they, in fact, identify a water quality concern.

- There are specific seasonal requirements for biological (see "Determining Overall Aquatic Life Use" in Chapter 3) and 24-hour DO measurements (see "Dissolved Oxygen" in Chapter 3). Note DO criteria may vary seasonally or with flow (see Appendix A of Chapter 307 footnotes of the TSWQS).
- Sample events should be separated by approximately equal time intervals.
- Samples using more accurate methods or indicators may be used preferentially over older data.
- More recent data that meet the requirements for a representative data set may be used, and older data excluded, if the water quality is known to have changed, and there is evidence that these changes will persist.

Period of Record

The 2016 assessment period of record for the last seven years is December 1, 2007 through November 30, 2014. Samples from these seven years are evaluated when available, and if necessary, the most recent samples collected in the preceding three years (December 1, 2004 through November 30, 2007) can also be included to meet the requirements for minimum sample number.

Minimum Number of Samples

At least 10 (20 for bacteria) samples over the seven-year period of record are required for assessment of use attainment (listing and delisting). However, less than the required number of samples can be used to identify nonsupport for use attainment parameters if the threshold number of exceedances for these parameters is met when using the binomial method (See "Small datasets indicating nonsupport" below). Use attainment and concern assessment parameters are identified in Table 2.3. Concerns can be identified with as few as four samples. This count of samples *does not include those measurements or samples that are excluded for use in calculations*, for example events when flow is below the 7Q2 on perennial streams. Samples collected from multiple monitoring stations in an assessment area may be aggregated to meet the minimum sample requirement. All assessment methods based on the *average* will require 10 samples (20 for bacteria) for listing and delisting, although in rare instances the assessor will make the use attainment decision with fewer samples and indicate this by reporting a data set qualifier of JQ (based on judgment of the assessor).

Each assessment method (parameter) is evaluated independently for minimum sample number. These minimum sample numbers were chosen to allow confidence in the assessment, while making the best use of limited monitoring resources. All stations with four or more temporally representative samples are assessed, although it may not be possible to establish use support with so few samples. Water bodies recently monitored, but with small data sets that are not temporally representative, will be listed in the narrative for the classified segment watershed.

Extending the period of record and minimum number of samples to increase confidence in listing and delisting. In order to ensure that minimum sample size requirements can be met for determining use support, the period of record will be extended back in time, up to ten years, until the minimum sample number is identified. At least half of the samples (five samples) must come from the most recent seven-year sample period. This will establish use support for more water bodies and parameters, and will report more recent water quality conditions than the previous practice of carrying forward the assessment information from only the last period that had a complete dataset.

A minimum of 10 (20 for bacteria) samples from the last seven years *or* the most recently collected 10 samples (20 for bacteria) for up to ten years are used to determine use support.

Concerns will be identified with as few as four samples if they are within the last seven years. The sample set must be temporally representative and it may be useful to include recent samples from the previous seven-year period to establish concern status.

Beginning with the 2012 IR, the variability of bacteria data was considered by initiating a two-tiered approach for assessing new impairments in streams to (1) initially screen all AUs having 10 or more samples to determine exceedance of the geomean, and then to (2) identify impairments where sample size is greater than 20 and statistical confidence is sufficient to make this determination. The purpose of the secondary screening is to establish a greater level of confidence that a new listing is based on an exceedance of a criterion rather than random variation. This approach was developed to increase confidence in bacteria impairment listings while assuring concurrent implementation of management measures are directed to address the most severe impairments.

The tiered approach will be implemented in two steps. First, for those AUs with more than 10 samples, the geomean will be calculated and compared to the criterion. If the geomean is greater than the criterion and there are less than 20 samples in the dataset, a concern will be identified and monitoring in the AU will be prioritized during the coordinated monitoring process. This will ensure that in future listing cycles, there will be adequate samples to determine if an impairment exists. The second tier will require 20 samples and be conducted to determine the use support status. For AUs with more than 20 samples, a confidence interval (CI) will be calculated (at the 80% confidence level) to determine the use attainment status. If the lower boundary of the CI is below the 126 (*E. coli*) or 33 (Enterococci) criterion, then the AU will not be placed on the 303(d) List but will also be identified as a concern and targeted for additional monitoring. Water bodies will be listed if the lower boundary is above 126 or 33 respectively.

The use of the CI allows recreational attainment to be effectively assessed without requiring an extraordinarily high requirement for minimum number of samples. The procedures for applying the CI also provide several measures to reduce the risk of missing a significant impairment:

- The required confidence level is lower than typical statistical confidence levels (usually 0.95).
- Confidence interval screening will only apply to potential new listings. Delistings will require 20 samples and that the geomean be below the geomean criterion.

Table 2.3. Sample Size Requirements for Assessment Methods

Use	Assessment Method	Use Attainment or Concern Assessment	Minimum Sample Sizes and Levels of Parameter Support for Data Qualifier (see Table 2-4 for definitions of levels of support and data qualifier)		
			ID Inadequate Data	LD Limited Data	AD Adequate Data
Aquatic Life Use	Dissolved oxygen 24-hr average	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Dissolved oxygen 24-hr minimum	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Dissolved oxygen grab minimum	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Dissolved oxygen grab screening level	C	<4 NA	4-9 CS, NC	10 CS, NC
	Acute toxic substances in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Chronic toxic substances in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Acute ambient toxicity tests in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Chronic ambient toxicity tests in water	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	TOXNET ambient toxicity tests in water - lethality	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	TOXNET ambient toxicity tests in water - sublethality	C	<4 NA	4-9 CS, NC	10 CS, NC
	Acute toxicity tests in whole sediment	N/A	<4 NA	4-9 Report tests only	10 Report tests only
	Chronic toxicity tests in whole sediment	N/A	<4 NA	4-9 Report tests only	10 Report tests only
	Elutriate toxicity tests in sediment	N/A	<4 NA	4-9 Report tests only	10 Report tests only
	Toxic substances in sediment	C	<4 NA	4-9 CS, NC	10 CS, NC
Aquatic Life Use (continued)	LOE toxic sediment condition	U	<4 (LOE is not reported if less than four samples are available)	4-9 CN, NC, NS (data set qualifier must be JQ rather than LD)	10 NS, CN, FS (data set qualifier must be JQ rather than AD)
	Habitat		0 NA	1 CS, NC	2 CS, NC
	Macrobenthic community	U	0 NA	1 CN, NC	2 NS, CN, FS
	Fish community	U	0 NA	1 CN, NC	2 NS, CN, FS
Recreation Use	*E.coli* and Enterococcus geomean	U	<4 NA	4-19 CN, NC, NS	20 NS, CN, FS

Use	Assessment Method	Use Attainment or Concern Assessment	Minimum Sample Sizes and Levels of Parameter Support for Data Qualifier (see Table 2-4 for definitions of levels of support and data qualifier)		
			ID Inadequate Data	**LD Limited Data**	**AD Adequate Data**
Recreational Beaches	Texas Beach Watch Program advisories	U	See text , NA, NS, FS (data qualifier OE)		
General Use	Water temperature	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	High pH	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Low pH	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Dissolved solids	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Enterococcus (1006, 1007) geometric mean	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Reservoir nutrient criteria	U	<10 NA		10 NS, CN, FS
	Reservoir nutrient criteria	C	<10 NA		10 CS, NC, FS
	Nutrient screening levels	C	<4 NA	4-9 CS, NC	10 CS, NC
	Nutrient enrichment	U	see text, NA, CN, NC, NS (data set qualifier OE)		
	Altered color	U	see text, NA, CN, NC, NS (data set qualifier OE)		
	Fish kill reports	U	see text, NA, CN, NC, NS (data set qualifier OE)		
Fish Consumption Use	DSHS advisories, closures, and risk assessments	U	see text, NA, NC, NS, FS (data set qualifier OE)		
	HH bioaccumulative toxics in water or tissue average	U	<4 NA	4-9 CN, NC, NS	10 NS, CN, FS
	Bioaccumulative toxics in fish tissue	C	<4 NA	4-9 CS, NC	10 CS, NC
Oyster Waters Use	DSHS shellfish harvesting maps	U	see text, NA, NS, FS (data set qualifier OE)		

Small data sets indicating nonsupport. Water bodies with small data sets (< 10) will be identified as not supporting designated uses for methods using a percent exceedance without regard for sample size, provided they meet the threshold number of exceedances that would be required for the minimum sample size and are otherwise representative-routine data collected over at least a two-year period. For these water bodies there is certainty that small datasets with a threshold number of exceedances will demonstrate nonsupport of uses should more samples be collected to reach a total sample size of 10. All assessment methods based on averages will require 10 (20 for bacteria) samples for listing unless there is considerable evidence indicating non-support. Best professional judgment will be used in these instances. Delisting with an assessment method based on an average requires a minimum of 10 (20 for bacteria) samples.

Flow Conditions

Water quality criteria and screening levels generally apply to perennially flowing streams when flow exceeds critical, low flow conditions. Many small, unclassified streams in Texas develop intermittent stream flow in summer months and eventually become completely dry, while others maintain perennial pools when flow is interrupted. The decision matrixes illustrated in Tables 3.2, 3.4, 3.8, 3.9, 3.10, 3.13, and 3.15 were developed for this guidance to explain which DO, toxic substances in water, bacteria, general use, human health, and surface water criteria respectively, apply under different flow conditions. These tables summarize when site-specific and general criteria are applicable, consistent with the TSWQS.

Eliminating Critical Low-Flow Events on Perennial Streams

Provisions in §307.8 of the TSWQS specify applicability of standards under flow conditions, particularly critical low-flows. Critical low-flow is defined as the low-flow condition that consists of the seven-day, two-year low-flow (7Q2 flow) or alternative low-flows for spring-fed streams. The 7Q2 is the lowest stream flow for seven consecutive days with a recurrence interval of two years, as statistically determined from historical data. Critical low-flows in springflow-dominated streams or rivers that contain federally listed endangered or threatened aquatic or aquatic dependent species are determined from the 0.1 percentile derived from a lognormal distribution of historical data. Critical low-flows in springflow-dominated streams that do not contain federally listed endangered or threatened species are determined from the 5th percentile of historical data. In the *Procedures to Implement the Texas Surface Water Quality Standards* (IPs), if the calculated critical low-flow was equal to or less than 0.1 cfs, it was rounded to 0.1 cfs. The IPs also indicate that if base flow information is not available to estimate the 7Q2, then a value of 0.1 cfs is usually assumed for perennial streams. Critical low-flows for classified segments are included in Appendix C of the IPs. Site-specific critical low-flow values for dissolved oxygen for the eastern and southeastern Texas ecoregions are specified in §307.7(b)(3)(A)(ii), Table 4 of the TSWQS. Site-specific critical low-flows for a subset of these streams is 0.0 cfs.

The first step is to assess a water body using data from all flow conditions and determine if there are any concerns or nonsupport for use attainment, for *any* of the assessment methods or parameters. Samples are reviewed to determine if any need to be removed due to critical low-flow, only if nonsupport or concerns are identified. Because the critical low-flow condition occurs rarely, and the accepted exceedance rate (percent of time the criterion is not attained) is already as large as 10%, the removal of low flow events from the dataset may be an unnecessary practice that contributes bias (disproportionally toward higher than actual flow on the segment) and introduces the possibility of errors (the critical low-flow applied to the sample location may not be accurate and flow measurements for events may not be available or accurate). The assessor will use judgment when evaluating samples to be removed.

Removing measurements made at critical low-flows is a way to avoid inappropriately listing a water body based on data that do not support the TSWQS when strictly applied. Samples from low flow events are not excluded when the samples support the water quality standards and would not result in a listing or concern. Only the individual sample values for the assessment parameter not meeting the criterion for an assessment method during the low flow event will be removed. For example, if the grab DO is less than the grab screening level of 5 mg/L the data value will be removed if < the critical low flow. However, if this same measurement is greater than the grab screening level, it will be included for that assessment method. The number of samples assessed for the data set are counted and reported after low flow samples are removed. General criteria are assessed at all flows in accordance with §307.8 (a) (9) of the TSWQS, except as specified elsewhere in the TSWQS.

Data for the following parameters are removed if the initial assessment using all of the samples indicates nonsupport and the measured flow is below the critical low-flow:

Classified stream segments

- DO
- pH
- temperature
- chronic toxic criteria
- chronic ambient toxicity tests

Unclassified stream segments

- DO
- chronic toxic criteria
- chronic ambient toxicity tests

Note: If there is no 7Q2 value, 0.1 cubic feet per second (cfs) will be used for assessment on perennial streams. If there is only flow severity information available, data with a flow severity equal to 1 – no flow (on perennial streams) will be excluded. If there is no available flow information for a particular classified perennial stream, flow will be presumed to be above the critical low-flow. Note that perennial streams are only rarely below the critical low-flow, so it is unlikely that samples were collected during this condition.

For unclassified intermittent streams and intermittent streams with perennial pools, do not evaluate the flow (cfs or flow severity) or eliminate data below the critical low flow, since this value is zero.

Toxicity: The following apply at all flows above a quarter of the critical low-flow (see §307.8 (a)(3) in the TSWQS) on perennial classified and unclassified streams:

- Acute toxic criteria.
- Acute ambient water toxicity test (the river authorities and EPA Houston Lab have been running only acute tests).

The chronic criteria and chronic ambient water toxicity tests also apply to intermittent streams that support significant aquatic life, including streams identified as intermittent with pools. This includes,

- Pools large enough to support significant aquatic life (greater than 20% stream bed, greater than 1 m deep).
- Perennial streams and small pools downstream of wastewater discharges on streams that would otherwise be intermittent, but outside the area where the criteria may not apply as established in the TCEQ permitting process.

Note: Chronic criteria do not apply to intermittent streams with no pools, only acute apply to streams with these conditions.

Determining Attainability due to Severe Low-Flow in Perennial Streams

In addition to applicability of standards below critical low flows, provisions addressing the attainability of standards in severe low-flow conditions are included in §307.9 of the TSWQS. These provisions address attainability of criteria applied as long-term averages during severe low-flow conditions, such as negligible streamflow or when residual pools in intermittent streams shrink during very dry periods. Below these severe low-flows, water quality tends to become degraded even under natural conditions.

Data for the following parameters are removed if the initial assessment using all of the samples indicates nonsupport and:

1. Perennial stream flow is below 0.1 cfs.

2. Intermittent streams when < 20% of the stream bed of a 500 meter sampling reach is covered by pools; or when extremely dry conditions are indicated by comparable observations in flow severity.

Classified Stream Segments

- TDS
- chloride
- sulfate
- bacteria
- human health criteria

Unclassified Water Bodies

- bacteria
- human health criteria

Methodology for Determining Standards Attainment

Levels of Support

A range of water quality conditions and assessment status is expressed by a level of support established in each assessment unit (in some instances each station) for each use and parameter combination. Support status reflects (1) that data are not sufficient to allow assessment, (2) when only a concern can be established from limited data, and (3) when the assessment can confidently establish the level of support.

Assessment methods for use attainment (based on numeric and narrative TSWQS) apply to the parameters, the use, the AU, and the segment. Assessment methods are discussed in Chapter 3 (also see Table 3-1). When current support status cannot be assessed because the dataset is not adequate, the support status from the previous assessment is reported if it was a concern or impairment. Impairments identified in previous years may be removed (delisted) when the data indicates that the use is fully supported.

Support status is expressed with a letter or several letters with the definitions in Table 2-4. A support code and data set qualifier from the columns in Table 2-4 are reported for each assessment use, method and parameter.

Values Below Reporting Levels

Many individual values in the SWQM water quality database are reported as less than the limit of quantitation (LOQ). There is no generalized way to determine the true value for an individual result in the range between zero and the LOQ. For assessments, half of an LOQ may be used to represent the data point in the calculations. This is done to include as many individual data points in the analysis as possible and to indicate the level of monitoring effort.

Values with an LOQ that exceeds criteria or screening levels are not counted as exceedances.

For criteria that are expressed as averages, including chronic toxicants (aquatic life use), bacterial indicators geometric mean (recreation use), human health criteria for water (fish consumption use), and primary organic substances (public water supply use), whichever of the following measurements is smaller is used in calculating the average—half of the LOQ or half of the criterion. For values expressed as greater than the LOQ, the whole value is used.

When most of the reported values for a parameter are less than the LOQ, and the LOQ is significantly greater than the criterion (note that a margin of safety of about two for aquatic life and five to ten is incorporated into criteria), the samples are not used for calculation of averages or percent exceedances. A status of Not Assessed may be identified, rather than fully supporting or

no concern. The assessor will use judgment when identifying parameters as fully supporting or delisting when the dataset includes values below the LOQ.

Rounding Values

For managing measurement values, the *EPA Standard Methods Rule of Rounding* is used. Digits that are not significant are dropped. If the digit 6, 7, 8, or 9 is dropped, the preceding digit is increased by one unit. For example, 2.89 becomes 2.9. If the digit 0, 1, 2, 3, or 4 is dropped, do not alter the preceding digit. For example, 2.53 becomes 2.5. If the digit 5 is dropped, round off the preceding digit to the nearest *even* number. For example, 2.25 becomes 2.2 and 2.35 becomes 2.4.

Table 2-4. Support Codes and Data Set Qualifiers

Resulting Support Code for Use	Support Code Assigned to Parameter	Level of Use Support	Use Standard or Screening Level Concern
FS	FS	standard for use fully supported—however may not meet delisting requirements; Note: Fish consumption rolls up to NA when advisories/risk assessment method is not available	Use
NS	NS	standard not supported	Use
FS	CN	concern—near nonattainment for parameter with adequate data	Use
NA	CN	concern—near nonattainment for parameter with limited data	Use
NA	NC	no concern for parameter with limited data	Use
NA	NA	not assessed	Use
NA	CS	concern—screening levels indicate marginal water quality for parameter by concern assessment methods	Concern
NA	NC	no concern—for screening level parameters	Concern
NA	NA	not assessed	Concern
Data Set Qualifier Code		Data Set Qualifier for Parameters	
AD		adequate data—meets minimum sample number and other requirements	
LD		limited data (less than minimum sample size of 10)	
TR		not temporally representative, used with NA	
SR		not spatially representative, used with NA	
JQ		based on judgement of the assessor	
SM		this assessment method is superseded by another method	
ID		inadequate data (<4 samples), used with NA	
OS		assessment area outside state boundaries	
OE		other information than ambient samples evaluated	

Notes:
A support code is assigned to the segment, AU, use, and parameters. Both the support code and dataset qualifier are required to describe attainment for parameters. The assessment method is not assigned a support code or a data set qualifier.
Assessment methods based on averages (including median and geometric mean) are reported as FS when criteria are attained.

Trend Analysis

The TCEQ has identified trend analysis as a tool to determine if a water body is not expected to meet applicable water quality standards. In general, trend analysis provides information which contributes to a quantitative, objective assessment of whether or not the values for a random variable such as chloride concentration, or biological integrity (the dependent variable) are increasing or decreasing over time, as a function of an independent variable such as time. Trend analysis also provides an estimate of the rate of change. In most cases the explanatory (independent) variable will be time. The TCEQ may also look at trend analyses to evaluate improvement in impaired water bodies as well as where there are no trends. However, trend analyses will most likely be prioritized to evaluate water bodies which appear to be threatened. For

purposes of generating a statistical trend, 20 to 60 samples collected over a period of five to 20 years are required. The TCEQ has some long-term stations as part of the routine monitoring network. One of the purposes of these monitoring stations is to assess long-term water quality trends.

Trend Analysis Method

For details relating to the trend analysis method refer to the Clean Rivers Program Guidance, Task 5—Data Analysis and Reporting, Exhibit 5B—Steps and Criteria for Trend Analysis. This guidance can be found on the Web at:

https://www.tceq.texas.gov/waterquality/clean-rivers/guidance

Methods described in Task 5 can be used by any data provider to the TCEQ and reviewed by the assessors for listing considerations.

Use of the Binomial Method for Establishing Required Number of Exceedances for Nonsupport of Designated Uses

A primary objective of water quality assessment is to draw conclusions about a water body based on a group of measurements for a particular water quality parameter of interest. The universe of existing values for a variable in the AU of interest is referred to as the *population*. In general, it is impossible to obtain all of the measurements for a population. Then it becomes necessary to describe the population, as reliably as possible, by collecting a set of samples from that population. There is always uncertainty and a potential for error in this process. For the 303(d) listing process, there are essentially two categories of such errors:

Type 1 Error. We would make a Type 1 error if we identified a water body as not supporting, when that water body is actually fully supporting.

Type 2 Error. We would make a Type 2 error if we identified a water body as fully supporting, when that water body is actually not supporting.

The *binomial method* is a useful tool for estimating the probability of committing Type 1 and/or Type 2 errors for situations when the analysis is based on a given variable that falls into one of two categories. Placing measurements of water quality variables in two categories—either equal to or less than a criterion, or greater than the criterion—is an example of such a situation.

Note: This method does not apply to criteria are expressed as averages, such as TDS, geometric mean for bacteria indicators, and chronic toxic criteria.

In general, when the binomial method is used, the proportion of the population that belongs to one of the two categories—in this case the proportion of the population that exceeds the criterion—is denoted as p. The proportion of the population that belongs to the second category (in this case the proportion of the population that meets the criterion) is denoted as q, which is equal to $1-p$. For example, for a fully supporting water body, p is equal to or less than 10% (0.1), and q is greater than or equal to 89.9% (0.899). In this case, p and q, respectively, represent the probabilities, for a single sample event, of collecting a sample that exceeds or a sample that meets the criterion.

During the assessment of water quality, multiple samples are collected and the cumulative probabilities are determined in order to estimate the probability of committing Type 1 and Type 2 errors.

The binomial method can be used to calculate the probability of observing more than 10% exceedances from a water body that actually contains less than 10% (0.10) exceedances—that is, erroneously classifying a water body as not supporting for each combination of number of samples (n) and number of exceedances (e). For example, this method can be used to determine the cumulative probability of error when two or more exceedances out of 10 samples are collected and when the actual exceedance rate in a water body is 10%. This cumulative probability represents

the Type 1 error probability. By calculating these cumulative probabilities for each combination of *n* and *e*, it becomes possible to select the combination which provides an acceptable probability of committing a Type 1 error and to identify the Type 2 error.

Error rates for delisting decisions can be described in a similar, but reversed, manner for each combination of number of samples and exceedances. We would make a Type 1 error if we delisted a water body when that water body is actually not supporting. We would make a Type 2 error if we did not delist a water body that is actually fully supporting.

For each number of samples available for a parameter (sample size), a minimum threshold number of exceedances must be identified for listing, considering Type 1 and II error rates (see Table 2-5). Appendices A and B provide examples of the number of samples and exceedances that result in various levels of use and concern attainment.

The specified maximum acceptable Type 1 error rate for identifying impairments and concerns for conventional parameters is less than 20% near the threshold frequency of exceedances (10% actual exceedances for conventionals). For toxics, in order to be more protective, a larger Type 1 error probability, 40%, is accepted. Specifying a maximum Type 1 error rate results in corresponding Type 2 error rates.

Table 2-5. Compliance with Water Quality Criteria and Acceptable Error for Listing, Delisting, and Concerns with at Least Ten Samples.

Use and Concerns Attainment	Error Type	List		Concern		Delist	
		Maximum Accepted Sample Error Rate (%)	Exceedance Rate for Parameter (%)	Maximum Accepted Sample Error Rate (%)	Exceedance Rate for Parameter (%)	Resulting Sample Error Rate*(%) Range for 10 to 20 samples	Exceedance Rate for Parameter (%)
Conventional Use Attainment	Type 1	20	10	20	8	**37 to 70**	**11**
	Type 2	91	11	62	20	**8 to 25**	**5**
		38	30				
Dissolved Oxygen Concerns	Type 1	n/a	n/a	20	8	n/a	n/a
	Type 2	n/a	n/a	62	20		
Toxic Use Attainment	Type 1	40	10	40	8	**35 to 71**	**9**
	Type 2	81	11	38	20	**12 to 43**	**5**
		16	30				
Screening Level Concerns	Type 1	n/a	n/a	20	20	n/a	n/a
	Type 2	n/a	n/a	44	40		

* The methodology for delisting is not based in target error rates. See discussion on delisting below.

The resulting Type 2 error rate at the threshold exceedance of 11% for conventional parameters is 91% and for toxics it is 81%. Because criteria are conservative and set to protect for the best water quality conditions when developing permits, exceedance rates of two to three times the threshold frequency can occur without the need for listing and additional water quality controls through the TMDL process. At these higher exceedance rates, the resulting Type 2 error rate is 38% for conventional parameters, and about 16% for toxics. Note that at the sample sizes less than 10, the Type 2 error rate cannot be controlled in a useful way.

Delisting parameters on the 303(d) List. Water bodies will be delisted from Category 5 when the rate of exceedances is not greater than 10% for conventional parameters (and/or the mean is not exceeded for criteria evaluated as a mean), and 8% for toxic substances. This delisting methodology is based on a simple percentage. The use of a simple percentage increases confidence that previously impaired waters are attaining their use before they are delisted.

An exception is when new standards and criteria have been adopted. Use attainment is determined by the statistical method and the additional level of assurance (requirement that the criteria are not exceeded more than 10% of the time) is not required for delisting. Similarly, for Category 4 impairments, because there are water quality controls in place, or the non-support is not caused by a pollutant, impairments are removed from this category when water quality standards are attained without this additional level of assurance.

For delisting impairments, this methodology results in a Type 1 error rate of 37 to 70% when the rate of criteria exceedance is just above the threshold of 10% for conventional parameters, and 8 to 38% when the exceedance rate is 20%. The Type 2 error rate is less than 8 to 25% for conventional parameters when water quality is good (exceedance rate of only 5%). Error rates when delisting toxic parameters are more protective.

Chapter 3

Assessment of Beneficial Uses

Introduction

Assessment of each beneficial use is accomplished by applying several assessment methods. These methods often have several criteria or screening levels that are used to evaluate assessment parameters (see Table 3.1). Use attainment assessment methods are used to determine use support and concerns for near-nonattainment for uses; concern assessment methods are used to identify concerns with screening levels.

Table 3.1. Use Assessment Methods, Parameters, and Impairments

Use	Assessment Method	Use Attainment or Concern Assessment	Assessment Parameter	Impairment
Aquatic Life Use	Dissolved oxygen 24-hr average	U	Dissolved oxygen 24-hr average	Depressed dissolved oxygen
	Dissolved oxygen 24-hr minimum	U	Dissolved oxygen 24-hr minimum	Depressed dissolved oxygen
	Dissolved oxygen grab minimum	U	Dissolved oxygen grab	Depressed dissolved oxygen
	Dissolved oxygen grab screening level	C	Dissolved oxygen grab	Depressed dissolved oxygen
	Acute toxic substances in water	U	Metals, organics	Lead in water, etc.
	Chronic toxic substances in water	U	Metals, organics	Lead in water, etc.
	Acute ambient toxicity tests in water	U	Water acute toxicity	Water toxicity
	Chronic ambient toxicity tests in water	U	Water chronic toxicity	Water toxicity
	TOXNET ambient toxicity tests in water - lethality	U	Water acute toxicity	Water toxicity
	TOXNET ambient toxicity tests in water - sublethality	C	Water chronic toxicity	Water toxicity
	Acute toxicity tests in whole sediment	N/A	Sediment acute toxicity	Report test results only
	Chronic toxicity tests in whole sediment	N/A	Sediment chronic toxicity	Report test results only
	Elutriate toxicity tests in sediment	N/A	Sediment elutriate toxicity	Report test results only
	Toxic substances in sediment	C	Lead, etc.	Lead in sediment, etc.
	LOE toxic sediment condition	U	Sediment Toxicity (LOE)	Toxic Sediment (LOE)
	Habitat	C	Habitat	Habitat
	Macrobenthic community	U	Macrobenthic community	Impaired macrobenthic community
	Fish community	U	Fish community	Impaired fish community

Use	Assessment Method	Use Attainment or Concern Assessment	Assessment Parameter	Impairment
Recreation Use	Bacteria geomean	U	*E. coli* or Enterococcus	Bacteria
Recreational Beaches	Number of Beach Advisories	U	Beach Watch Advisories	Beach Watch Advisories
General Use	Water temperature	U	Temperature	Temperature
	High pH	U	pH	pH
	Low pH	U	pH	pH
	Dissolved solids	U	Total dissolved solids, chloride, or sulfate	Total dissolved solids, chloride, or sulfate
	Enterococcus (1006, 1007) single sample	U	Enterococcus	Bacteria
	Enterococcus (1006, 1007) single sample	C	Enterococcus	Bacteria
	Nutrients (Reservoirs)	U	Secchi depth, dissolved oxygen, total nitrogen, total phosphorus, chlorophyll *a*	Excessive algal growth
	Nutrients (Reservoirs)	C	Secchi depth, dissolved oxygen, total nitrogen, total phosphorus, chlorophyll *a*	Excessive algal growth
	Nutrient screening levels	C	Orthophosphorus, ammonia, total phosphorus, nitrate, chlorophyll a	Orthophosphorus, ammonia, total phosphorus, nitrate, chlorophyll a
	Nutrient enrichment	C	Algae, macrophytes, or DO grab, DO 24-hr	Excessive algal growth, excessive macrophyte growth, or DO swings
	Altered color	U	Color	Color
	Fish kill reports	U	Golden alga	Harmful algal blooms/golden alga
Fish Consumption Use	DSHS advisories, closures and Risk Assessments	U	PCBs, etc.	PCB's in large-mouth bass (as specified in advisory)
	HH bioaccumulative toxics in water and tissue	U	Acrylonitrile, etc.	Acrylonitrile in water, etc.
	Bioaccumulative toxics in fish tissue	C	Arsenic, etc.	Arsenic in fish tissue, etc.
Public Water Supply Use	Surface water HH criteria for PWS average	U	Arsenic, nitrate, etc.	Arsenic in water, etc.
	Surface water toxic substances average concern	C	Alachlor, atrazine, MTBE, and perchlorate	Alachlor, atrazine, MTBE, and perchlorate in water
Oyster Waters Use	DSHS shellfish harvesting maps	U	Bacteria, zinc, etc.	Bacteria (oyster waters)

Aquatic Life Use

Each classified segment in the TSWQS (Appendix A) is assigned an aquatic life use, based on physical, chemical, and biological characteristics of the water body. The five aquatic life use (ALU) categories are exceptional, high, intermediate, limited, or minimal (no significant) aquatic life use.
Support of the ALU is based on assessment of dissolved oxygen criteria, toxic substances in water criteria, ambient water and sediment toxicity test results, and indices for habitat, benthic macroinvertebrate and fish community, provided that the minimum number of samples are available. Each set of criteria is generally evaluated independently of the others, and impairment of the ALU results when any of the individual criteria are not attained.

For freshwater streams not classified in the TSWQS, the ALU and criteria are presumed based on the stream flow type. Stream flow type; perennial, intermittent with pools, or intermittent; is established from flow data associated with samples, information provided by local monitoring staff, previous assessments, or recent RWAs. Flow types, assigned ALUs, and criteria, when established in Appendix D of the TSWQS or in support of TCEQ permit decisions will be used when available.

Dissolved Oxygen

Classified Water Bodies

Aquatic life uses are evaluated using an average DO criterion (measured over 24-hours) and absolute minimum criterion. The criteria are not supported when these criteria are exceeded more than 10 percent of the time using the binomial method.
24-hour average criteria. DO criteria (24-hour averages) to protect these ALUs for freshwater range from 2.0 to 6.0 mg/L (see Table 3.2).
In tidally influenced water bodies the dissolved oxygen criteria are 1 mg/L lower than freshwater for exceptional, high, and intermediate ALUs due to differences between oxygen solubility in fresh and salt water. A minimal ALU and dissolved oxygen screening level of 2.0/1.5 mg/L (average/minima) are used where the TSWQS designate minimal ALU.
DO average criteria are compared to the measurement taken at the surface or to the average of measurements in the mixed surface layer when a profile of measurements is reported.
Minimum criteria. In addition, the TSWQS designates *minimum criteria* to protect the range of ALUs. In freshwater, these minimum criteria range from 2.0 to 4.0 mg/L and the minimum screening level for minimal ALU is 1.5 mg/L. Minimum in tidal waters are the same, except the criterion for the intermediate use is 2.0 mg/L, and there ~~is~~ are no limited or minimal ALU subcategory or criteria (see Table 3.2). DO minimum criteria are compared to the instantaneous measurement taken at the surface or to the average of measurements in the mixed surface layer when a profile of measurements is reported.
Seasonal and flow dependent criteria. For some classified and unclassified water bodies, DO criteria may vary dependent on seasonal or flow conditions. In these cases, the DO average and minimum criteria are lower during the warmer months, during low flow, or during a combination of season and flow.
Dissolved oxygen grab screening level. Grab dissolved oxygen measurements are made at the majority of sampling events. These measurements are compared to the average DO criterion value and a concern is identified when this screening level is exceeded. The DO grab screening level is compared to the instantaneous measurement taken at the surface or to the average of measurements in the mixed surface layer when a profile of measurements is reported.
Seasonal Requirements for 24-hour Dissolved Oxygen Data Sets.
Twenty-four-hour DO monitoring events can be conducted year-round, however, to ensure unbiased, seasonally representative data, samples are allocated to various times of the year. At least one half of the 24-hour DO monitoring events must be spaced over an index period representing warm-weather seasons of the year (March 15-October 15). One-fourth to one-third of the measurements must be made during the critical period (July 1-September 30). Approximately one month must separate each 24-hour sampling event. Although samples over the entire year are not required at this time, current monitoring guidance encourages year-round sampling. Additional temporal guidelines and details for

collecting 24-hour data sets are included in TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods* (RG-415)

Hierarchy of assessment methods for determining use support for dissolved oxygen. When the number of both 24-hour measurements (average and minima) and grab DO measurements (evaluated against the DO minimum criterion and DO screening level) are adequate for assessment, the assessment results for 24-hour DO data set are used to determine both use support and concerns. When this is the case, the data set qualifier for the assessment methods using grab samples is reported as SM (superseded by another method). The assessor must consider grab exceedances of the DO minimum criterion and use judgment to determine if these exceedances indicate nonsupport of the criterion and use. When this is the case, the data set qualifier for the 24-hour minimum is reported as JQ (based on judgment of the assessor).

Unclassified Streams

Establishing ALU based on stream flow-type. In contrast to other criteria, dissolved oxygen criteria are derived from ALU categories. The ALU is assigned to unclassified segments for assessment, based on the flow-type for the segment.

Unclassified perennial streams are presumed to have a high ALU and corresponding average DO criterion of 5.0 mg/L (3.0 mg/L minimum). Unclassified intermittent streams with significant ALU created by perennial pools are presumed to have limited ALUs protected by a 3.0 mg/L criterion for average dissolved oxygen (2.0 mg/L minimum). Intermittent streams without perennial pools are presumed to have a minimal ALU~~s~~ protected by a 2.0 mg/L average criterion (1.5 mg/L minimum).

Site specific standards. Site-specific ALU and associated dissolved oxygen criteria have been assigned to some unclassified water bodies through receiving water assessments (see Appendix D of the TSWQS). For other unclassified water bodies, the ALU and associated DO criteria are presumed based on the flow-type or other information developed by the TCEQ water programs. The ALU and criteria for unclassified water bodies most recently used for assessment will be provided with assessment results. Another exception is perennial streams located in the eastern and southern areas of the state-as described in the TSWQS, 307.7(b) (3)(a)(ii)-where a strong dependent relationship has been demonstrated to exist among summertime dissolved oxygen concentration, stream flow, and channel bed slope. Streams with significant ALU in these areas of the state are evaluated for 24-hour dissolved oxygen concentrations using criteria dependent on flow and stream channel bed slope. If a water body or AU does not support the DO criteria, the impairment must be verified according to the steps outlined in the following section.

Eastern and Southern Texas Dissolved Oxygen

The Regression equation for DO/streamflow/bedslope. A regression equation was used to develop a table that relates DO/streamflow/bedslope in Section 307.7 of the TSWQS. The table is applicable to classified and unclassified perennial streams in defined areas of East and South Texas.

The following steps demonstrate how this regression equation can be used to define an adjusted critical low flow value below which the dissolved oxygen criterion does not apply.

To develop the original regression equation, stream flows and average DO concentrations were measured during steady-state conditions, and bedslopes were estimated from 1: 24000 scale USGS topographic maps. Approximately 72% of the variation in observed average dissolved oxygen concentrations in these minimally impacted streams is explained by the regression equation.

To reproduce the results of the table in the WQ Standards and solve for flow, the regression is applied as follows:

$$Q = e^{(DO - 7.088 - 0.686\ln(Bd) + k + j)/0.551} - 0.01$$

Where:

DO = DO criterion from regression (mg/L; 24-hour average)
Q = adjusted critical low flow (ft^3/s)
Bd = Bedslope (m/km)

k = 1.61 (constant for 50th percentile of tree canopy cover)
j = 0.5 (to set the DO criterion an increment below the predicted ambient DO)

Calculating bedslope (from *Procedures to Implement the Texas Surface Water Quality Standards 2010 – RG 194*). Bedslopes are calculated from USGS 1:24,000 scale topographic maps for the portion of stream from the first contour line crossing the stream greater than one-half mile upstream of the point of discharge to the first contour line crossing the stream downstream beyond the estimated distance of discharge impact. The actual stream bedslope is calculated using the following equation:

$$Bd = \frac{(E_u - E_d)}{D}$$

Where:

Bd = bedslope (m/km)
Eu = upstream elevation (m)
Ed = downstream elevation (m)
D = linear distance along the streambed between the two elevation contours (km)

(Note: the elevations and linear distance in the formula can be calculated in feet and then multiplied by 1,000 to convert to meters per kilometer.)

Confirming apparent DO impairments in the eastern or southern portions of the state. If a perennial water body in the eastern or southern portions of the state (as defined on page 45 of the TSWQS) does not support the DO criteria (new impairments only), then each individual sample not attaining the assigned criterion (24-hour average, 24-hour minimum, or grab minimum) is evaluated to further assess validity of the sample. Using Table 4 in the TSWQS, the procedure described below is used to determine an adjusted critical low flow under which a DO measurement should be excluded. When the measured flow is below this adjusted critical low flow value the DO measurement is excluded and not used for use attainment determinations. This procedure applies to both classified and unclassified water bodies, and is performed only for sample results that exceed the criteria and are collected when the flow equals or exceeds the critical low-flow.

1. Calculate the bedslope for the subject stream reach or use the monitoring station bedslope found in SWQMIS.
2. Find the adjusted critical low flow using bedslope and flow for the stream 24-hour average DO criteria using Table 4 of the WQS. For bedslopes below the minimum listed in Table 4, use 0.1 m/km. For bedslopes above the maximum listed in Table 4, use 2.4 m/km.

   Example for a stream with a bedslope of 0.4 m/km,

   - If the DO criterion is 6.0 mg/L, the appropriate critical low flow is 20.0 cfs
   - If the DO criterion is 5.0 mg/L, the appropriate critical low flow is 3.3 cfs
   - If the DO criterion is 4.0 mg/L, the appropriate critical low flow is 0.5 cfs
   - If the DO criterion is 3.0 mg/L, the appropriate critical low flow is 0.1 cfs

   Note: Use the DO column corresponding to the DO criterion for the segment to evaluate all exceedances, including the minimum. For example, Segment 0404 has a DO criterion of 5.0 mg/L listed in Appendix A of the TSWQS. In this case, the 3.3 cfs listed in the above example would be the adjusted critical low flow for determination of validity of all samples (24-hour average, 24-hour minimum, and grab minimum) not meeting their respective criterion.
3. If the flow at the time of DO measurement is above the adjusted critical low from the table, then the violation indicated in the initial screening for this sample is correct.
4. If the flow at the time of DO measurement is below the adjusted critical low flow from the table, then the sample event is not considered in the assessment.
5. Reassess the DO for the water body or AU using the appropriate data.

In cases where discreet flow was not recorded during the sampling event, a flow severity value may be used to estimate flow. If flow severity was recorded as "2" (low flow) then an estimate of 2.0 cfs is used to compare to the adjusted critical low flow value. If a flow severity of "3", "4", or "5" is recorded the flow is considered to be above

the critical low flow and the DO measurement is used. If a flow severity of 1 (no flow), or flow value of 0 is recorded, the data are considered below the critical low-flow and automatically excluded. If neither flow nor flow severity was recorded the data is presumed to be above the critical low flow and the DO data is assessed against the criterion.

Table 3.2. Aquatic Life Use—Dissolved Oxygen Criteria

Water Body/ Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A				Unclassified Water Bodies and Water Bodies Identified in Appendix D of the TSWQS			
		Most Typically Designated Aquatic Life Use	Typically Designated Criteria ⑥ 24-hour average/ minimum (mg/L) ⑥	Eliminate samples collected below the critical low-flow ②	Presumed 7Q2—if not published or no information to contrary⑥	Presumed Aquatic Life Use ①	Presumed Criteria 24-hour average/ minimum (mg/L)	Eliminate samples below critical low-flow ③	Presumed 7Q2 if not published or no information to contrary ⑥
Freshwater Stream	***Freshwater Perennial Stream*** ③	Exceptional	6.0/4.0	Yes	0.1 cfs	High	5.0/3.0	Yes	0.1 cfs
		High	5.0/3.0						
		Intermediate	4.0/3.0						
		Limited	3.0/2.0						
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ⑤	Limited	3.0/2.0	n/a	0.0 cfs	Limited	3.0/2.0	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream*** ④ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	Minimal	2.0/1.5	n/a	0.0 cfs	Minimal	2.0/1.5	No 7Q2 is 0.0 cfs	0.0 cfs
Reservoir	***Reservoir***	Exceptional	6.0/4.0	n/a	n/a	High	5.0/3.0	n/a	n/a
		High	5.0/3.0						
		Intermediate	4.0/3.0						
		Limited	3.0/2.0						
Tidal Stream	***Tidal Stream***	Exceptional	5.0/4.0	n/a	n/a	High	4.0/3.0	n/a	n/a
		High	4.0/3.0						
		Intermediate	3.0/2.0						
Estuary	***Estuary***	Exceptional	5.0/4.0	n/a	n/a	High	4.0/3.0	n/a	n/a
		High	4.0/3.0						
		Intermediate	3.0/2.0						
Ocean	***Ocean***	Exceptional	5.0/4.0	n/a	n/a	n/a	n/a	n/a	n/a
Freshwater Wetland	***Freshwater Wetland***	Aquatic life use is derived from contiguous/adjoining segments. Criteria are not specified, but criteria of 2.0/1.5 must be attained.		n/a	n/a	Aquatic life use is derived from contiguous/adjoining segments. Criteria are not specified, but criteria of 2.0/1.5 must be attained.		n/a	n/a
Saltwater Wetland	***Saltwater Wetland***								

① Presumed ALU and criteria are used for unclassified water bodies except for perennial streams listed in Appendix D of the Texas Surface Water Quality Standards (TSWQS).

② Presume event was above the critical low-flow for classified perennial stream segments when no flow information is available (either severity code or measurement) for the event. Flow severity of 1 is no flow, and thus the event is below critical low-flow. Flow severity of 2 through 5 is above the critical low-flow.

③ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.

④ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.

⑤ Definition of intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. Generally, an "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.

⑥ For East Texas—see TSWQS Table 4 for site-specific critical low flows. The critical low-flow is published however if a more recent TCEQ permit action alters the critical low-flow at the site, a more accurate critical low-flow may be calculated and used.

⑦ Springtime criteria, up to 1.5 mg/L higher than shown, to protect fish spawning periods are applied during that portion of the first half of the year when water temperatures are 63.0 to 73.0 degrees Fahrenheit (see Table 3 in the TSWQS).

Toxic Substances in Water

Support of the ALU, based on toxic chemicals in water, includes an evaluation of those metals and organic substances for which criteria have been developed. The TCEQ has developed water quality criteria in the TSWQS for metals and organic substances (see Tables 3.3). *Acute criteria* apply to all waters of the state and at all flows above one-fourth the critical low-flow except in small zones of initial dilution near wastewater discharge points. *Chronic criteria* apply outside of mixing zones in water bodies with ALUs designated in Appendixes A and D of the TSWQS, in unclassified perennial streams when the stream flow is greater than the critical low-flow, and in intermittent streams that support significant aquatic life.

For evaluating acute toxicity, individual measurements of metals and organic substances are compared against acute criteria established in the TSWQS (Table 1 in the TSWQS). Selection of which set of criteria (freshwater or tidal water) to use in the comparison is based on the location of the station; for example, for a station located in tidally influenced water, the marine criteria are applicable (see Table 3.4).

Support of the ALU is also based on *toxic substance chronic criteria* for either freshwater or saltwater. Marine criteria are used at stations in segments classified as tidal or where tidal activity is indicated by specific conductance measurements that routinely exceed 3,000 µS/cm, or where the stream is below five feet in elevation and tidal activity is presumed. For each parameter at each site, the average of all values is compared against the chronic criterion to determine ALU support. If the average exceeds the criterion, the use is not supported. Should the average be exceeded over the period of record, the data set is subsequently evaluated to ensure the criterion is also exceeded more than one time. If the average exceeds, and this is the result of only an occasional high value, the assessor will use judgment in the evaluation of the data set and a concern rather than impairment, is identified. Additional monitoring is initiated when a concern for toxic contaminants is identified.

Assessing Compliance with an Acute Toxic Criterion as a Percent of Samples Exceeding the Criterion Up to 10 Percent

Since acute criteria have additional statistical safeguards and safety factors incorporated into them, even moderate rates of exceedance would not constitute an ecological disruption. In order to assess compliance from limited data sets, even the use of a 10 percent exceedance rate will cause a water body to be considered impaired. This is an important consideration with a very small number of measured exceedances when the possibility of statistical and measurement error is only marginally acceptable. Consideration of a smaller frequency of exceedance would be impractical.

The relevant narrative provisions in the EPA-approved TSWQS [30 TAC §307.4(d), §307.6(b), §307.6(c)] do not suggest that a single measured exceedance of an acute (or chronic) toxic criterion should be considered a violation of the standards. TCEQ added the following clarification in §307.9(a) of the 2010 TSWQS: "Unless otherwise stated in this chapter, additional details concerning how sampling data are evaluated to assess standards compliance are provided in the latest approved version of the TNRCC [now TCEQ] Guidance for Screening and Assessing Texas Surface and Finished Drinking Water Quality Data."

Using the Sample Average to Compare to a Chronic Toxic Criterion Instead of Assessing Compliance as a Percentage of Samples Exceeding the Criterion

The definition of chronic toxicity in the 2010 TSWQS is as follows: "Toxicity which continues for a long-term period after exposure to toxic substances. Chronic exposure produces sub-lethal effects, such as growth impairment and reduced reproductive success, but it may also produce lethality. The duration of exposure applicable to the most common chronic toxicity test is seven days or more."

The standards also indicate that "specific numerical chronic aquatic life criteria are applied as seven-day averages." The purposes of the seven-day average are (1) to establish a low-flow "cut-off" for applicability of the criterion as defined by 7Q2 stream flows, (2) to tie the criteria to a typical seven-day duration of chronic lab tests, and (3) to indicate that assessment of instream compliance is based on an average condition not on a single "grab" sample.

For purposes of monitoring instream compliance with standards, it is not appropriate to compare single samples against the chronic criteria because that approach does not allow for any averaging of instream measurement. EPA guidance suggests that exceedances of chronic criteria should only occur every three years. This is based on the observation that three years might be needed between substantial ecological disruptions in order to allow time for aquatic biota to recover. However, moderate exceedances of the adopted chronic criteria do not in any way constitute an ecological disruption. The criteria, which are in fact an attempt to develop an acceptable concentration for average exposure (albeit over somewhat limited time periods in testing), have a variety of safety factors and statistical safeguards incorporated into them.

Hardness and pH-based Criteria

To get the most accurate determination of instream conditions for acute toxicity, the existence of toxicity is determined at the time of the sampling event. This is done by computing the threshold concentration of toxicant needed to cause toxicity at the time of collection, and then comparing this threshold concentration to the sample event toxicant concentration. It is necessary to use the event hardness or pH and the TSWQS equation to calculate a unique acute criterion for each event.

Using event specific hardness. When event specific hardness data are available, these results are used for determining acute toxicity. Then, each calculated criterion is compared to the corresponding measured concentration of toxicant in order to determine support of the criterion for that sample.
Note: Calcium and magnesium are often reported instead of hardness. Hardness can be computed from calcium and magnesium for a sample event using this equation:
Hardness (mg/L CaCO3) = 2.497 (calcium, mg/L) + 4.118 (magnesium, mg/L)

Using default values. When event specific hardness is available or calculated, this value is used for determining acute toxicity. When event specific data are not available, default values for segment specific hardness or pH are used in the screening program to calculate an allowable instream concentration of toxicants. Hardness or pH values, published in the *Procedures to Implement the Texas Surface Water Quality Standards*, were developed in order to calculate a conservative threshold concentration for permitting, above which the instream conditions would exceed the criterion. When a permitted discharge is modeled using the computed criteria, instream concentrations are expected to exceed the criterion about 15 percent of the time if the facility is discharging at the permitted limit and when a stream is near critical low flow conditions. The published segment specific hardness or pH values are used in the calculation of both acute and chronic criteria for a classified segment and its unclassified tributaries. See Table 5 of the *Procedures to Implement the Texas Surface Water Quality Standards* for segment specific hardness and pH values.

Hierarchy for using pH and hardness values. When data are available, the hierarchy of preferred hardness or pH values for calculation criteria is as follows:
Classified segments. Assessors will use event hardness values. When no event values exist, 15th percentile values published in the *Implementation Procedures*, RG-194 for the segment (or basin when segment values do not exist) are used.
Unclassified segments. Assessors will use event hardness values. When no event values exist, 15th percentile values published in the *Procedures to Implement the Texas Surface Water Quality Standards* for the basin are used.

Use of the 15th percentile of hardness is conservative when applied to all of the samples in a data set and, on occasion, may incorrectly identify nonsupport of acute criteria for the segment. The assessor can develop a rationale (e.g. a data set of <30 values) for using an alternate percentile, perhaps the 50th, when it is more appropriate for the AU or station.

Free Ionic Form of Silver

The TSWQS express the freshwater criterion for silver in the *free ionic form*. Silver data in the SWQMIS database are reported as the dissolved fraction. The percentage of dissolved silver that is present in the free ionic form is calculated and compared to the criterion.

The TCEQ developed a regression equation ($R^2 = 0.87$) that calculates the percentage of dissolved silver that is in the free ionic form. The following equation is used to determine what percentage of dissolved silver is in the free ionic form:

$$Y = \exp [\exp (1/(0.6559 + 0.0044 \times Cl))]$$

Where:

Y = percent of dissolved silver in the free ionic form
Cl = dissolved chloride (mg/L)

The percentage obtained from the above equation is converted to a proportion and then multiplied by the dissolved fraction to obtain the free ionic silver concentration. For this equation, chloride values are obtained from the *Procedures to Implement the Texas Surface Water Quality Standards*, Tables D1-D25. When the range of chloride values exceeds 140 mg/L, the percentage of silver in the free ionic form will be 8.98 percent. The event-specific chloride or the 50th percentile value of the dissolved chloride concentration for each AU or station can be used, provided that 30 or more chloride measurements from ambient samples are available. For unclassified water bodies, the 50th percentile for the classified segment that receives the water can be used, or when the unclassified water body is fresh water and the segment is saltwater, the basin values can be used.

Table 3.3. Criteria for Specific Metals and Organic Substances in Water for Protection of Aquatic Life

Criteria in Water for Specific Toxic Materials –
AQUATIC LIFE PROTECTION
(All values are listed or calculated in micrograms per liter)
(Hardness concentrations are input as milligrams per liter)

Parameter	Parameter Code	Freshwater Acute Criteria	Freshwater Chronic Criteria	Saltwater Acute Criteria	Saltwater Chronic Criteria
Aldrin	39330	3.0	---	1.3	---
Aluminum (d)	01106	991w	---	---	---
Arsenic (d)	01000	340 w	150 w	149w	78w
Cadmium (d)	01025	$(1.136672-(\ln(\text{hardness})(0.041838)))\ (we^{(1.0166\ (\ln(\text{hardness}))-2.4743)})$	$(1.101672-(\ln(\text{hardness})(0.041838)))\ (we^{(0.7409\ (\ln(\text{hardness}))-4.719)})$	40.0 w	8.75w
Carbaryl	39750	2.0	---	613	---
Chlordane	39350	2.4	0.004	0.09	0.004
Chlorpyrifos	81403	0.083	0.041	0.011	0.006
Chromium (Tri) (d)	01030	$0.316we^{(0.8190(\ln(\text{hardness}))+3.7256)}$	$0.860we^{(0.8190(\ln(\text{hardness}))+0.6848)}$	---	---
Chromium (Hex) (d)	10220	15.7w	10.6w	1,090w	49.6w
Copper (d)*	01040	$0.960m\ e^{(0.9422(\ln(\text{hardness}))-1.6448)}$	$0.960m\ e^{(0.8545(\ln(\text{hardness}))-1.6463)}$	13.5w	3.6w
Cyanide † (free)	00722	45.8	10.7	5.6	5.6
4,4'- DDT	39370	1.1	0.001	0.13	0.001
Demeton	39560	---	0.1	---	0.1
Diazinon	39570	0.17	0.17	0.819	0.819
Dicofol	39780	59.3	19.8	---	---
Dieldrin	39380	0.24	0.002	0.71	0.002
Diuron	39650	210	70	---	---

Parameter	Parameter Code (or CASRN)	Freshwater Acute Criteria	Freshwater Chronic Criteria	Saltwater Acute Criteria	Saltwater Chronic Criteria
Endosulfan I (*alpha*)	34361	0.22	0.056	0.034	0.009
Endosulfan II (*beta*)	34356	0.22	0.056	0.034	0.009
Endosulfan sulfate	34351	0.22	0.056	0.034	0.009
Endrin	39390	0.086	0.002	0.037	0.002
Guthion	39580	---	0.01	---	0.01
Heptachlor	39410	0.52	0.004	0.053	0.004
Hexachloro-cyclohexane (*gamma*)(Lindane)	39782	1.126	0.08	0.16	---
Lead (d)	01049	$(1.46203-(\ln(\text{hardness})(0.145712)))\ (we^{(1.273(\ln(\text{hardness}))-1.460)})$	$(1.46203-(\ln(\text{hardness})(0.145712)))\ (we^{(1.273(\ln(\text{hardness}))-4.705)})$	133w	5.3w
Malathion	39530	---	0.01	---	0.01
Mercury	71900	2.4	1.3	2.1	1.1
Methoxychlor	39480	---	0.03	---	0.03
Mirex	39755	---	0.001	---	0.001
Nickel (d)	01065	$0.998we^{(0.8460(\ln(\text{hardness}))+2.255)}$	$0.997we^{(0.8460(\ln(\text{hardness}))+0.0584)}$	118w	13.1w
Nonylphenol	84852-15-3 and 25154-52-3	28	6.6	7	1.7
Parathion (ethyl)	39540	0.065	0.013	---	---
Pentachlorophenol	39032	$e^{(1.005(\text{pH})-4.869)}$	$e^{(1.005(\text{pH})-5.134)}$	15.1	9.6
Phenanthrene	34461	30	30	7.7	4.6
Polychlorinated Biphenyls (PCBs) ‡	39516	2.0	0.014	10	0.03

Parameter	Parameter Code	Freshwater Acute Criteria	Freshwater Chronic Criteria	Saltwater Acute Criteria	Saltwater Chronic Criteria
Selenium	01147	20	5	564	136
Silver, as free ion	01523	0.8w	---	2w	---
Toxaphene	39400	0.78	0.0002	0.21	0.0002
Tributyltin (TBT)	30430	0.13	0.024	0.24	0.0074
2,4,5 Trichlorophenol	77587	136	64	259	12
Zinc (d)	01090	$0.978we^{(0.8473(\ln(\text{hardness}))+0.884)}$	$0.986we^{(0.8473(\ln(\text{hardness}))+0.884)}$	92.7w	84.2w

* In designated oyster waters, an acute saltwater copper criterion of 3.6 micrograms per liter applies outside of the mixing zone of permitted discharges, and specified mixing zones for copper do not encompass oyster reefs containing live oysters.

† Compliance will be determined using the analytical method for available cyanide.

(d) Indicates that the criteria for a specific parameter are for the dissolved portion in water. All other criteria are for total recoverable concentrations, except where noted.

‡ These criteria apply to the sum of all congener or all isomer or homolog or Arochlor analysis.

w Indicates that a criterion is multiplied by a water-effect ratio (WER) in order to incorporate the effects of local water chemistry on toxicity. The WER is equal to 1 except where sufficient data is available to establish a site-specific WER. WERs for individual water bodies are listed in Appendix E when standards are revised. The number preceding the w in the freshwater criterion equation is an EPA conversion factor.

m Indicates that a criterion may be multiplied by a WER or a biotic ligand model result in order to incorporate the effects of local water chemistry on toxicity. The multiplier is equal to 1 except where sufficient data is available to establish a site-specific multiplier. Multipliers for individual water bodies are listed in Appendix E when standards are revised. The number preceding the m in the freshwater equation is an EPA conversion factor.

e The mathematical constant that is the basis of the natural logarithm. When rounded to four decimal points, *e* is equal to 2.7183.

Narrative Criteria Protecting Aquatic Life

Ambient Water Toxicity

Aquatic life is protected from toxic conditions in water by narrative criteria. ALU support is evaluated based on ambient water toxicity tests using sensitive test organisms. Sample toxicity can be established with tests using more than one species of test organism. If any of these tests exhibit toxicity, the sample is considered toxic. Support of the ALU is determined with ambient acute and chronic toxicity tests in water. The narrative criteria protecting aquatic life is not supported when samples are toxic more than ten percent of the time using the binomial method. Although a minimum of ten samples are required for full assessment when two or more ambient water (or sediment) samples are toxic in smaller data sets, the ALU is not attained.

Samples generated by EPA Region 6 TOXNET Program will be evaluated as concerns when persistent (> 50% and based on the judgment of the assessor) sublethal effects are identified. Where such concerns for sublethal effects are identified with TOXNET samples, subsequent testing using conventional water toxicity testing methods will be initiated to confirm sublethal effects. The water body may be listed based on lethal effects demonstrated with TOXNET samples, and with conventional water toxicity testing methods exhibiting lethal or sublethal effects. Persistent sublethal effects based on conventional water toxicity testing will be used to list the water body, with some judgement allowed to the assessor in cases where toxicity testing is highly episodic and occurrences of sublethal toxicity are observed at varying points in time and under various water quality conditions (e.g. sublethal toxicity is observed under a condition of flow or temperature that confounds the attribution of toxicity to a given condition and all other indicators demonstrate support of a use).

Determination of ambient toxicity is subject to some judgment by the assessor. All available information must be evaluated, including the reliability of the toxicity tests, presence of toxic contaminants, health of the biological community and condition of fish sampled, and the proximity and route to known and potential sources of toxic contaminants.

Ambient Sediment Toxicity

Aquatic organisms are also protected against toxic conditions in sediment. Sediment toxicity in conjunction with other water quality information may be used to make determinations of water quality standards attainment. Sediment toxicity sample collection is to be conducted to examine specific water bodies where concerns have been identified. Ambient sediment toxicity assessments will examine the spatial and temporal relationship between contaminants, observed toxicity, and resident biological communities. All information will be integrated into a weight of evidence approach to best judge the condition of the area of investigation and to identify toxic sediment. The lines of evidence (LOE) process described in this guidance document is appropriate for defining use support and listing or delisting on the 303(d) List. Planning water quality restoration and decisions about implementation, will require additional sampling and information gathering.

The method for evaluating sediment toxicity is outlined in Appendix C. Ambient sediment toxicity status is reported only with the LOE assessment method and only when there are at least two of the following LOE available for consideration-toxicity tests (ambient whole sediment or elutriate tests), sediment contaminant levels, or biological community data. However, use support of aquatic life using the LOE ambient sediment toxicity method is routinely reported only when ambient whole sediment or elutriate tests are available. Acute and chronic whole sediment and elutriate test outcomes are reported as results for these assessment methods (number of samples and number of exceedances), but use attainment or concern status is not reported for these methods.

When concerns for sediment toxicity are identified using elutriate samples, additional monitoring and evaluation of use attainment will be initiated within two years using whole sediment toxicity tests.

Table 3.4. Aquatic Life Use—Toxic Criteria

Water Body/ Segment Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A			Unclassified Water Bodies including water bodies identified in Appendix D of the TSWQS ①		
		Aquatic Life Criteria	Eliminate samples collected below the Critical low-flow ②	Presumed 7Q2 if not published or no information to contrary	Aquatic Life Criteria	Eliminate samples below Critical low-flow ②	Presumed 7Q2 if not published or no information to contrary
Freshwater Stream	***Freshwater Perennial Stream*** ③	FW Acute	No	0.1 cfs	FW Acute	No	0.1cfs
		FW Chronic	Yes	0.1 cfs	FW Chronic	Yes	0.1 cfs
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ⑤	FW Acute	n/a	0.0 cfs	FW Acute	No 7Q2 is 0.0 cfs	0.0 cfs
		FW Chronic	n/a	0.0 cfs	FW Chronic	No 7Q2 is 0.0 cfs	0.0 cfs
Freshwater Stream	***Freshwater Intermittent Stream*** ④ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	FW Acute	n/a	0.0 cfs	FW Acute	No 7Q2 is 0.0 cfs	0.0 cfs
Reservoir	***Reservoir***	FW Acute	n/a	n/a	FW Acute	n/a	n/a
		FW Chronic	n/a	n/a	FW Chronic	n/a	n/a
Tidal Stream	***Tidal Stream***	SW Acute	n/a	n/a	SW Acute	n/a	n/a
		SW Chronic	n/a	n/a	SW Chronic	n/a	n/a
Estuary	***Estuary***	SW Acute	n/a	n/a	SW Acute	n/a	n/a
		SW Chronic	n/a	n/a	SW Chronic	n/a	n/a
Ocean	***Ocean***	SW Acute	n/a	n/a	n/a	n/a	n/a
		SW Chronic	n/a	n/a	n/a	n/a	n/a
Freshwater Wetland	***Freshwater Wetland***	FW Chronic	n/a	n/a	FW Acute	n/a	n/a
		FW Acute	n/a	n/a	FW Chronic	n/a	n/a
Saltwater Wetland	***Saltwater Wetland***	SW Acute	n/a	n/a	SW Acute	n/a	n/a
		SW Chronic	n/a	n/a	SW Chronic	n/a	n/a

① Presumed ALU and criteria are used for unclassified water bodies except for the site specific criteria listed in Appendix E, and perennial streams listed in Appendix D of the Texas Surface Water Quality Standards (TSWQS).

② Presume event was above the critical low-flow for classified perennial stream segments when no flow information is available (either severity code or measurement) for the event. Flow severity of 1 is no flow, and thus the event is below critical low-flow. Flow severity of 2 through 5 is above the critical low-flow.

③ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years

④ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.

⑤ Definition of intermittent with perennial pools: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life (not just a refuge). Generally, an "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.

Metal and Organic Substances Sediment Contaminant Levels

Sediments are screened for metal and organic substances that have demonstrated adverse ecological effects. Sample contaminant concentrations are compared to screening levels developed by TCEQ's Ecological Assessment Program outlined in Table 3.5. A concern for aquatic life is identified if more than 20 percent of the contaminant samples exceed the screening levels using the binomial method.

Table 3.5. Screening Levels for Sediment

CAS #	Constituent	Freshwater	Marine
Inorganics (mg/kg dry wt)			
7440-36-0	Antimony	25 [a]	-
7440-38-2	Arsenic	33	70
7440-43-9	Cadmium	4.98	9.6
7440-47-3	Chromium	111	370
7440-50-8	Copper	149	270
7439-89-6	Iron	40,000 [b]	-
7439-92-1	Lead	128	218
7439-96-5	Manganese	1,100 [b]	-
7439-97-6	Mercury	1.06	0.71
7440-02-0	Nickel	48.6	51.6
7440-22-4	Silver	2.2 [a]	3.7
7440-66-6	Zinc	459	410
Polycyclic Aromatic Hydrocarbons (µg/kg dry wt) **Footnote (i) applies to all listed PAHs**			
83-32-9	Acenaphthene	89[j]	500
208-96-8	Acenaphthylene	128 [j]	640
120-12-7	Anthracene	845	1,100
56-55-3	Benz(a)anthracene	1,050	1,600
50-32-8	Benzo(a)pyrene	1,450	1,600
218-01-9	Chrysene	1,290	2,800
53-70-3	1,2,5,6-Dibenz(a,h)anthracene	140[j]	260
206-44-0	Fluoranthene	2,230	5,100
86-73-7	Fluorene	536	540
91-57-6	2- Methyl naphthalene	-	670
91-20-3	Naphthalene	561	2,100
85-01-8	Phenanthrene	1,170	1,500
129-00-0	Pyrene	1,520	2,600
	Low Molecular Weight PAHs	-	3,160 [d,k]
	High Molecular Weight PAHs	-	9,600 [f,i]
	Total PAH	22,800 [g, i, j]	44,790 [f,h,i]
Chlorinated Pesticides/PCBs/Benzenes (µg/kg dry wt)			
309-00-2	Aldrin	80 [b, g]	-
27323-18-8	Aroclor 1254	340 [b, g]	-
12674-11-2	Aroclor 1016	530 [b, g]	-
11096-82-5	Aroclor 1260	240 [b, g]	-
12672-29-6	Aroclor 1248	1,500 [b]	-
319-84-6	alpha-BHC	100 [b, g]	-
319-85-7	beta-BHC	210 [b, g]	-
58-89-9	gamma-BHC (Lindane)	4.99	0.99 [c]

Table 3.5. Screening Levels for Sediment

CAS #	Constituent	Freshwater	Marine
608-73-1	BHC	120 [b, g, h]	-
57-74-9	Chlordane (Total)	17.6	4.79 [c]
60-57-1	Dieldrin	61.8	4.3 [c]
72-20-8	Endrin	207	-
118-74-1	HCB (Hexachlorobenzene)	240 [b, g]	-
1024-57-3	Heptachlor epoxide	16	-
2385-85-5	Mirex	1,300 [b, g]	-
72-55-9	Sum DDE	31.3 [h]	374 [c, h]
72-54-8	Sum DDD	28 [h]	7.81 [c, h]
50-29-3	Sum DDT	62.9 [h]	4.77 [c, h]
1336-36-3	Total PCBs	676 [h]	180 [h]
Other Pesticides (µg/kg dry wt)			
8001-35-2	Toxaphene	32 [l]	-
Phthalates (µg/kg dry wt)			
117-81-7	Bis(2-ethyl-hexyl)phthalate	-	2,647 [c]
	Di-n-butyl phthalate	43 [k]	-
Volatiles (µg/kg dry wt) **Footnote (m) applies to all listed volatiles**			
67-64-1	Acetone	360,180	1,003,360
107-13-1	Acrylonitrile	1,360	1,040
71-43-2	Benzene [n]	45,010	45,010
104-51-8	N-butylbenzene	6,570	-
103-65-1	Propyl benzene	4,350	-
135-98-8	Sec-butylbenzene	5,280	-
98-06-6	Tert-butylbenzene	7,260	-
75-27-4	Bromodichloromethane	14,740	-
78-93-3	2-butanone (MEK)	154,260	-
75-15-0	Carbon disulfide	780	-
56-23-5	Carbon tetrachloride [n]	37,330	37,330
108-90-7	Chlorobenzene [n]	19,870	19,870
124-48-1	Chlorodibromomethane	940	-
67-66-3	Chloroform (trichloromethane)	5,630	25,800
74-87-3	Chloromethane	106,800	52,430
98-82-8	Cumene	53,950	-
99-87-6	p-Cymene	5,980	-
95-50-1	1,2-dichlorobenzene	4,950	4,440
541-73-1	1,3-dichlorobenzene	350	1,950
106-46-7	1,4-dichlorobenzene	4,650	4,210
75-71-8	Dichlorodifluoromethane	22,090	-
75-34-3	1,1-dichloroethane	13,890	-
107-06-2	1,2-dichloroethane	28,690	25,800
156-60-5	1,2-dichloroethene (trans)	71,840	-
78-87-5	1,2-dichloropropane	13,170	-
542-75-6	1,3-dichloropropene	1,370	260
100-41-4	Ethylbenzene	17,180	3,930

Table 3.5. Screening Levels for Sediment

CAS #	Constituent	Freshwater	Marine
87-68-3	Hexachlorobutadiene	550 [l]	12,760 [m, n]
67-72-1	Hexachloroethane [n]	13,770	13,770
110-54-3	Hexane, n- [n]	12,770	-
591-78-6	2-hexanone	28,200	-
108-10-1	4-methyl-2-pentanone (MIBK)	116,590	272,060
74-83-9	Methyl bromide	460	2,490
80-62-6	Methyl methacrylate	56,980	-
75-09-2	Methylene chloride	46,520	22,910
98-95-3	Nitrobenzene [n]	161,060	161,060
67-63-0	2-Propanol [n]	443,990	-
100-42-5	Styrene	61,420	22,310
79-34-5	1,1,2,2-tetrachloroethane	3,800	3,690
127-18-4	Tetrachloroethene	10,500	18,590
108-88-3	Toluene	17,290	5,660
75-25-2	Bromoform	1,310	10,670
120-82-1	1,2,4-trichlorobenzene	5,310	2,320
71-55-6	1,1,1-trichloroethane	24,800	15,830
79-00-5	1,1,2-trichloroethane	5,880	1,800
79-01-6	Trichloroethene	5,070	8,820
75-69-4	Trichlorofloromethane	10,120	-
75-01-4	Vinyl chloride	11,780	-
1330-20-7	Xylenes	12,010	7,470

Table 3.5. Screening Levels for Sediment

CAS #	Constituent	Freshwater	Marine
Freshwater - Unless otherwise noted, values are Probable Effect Concentration (PEC) from: MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.			
Marine - Unless otherwise noted, values are Effects Range Median (ERM) from: Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environ. Manage. 19(1):81-97.			

a. Effects Range Median (ERM) from: Long, E.R. and L.G. Morgan. 1990. The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, March 1990.
b. Severe Effects Level (SEL) from: Persaud, D., R. Jaagumagi and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Water Resources Branch. Ontario Ministry of the Environment and Energy. August.
c. Probable Effect Level (PEL) from: Smith, S.L., D.D. MacDonald, K.A. Keenleyside, and C.L. Gaudet. 1996b. The Development and Implementation of Canadian Sediment Quality Guidelines. In: Development and Progress in Sediment Quality Assessment: Rationale, Challenges, Techniques & Strategies. Ecovision World Monograph Series. Munawar & Dave (Eds.). Academic Publishing, Amsterdam.
d. The sum of the concentrations of the following compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, and 2-methyl napthalene .
e. The sum of the concentrations of the following compounds: fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(a)pyrene, and dibenzo [a,h]anthracene .
f. The sum of the concentrations of each of low and high molecular weight PAHs listed above and any other PAH compounds that are COCs .
g. Values in the original reference were based on percent total organic carbon. These values were converted to bulk sediment values by assuming 1% TOC (SEL x 0.01).
h. When benchmarks represent the sum of individual compounds, isomers, or groups of congeners, and the chemical analysis indicates an undetected value, the proxy value specified at §350.51 (n) shall be used for calculating the sum of the respective compounds, isomers, or congeners. This assumes that the particular COC has not been eliminated in accordance with the criteria at §350.71 (k).
i. The benchmarks for total PAHs are the most relevant in evaluating risk in an ERA as PAHs almost always occur as mixtures. Values for individual, low molecular weight, and high molecular weight PAHs are provided as guidelines to aid in the determination of disproportionate concentrations within the mixture that may be masked by the total. See discussion in Section 3.5.4.
j. CCME (Canadian Council of Ministers of the Environment). 1999. Canadian environmental quality guidelines. Winnipeg, Manitoba.
k. Cubbage, J., D. Batts, and S. Briedenbach. 1997. Creation and analysis of freshwater sediment quality values in Washington State. Environmental Investigations and Laboratory Services Program. Washington Department of Ecology. Olympia, Washington.
l. NYSDEC (New York State Department of Environmental Conservation). 1999. Technical guidance for screening contaminated sediments. Division of Fish, Wildlife, and Marine Resources. Albany, New York. 36 pp.
m. Benchmarks derived using formula in: Fuchsman, P.C. 2003. Modification of the Equilibrium Partitioning Approach for Volatile Organic Compounds in Sediment. Environ Toxicol Chem. 22:1532-1534. TCEQ's LC50 database used for water quality values, except where noted. TRRP-24 default values of 1% fraction organic carbon (foc) and 0.37 porosity were used. The person should adjust these values if sufficient site-specific data indicate they are not representative.
n. Acute water quality values were used as input for these COCs and were derived from DiToro, D.M., J.A. McGrath, and D.J. Hansen. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. I. Water and tissue. Environ. Toxicol. Chem. 19: pp 1951-1970.

Fish and Benthic Community Assessment

In the TSWQS, an exceptional, high, intermediate, or limited ALU is assigned to each classified water body, and to some unclassified water bodies, based on physical, chemical, and biological characteristics (see Appendixes A and D of the TSWQS). Biological characteristics that describe each ALU category are assessed, based on fish and/or benthic macroinvertebrate data.

For water bodies where ALU categories have been designated or presumed, use attainment can be assessed using biological data. Determination of attainment of biological characteristics deemed appropriate for each ALU category is based on the use of multimetric indices of biological integrity which integrate structural and functional attributes of biotic assemblages.

Fish and benthic community data are collected according to field methods specified in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data* (RG-416). These data are used to evaluate the integrity of the fish community based on the index of biotic integrity (IBI). The IBI is exclusive to freshwater streams and cannot be used to assess fish community samples collected from reservoirs or tidal streams. Please refer to the RG-416 for guidance on the use of IBIs. Regional IBIs must be used where available.

If benthic macroinvertebrates are collected according to *quantitative protocols* using a Surber sampler, the integrity of the benthic macroinvertebrate community should be evaluated based on the benthic index of biotic integrity. If benthic macroinvertebrates are collected according to *rapid bioassessment* (RBA) protocols (5-minute kicknet, RBA snags), then the integrity of the benthic macroinvertebrate community should be evaluated based on the metric set for evaluation of benthic macroinvertebrate data outlined in RG-416.

Aquatic Habitat

An evaluation of habitat quality is critical to any assessment of ecological integrity. Habitat protocols have been developed primarily for wadeable streams. A habitat quality evaluation is accomplished by measurement of physical habitat parameters at evenly-spaced transects over a defined stream reach according to established TCEQ protocols (TCEQ *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data,* RG-416). These habitat measurements should be conducted at the same time as biological field work. Measurements are made instream, along the stream channel and banks, and in the riparian zone to provide a holistic habitat assessment. The actual habitat evaluation process involves rating nine parameters across four categories through use of a *multimetric habitat quality index*. The total score obtained from the stream reach is compared to categorical ranges that relate to exceptional, high, intermediate, and limited ALUs. When the habitat index indicates nonsupport, the habitat attainment status is reported as a concern.

Determining Overall Aquatic Life Use

When available, the determination of fish and/or benthic macroinvertebrate integrity should be used in conjunction with physical and chemical data to provide an integrated assessment of support of the aquatic life use for water bodies identified in the TSWQS (Appendixes A and D). Support for a given water body should be assessed according to the decision matrix specified in Table 3.6. Determination of attainment for bioassessment data is based on the average of the total scores. Scores are derived for each of two or more bioassessment events as described in RG-416.

Two bioassessment events. If only two bioassessment events are considered, both should be conducted during the index period March 15 to October 15, with only one of the two events occurring between July 1 and September 30. An effort should be made to collect both samples from the same index period. This reduces the probability of missing effects of perturbation(s) that occurred in the latter portion of the index period.

More than two bioassessment events. If more than two bioassessment events are considered, then the period of study should be two or more years, with two events or more samples per year. More than two samples collected during the same year may be considered as long as sample dates are consistent with temporal guidelines below.

All events should occur between March 15 and October 15 with one-half to two-thirds of the events occurring between July 1 and September 30.

Sample events are conducted at about one month apart and during periods of moderate to low flow but above the 7Q2.

The average score is compared to the aquatic life use point score ranges for fish, and for benthic macroinvertebrates, depending on what field protocols were followed. If sample results from multiple events are very different, the reasons will be evaluated, and the validity of the samples will be assessed. An aquatic life concern is identified when only one sample event is available for assessment and nonsupport of the use is indicated.

Determining Aquatic Life Use Standards Attainment

When using biological data collected during Aquatic Life Monitoring (ALM) to assess a water body for which the ALU Category was established without bioassessments, the highest ALU category indicated by either the fish or benthic macroinvertebrates will be compared to the designated or presumed use to determine support. In this scenario, if results from an ALM for both assemblages indicate support of the designated or presumed use, the water body will be considered fully supporting. However, if results from an ALM for either assemblage indicates non-support of the designated or presumed use, the water body will be identified as fully supporting, but with a concern, and an effort will be undertaken to properly define the ALU category for both assemblages for future assessments. This may reduce the possibility of inappropriately listing a water body as a result of natural inherent differences between the integrity of the fish and benthic assemblages. This is consistent with findings of an ongoing study conducted on least disturbed streams throughout Texas. In cases where the ALU indicated by each assemblage differs from the other and the results from an ALM indicate that neither assemblage support the designated, or presumed use, the water body will be placed on the 303d list.

When the ALU category for a water body was established based on a Use Attainability Analysis (UAA) including biological data, and the methods used in the UAA are current, the assessment should be consistent with the findings of the UAA for each assemblage. For example, consider a water body where a UAA was conducted which resulted in establishing a high ALU category for fish, and an intermediate ALU category for benthic macroinvertebrates. Subsequently, when and if an ALM is conducted in the same water body, then the fish will be assessed against the criterion for high ALU, and the benthic macroinvertebrates will be assessed against the criterion for intermediate ALU. If results for both assemblages as determined from ALM agree with the results of the UAA the water body will be considered to be fully supporting. If the ALU determination results from ALM for either assemblage is lower than the ALU designated in the UAA, then the water body will be placed on the 303d list. This will reduce the likelihood of missing a source of impairment that is affecting primarily one of the assemblages, but not the other.

Application of the Coefficient of Variation (CV) in Bioassessments

To assess attainment of the designated or presumed ALU category for an AU, the mean of a minimum of two samples collected from each of one or more representative sites within the AU will be used in conjunction with the ecoregion coefficient of variability (CV) for the designated ALU. All samples from all sites in the AU will be used to calculate the mean IBI score for each assemblage for that AU. If it is determined that a site is not representative of aquatic habitat in the AU, then results for bioassessments conducted at that site will not be included in the calculation of the mean. The Ecoregion/ALU specific CV will be used in conjunction with this mean to establish an interval about the mean IBI for each assemblage for the AU. To assess support of the designated or presumed ALU, the highest ALU category included in the interval described about the mean by the CV will be used to determine attainment for each assemblage. See Appendix D for detailed information on the development and application of the CV.

Threatened and Endangered Species

When water quality conditions do not support a healthy aquatic community or individual populations, including threatened and endangered species, that ALU is not attained. Up-to-date information for threatened and endangered species can be found on the Texas Parks and Wildlife Department website. This information can be used to identify the presence of these species for use in assigning categories for TMDL development and planning the basin cooperative monitoring schedule.

Table 3.6. Decision Matrix for Integrated Assessments of Aquatic Life Use (ALU) Support

Overall ALU Support based on Bioassessment, Dissolved Oxygen, Toxics in Water, and Ambient Toxicity in Water. For three or more lines of evidence, unless otherwise illustrated here, nonattainment of any line of evidence discussed here results in nonsupport of the ALU.

Bioassessment Data	**Aquatic Life Use Support Attainment**					
	Dissolved Oxygen Data Meets Criteria**	**Toxics in Water, Toxicity Testing All Meet Criteria**	**Dissolved Oxygen Data DO Not Meet Criteria**	**Toxics in Water, Toxicity Testing Do Not Meet Criteria**	**Habitat Assessment Meets Screening Criteria**	**Habitat Assessment Does Not Meet Screening Criteria (reported as a concern)**
Benthic macroinvertebrate and fish bioassessments done and both attain designated ALU	Fully Supported	Fully Supported	Not Supported*	Not Supported	Fully Supported	Fully Supported *
Benthic macroinvertebrate and fish bioassessments done and one of the two does not attain designated ALU	Fully Supporting with a Concern	Fully Supporting with a Concern	Not Supported	Not Supported	Fully Supporting with a Concern	Fully Supporting with a Concern
Both benthic macroinvertebrate and fish bioassessment done and both indicate non-attainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only fish bioassessment done and indicates nonattainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only benthic macroinvertebrate bioassessment done and indicates nonattainment of designated ALU	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Only fish bioassessment done and indicates attainment of designated ALU****	Fully Supported	Fully Supported	Not Supported*	Not Supported	Fully Supported	Fully Supported *
Only benthic macroinvertebrate bioassessment done and indicates attainment of designated ALU****	Fully Supported	Fully Supported	Not Supported*	Not Supported	Fully Supported	Fully Supported *
Bioassessment data not available	Fully Supported	Fully Supported	Not Supported	Not Supported	Fully Supported	Not Supported**

Both fish and macroinvertebrate samples are required to make an ALU attainment determination for 305(b)/303(d) assessment purposes. In certain cases where it is only possible to collect one or the other, the ALU determination may be made based on only fish or benthic macroinvertebrates according to the framework presented in this table. Proper justification is required for why only one type of community was sampled.

* Long-term bioassessment monitoring will be conducted to determine if adverse effects to the fish and/or benthic macroinvertebrates are detected.

** When the habitat index indicates nonsupport, the habitat attainment status is reported as a concern.

*** The average IBI and HBI scores are compared to the ALU point score ranges for fish, and for benthic macroinvertebrates, depending on what field protocols were followed. If sample results from multiple events are very different, the reasons will be determined, if possible, and it will be determined if the samples are appropriate for use.

**** When it is only possible, or appropriate (e.g. due to habitat limitations), to sample either the fish or benthic macroinvertebrate assemblage then the results will be evaluated for support. If samples are collected for only one assemblage but it would be possible or appropriate to sample both the fish and benthic macroinvertebrate assemblage then results will be evaluated as a concern.

Recreation Use

Recreation Use categories and criteria (Table 3.7) are assigned to all water bodies. Two organisms are routinely analyzed in water samples collected to determine support of the recreation use: *Escherichia coli* (*E. coli*) in fresh-water, and Enterococci in tidal water bodies and certain inland water bodies (see Table 3.8). Fecal coliform will continue to be used to assess the oyster waters (14col./100mL median).

Table 3.7. Contract Recreation Use Categories

Uses	E. coli (FW) (colonies/100mL)	Enterococci (Salty inland FW)* (colonies/100mL)	Enterococci (SW) (colonies/100mL)
Primary contact (PCR)	126	33	35
Secondary contact 1 (SCR1)	630	165	175**
Secondary contact 2 (SCR2)	1030	270	--
Noncontact recreation (NCR)	2060	540	350

* Salty (high saline) inland FW = High saline inland water bodies (conductivity ≥ 10000 μmhos/cm)

** Secondary contact 1 for SW would only be applicable when not in conflict with the federal Beach Act

Recreation use categories and criteria for classified segments are specified in Appendix A of the TSWQS. Site-specific recreation use categories and criteria for selected unclassified water bodies are specified in Appendix G. For water bodies not specifically listed in Appendix A or Appendix G, primary contact recreation is the presumed use, except that secondary contact recreation 1 can be assigned to individual streams if (1) the stream is less than 0.5 meters deep, (2) an analysis demonstrates that primary contact recreation does not occur, and (3) the use of the stream is reviewed during a prescribed public participation process. Establishment of another recreation use category requires a recreational use attainment analysis (RUAA) or other standards revision process to determine the appropriate recreation use category.

The recreation uses in the TSWQS are as follows:

- Primary contact recreation (PCR): Water recreation activities, such as wading by children, swimming, water skiing, diving, tubing, surfing, and whitewater kayaking, canoeing, and rafting, involving a significant risk of ingestion of water.
- Secondary contact recreation 1(SCR1): Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion and that commonly occur.
- Secondary contact recreation 2(SCR2): Water recreation activities, such as fishing, commercial and recreational boating, and limited body contact incidental to shoreline activity, not involving a significant risk of water ingestion but that occur less frequently than for secondary contact recreation 1 due to (1) physical characteristics of the water body and/or (2) limited public access.
- Noncontact recreation: Activities, such as ship and barge traffic, birding, and using hike and bike trails near a water body, not involving a significant risk of water ingestion, and where primary and secondary contact

recreation should not occur because of unsafe conditions. The recreation use for these water bodies is protected by the same criteria and indicators assigned to contact recreation waters—*E. coli*, and Enterococci.
A noncontact recreation use and an *E.coli* geometric average of 605 colonies/100mL is assigned to Segment 2308 of the Rio Grande near El Paso. A noncontact recreation use and an *E.coli* geometric average of 126 colonies/100mL is assigned to Segment 0105, Rita Blanca Lake. A noncontact recreation use and an *Enterococci* geometric average of 35 colonies/100mL is assigned to Segments 1005, 1701, 2436, 2437, 2438, 2484, and 2494. Some water bodies (for example, Segments 1006 and 1007 of the Houston Ship Channel) are not assigned recreation use due to local statutes that preclude any recreational uses for safety reasons.

Table 3.8. Recreation Use—Bacterial Indicator Criteria

Water Body Type	Flow-Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Recreation Use Categories	Criteria * Geomean (colonies/100mL) EC=*E. coli*, E=*Enterococcus*	Eliminate samples collected when:
Freshwater Stream	*Freshwater Perennial Stream* ①	PCR SCR1 SCR2 NCR	126 EC 630 EC 1030 EC 2060 EC	Flow < 0.1 cfs
Freshwater Stream	*Freshwater Intermittent Stream with Perennial Pools* adequate to support significant aquatic life②	PCR SCR1 SCR2 NCR	126 EC 630 EC 1030 EC 2060 EC	④
Freshwater Stream	*Freshwater Intermittent Stream* ③ and intermittent stream with perennial pools not adequate to support significant aquatic life	PCR SCR1 SCR2 NCR	126 EC 630 EC 1030 EC 2060 EC	④
Salty Inland Freshwater Stream	*Freshwater Perennial Stream* ①	PCR SCR1 SCR2 NCR	33 E 165 E 270 E 540 E	Flow < 0.1 cfs
Salty Inland Freshwater Stream	*Freshwater Intermittent Stream with Perennial Pools* adequate to support significant aquatic life②	PCR SCR1 SCR2 NCR	33 E 165 E 270 E 540 E	④
Salty Inland Freshwater Stream	*Freshwater Intermittent Stream* ③ and intermittent stream with perennial pools not adequate to support significant aquatic life	PCR SCR1 SCR2 NCR	33 E 165 E 270 E 540 E	④
Reservoir	*Reservoir*	PCR	126 EC	n/a
Tidal Stream	*Tidal Stream*	PCR SCR1 NCR	35 E 175 E 350 E	n/a
Estuary	*Estuary*	PCR	35 E	n/a
Ocean	*Ocean*	PCR	35 E	n/a
Freshwater Wetland	*Freshwater Wetland*	PCR	126 EC	n/a
Saltwater Wetland	*Saltwater Wetland*	PCR	35 E	n/a
Freshwater Perennial Stream	*Freshwater Perennial Stream* Segment 2308 only	NCR	605 E	yes
Reservoir	*Reservoir* Segment 0105 only	NCR	126 EC	n/a
Tidal Stream	*Tidal Stream* Segments 1005, 1701, 2436, 2437, 2438, 2484, and 2494 only	NCR	35 E	n/a
Coastal Beaches	*Estuary (Basin 24)/Ocean (Basin 25)*	PCR	104 (E single sample)	n/a

① Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
② Definition of intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. Generally, an "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
③ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.
④ Less than 20% of the stream bed of a 500 meter sampling reach is covered by pools; or when extremely dry conditions are indicated by comparable observations of flow severity.
* Fecal coliform has been phased out as criteria for salty inland waters however, fecal coliform would continue to be used for oyster waters criterion (14 colonies/100ml median)

Delisting bacteria impairments on perennial streams. If nonpoint sources are the primary contributors of bacteria to a water body, then bacteria may support if better quality low-flow samples are over represented in the data set. When removing perennial streams from the 303(d) List due to improved conditions for bacterial indicators, consideration should be given to over-representation of low flow conditions in the dataset (the criteria do not apply below 0.1 cfs in perennial streams).

Recreational Beaches

The BEACH Act requires that states, in cooperation with EPA, develop and implement a program to monitor for pathogens and pathogen indicators in coastal recreation waters adjacent to public bathing beaches. The Act also requires public notification when water quality standards for pathogens or pathogen indicators are exceeded.

The GLO Texas Beach Watch Program collects water samples from 164 stations along the Texas coast in Aransas, Brazoria, Cameron, Galveston, Jefferson, Kleberg, Matagorda, Nueces, and San Patricio Counties. The GLO contracts with universities, local governments and laboratories to collect samples and test them for the presence of *Enterococcus*. Samples are collected weekly during the peak beach season from May through September and every other week from October through April. The GLO maintains an interactive mapping tool locating each beach by county. Maps and other information are available on the Texas Beach Watch Program website at < http://www.texasbeachwatch.com>.

Advisories are recommended when the samples of *Enterococcus* bacteria exceed the recommended single sample maximum density (SSMD) criteria of 104 colonies/100mL. When samples indicate bacteria levels are high enough to warrant an advisory, the water at that beach must be sampled every 24-hours until bacteria levels fall within a safe range. An advisory lasts at least 24-hours, but can be extended if bacteria levels continue to exceed recommended levels. Samples are collected under a QAPP consistent with TCEQ bacteria collection and analysis protocols. Samples are analyzed for Enterococci bacteria using EPA's Method 1600 or the IDEXX Enterolert system.

Reporting Beach Assessment Information

The GLO compiles the beach data and provides the TCEQ with summary information for each beach monitored. The information includes the total number of samples for each beach and the number of days each beach is under an advisory. TCEQ assesses each of the years in the assessment period of record. For all available data, the total number of advisory days is divided by the total number of samples. If a beach is under an advisory for greater than or equal to 25% of the sampled days, the beach is "Not Supporting" the recreation beaches use. If there are numerous sites monitored within a beach area, only one advisory is counted per beach per day. All impairments identified using this method are categorized as 5a due to human health considerations.
Beach advisories <25% of the time—Fully Supporting
Beach advisories 20-25% of the time—Concern and Fully Supporting.
Beach advisories < 20% of the time—Delisted and Fully Supporting.
Beach advisories > 25% of the time—Not Supporting.

Table 3.9. General Use—Criteria for Assessment

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A and/or Appendix F of the TSWQS			Unclassified Water Bodies ③		
		Assigned Criteria and Screening Levels ① Also see Table 3.10	Eliminate samples collected below the critical low-flow②	Presumed 7Q2 if not published or with no information to contrary	Criteria and Screening Levels	Eliminate samples below critical low-flow	Presumed 7Q2 if not published with or no information to contrary
Freshwater Stream	*Freshwater Perennial Stream* ④	-Water temperature -Dissolved solids -High pH -Low pH -Nutrients screening levels -Chlorophyll *a* screening levels	Yes for Water Temp High pH Low pH only	0.1 cfs	Nutrients screening levels Chlorophyll *a* screening levels	n/a	0.1 cfs
Freshwater Stream	*Freshwater Intermittent Stream with Perennial Pools* adequate to support significant aquatic life ⑥	-Water temperature -Dissolved solids -High pH -Low pH -Nutrients screening levels -Chlorophyll *a* screening levels	n/a	0.0 cfs	Nutrients screening levels Chlorophyll *a* screening levels	n/a	0.0 cfs
Freshwater Stream	*Freshwater Intermittent Stream* ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	-Water temperature -Dissolved solids -High pH -Low pH -Nutrients screening levels -Chlorophyll *a* screening levels	n/a	0.0 cfs	Nutrients screening levels Chlorophyll *a* screening levels	n/a	0.0 cfs
Reservoir	*Reservoir*	-Water temperature -Dissolved solids -High pH -Low pH	n/a	n/a	n/a	n/a	n/a
Tidal Stream	*Tidal Stream*	-Water temperature -High pH -Low pH -Nutrients screening levels -Chlorophyll *a* screening levels	n/a	n/a	Nutrients screening levels Chlorophyll *a* screening levels	n/a	n/a
Estuary	*Estuary*	-Water temperature -High pH -Low pH -Nutrients screening levels -Chlorophyll *a* screening levels	n/a	n/a	Nutrients screening levels Chlorophyll *a* screening levels	n/a	n/a
Ocean	*Ocean*	-Water temperature -High pH -Low pH	n/a	n/a	Screening levels for nutrients and chlorophyll *a* not available	n/a	n/a
Freshwater Wetland	*Freshwater Wetland*	-Water temperature -Dissolved solids -High pH -Low pH -Nutrients -Chlorophyll *a*	n/a	n/a	Screening levels for nutrients and chlorophyll *a* not available	n/a	n/a

Table 3.9. General Use—Criteria for Assessment

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A and/or Appendix F of the TSWQS			Unclassified Water Bodies ③		
		Assigned Criteria and Screening Levels ① Also see Table 3.10	Eliminate samples collected below the critical low-flow②	Presumed 7Q2 if not published or with no information to contrary	Criteria and Screening Levels	Eliminate samples below critical low-flow	Presumed 7Q2 if not published with or no information to contrary
Saltwater Wetland	*Saltwater Wetland*	-Water temperature -High pH -Low pH -Nutrients -Chlorophyll *a*	n/a	n/a	Screening levels for nutrients and chlorophyll *a* not available	n/a	n/a
Tidal Stream	*Tidal Stream* Segments 1006 and 1007 only	*Enterococcus* ⑦	n/a	n/a	n/a	n/a	n/a

① General Use criteria are listed in Appendix A and/or Appendix F of the Texas Surface Water Quality Standards (TSWQS). Nutrient and chlorophyll *a* screening levels are listed in Table 3.11.
② Presume event was above the critical low-flow for classified perennial stream segments when no flow information is available for the event, unless a flow severity of 1, indicating no flow, is reported.
③ General Use criteria are not assigned in the TSWQS to unclassified water bodies.
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.1 cfs is considered intermittent.
⑥ Definition of intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. An "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦ *Enterococcus* 30-day geometric mean - 168 colonies/100mL; the maximum *Enterococcus* density in 10% of samples in a 30-day period if greater than ten samples or in a single sample if fewer than ten samples are collected is 500 colonies/100mL.

Table 3.10. General Use—Chloride, Sulfate, and Total Dissolved Solids (TDS) Criteria

Water Body/Segment Type	Flow Type (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	Classified Water Bodies in Appendix A of the TSWQS ③	
		Assigned Criteria ①	Eliminate samples collected when**:**
Freshwater Stream	*Freshwater Perennial Stream* ④	-Chloride -Sulfate -TDS	Flow < 0.1 cfs ②
Freshwater Stream	*Freshwater Intermittent Stream with Perennial Pools* adequate to support significant aquatic life ⑥	-Chloride -Sulfate -TDS	Yes ⑦
Freshwater Stream	*Freshwater Intermittent Stream* ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	n/a	n/a
Reservoir	*Reservoir*	-Chloride -Sulfate -TDS	n/a
Tidal Stream	*Tidal Stream*	n/a	n/a
Estuary	*Estuary*	n/a	n/a
Ocean	*Ocean*	n/a	n/a
Freshwater Wetland	*Freshwater Wetland*	n/a	n/a
Saltwater Wetland	*Saltwater Wetland*	n/a	n/a

① General Use (chloride, sulfate, and TDS) criteria are listed in Appendix A of the Texas Surface Water Quality Standards (TSWQS).
② Presume event was above 0.1 cfs for classified perennial stream segments when no flow information is available for the event, unless a flow severity of 1, indicating no flow, is reported.
③ General Use criteria are not assigned in the TSWQS to unclassified water bodies.
④ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.
⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.1 cfs is considered intermittent.
⑥ Definition of intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. An "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.
⑦Less than 20% of the stream bed of a 500 meter sampling reach is covered by pools; or when extremely dry conditions are indicated by comparable observations of flow severity.

General Use

Water quality criteria for several constituents are established in the TSWQS to safeguard general water quality, rather than for protection of one specific use (see Tables 3.9 and 3.10). Water temperature, pH, chloride, sulfate, total dissolved solids (TDS), and chlorophyll *a* are the parameters protecting aquatic life, recreation, public water supply, and other beneficial uses of water resources. For the purpose of assessment, the criteria protecting these multiple uses are evaluated for attainment of a construct that we entitled, "general use."

Specific criteria for each of the other parameters are assigned to every classified segment in the TSWQS based on physical, chemical, and biological characteristics. Water temperature, pH, chloride, sulfate, TDS, and chlorophyll *a* criteria developed for classified segments do not apply to unclassified water bodies. Enterococci criteria are also assigned to two Houston Ship Channel segments to protect general uses.

Concerns for general uses are identified with screening levels for nutrients and chlorophyll *a* (see Table 3.11) for both classified and unclassified water bodies with the exception of some classified reservoirs identified in the TSWQS for which chlorophyll *a* site specific criteria were developed. Although other concerns are reported for general use, attainment of the general use for unclassified water bodies is not assessed and therefore not reported.

Water Temperature

Compliance with the temperature criterion is determined by evaluating only the surface samples. The use is supported when it is demonstrated that the temperature criterion is not attained due to permitted thermal discharges and it can be demonstrated that there is a healthy and balanced indigenous aquatic community.

High and Low pH

Values of pH are evaluated over the mixed surface layer when data are available. The median of the value in the mixed surface layer for each sample event is determined and these median values are evaluated against the high and low criteria using the binomial method. Use of the median measurement avoids comparing the criteria to extreme values observed at times in the summer near the surface and caused by natural conditions.

Chloride, Sulfate, and Total Dissolved Solids

Chloride, sulfate, and TDS criteria in the TSWQS were developed to represent annual averages of all values that were collected when stream flow equaled or exceeded the 7Q2 value established for each segment. Due to infrequent monitoring and absence of stream flow information at many sites, all of the chloride, sulfate, and TDS values are averaged for all sites within the segment and compared to the criterion for each parameter. The assessment of general uses based on the average concentration applies to the entire length or area of the segment. Samples collected at the surface or within the mixed surface layer are used when they are available. For TDS, a value is calculated by multiplying specific conductance measured at the surface by a factor of 0.65. The chloride, sulfate, and TDS criteria are not supported if the average value exceeds the criteria.

Enterococci—Segments 1006 and 1007

An Enterococci bacterial screening level is established for two Houston Ship Channel Segments (1006 and 1007) to provide indication of contamination, rather than protection of a recreational use. Due to heavy ship and barge traffic on the Houston Ship Channel, local statutes have been enacted to discourage any kind of water based recreation. Attainment of the Enterococci criteria is based on the long-term geometric mean.

Reservoir Nutrient Criteria

Site specific chlorophyll *a* criteria have been established in Appendix F of the TSWQS for selected reservoirs throughout the state. Nutrients are also assessed for reservoirs not included in the TSWQS. Assessment of the general use is based on a weight of evidence framework that considers multiple conditions and parameters. Specific information on the assessment method for evaluating nutrient criteria are included in Appendix F of this Guidance.

Narrative Criteria for Nutrient Enrichment

Excessive Vegetation Growth—Algae

The growth of microscopic algae can be stimulated by nutrient enrichment. Excessive growth of algae can result in unhealthy levels of DO for aquatic life as well as interfere with recreational uses of the water body and imparts unpleasant taste to drinking water. General use concerns or impairments due to excessive algae may be addressed through the implementation of TMDLs or WPPs.

Screening Levels for Nutrients and Chlorophyll *a*

Water bodies are protected from excessive nutrient levels in order to support the general uses through the use of screening levels. The screening levels listed for nutrients and chlorophyll *a* in Table 3.11 were statistically derived from SWQM monitoring data. They are based on the 85th percentile values for each parameter in freshwater streams, tidal streams, reservoirs without numeric criteria and thresholds for narrative criteria, and estuaries. A concern for water quality is identified if the screening level is exceeded greater than 20 percent of the time using the binomial method, based on the number of exceedances for a given sample size (see Appendices A and B).

Dissolved Oxygen

Changes in dissolved oxygen including low dissolved oxygen and dissolved oxygen swings can result from eutrophic conditions. Such conditions can limit the development of healthy aquatic communities or cause fish kills. Exceedances due to low dissolved oxygen are documented by comparing diel concentrations against the 24 hour minimum criteria. When the minima are exceeded, an impairment of the dissolved oxygen criteria is identified. If a TMDL or Watershed Protection Plan identifies excessive algae growth as a cause, then these plans may include a target for nutrients.

Narrative Criteria for Color

To ensure support of the general uses, Section 307.4 (b)(5) of the TSWQS specifies that waste discharges shall not cause substantial and persistent changes from ambient conditions of turbidity or color.

Support of the color standard will be a judgment made by the assessor and based on an evaluation of a number of factors. Visible changes in the water downstream of a colored wastewater discharge must be reported by field observers for an assessment to be made. Some of the factors that may be used include:

Quantitative data. The platinum-cobalt method (Standard Method 2120B) for water samples collected from both upstream and downstream of discharges. The magnitude and areal extent of color changes will be quantified.
Qualitative information. Photographic evidence. Local information (public or professional).
Additional information may be considered, such as, color sample results for other water bodies in the same ecoregion.

Support of this narrative criterion under 307.4(b)(5) applies only to surface waters directly influenced by waste discharges. Determination of support of 307.4(b)(5) will be based on a combination of the methods described above, and should include quantitative measures using the platinum-cobalt method or other applicable methods approved by the TCEQ executive director.

Table 3.11. Screening Levels for Nutrient Parameters

Water Body Type	Nutrients	Screening Level
Freshwater Stream	NH_3-N	0.33 mg/L
	NO_3-N	1.95 mg/L
	OP	0.37 mg/L
	TP	0.69 mg/L
	Chl *a*	14.1 µg/L
Reservoir	NH_3-N	0.11 mg/L
	NO_3-N	0.37 mg/L
	OP	0.05 mg/L
	TP	0.20 mg/L
	Chl *a*	26.7 µg/L
Tidal Stream	NH_3-N	0.46 mg/L
	NO_3-N	1.10 mg/L
	OP	0.46 mg/L
	TP	0.66 mg/L
	Chl *a*	21.0 µg/L
Estuary	NH_3-N	0.10 mg/L
	NO_3-N	0.17 mg/L
	OP	0.19 mg/L
	TP	0.21 mg/L
	Chl *a*	11.6 µg/L

Fish Kill Reports and Support of Other Narrative Criteria

Additional information is solicited from CRP partners, TCEQ central and regional office staffs, and other basin stakeholders to document conditions that may contribute to narrative criteria concerns or nonsupport. Such information may consist of water quality studies, occurrence of fish kills or contaminant spills, photographic evidence, local knowledge, and best professional judgment.

In some cases fish kills occur when physicochemical conditions stimulate a bloom of golden algae (*Prymnesium parvum*) and the subsequent formation of toxins. In these cases the excessive growth of golden algae is identified as a concern or impairment for general use attainment.

Trophic Status of Lakes

As reservoirs and lakes age, eutrophication increases producing conditions less suitable to support general uses. Eutrophication of reservoirs and lakes in southern states is enhanced due to warm, fertile climates. Human activities can accelerate the process by increasing the rate at which nutrients and organic substances enter the impoundments by way of the surrounding watershed. Sewage discharges, agricultural and urban runoff, leaking septic tanks, and erosion of stream banks can increase the flow of nutrients and organic substances into reservoirs and lakes. These substances may overstimulate the growth of algae and aquatic plants, creating conditions that interfere with contact recreation (swimming), boating (noncontact recreation), and the health and diversity of native fish, plant, and animal populations. Over-production of bacteria, fungi, and algae may also impart foul odors and tastes to the water.

Section 314 of the CWA of 1987 requires all states to classify lakes and reservoirs according to trophic state. The trophic state of a reservoir refers to its nutritional status. Various classification schemes or indices have been developed that group reservoirs into discrete quality (trophic) states along a continuum from oligotrophic (poorly nourished) to hypereutrophic (over nourished). The basis for the trophic state index concept is that, in many reservoirs, the degree of eutrophication may be related to increased nutrient concentrations. Typically, phosphorus is the nutrient of concern, and an increase in its concentration may trigger a responding increase in the amount of algae (estimated by chlorophyll *a*) in the reservoir. Due to increased algal biomass, water transparency, as measured by a Secchi disk or submarine photometer, decreases.

Major Texas reservoirs are evaluated and ranked by the TCEQ using Carlson's Trophic State Index (TSI). Carlson's Index was developed to compare Secchi disk depths, chlorophyll *a* concentrations, and total phosphorus concentrations obtained by in- reservoir sampling (Carlson, 1977). These three variables are highly correlated

and are considered estimators of algal biomass. By using multiple regression analysis, the index relates Secchi disk depth to total phosphorus concentration and to chlorophyll *a* concentration. The final result of the analysis is a ranking of reservoirs from the least to most eutrophic.

Fish Consumption Use

Fish consumption use attainment and concerns are evaluated with three assessment methods described below. For a full assessment of use attainment for fish consumption and a determination of fully supporting, a Texas Department of State Health Services (DSHS) risk assessment or advisory is required. Risk assessments are costly and conducted only on water bodies where the assessment has indicated a risk from consumption.

Advisories, Closures, and Risk Assessments

The TCEQ assesses the fish consumption use by reviewing DSHS human risk assessment information, consumption advisories, and aquatic life closures. The TCEQ and DSHS routinely coordinate on activities related to fish consumption use by exchanging information, discussing candidate water bodies for risk assessments, and funding projects. The TCEQ consults with the DSHS concerning recent data and information on existing and imminent fish consumption advisories and aquatic life closures. The fish consumption use is supported in water bodies where the DSHS has collected tissue data and a subsequent risk assessment for parameters of local concern indicates no significant risk due to consumption over a person's lifetime. Where risk assessments have been performed for only a limited number of pollutants or the risk assessment is not up to date, yet no risk is identified, a support status of NC (no concern) is reported. The use is not supported when a consumption advisory has been issued for the general population, or a subpopulation that could be at greater risk (children or women of child-bearing age), or when an aquatic life closure has been issued that prohibits the taking of aquatic life from the affected water body. Parameters causing nonsupport of the criteria are identified by a review of the DSHS risk assessment that forms the basis for an advisory. TCEQ will list water body impairments for fish-tissue on the 303(d) list where DSHS has issued public consumption advisories.

Human Health Criteria for Bioaccumulation and Fish Consumption Use

Support of the fish consumption use is also determined by review of human health criteria for toxics in water designated in the TSWQS (see Table 3.12 of the Guidance). For each toxicant parameter, across the segment, the average of all values for water samples collected during a 7-10 year period is computed. The averages are evaluated for human health criteria as indicated in Table 3.12 of the Guidance. The assessment of fish consumption use with human health water column criteria applies to all of the AUs with a sustainable or incidental fishery.

Should the average be exceeded over the period of record, the data set is subsequently evaluated to ensure the criterion is also exceeded more than one time. If the average exceeds, and this is the result of only an occasional high value, the assessor will use judgment in the evaluation of the data set and a concern, rather than impairment, is identified. Additional monitoring is initiated when a concern for toxic contaminants is identified.

Column A criteria are used for freshwater bodies which are designated for public water supply. These levels of contaminants pose a risk to humans when they are exposed through both drinking water and eating fish from the water body. Column B criteria are used for fresh and tidal waters that are capable of supporting sustainable fisheries and that are not designated for public water supply. Ten times the levels in Column B are used for unclassified perennial water bodies that are less than third order streams, reservoirs less than 50 acres in size, or other water bodies with only an incidental fishery. The average of data from all sites in the segment is used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

TABLE 3.12
Criteria in Water (and Tissue) for Specific Toxic Materials
HUMAN HEALTH PROTECTION

(All values are listed or calculated in micrograms per liter unless otherwise noted)

COMPOUND	Parameter Code or CASNR	A Water and Fish µg/L	B Fish Only µg/L
Acrylonitrile	34215	0.80	3.8
Aldrin	39330	0.00094	0.0010
Anthracene	34220	5,569	--
Antimony	01097	6[1]*	1,071
Arsenic (d)	01000	10[1]	---
Barium (d)	01005	2,000[1]	---
Benzene	34030	5[1]	513
Benzidine	39120	0.00086	0.0020
Benzo(*a*)anthracene	34526	0.68	0.328
Benzo(*a*)pyrene	34247	0.068	0.33
Bis(chloromethyl)ether	34268	0.0024	0.44
Bis(2-chloroethyl)ether	111-44-4	0.57	10.06
Bis(2-ethylhexyl)phthalate	117-81-7	6[1]	41
Bromodichloromethane	32101	10.2	322
Bromoform	32104	69.1	2,175
Cadmium (d)	01025	5[1]	---
Carbon Tetrachloride	32102	4.3	30.5
Chlordane	39350	0.0080	0.0081
Chlorobenzene	34301	100[1]	5,201
Chlorodibromomethane	124-48-1	7.6	239
Chloroform	32106	70[1]	7,143
Chromium (Hex) (d)	10220	62	502
Chrysene	34320	68.13	327
Cresols[2]	79778	1,041	9,301
Cyanide (free)[3]	00722	200*	---
4,4' - DDD	81897	0.0059	0.0059
4,4' - DDE	81896	262	473
4,4' - DDT	39376	17	24
2,4 – D	39730	70[1]	---
Danitol	04320	262	473
1,2 - Dibromoethane	77651	17	4.24
m-Dichlorobenzene	541-73-1	473	1,445
o-Dichlorobenzene	95-50-1	600[1]	4,336
p-Dichlorobenzene	34571	75[1]	---
3,3'-Dichlorobenzidine	34631	0.32	0.44

COMPOUND	CASRN	A Water and Fish µg/L	B Fish Only µg/L
1,2 - Dichloroethane	34531	5[1]	553
1,1 - Dichloroethylene	34501	7[1]	23,916
Dichloromethane	75-09-2	5[1]	22,222
1,2-Dichloropropane	78-87-5	5[1]	226
1,3-Dichloropropene	542-75-6	3.4	211
Dicofol	39780	0.30	0.30
Dieldrin	39380	0.001	0.001
2,4-Dimethylphenol	34606	257	571
Di-*n*-Butyl Phthalate	39110	1,318	3,010
Dioxins/Furans(TCDD Equivalents, tissue)	1746-01-6	7.80E-8	7.97E-8
Congener/Isomer	Toxic Equivalency Factors		
2,3,7,8 TCDD	1		
1,2,3,7,8 PeCDD	1		
2,3,7,8 HxCDDs	0.1		
1,2,3,4,6,7,8 HpCDD	0.01		
2,3,7,8 TCDF	0.1		
1,2,3,7,8 PeCDF	0.03		
2,3,4,7,8 PeCDF	0.3		
2,3,7,8 HxCDFs	0.1		
2,3,4,7,8 HpCDFs	0.01		
OCDD	0.0003		
OCDF	0.0003		
PCB 77	0.0001		
PCB 81	0.0003		
PCB 126	0.1		
PCB 169	0.03		
Endrin	39390	0.20	0.20
Ethylbenzene	34371	700[1]	7,143
Fluoride	00951	4,000[1]	---
Heptachlor	39410	0.0015	0.0015
Heptachlor Epoxide	39420	0.00074	0.00075
Hexachlorobenzene	39700	0.0044	0.0045
Hexachlorobutadiene	34391	6.5	274
Hexachlorocyclohexane (*alpha)*	39337	0.050	0.093
Hexachlorocyclohexane *(beta)*	39338	0.17	0.33
Hexachlorocyclohexane *(gamma)* (Lindane)	39782	0.2[1]	6.2

		A	B	
		Water and Fish	Fish Only	Fish Only Tidal
COMPOUND	CASRN	µg/L	µg/L	µg/L
Hexachlorocyclopentadiene	34386	50[1]	--	
Hexachloroethane	34396	4.97	11.51	
Hexachlorophene	88813	2.05	2.90	
Lead (d)	01049	1.15	3.83	
Mercury †, ††	71900	0.0122	0.0122	0.0250
Methoxychlor	39480	1.59	1.61	
Methyl Ethyl Ketone	81595	13,865	9.92E+5	
Nickel (d)	01065	332	1140	
Nitrate-Nitrogen as total Nitrogen	00620	10,000[1]	---	
Nitrobenzene	34447	45	1,853	
N-Nitrosodiethylamine	73611	0.0037	2.1	
N-Nitroso-di-*n*-Butylamine	73609	0.119	4.2	
Pentachlorobenzene	57793	1.0	1.0	
Pentachlorophenol	39032	0.80	91	
Polychlorinated Biphenyls *(PCBs)*	39515	6.4E-4	6.4E-4	
Pyridine	77045	23	947	
Selenium	01147	50[1]	---	
1,2,4,5 - Tetrachlorobenzene	77734	0.65	0.71	
1,1,2,2-Tetrachloroethane	34516	3.2	40	
Tetrachloroethylene	34475	5*	525	
Thallium	01059	0.75	0.23	
Toluene	78131	1,000*	---	
Toxaphene	39400	0.0053	0.0053	
2,4,5 - TP (Silvex)	39760	19	21	
1,1,1 - Trichloroethane	34506	200[1]	956,663	
1,1,2-Trichloroethane	34511	5[1]	295	
Trichloroethylene	39180	5[1]	82	
2,4,5 - Trichlorophenol	77687	1,194	2,435	
TTHM (Sum of total trihalomethanes)	82080	80	---	
bromodichloromethane	32101			
dibromochloromethane	32105			
tribromomethane (bromoform)	32104			
trichloromethane (chloroform)	32106			
Vinyl Chloride	39175	0.25	24	

1Based on Maximum Contaminant Levels (MCLs) specified in 30 TAC §290 (relating to Public Drinking Water).

2Consists of *m*, *o*, and *p* Cresols. The criteria are the same for all three, and the criteria are applied independently to each form of cresol. CASRNs for cresols are 95-48-7 for *o*-Cresol, 108-39-4 for *m*-Cresol, and 106-44-5 for *p*-Cresol.

3Compliance is determined using the analytical method for available cyanide

(d)Indicates the criteria is for the dissolved fraction in water. All other criteria are for total recoverable concentrations.

4Until Method 1668 or equivalent method to measure PCB congeners is approved in 40 Code of Federal Regulations Part 136, compliance with PCB criteria is determined using Arochlor data or any alternate method listed in a TCEQ-approved Quality Assurance Plan.

Table 3.13. Fish Consumption Use—Human Health Criteria

Water Body/Segment Type	**Flow Type** (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	**Classified Water Bodies in Appendix A of the TSWQS** See Table 3.12—Human Health Criteria and Table 3.14—Tissue Screening Levels in the Guidance				**Unclassified Water Bodies** See Table 3.11—Human Health Criteria in the Guidance				
		Criteria for water bodies designated for public water supply Human Health Criteria—Col. A Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for freshwater bodies capable of supporting sustainable fishery, not designated for public water supply** ① Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Eliminate samples collected when:**	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for water bodies designated for public water supply** Human Health Criteria—Col. A Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for freshwater bodies capable of supporting sustainable fishery, not designated for public water supply** ① Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Eliminate samples collected when:**	**Criteria for freshwater bodies with incidental fishery** ② Ten times Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧
Freshwater Stream	***Freshwater Perennial Stream*** ③	Human Health Criteria—Col. A	Human Health Criteria—Col. B	Flow < 0.1 cfs ⑥	n/a	Human Health Criteria—Col. A	Human Health Criteria—Col. B	Flow < 0.1 cfs ⑥	Ten times Human Health Criteria—Col. B	n/a
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** ④adequate to support significant aquatic life	Human Health Criteria—Col. A	Human Health Criteria—Col. B	Yes ⑦	n/a	Human Health Criteria—Col. A	n/a	Yes ⑦	Ten times Human Health Criteria—Col. B	n/a
Freshwater Stream	***Freshwater Intermittent Stream*** ⑤ and intermittent stream with perennial pools not adequate to support significant aquatic life (with or without wastewater flow)	n/a	n/a	n/a	n/a		n/a	n/a	n/a	n/a
Reservoir	***Reservoir***	Human Health Criteria—Col. A	Human Health Criteria—Col. B	n/a	n/a	Human Health Criteria—Col. A	Human Health Criteria—Col. B	n/a	Ten times Human Health Criteria — Col. B	n/a
Tidal Stream	***Tidal Stream***	n/a	n/a	n/a	Human Health Criteria—Col. B	n/a	n/a	n/a	n/a	Human Health Criteria—Col. B
Estuary	***Estuary***	n/a	n/a	n/a	Human Health Criteria—Col. B	n/a	n/a	n/a	n/a	Human Health Criteria—Col. B
Ocean	***Ocean***	n/a	n/a	n/a	Human Health Criteria— Col. B	n/a	n/a	n/a	n/a	Human Health Criteria—Col. B
Freshwater Wetland	***Freshwater Wetland***	Human Health Criteria—Col. A	Human Health Criteria—Col. B	n/a	n/a	Human Health Criteria—Col. A	Human Health Criteria—Col. B	n/a	Ten times Human Health Criteria — Col. B	n/a

Table 3.13. Fish Consumption Use—Human Health Criteria

Water Body/Segment Type	**Flow Type** (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	**Classified Water Bodies in Appendix A of the TSWQS** See Table 3.12—Human Health Criteria and Table 3.14—Tissue Screening Levels in the Guidance				**Unclassified Water Bodies** See Table 3.11—Human Health Criteria in the Guidance				
		Criteria for water bodies designated for public water supply Human Health Criteria—Col. A Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for freshwater bodies capable of supporting sustainable fishery, not designated for public water supply** ① Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Eliminate samples collected when:**	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for water bodies designated for public water supply** Human Health Criteria—Col. A Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for freshwater bodies capable of supporting sustainable fishery, not designated for public water supply** ① Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Eliminate samples collected when:**	**Criteria for freshwater bodies with incidental fishery** ② Ten times Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧	**Criteria for tidally-influenced water bodies** Human Health Criteria—Col. B Screening levels for bioaccumulative substances in tissue ⑧
Saltwater Wetland	***Saltwater Wetland***	n/a	n/a	n/a	Human Health Criteria—Col. B	n/a	n/a	n/a	n/a	Human Health Criteria—Col. B

① *Sustainable fisheries*—Descriptive of water bodies which potentially have sufficient fish production or fishing activity to create significant long-term human consumption of fish. Sustainable fisheries include perennial streams and rivers with a stream order of three or greater; lakes and reservoirs greater than or equal to 150 acre-feet and/or 50 surface acres; all bays, estuaries, and tidal rivers. Water bodies which are presumed to have sustainable fisheries include all designated segments listed in Appendix A unless specifically exempted.

② *Incidental fishery*—A level of fishery which applies to water bodies that are not considered to have a sustainable fishery but which have an ALU of limited, intermediate, high, or exceptional. Water bodies with minimal ALU, such as intermittent streams, are not assigned either a sustainable or incidental fishery (noted as "no fishery" in the assessment and not assessed for fish consumption use).

③ Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.

④ Definition of Intermittent with perennial pools for purposes of determining criteria support: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life. An "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.

⑤ Definition of intermittent stream: A stream that has a period of zero flow for at least one week during most years. If flow records are available, a stream with a 7Q2 of less than 0.10 cfs is considered intermittent.

⑥ Presume event was above 0.1 cfs for classified perennial stream segments when no flow information is available for the event, unless a flow severity of 1, indicating no flow, is reported.

⑦ Less than 20% of the stream bed of a 500 meter sampling reach is covered by pools; or when extremely dry conditions are indicated by comparable observations of flow severity.

⑧ Screening levels for bioaccumulative substances in tissue samples are not subject to elimination based on flow.

Bioaccumulative Substances in Fish Tissue

The screening levels for concentrations of toxicants in fish tissue were developed from human health criteria in the TSWQS, except for the metals. Screening levels for these nine metals are based on DSHS screening levels that are slightly lower than the levels used to issue consumption advisories (see Table 3.14). The human health criteria in the TSWQS are expressed as allowable concentrations of toxicants in surface waters and tissue. This allowable concentration in water is determined by calculating an allowable concentration in fish tissue and then dividing by the bioaccumulation factor for that particular toxicant. The formulas for deriving human health criteria were developed by the EPA.

The screening levels for 31 organic substances and 9 metals in fish tissue are used to determine concerns for the fish consumption use (see Table 3.14). Screening levels developed by the DSHS are used for the other six metals (see Table 3.14). Seven years of data are screened using these levels. Identification of concerns for water quality is determined when the screening levels are exceeded greater than 20 percent of the time based on the binomial method. The assessment of fish consumption use with tissue screening levels applies to all of the AUs with a sustainable or incidental fishery. Data from all sites in the segment are used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

Table 3.14. Screening Levels for Metals and Organic Substances in Tissue
(All values listed as mg/kg or µg/g* Wet Weight)

Parameter Code	Parameter	Freshwater and Tidal water
Metals		
01004	Arsenic	0.036
71940	Cadmium	0.175*
71939	Chromium	5.25*
71937	Copper	250.5*
71936	Lead	0.6*
71930	Mercury	0.525*
01069	Nickel	0.035
01149	Selenium	4.375
71938	Zinc	525
Pesticides		
34680	Aldrin	0.0044
39074	*alpha*-Hexachlorocyclohexane	0.0121*
34258	*beta*-Hexachlorocyclohexane	0.0424
39075	*gamma*-Hexachlorocyclohexane (lindane)	0.8036*
34682	Chlordane	0.1134
85684	Dicofol (Kelthane)	1.8403
81897	4,4'-DDD	0.3181
81896	4,4'-DDE	0.2141
39376	4,4'-DDT	0.2111
39406	Dieldrin	0.0048
34685	Endrin	0.8036
34687	Heptachlor	0.017
34686	Heptachlor epoxide	0.0084
34688	Hexachlorobenzene	0.039
85679	Pentachlorobenzene	2.1429
34691	Toxaphene	0.0694
Semivolatile Organic Substances		
34241	Benzidine	0.0001
34530	Benzo(a)anthracene	0.0204
34251	Benzo(a)pyrene	0.002
88812	Cresols, total	133.9286
34324	Chrysene	2.0438
34395	Hexachlorobutadiene	0.7614
34400	Hexachloroethane	1.0

Table 3.14. Screening Levels for Metals and Organic Substances in Tissue (All values listed as mg/kg or µg/g* Wet Weight)		
Parameter Code	**Parameter**	**Freshwater and Tidal water**
88815	Hexachlorophene	0.8036
34451	Nitrobenzene	5.3571
88818	N-Nitrosodiethylamine	0.0004
88821	N-Nitrosodi-n-butylamine	0.0141
39515	PCBs	0.02
39060	Pentachlorophenol	0.1
88824	Pyridine	2.6786
88827	1,2,4,5-Tetrachlorobenzene	0.8036

Public Water Supply Use

Surface Water

Human Health Criteria for Public Water Supply Use

The public water supply (PWS) use is evaluated for surface water bodies by comparing the average of constituents in Column A of the human health criteria from the TSWQS (see Table 3.12). The human health criteria are in part based on the primary maximum contaminant level adopted in 30 TAC §290. These assessments are restricted to water bodies designated in Appendix A of the TSWQS for public water supply use or unclassified water bodies designated as sole-source surface drinking water supplies in Appendix B of the TSWQS (see Table 3.15). The average of data from all sites in the segment is used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

Should the average be exceeded over the period of record, the data set is subsequently evaluated to ensure the criterion is also exceeded more than one time. If the average exceeds, and this is the result of more than one high value, the assessor will use judgment in the evaluation of the data set and a concern rather than impairment, is identified. Additional monitoring is initiated when a concern for toxic contaminants is identified.

Toxic Substances Long-Term Average Concerns

Some organic compounds (at this time only alachlor, atrazine, MTBE, and perchlorate) that have potential human health impacts are evaluated. When data are available for surface waters designated or currently used for public water supply, concerns for water quality will be identified if the average concentrations of all sites in the segment exceed human health screening guidelines established by the TCEQ for drinking water. Human health screening levels are 2 µg/L for alachlor, 3 µg/L for atrazine, 240 µg/L for MTBE, and 22 µg/L for perchlorate. The average of data from all sites in the segment is used with the exception of very long stream segments where water may be taken from hydrologically isolated assessment units.

Table 3.15 Public Water Supply Use— Criteria and Screening Levels for Assessment of Surface Water

Water Body/Segment Type	**Flow -Type** (use published flow type or other reliable source such as the SWQM flow-type questionnaire)	**Classified Water Bodies in Appendix A of TSWQS with PWS Use Assigned and Unclassified Water Bodies in Appendix B of TSWQS as Sole-source Surface Drinking Water Supplies**	
		Criteria and Screening Levels ▸ ***Human Health Criteria***—Col A (see Table 3.11) ▸ ***alachlor, atrazine, MTBE and perchlorate*** (see Concerns for PWS Surface Water section) ④	**Eliminate samples collected when flow < 0.1 cfs. ①**
Freshwater Stream	***Freshwater Perennial Stream*** ②	Human Health Criteria alachlor, atrazine, MTBE, and perchlorate	Yes
Freshwater Stream	***Freshwater Intermittent Stream with Perennial Pools*** adequate to support significant aquatic life ③	Human Health Criteria alachlor, atrazine, MTBE, and perchlorate	n/a
Reservoir	***Reservoir***	Human Health Criteria alachlor, atrazine, MTBE, and perchlorate	n/a

① Presume event was above 0.1 cfs for classified perennial stream segments when no flow information is available for the event, unless a flow severity of 1, indicating no flow, is reported.

② Definition of perennial stream: A stream that does not have a period of zero flow at any time during most years.

③ Definition of intermittent with perennial pools: A stream that has a period of zero flow for at least one week during most years, but has adequate and persistent pools that provide habitat to support significant aquatic life (not just a refuge). Generally, an "adequate pool" to support aquatic life is deeper than one meter and >100 meters long; or where large pools cover >20% of the stream bed in a 500 meter reach.

④Screening levels for Alachlor, atrazine, MTBE, and perchlorate are not subject to elimination based on flow.

Oyster Waters Use

Oyster water use is assigned to most coastal bays to protect existing and potential harvest of edible species of clams, oysters, and mussels. The oyster water use is not assessed within a 1,000 foot buffer zone—an area measured from the shoreline to ordinary high tide. This zone is established for all bay and gulf waters with the exception those associated with river and coastal basins. Concentrations of bacteria in water must not exceed criteria established to maintain seafood safe for human consumption. The median fecal coliform concentration criterion in bay and gulf waters is 14 colonies per 100 mL. The Department of State Health Services (DSHS) has authority to administer the National Shellfish Sanitation Program for Texas. This authority allows the DSHS to classify shellfish growing areas and to issue certificates for the interstate shipment of shellfish. The Texas Parks and Wildlife Department (TPWD) has the responsibility for enforcement of laws concerning harvesting of shellfish.

Oyster Water Classification Categories

The DSHS produces and provides annual updates to maps that delineate the classification of shellfish harvesting areas along the Texas coast. The status (open or closed) of shellfish growing areas is subject to change by the DSHS at any time. These changes may be the result of high rainfall and runoff, flooding, hurricanes and other extreme weather conditions, major spills, red tides, or the failure or inefficient operation of wastewater treatment facilities.

Assessment of the oyster waters use is made using the most recent DSHS Shellfish Classification Harvesting Area Maps. The maps are located on the Web at <www.dshs.state.tx.us/seafood/classification.shtm>**.**

The DSHS classifies shellfish growing areas into one of four categories.

Approved area. An area approved for growing and harvesting shellfish for direct marketing. Approved areas are not contaminated by pathogenic organisms, toxic substances, or marine biotoxins in concentrations that present actual or potential hazards to public health. The classification of approved areas is determined by sanitary surveys conducted by the DSHS.

Approved areas meet the standard except under extreme conditions and are assessed as—**Fully Supporting**.

Conditionally approved area. A conditionally approved area is a classification used to identify harvest areas which meet the criteria for an approved area except under certain conditions. Conditions causing degraded water quality must be predictable and definable-river stage, wastewater treatment plant effluents, run-off conditions. A conditionally approved area is closed when the approved criteria are not supported.

Conditionally approved areas are assessed as-**Fully Supporting**.

Restricted area. Restricted areas are shellfish growing areas classified as threatened or contaminated by poor water quality. Shellfish harvested from these areas must be cleaned by depuration (moved to processing plants for cleansing in clean water) or by relaying (moved to estuarine waters in an approved area).

Areas classified as restricted due to poor water quality are assessed as-**Not Supporting**.

Some restricted areas have recent water quality surveys indicating acceptable fecal coliform densities, yet the area is restricted based on high risk of microbial contamination-proximity to marinas and wastewater treatment plants, stormwater runoff, drainage from areas frequented by livestock or waterfowl.

Areas classified as restricted for reasons other than water quality impairment are reported as -**Not Assessed**.

Prohibited area. A prohibited area is where recent DSHS sanitary surveys or other monitoring program data indicate that fecal material, pathogenic microorganisms, poisonous or deleterious substances, marine toxins, or radionuclides may reach the area in excessive concentrations. The taking of shellfish for any human food

purposes from such areas is prohibited. Shellfish from a prohibited area may not be taken for cleansing by depuration or relaying.

Prohibited areas with sanitary surveys indicating poor water quality, or where the DSHS has determined that water quality is likely to be poor based in historical surveys are assessed as-**Not Supporting**.

Areas classified as prohibited for reasons other than water quality impairment or are prohibited solely because DSHS does not have the resources to conduct sanitary surveys are reported as-**Not Assessed**.

Reporting Oyster Water Use Attainment

The assessment describes the general attainment condition for large areas of the bay and reflects both water quality conditions and administrative decisions made by the DSHS Seafood and Aquatic Life Group. Due to the complexity of shellfish classification areas, assessment units will include the open bay area only. Restricted areas that include river channels, the Intracoastal Waterway, shoreline, harbors, ship channels, tidal wetlands, subdivision channels and other structures identified by DSHS Classification of Shellfish Harvesting Area maps will not be included in the defined oyster water assessment units. When the attainment status is assigned to entire assessment units for the Integrated Report, decisions on area-specific detail may be made in the planning stages of a TMDL.

Chapter 4

Methodology for Assigning Pollutant Causes and Sources

Cause and Source Codes for Pollutants

For each water body or portion of a water body where a nonsupport of a designated use or a use concern has been identified, the cause(s) and source(s) are evaluated from available information (SWQM data, field observations, land use, CRP assessments, nonpoint source assessment reports, special studies, and intensive surveys). The origin of the information and level of confidence are also reported.

The *sources of impairment and concerns* defined in this document reflect "possible" source information. Possible sources include activities, facilities, or conditions occurring in the watershed that might keep the water from meeting the criteria to prevent the attainment of designated uses. These lists of possible sources are not exhaustive, and do not constitute defined targets for water quality management actions. As water quality strategies and management actions are developed and implemented (e.g., TMDLs and watershed protection plans), pollution sources will be identified and quantified through additional monitoring, land use evaluations, and modeling efforts; and this new information overrides the preliminary source lists in this document. Interested parties should refer to the source identifications as developed by specific water quality management projects for definitive information.

Whenever possible, analysts link pollution causes and stressors with their sources for the analysis. *Causes* are those pollutants (for example, pesticides, metals, or low dissolved oxygen) that contribute to actual nonsupport or partial support of designated uses (see Table 4.1). *Stressors* are factors or conditions (for example, stream flow, siltation, or habitat alterations) other than specific pollutants that cause nonsupport of uses. Activities, facilities, or conditions that contribute pollutants or stressors are sources that result in nonsupport of designated uses in a water body (see Table 4.2).

Sources of pollution can be classified into two primary groups depending on their origin. Each of these types result from different natural conditions or anthropogenic activities and may be controlled by specific voluntary or regulatory water quality management measures.

> *Nonpoint source pollution* is diffuse runoff that originates from precipitation moving over and through the ground. As nonpoint source runoff moves, natural pollutants and pollutants resulting from human activity are carried with it to water bodies. Nonpoint sources include agricultural and urban storm water runoff.
>
> *Point source pollution* has as its source any discernible, confined, and discrete conveyance, such as any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, concentrated animal feeding operation, or vessel or floating craft, from which pollutants are discharged to surface water bodies. Point sources are regulated by Texas Pollutant Discharge Elimination System (TPDES) permits, which may include effluent limitations, monitoring, and reporting requirements. Consistent with the TPDES, storm water discharges from separate storm sewer systems from cities and storm water discharges associated with industry and construction are considered point sources of pollution.

Table 4.1. List of EPA Causes and Stressors with Associated Codes			
EPA Cause Code	**EPA Cause Name**	**EPA Cause Code**	**EPA Cause Name**
7	1,1,1-Trichloroethane	137	Chlordane
9	1,1,2-Trichloroethane	138	Chloride
11	1,1-Dichloroethane	154	Chromium (total)
19	1,2-Dichloroethane	155	Chromium, hexavalent
67	Abnormal Fish Histology (Lesions)	156	Chromium, trivalent
68	Acenaphthene	157	Chrysene (C1-C4)
69	Acenaphthylene	158	Ciguatera fish poisoning (CFP) biotoxins
77	Alachlor	160	Color
84	Alteration in stream-side or littoral vegetative covers	161	Combination Benthic/Fishes Bioassessments (Streams)
85	Alterations in wetland habitats	162	Combined Biota/Habitat Bioassessments (Streams)
87	Aluminum	163	Copper
88	Ambient Bioassays—Acute Aquatic Toxicity	175	DDD
89	Ambient Bioassays— Chronic Aquatic Toxicity	176	DDE
91	Ammonia (Un-ionized)	177	DDT
92	Amnesic shellfish poisoning (ASP) biotoxins	186	Diarrhetic shellfish poisoning (DSP) biotoxins
94	Anthracene	188	Dibenz[a,h]anthracene
96	Arsenic	198	Dieldrin
99	Atrazine	203	Dioxin (including 2,3,7,8-TCDD)
100	BOD, Biochemical oxygen demand	205	Dissolved oxygen saturation
101	BOD, carbonaceous	213	Endrin
102	BOD, nitrogenous	215	Enterococcus
103	BOD, sediment load (Sediment Oxygen Demand)	217	Bacteria, Escherichia coli
104	Barium	218	Estuarine Bioassessments
105	Benthic-Macroinvertebrate Bioassessments (Streams)	227	Excess Algal Growth
109	Benzo(a)pyrene (PAHs)	229	Fish Kills
110	Benzo[a]anthracene	230	Fishes Bioassessments (Streams)
111	Benzo[b]fluoranthene	232	Fluoranthene
112	Benzo[g,h,i]perylene	233	Fluorene
113	Benzo[k]fluoranthene	243	Habitat Assessment (Streams)
127	Cadmium	244	Heptachlor
131	Carbon Disulfide	245	Heptachlor epoxide
134	Chemical oxygen demand (COD)	246	Hexachlorobenzene

Table 4.1. List of EPA Causes and Stressors with Associated Codes			
EPA Cause Code	**EPA Cause Name**	**EPA Cause Code**	**EPA Cause Name**
247	Hexachlorobutadiene	388	Temperature, water
259	Indeno[1,2,3-cd]pyrene	398	Bacteria, Total Coliform
266	Lake Bioassessments	399	Total Dissolved Solids
267	Lead	400	Fecal Coliform
268	Lindane	403	Total Suspended Solids (TSS)
270	Low flow alterations	405	Toxaphene
271	Malathion	423	Zinc
274	Mercury	429	m-Dichlorobenzene
288	Methylmercury	429	m-Dichlorobenzene
299	Naphthalene	441	pH
300	Neurotoxic shellfish poisoning (NSP) biotoxins	441	pH
301	Nickel	445	Abnormal Fish deformities, erosions, lesions, tumors (DELTS)
302	Nitrates	445	Abnormal Fish deformities, erosions, lesions, tumors (DELTS)
307	Nitrogen, Nitrite	446	Habitat Assessment (Lakes)
308	Ammonia (Total)	447	Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)
312	Non-Native Aquatic Plants	448	Nutrient/Eutrophication Biological Indicators
313	Nonnative Fish, Shellfish, or Zooplankton	452	Nitrogen, Nitrate
322	Oxygen, Dissolved	456	Nitrate/Nitrite (Nitrite + Nitrate as N)
328	Paralytic shellfish poisoning (PSP) biotoxins	460	Aquatic Plants - Native
331	Particle distribution (Embeddedness)	462	Phosphorus (Total)
337	Phenanthrene	463	Impairment Unknown
340	Phosphate	464	Single Sample Toxic Exceedence
341	Phosphorus, Elemental	465	Fish Advisory - No Restriction
344	Physical substrate habitat alterations	466	Sediment Screening Value (Exceedence)
356	Pyrene	467	Mercury in Fish Tissue
369	Sediment Bioassays -- Chronic Toxicity Freshwater	468	Mercury in Water Column
370	Sediment Bioassays for Estuarine and Marine Water	472	PCB in Fish Tissue
371	Sedimentation/Siltation	473	PCB in Water Column
372	Selenium	475	Sediment Bioassays -- Acute Toxicity Freshwater
375	Silver	476	Other
385	Sulfates	478	Aquatic Plants (Macrophytes)
387	Suspended Algae	479	Aquatic Algae

Table 4.2. List of EPA Source Codes and Source Categories	
Code	**Source Category Name**
1	Above Ground Storage Tank Leaks (Tank Farms)
2	Acid Mine Drainage
3	Airports
4	Animal Feeding Operations (NPS)
5	Animal Shows and Racetracks
6	Aquaculture (Not Permitted)
7	Aquaculture (Permitted)
8	Atmospheric Deposition - Acidity
9	Atmospheric Deposition - Nitrogen
10	Atmospheric Deposition - Toxics
11	Auction Barns and Off-farm Animal Holding/Management Area
12	Ballast Water Releases
13	Baseflow Depletion from Groundwater Withdrawals
14	Brownfield (Non-npl) Sites
15	Cargo Loading/Unloading
16	Cercla NPL (Superfund) Sites
17	Changes in Ordinary Stratification and Bottom Water Hypoxia/Anoxia
18	Changes in Tidal Circulation/Flushing
19	Channel Erosion/Incision from Upstream Hydromodifications
20	Channelization
21	Clean Sediments
22	Coal Mining Discharges (Permitted)
23	Combined Sewer Overflows
24	Commercial Districts (Industrial Parks)
25	Commercial Ferries
26	Commercial Districts (Shopping/Office Complexes)
27	Construction Stormwater Discharge (Permitted)
28	Contaminated Sediments
29	Cooling Water Intake Structures (Impingement or Entrainment)
30	Crop Production with Subsurface Drainage
31	Dairies (Outside Milk Parlor Areas)
32	Dam Construction (Other than Upstream Flood Control Projects)

Table 4.2. List of EPA Source Codes and Source Categories	
Code	**Source Category Name**
33	Discharges from Biosolids (SLUDGE) Storage, Application or Disposal
34	Discharges from Municipal Separate Storm Sewer Systems (MS4)
35	Discharges from Offshore Oil and Gas Exploration (Permitted)
36	Drainage/Filling/Loss of Wetlands
37	Dredge Mining
38	Dredging (E.g., for Navigation Channels)
39	Drought-related Impacts
40	Dry Weather Flows with NPS Pollutants
41	Erosion from Derelict Land (Barren Land)
42	Flow Alterations from Water Diversions
43	Forest Roads (Road Construction and Use)
44	Freshettes or Major Flooding
45	Golf Courses
46	Grazing in Riparian or Shoreline Zones
47	Hardrock Mining Discharges (Permitted)
48	Heap-leach Extraction Mining
49	Highway/Road/Bridge Runoff (Non-construction Related)
50	Highways, Roads, Bridges, Infrastructure (New Construction)
51	Historic Bottom Deposits (Not Sediment)
52	Hydrostructure Impacts on Fish Passage
53	Illegal Dumping
54	Illegal Dumps or Other Inappropriate Waste Disposal
55	Illicit Connections/Hook-ups to Storm Sewers
56	Impacts from Abandoned Mine Lands (Inactive)
57	Impacts from Geothermal Development
58	Impacts from Hydrostructure Flow Regulation/modification
59	Impacts from Land Application of Wastes
60	Impacts from Resort Areas (Winter and Non-winter Resorts)
61	Industrial Land Treatment
62	Industrial Point Source Discharge
63	Industrial Thermal Discharges
64	Industrial/Commercial Site Stormwater Discharge (Permitted)
65	Internal Nutrient Recycling

Table 4.2. List of EPA Source Codes and Source Categories	
Code	**Source Category Name**
66	Irrigated Crop Production
67	Land Application of Wastewater (Non-agricultural)
68	Land Application of Wastewater Biosolids (Non-agricultural)
69	Landfills
70	Leaking Underground Storage Tanks
71	Littoral/shore Area Modifications (Non-riverine)
72	Loss of Riparian Habitat
73	Managed Pasture Grazing
74	Marina Boat Construction
75	Marina Boat Maintenance
76	Marina Dredging Operations
77	Marina Fueling Operations
78	Marina-related Shoreline Erosion
79	Marina/boating Pumpout Releases
80	Marina/Boating Sanitary On-vessel Discharges
81	Mill Tailings
82	Mine Tailings
83	Mountaintop Mining
84	Municipal (Urbanized High Density Area)
85	Municipal Point Source Discharges
86	Municipal Point Source Impacts from Inadequate Industrial/Commercial Pretreatment
87	Non-irrigated Crop Production
88	Non-metals Mining Discharges (Permitted)
89	Nps Pollution from Military Base Facilities (Other than Port Facilities)
90	Nps Pollution from Military Port Facilities
91	Off-road Vehicles
92	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)
93	Open Pit Mining
94	Other Marina/Boating On-vessel Discharges
95	Other Recreational Pollution Sources
96	Other Shipping Releases (Wastes and Detritus)
97	Other Spill Related Impacts
98	Other Turf Management

Table 4.2. List of EPA Source Codes and Source Categories	
Code	**Source Category Name**
99	Package Plant or Other Permitted Small Flows Discharges
100	Permitted Runoff from Confined Animal Feeding Operations (CAFOs)
101	Permitted Silvicultural Activities
102	Petroleum/natural Gas Activities
103	Petroleum/natural Gas Production Activities (Permitted)
104	Pipeline Breaks
105	Placer Mining
106	Pollutants from Public Bathing Areas
107	Post-development Erosion and Sedimentation
108	Rangeland Grazing
109	Rcra Hazardous Waste Sites
110	Releases from Waste Sites or Dumps
111	Residential Districts
112	Salt Storage Sites
113	Saltwater Intrusion from Groundwater Overdrafting
114	Sand/gravel/rock Mining or Quarries
115	Sanitary Sewer Overflows (Collection System Failures)
116	Septage Disposal
117	Shipbuilding, Repairs, Drydocking
118	Silviculture - Large Scale (Industrial) Unpermitted Forestry
119	Silviculture Harvesting
120	Silviculture Plantation Management
121	Silviculture Reforestation
122	Site Clearance (Land Development or Redevelopment)
123	Specialty Crop Production
124	Spills from Trucks or Trains
125	Streambank Modifications/destabilization
126	Subsurface (Hardrock) Mining
127	Surface Mining
128	Total Retention Domestic Sewage Lagoons
129	UIC Wells (Underground Injection Control Wells)
130	Unpermitted Discharge (Domestic Wastes)

Table 4.2. List of EPA Source Codes and Source Categories	
Code	**Source Category Name**
131	Unpermitted Discharge (Industrial/commercial Wastes)
132	Upstream Impoundments (e.g., Pl-566 NRCS Structures)
133	Wastes from Pets
134	Waterfowl
135	Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO)
136	Wildlife Other than Waterfowl
137	Woodlot Site Clearance
138	Woodlot Site Management
139	Yard Maintenance
140	Source Unknown
141	Non-Point Source
142	Dam or Impoundment
143	Livestock (Grazing or Feeding Operations)
144	Crop Production (Crop Land or Dry Land)
145	Natural Conditions - Water Quality Standards Use Attainability Analyses Needed
146	Sources Outside State Jurisdiction or Borders
147	Upstream Source
148	Sediment Resuspension (Clean Sediment)
149	Sediment Resuspension (Contaminated Sediment)
150	Forced Drainage Pumping
151	Naturally Occurring Organic Acids
152	Transfer of Water from an Outside Watershed
153	Wet Weather Discharges (Non-Point Source)
154	Upstream/Downstream Source
155	Natural Sources
156	Agriculture
157	Habitat Modification - other than Hydromodification
158	Silviculture, Fire Suppression
159	Reclamation of Inactive Mining
160	Inappropriate Waste Disposal
161	Pesticide Application
162	Watershed Runoff following Forest Fire
163	Low Water Crossing

Table 4.2. List of EPA Source Codes and Source Categories	
Code	**Source Category Name**
164	Impervious Surface/Parking Lot Runoff
165	Coal Mining
166	Silviculture Activities
167	Unspecified Domestic Waste
168	Sewage Discharges in Unsewered Areas
169	Unspecified Urban Stormwater
170	Unspecified Unpaved Road or Trail
171	Unspecified Land Disturbance
172	Potash Mining
173	Manure Runoff
174	Unrestricted Cattle Access
175	Contaminated Groundwater
176	Rural (Residential Areas)
177	Urban Runoff/Storm Sewers
178	Coal Mining (Subsurface)
179	Lake Fertilization
180	Introduction of Non-native Organisms (Accidental or Intentional)
181	Runoff from Forest/Grassland/Parkland
182	Seafood Processing Operations
183	Accidental release/Spill
184	Marina Related Shoreline Habitat Degradation
185	Fire Retardant Slurry
186	Legacy coal extraction
187	Shallow Lake/Reservoir
1000	Multiple Non-Point Sources

Chapter 5

Categorizing Water Quality Conditions for Management Activities

Introduction

The goal of the CWA is the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters; to attain water quality which provides for protection and propagation of fish and wildlife; and provide recreation. This translates into the TCEQ's goal that all water quality standards are attained for all surface waters in Texas.

The initial step in determining the appropriate management activity to maintain water quality is to assess conditions of the state's surface waters. See Chapters 2 and 3 for general assessment methods.

This chapter describes the categorization of waters and associated water quality management activities. Assigning categories is part of the TCEQ's strategy for overall management of water quality, and supports administration of the various programs that implement protection and improvement strategies.

Assigning categories to indicate how specific water quality issues are being addressed is part of the State's watershed action planning (WAP) process. The primary objectives of the WAP process are to improve access to the State's water quality management decisions and to improve transparency and coordination in water quality improvement efforts. The WAP process facilitates input from stakeholders and cooperators for determining the appropriate categories and steps towards restoring water quality.

Describing Water Bodies and Standards Attainment

The TCEQ and its cooperators monitor the State's surface waters. The TCEQ, in turn, analyzes the data and information, and assesses the water quality by comparing the data to the water quality standards and criteria. Water quality standards are composed of designated uses and their associated criteria for instream conditions necessary to support those uses. The uses represent the purposes designated for a water body, such as aquatic life use-providing a suitable environment for fish and other aquatic life, or contact recreation use - providing water that is safe for swimming or other contact with water. The criteria may be expressed in terms of narrative descriptions of desirable conditions, or as numeric limits on certain pollutants. These pollutants or conditions are collectively referred to as parameters. For example, a high aquatic life use is generally associated with an average criterion of 5 mg/L of dissolved oxygen; the parameter (or condition) in this case is dissolved oxygen. In other words, each criterion consists of a measurable value and a parameter.

Uses and criteria are usually assigned to an entire segment. A segment is a water body or part of a water body with a specific location, defined dimensions, and designated or presumed uses. Segments are the basic geographic unit used in defining and measuring water quality.

To increase the spatial accuracy of the assessment, many segments may be further divided into AUs in order to evaluate conditions in areas that are more homogeneous in chemical, physical, and hydrological characteristics than are whole segments. An AU may be evaluated using data from one or more monitoring sites. See Chapter 2 for a more complete definition of AUs.

If a criterion is not attained, the associated use is identified as impaired. The combination of one parameter (where the measurable value exceeds the criterion) with one use is called an impairment. In some cases there are insufficient data to determine if the standard is attained, but the available data may point to a concern that water quality may be declining. Since more than one use is usually applied to any segment, the water quality data may indicate support of one use, but not another. For instance, the contact recreation use may be impaired, while the aquatic life use is still supported.

Water Quality Categories

Defining overall water quality conditions within a specific waterbody allows the TCEQ to communicate information on the status of the State's water resources. This information can be used by the public, municipalities as well as by state and federal agencies to make decisions regarding water quality. Classifying the overall condition of a specific water body can provide an overall demonstration of the condition of water resources and the effectiveness of programs responsible for the protection of water quality.

As part of the development of the Integrated Report, one of five categories is assigned to each of the segments. The categories indicate the status of water quality in the segment and indicate an overall status of water quality condition. Strategies for water bodies in Categories 1, 2, and 3 include additional data collection and assessment, and implementation through wastewater permits and other protective measures. Strategies for water bodies in Categories 4 and 5 are summarized in the subcategories, and targeted for the specific AUs and uses that are impaired. Strategies for AUs in 4 and 5 include review of water quality standards; projects to characterize the sources, extent, and severity of impairments; and projects to improve water quality or restore support of an impaired use.

The five categories for segments are:

1. All standards are attained; no evidence that nonattainment of any standard will occur in the near future.
2. Some standards are attained; no evidence that nonattainment of any standard will occur in the near future; and insufficient or no data and information are available to determine if the remaining standards are attained.
3. Insufficient or no data and information to determine if any standard is attained.
4. Standard is not attained or nonattainment is predicted in the near future due to one or more parameters, but no TMDLs are required.
    a. All TMDLs have been completed and approved by EPA.
    b. Other control requirements (including Watershed Protection Plans) are reasonably expected to result in the attainment of all standards.
    c. Nonattainment of the standard for one or more parameters is shown to be caused by pollution, not by pollutants and that the water quality conditions cannot be changed by the allocation and control of pollutants through the TMDL process.
5. Standard is not attained or nonattainment is predicted in the near future for one or more parameters.
    a. TMDLs are underway, scheduled, or may be scheduled for one or more parameters.
    b. A review of the standards for one or more parameters will be conducted before a management strategy is selected, including a possible revision to the water quality standards.
    c. Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected. A Watershed Protection Plan is currently under development or being implemented

Assigning Categories

A category is assigned to each impairment by the SWQM assessor. For existing impairments, SWQM assessors start with the category carried over from the previous cycle and review and consider other information, including recommendations from the Watershed Action Planning (WAP) process. In the WAP process, the TCEQ, Texas State Soil and Water Conservation Board (TSSWCB), and the Clean Rivers Program Partners determine and document specific strategies for each impairment, which may include a recommendation for a category change in the next IR update.

For new impairments, SWQM assessors assign a category based on program recommendations, data provider information or stakeholder input. For both existing and new impairments, recommendations for categories may be made outside the IR cycle within WAP proceedings. These will be considered by the SWQM assessor during the next IR update.

Hierarchical Category Assignments

The overall category assigned to a segment is dependent on the categories of all the AUs in that segment. Categories are assigned based on the evaluation of the criterion of each individual parameter within an AU. Because multiple parameters are used to evaluate most uses, each parameter must first be evaluated against the associated criteria before the overall use support for the AU can be determined. Similarly, the use support of each AU within a segment must be determined to evaluate the overall use support of that segment.

For example, Segment 0101 is composed of two AUs. Two uses are designated for the segment-support of aquatic life and contact recreation. In AU_01 both uses are supported, so the AU is assigned to Category 1. In AU_02, the aquatic life use is supported but there is insufficient data to determine whether the contact recreation use is supported, so that AU is assigned to Category 1 for the aquatic life use and Category 3 for the contact recreation use. Overall, the segment would be assigned to Category 2-one or more uses are supported but there is insufficient information to determine use attainment for others.

Similarly, in another segment, if some of the uses are supported, but others are not, then the segment would be assigned to Category 4 or 5, depending on whether the state is already taking action to improve water quality (Category 4), or plans to take such action in the future (Category 5).

Table 5.1 shows the progression from categorizing each parameter in one AU, to categorizing each use in each AU within a segment, and then determining the final segment category. It also summarizes the strategies associated with the subcategories of Categories 4 and 5.

Table 5.1. Assigning Categories to Parameters, Uses, AUs, and Segments

Category Number	Category for Each Parameter within AU (parameter AU)	Category for Each Overall Use within AU (use/AU)	Overall Category for AU (all uses/AU)	Overall Category for Segment (all uses/ all AUs)
1		Overall Use is attained for this AU. (General Use is attained unless there is an impairment.)	All uses are assessed and attained	All uses are attained; no evidence that nonattainment of any standard will occur in the near future
2			Some uses are assessed and attained, others are not assessed	Some uses are attained; no evidence that nonattainment of any use will occur in the near future; and insufficient or no data and information are available to determine if the remaining uses are attained
3		Overall Use not assessed for this AU	No uses are assessed	Insufficient or no data and information to determine if any use is attained
4		Overall Use not attained but a TMDL is not required	Some uses are not attained in the AU, but a TMDL is not required	Use is not attained or nonattainment is predicted in the near future for one or more parameters, but no TMDLs are required
4a	TMDL completed and approved by EPA for this parameter			
4b	Other control requirements are reasonably expected to result in attainment of the standard in the near future for this parameter			

Table 5.1. Assigning Categories to Parameters, Uses, AUs, and Segments

Category Number	Category for Each Parameter within AU (parameter AU)	Category for Each Overall Use within AU (use/AU)	Overall Category for AU (all uses/AU)	Overall Category for Segment (all uses/ all AUs)
4c	Nonattainment of the standard is shown to be caused by pollution, not by a pollutant for this parameter			
5		Overall Use not attained and a TMDL may be required for a parameter	Some uses are not attained and a TMDL may be required	One or more uses are not attained or nonattainment is predicted in the near future for one or more parameters, and a TMDL may be required.
5a	A TMDL is underway, scheduled, or may be scheduled for this parameter			
5b	A review of the standard will be conducted before a management strategy is scheduled for this parameter			
5c	Additional data or information will be collected and/or evaluated before a management strategy is selected for this parameter			

Categories 1, 2, and 3

The management actions and the most common ways that segments move from one category to another during subsequent biennial assessments are detailed for segments assigned to Categories 1 through 3 in Table 5.2.

For some uses in both Category 1 and 3, the available data may indicate what is termed a "concern" (see Chapter 2). A concern is identified in Category 1 segments if the standard is attained and there is no threat, but one or more data points do exceed the standard. A concern may be identified in Category 3 segments, even though there are fewer than the minimum numbers of samples required for full assessment, if one or more of these samples exceeds the standard. Category 3 may also be assigned when use impairments are the result of changes in water quality due to persistent drought conditions.

Table 5.2. Categories 1,2, and 3—Management Strategies

Category	Action
1. All standards are attained; no evidence that nonattainment of any standard will occur in the near future	TCEQ and/or other ag example, how often is a water body used for swimming), and water quality concerns is considered during annual planning meetings at the river basin scale involving agency staff and local monitoring entities. The cooperative multi-agency routine monitoring schedule and more details on the monitoring strategy are available on the TCEQ Web site at: https://cms.lcra.org/ • Conduct routine monitoring to document ongoing conditions. • Reassess uses based on new data.
2. Some standards are attained. No evidence that nonattainment of any standard will occur in the near future. Insufficient or no data and information are available to determine if the remaining standards are attained.	TCEQ and/or other agencies: • Set priorities for data collection based on concerns, the importance of the resource, and local interest. Information about pollution risk, intensity of use (for example, how often is a water body used for swimming), and water quality concerns is considered during annual planning meetings at the river basin scale involving agency staff and local monitoring entities. The cooperative multi-agency routine monitoring schedule and more details on the monitoring strategy are available on the TCEQ Web site at: https://cms.lcra.org/ • Conduct routine monitoring to document ongoing conditions. • Reassess uses based on new data.
3. Insufficient or no data and information to determine if any standard is attained.	TCEQ and/or other agencies: • Set priorities for data collection based on concerns, the importance of the resource, and local interest. • Conduct routine monitoring to document ongoing conditions. • Reassess uses based on new data. In addition, the TCEQ is developing a statistically-based monitoring program to provide information on various classes of water bodies (for example, small streams). This additional information will be used to target monitoring for water bodies that are likely to have impairments or concerns.

Category 4

Category 4 is for those impairments that do not require a TMDL. The uses and parameters in this category are not part of the 303(d) List. Category 4 is divided into three sub-categories. These subcategories convey the status and plans for different kinds of impairments (see Table 5.3).

Note that for Category 4 impairments, because there are water quality controls in place, or the non-support is not amenable to TMDL processes, impairments are removed from this category when water quality standards are attained without the additional level of assurance required for delisting from Category 5 (that no more than 10% of the samples exceed).

With each subsequent assessment, the AU may be moved to a different category. The ultimate goal is to attain all uses so it can be removed from Category 4a. It is also possible, though less likely, that data or information collected under a TMDL Implementation Plan would indicate that the parameter should be moved to Category 5b or 4c.

Table 5.3. Category 4-Management Strategies

CATEGORY 4 Use is not supported, but does not require a TMDL.		
Category	**Action**	**Most Common Category Reassignment**
4a. TMDL completed and approved by EPA.	• TCEQ develops an implementation plan (I-Plan) to reduce pollutant load, based on TMDL(s). • TCEQ issues or renews TPDES permits according to the TMDL, adjusting effluent limitations as needed. • Local, state or federal authorities, or private entities, implement other actions according to the I-Plan. • TMDL program tracks implementation of all planned activities and progress toward standards attainment. • If control measures do not lead to attainment of the standard in the time frame set out in the I-Plan, TCEQ may revise the TMDL and/or the I-Plan. • TCEQ or other agencies continue routine monitoring and conduct additional monitoring as described in the I-Plan.	If standard is attained, and all other uses are met, the AU and segment are removed from Category 4a.
4b. Other control requirements are reasonably expected to result in attainment of the standard in the near future.	• TCEQ will not permit additional loading that will cause or contribute to the impairment. • Local, state, or federal authorities, or private entities, implement actions that are expected to result in standards attainment. • SWQM tracks progress towards standards attainment through monitoring program. • TCEQ or other agencies continue routine monitoring.	If standard is attained, the AU and segment are removed from Category 4.
4c. Water quality degradation is not due to a specific pollutant.	No action required.	

CATEGORY 4 Use is not supported, but does not require a TMDL.		
Category	**Action**	**Most Common Category Reassignment**
4a. TMDL completed and approved by EPA.	• TCEQ develops an implementation plan (I-Plan) to reduce pollutant load, based on TMDL(s). • TCEQ issues or renews TPDES permits according to the TMDL, adjusting effluent limitations as needed. • Local, state or federal authorities, or private entities, implement other actions according to the I-Plan. • TMDL program tracks implementation of all planned activities and progress toward standards attainment. • If control measures do not lead to attainment of the standard in the time frame set out in the I-Plan, TCEQ may revise the TMDL and/or the I-Plan. • TCEQ or other agencies continue routine monitoring and conduct additional monitoring as described in the I-Plan.	If standard is attained, and all other uses are met, the AU and segment are removed from Category 4a.
4b. Other control requirements are reasonably expected to result in attainment of the standard in the near future.	• TCEQ will not permit additional loading that will cause or contribute to the impairment. • Local, state, or federal authorities, or private entities, implement actions that are expected to result in standards attainment. • SWQM tracks progress towards standards attainment through monitoring program. • TCEQ or other agencies continue routine monitoring.	If standard is attained, the AU and segment are removed from Category 4.
4c. Water quality degradation is not due to a specific pollutant.	No action required.	

Category 4a

A parameter is moved into Category 4a during the assessment that immediately follows EPA approval of a TMDL for that parameter. Depending on when the EPA approves the TMDL, the actual move to Category 4a may take place as long as two years after approval. In any case, immediately after the TCEQ submits the TMDL to EPA, and in some cases before the submission, the TCEQ leads the effort to develop an I-Plan to carry out the TMDL. Depending on the types of actions needed to restore the use of the water body, other agencies play a leadership or partnership role in the development and execution of the I-Plan. Attainment of the standard is expected upon full implementation of the plan, although that may take many years or decades. In some cases, an adaptive management approach is used that allows for periodic revisions of the TMDL or the I-Plan.

Category 4b

This category represents a situation where controls other than a TMDL are expected to result in attainment of the standard within a reasonable time frame. These other controls must be in progress or planned, and the TCEQ must provide credible evidence that these measures will result in standards attainment. The exact definition of a "reasonable time frame" will vary depending on the impaired use, but will be defined in the justification TCEQ presents to move the AU into Category 4b.

From EPA's *Guidance for 2006 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act* (July 29, 2005):

"EPA will evaluate on a case-by-case basis a state's decisions to exclude certain segment/pollution combinations from Category 5 (the Section 303(d) List) based on the 4b alternative. States should provide in their submission the rationale which supports their conclusion that there are "other pollutant control requirements" sufficiently stringent to achieve applicable water quality standards with a reasonable period of time."

Some Category 4b examples are:

- Impairments due to legacy pollutants where remediation under a superfund project or natural attenuation (in the absence of a current source) is projected to result in standards attainment.
- AUs where a specific discharger is known to be the source of the impairment and enforcement actions are underway to correct the problem.
- A watershed protection plan has been prepared with nine required elements, and the watershed plan is approved by the Commission as part of the Water Quality Management Plan and a commitment to implement water quality controls that will restore water quality.

TCEQ will provide a description of pollution controls and how they will achieve water quality standards, and the measures that will track the progress in restoring water quality so the plan can be revised as needed.

If these other controls result in attainment of the standard, the AU is removed from Category 4b. If the measures have not been successful in the expected time frame, the AU will be moved to one of the subcategories of Category 5. It is also possible, though less likely, that more recent data or information would indicate that the parameter should be moved to Category 5b or 4c.

Category 4c

This category is reserved for those water bodies where the impairment is caused by stressors other than specific pollutants that can be allocated under a TMDL. This may also include situations where water quality degradation is not due to a specific pollutant (for example, habitat loss).

There are conceivably many types of non-pollutant impairments which could be considered for this subcategory. Prior to the release of a draft 303(d) List, candidates for Category 4c are identified. This step includes consideration of the appropriateness of the standard, and thus whether the impairment more appropriately belongs in Category 5b.

A primary consideration for Category 4c relies on the differentiation between "pollution" and "pollutant." The CWA and Texas Water Code (TWC) include specific information which clearly define each:

CWA Section 502(6). The term "pollutant" means dredged spoil, solid waste, incinerator residue, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, salt, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. This term does not mean (A) "sewage from vessels" within the meaning of section 312 of the Act; or (B) water, gas, or the materials which are injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if such State determines that such injection or disposal will not result in the degradation of ground or surface water resources.

CWA Section 502(19). The term "pollution" means the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.

Texas Surface Water Quality Standards (TWC §26.023). The term "pollution" is defined as the alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

1. When information confirms that nonsupport of criteria of the standard is caused by pollution, the impairment is put in Category 4c. The available data and information are researched to rule out a pollutant as the cause of the impairment. It is possible that some small level of a pollutant loading might be identified, but TCEQ must demonstrate that the pollutant loading is inconsequential. In some cases, the TCEQ may not have the staff resources to carry out this step at the time of the assessment; and in that case the parameter is placed in Category 5c, and this additional assessment work is carried out at a later date.
2. When available information confirms that the nonsupport of criteria and standard is caused by natural conditions or sources of pollutants that cannot be allocated and controlled through TMDL, the impairment is put into Category 4c. For example:
    - Natural low flow conditions of water which prevent the attainment of the use.
    - Physical conditions related to the natural features of the water body which preclude attainment of the use.
    - A naturally occurring pollutant concentrations not attributed to waste discharges or the activity of man which prevents attainment of criteria not related to human health, e.g., rather aquatic life use criteria.

Justification for the placement of the impairment in Category 4c is drafted and this information is provided with the draft IR. The justification includes information as to the probable sources and causes, however, there is no commitment by the TCEQ or any other agency to carry out restoration activities.

Once a parameter is in Category 4c, TCEQ will not permit additional loading that causes or contributes to the impairment. However, TCEQ may consider trading opportunities.

Category 5

Category 5 includes impairments which may require a TMDL or other water quality management strategy. This category is divided into three subcategories indicating specific actions necessary to address impairments. These subcategories are a useful management tool for the TCEQ, and inform stakeholders of the status and plans for different kinds of impairments (see Table 5.4).

Table 5.4. Category 5–Management Strategies

CATEGORY 5 Use is not supported		
Category	**Action**	**Most Common Category Reassignment**
5a. A TMDL is underway, scheduled, or may be scheduled.	• TCEQ schedules a TMDL dependent upon available funding and develops a TMDL for each pollutant or condition. • TCEQ will not permit additional loading that will cause or contribute to the impairment. • In some cases, new data and information gathered for the TMDL may lead to a different restoration approach prior to completion of the TMDL. • TCEQ or other agencies continue routine monitoring.	If TMDL is approved by EPA, parameter moves to Category 4a. If the parameter is fully supporting, it remains in Category 5a until the TMDL is approved, or in 4a if the Implementation Plan is completed.
5b. A review of the standard will be conducted before a management strategy is selected.	• TCEQ will not permit additional loading that will cause or contribute to the impairment. • TCEQ sets priorities for these impairments then initiates a use attainability analysis (UAA) or other special study for each affected AU. If appropriate, a new standard (designated use and/or site-specific criterion) will be proposed to EPA. • TCEQ or other agencies continue routine monitoring.	If TCEQ does not propose standards revision, or if TCEQ proposes a change that EPA disapproves, the parameter moves to Category 5a if impairment continues and pollutant is identified. If impairment is not caused by a pollutant, the parameter is moved to Category 4c.

5c. Additional data and/or information will be collected or evaluated before a management strategy is selected.	• TCEQ will not permit additional loading that will cause or contribute to the impairment.
	• TCEQ or other agencies:
	  • Carry out parameter or area-specific study.
	  • Continue routine monitoring.
	• Watershed protection plans with 9 elements may be pursued.
		If pollutant is identified, parameter moves to Category 5a. If impairment is not caused by a pollutant, the parameter is moved to Category 4c. In rare instances, additional data may show the affected use is being met, and the parameter is moved to Category 1.

Category 5a

Impairments are placed in Category 5a only after the TCEQ determines that the impairment does not more appropriately belong in categories 5b, 5c, 4b, or 4c, and a TMDL is determined to be appropriate.

In each of these cases, the TCEQ would identify the pollutant prior to placement of the impairment in Category 5a. If it is unclear that the impairment is caused by a pollutant, it is placed in Category 5c. If the impairment is clearly not caused by a pollutant, the AU is placed in Category 4c.

After the 303(d) List is finalized, but prior to submission to EPA, the TCEQ develops a schedule for TMDLs for parameters in Category 5a. The schedule includes the anticipated date of submittal of the TMDLs to EPA for those TMDLs that will be completed in the next two years.

Upon approval of the TMDL by EPA, the parameter is moved to Category 4a during the subsequent assessment, unless the standard is attained, in which case the AU and segment are moved to Category 1. In some cases, new data and information gathered for the TMDL may lead to a different strategy prior to completion of the TMDL, and the parameter is moved to Category 4b, 4c or 5b, as appropriate.

Category 5b

Parameters are placed in this subcategory if there is a need to review the designated use or water quality criteria. Water bodies listed on the 303(d) list may be considered candidates for a use attainability analysis (UAA) or recreational use attainability analysis (RUAA). UAAs and RUAAs are conducted on classified or on unclassified water bodies for which uses and criteria have been established. Aquatic Life

Assessments (ALA) are conducted on unclassified water bodies where the presumed aquatic life use and/or the associated dissolved oxygen criteria are not attained. The purpose of the UAA or ALA is to determine if existing uses and criteria are appropriate and, if not, to develop uses, assign presumed uses, and criteria adjustment information.

The TCEQ has developed a process for prioritizing these water bodies for the development a UAA or site-specific criterion. The factors used by the TCEQ and WAP partners to prioritize water bodies for standards review are:

- Adequacy of the data set describing the extent and severity of the nonsupport, including direct measurements of use support such as biological data
- Comparison of conditions and measurements at similar sites in the ecoregion
- History of recent UAAs or other standard-related work
- Changes in water quality since a previous review of the standards
- The extent to which natural causes and sources are believed to contribute to nonsupport of the existing standards

Common examples of Category 5b parameters are:

- Total dissolved solids, chloride, and sulfate where current or historical data set indicate criteria should be reviewed.
- The physical suitability of a waterbody to support primary contact recreation. Conditions related to flow status or hydrology may limit activities associated with primary contact recreation
- Dissolved oxygen, where (1) the criteria are not supported but the biological community is healthy; or (2) modeling shows that the dissolved oxygen criteria cannot be met under natural conditions; or (3) data collected for a pending permit prompts a review of the standard.
- Biological community is impaired based on a presumed or designated use, where information indicates that to be an inappropriate use designation.

If a standard revision is proposed, the parameter remains in Category 5b until EPA takes action on the proposed standard. A reassessment against the new standard will then determine the new category for the parameter. If the impairment still exists, the parameter is moved to Category 4b, 4c, 5a, or 5c, as appropriate. If revision of the standard is not proposed by the TCEQ, or if the TCEQ proposes a change that EPA disapproves, the parameter moves to Category 4b, 4c, 5a, or 5c as appropriate.

Category 5c

Impairments are commonly placed in Category 5c if there is insufficient information to determine the best course of action. Impairments are also placed in Category 5c if there is existing information that has not yet been thoroughly evaluated to determine the best management strategy. The information needed, and therefore the action required, for each Category 5c impairment is parameter-specific. An impairment may be the result of poor water quality conditions observed for only a few years. It may be prudent to continue sampling for several more years and reassess to confirm that the impairment is persistent and characteristic of the water body before initiating a TMDL or standards review.

Water Quality Concerns

Water quality concerns include those waters not considered impaired, however, data indicate that pollutant levels are elevated or exceed specific screening thresholds. These water bodies are prioritized through routine monitoring and directed toward the following:

- Completing data sets where limited information indicates that a water quality criterion shows a standard is not supported but with a limited data set.
- Concerns for water bodies that are near nonattainment.
- Waters with known water quality concerns.
- No specific priority for bodies that have no known water quality problems or without current water quality data.

These priorities for routine monitoring are outlined in Table 5.6. A more detailed description of TCEQ's monitoring process for waters with concerns and impairments can be found in the most current version of the Texas Surface Water Quality Monitoring and Assessment Strategy. The TCEQ SWQM Program and the Texas Clean Rivers Program provide for an integrated evaluation of physical, chemical, and biological characteristics of aquatic systems in relation to human health concerns, ecological condition, and designated uses. The monitoring strategy outlines the basis for the establishment of effective TCEQ management policies that promote the protection, restoration, and responsible use of Texas surface-water resources.

Table 5.5. Monitoring Objectives to Address Concerns

Level of Support for Parameter	General Monitoring Objective	Priority
Concern for standard support (CN) or not supporting (NS) with a limited data set (LD) (small data set; < 10 samples) or even insufficient data (ID) (<10 samples)	Sample until an adequate data set is available for assessment. The few samples collected in these AUs show problems.	1st
Concern near nonattainment of standard support (CN) with adequate data (AD) for water quality criteria. Or concerns (CS) for DO grab samples	Continue routine monitoring to establish that near nonattainment is ongoing. When DO grab samples identify a concern, schedule 24-hour sampling to determine if the mean criterion is supported?	2nd
Concern for support (CS) with adequate data (AD) for narrative screening criteria, i.e., nutrients and sediment	Continue monitoring to establish that concern is ongoing. Monitor other water quality causes and sources related to the parameter of concern.	3rd
For water bodies where uses are fully supported (FS) with adequate data (AD), or no concern (NC) with limited data (LD)	Continue monitoring to establish that the designated uses are supported. Include conventional parameters on high use water bodies and water bodies of local interest. Monitor at least one station in each classified segment and important water body. Monitor toxics and biological monitoring in areas where this monitoring has not been conducted.	4th

Appendix A
Number of Samples and Exceedances to Identify Concern, Impairment, or to Delist a Parameter by the Binomial Method—Tables

Table A-1. Minimum Threshold Number of Exceedances to List or to Identify a Concern for Use-Attainment of *Conventional* Parameters.								
LISTING						CONCERN		
Number of Samples	To identify a water body as impaired with an intended Type-1 error rate of no more than 20% at an exceedance rate of 10% and a Type-2 error rate of less than about 40% at an exceedance rate of 30%. A minimum number of three exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					To identify a water body as a concern for near non-attainment with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exceedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1 at 8% Exceedance	Actual Type-2 at 20% Exceedance
4	1 2 3				3	1 2 3	28 3 0	41 82 97
5	1 2 3				3	1 2 3	34 5 0.1	33 74 94
6	1 2 3				3	1 2 3	39 8 1	26 66 90
7	1 2 3				3	1 2 3	44 10 1	21 58 85
8	1 2 3				3	1 2 3	49 13 2	17 50 80
9	1 2 3				3	1 2 3	53 16 3	13 44 74
10	1 2 3	65 26 7	11 38 68	3 15 38	3	1 2 3	57 19 4	11 38 68
11	1 2 3	69 30 9	09 32 62	2 11 31	3	1 2 3	60 22 5	9 32 62
12	1 2 3	72 34 11	7 27 56	1 9 25	3	1 2 3	63 25 7	7 27 56
13	1 2 3 4	75 38 13 3	5 23 50 75	1 6 20 42	3	1 2 3 4	66 28 8 2	5 23 50 75

Table A-1. Minimum Threshold Number of Exceedances to List or to Identify a Concern for Use-Attainment of *Conventional* Parameters (continued).

Number of Samples	LISTING: To identify a water body as impaired with an intended Type-1 error rate of no more than 20% at an exceedance rate of 10% and a Type-2 error rate of less than about 40% at an exceedance rate of 30%. A minimum number of three exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					CONCERN: To identify a water body as a concern for near non-attainment with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exceedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1 at 8% Exceedance	Actual Type-2 at 20% Exceedance
14	1	77	4	1	3	1	69	4
	2	42	20	5		2	31	20
	3	16	45	16		3	10	45
	4	4	70	36		4	2	70
15	1	79	4	1	3	1	71	4
	2	45	17	4		2	34	17
	3	18	40	13		3	11	40
	4	6	65	30		4	3	65
16	1	81	3	0	4	1	74	3
	2	49	14	3		2	37	14
	3	21	35	10		3	13	35
	4	7	60	25		4	3	60
17	1	83	2	0	4	1	76	2
	2	52	12	2		2	40	12
	3	24	31	8		3	15	31
	4	8	55	20		4	4	55
18	1	85	2	0	4	1	78	2
	2	55	10	1		2	43	10
	3	27	27	6		3	17	27
	4	10	50	16		4	5	50
19	1	86	1	0	4	1	79	1
	2	58	8	1		2	46	8
	3	29	24	5		3	19	24
	4	12	46	13		4	6	46
20	1	88	1	0	4	1	81	1
	2	61	7	1		2	48	7
	3	32	21	4		3	21	21
	4	13	41	11		4	7	41

Table A-2. Maximum Threshold Number of Exceedances to Delist a Water Body for *Conventional* Parameters.					
DELISTING					
Number of Samples	To identify a water body as attaining its use, and delisted with an exceedances rate of no more than 10%, resulting in a Type-1 error rate of no more than 70% at an exceedance rate of 11% and no more than 38% at an exceedance rate of 20%; and a Type-2 error rate of 8 to 25% at an exceedance rate of 5%.				
	Number of Exceedances	Actual Type-1 at 11% Exceedance	Actual Type-1at 20 % Exceedance	Actual Type-2 at 5% Exceedance	Actual % Exceedance When Delisting
10	0	31	11	40	10
	1	70	38	9	
	2	91	68	1	
11	0	28	9	43	9
	1	65	32	10	
	2	89	62	2	
12	0	25	7	46	8
	1	61	27	12	
	2	86	56	2	
13	0	22	5	49	8
	1	57	23	14	
	2	83	50	2	
14	0	20	4	51	7
	1	53	20	15	
	2	81	45	3	
15	0	17	4	54	6
	1	50	17	17	
	2	78	40	4	
16	0	16	3	56	6
	1	46	14	19	
	2	76	35	4	
17	0	14	2	58	6
	1	43	12	21	
	2	71	31	5	
18	0	12	2	60	6
	1	40	10	23	
	2	68	27	6	
19	0	11	1	62	5
	1	37	8	25	
	2	65	24	7	
20	0	10	1	64	10
	1	34	7	26	
	2	67	27	8	

Table A-3. Minimum Threshold Number of Exceedances to Identify a Concern for *Dissolved Oxygen*.			
CONCERN			
Number of Samples	To identify a water body as a concern (using an average of dissolved oxygen grabs) with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1at 8% Exceedance	Actual Type-2 at 20 % Exceedance
4	1	28	41
	2	3	82
	3	0	97
5	1	34	33
	2	5	74
	3	0.1	94
6	1	39	26
	2	8	66
	3	1	90
7	1	44	21
	2	10	58
	3	1	85
8	1	49	17
	2	13	50
	3	2	80
9	1	53	13
	2	16	44
	3	3	74
10	1	57	11
	2	19	38
	3	4	68
11	1	60	9
	2	22	32
	3	5	62
12	1	63	7
	2	25	27
	3	7	56
13	1	66	5
	2	28	23
	3	8	50
	4	2	75

Table A-3. Minimum Threshold Number of Exceedances to Identify a Concern for *Dissolved Oxygen* (continued).			
Number of Samples	CONCERN		
	To identify a water body as a concern (using an average of dissolved oxygen grabs) with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 8% and a Type-2 error rate of less than about 40% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1at 8% Exceedance	Actual Type-2 at 20 % Exceedance
14	1	69	4
	2	31	20
	3	10	45
	4	2	70
15	1	71	4
	2	34	17
	3	11	40
	4	3	65
16	1	74	3
	2	37	14
	3	13	35
	4	3	60
17	1	76	2
	2	40	12
	3	15	31
	4	4	55
18	1	78	2
	2	43	10
	3	17	27
	4	5	50
19	1	79	1
	2	46	8
	3	19	24
	4	6	46
20	1	81	1
	2	48	7
	3	21	21
	4	7	41

Table A-4. Minimum Threshold Number of Exceedances to Identify a Concern for *Screening Level* Parameters.			
CONCERN			
Number of Samples	To identify a water body as a screening level concern with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 20% Exceedance	Actual Type-2 at 40 % Exceedance
4	1	59	13
	2	18	48
	3	3	82
5	1	67	8
	2	26	34
	3	6	68
6	1	74	5
	2	34	23
	3	10	54
7	1	79	3
	2	42	16
	3	15	42
	4	3	71
8	1	83	2
	2	50	11
	3	20	32
	4	6	59
9	1	87	1
	2	56	7
	3	26	23
	4	9	48
10	1	89	1
	2	62	5
	3	32	17
	4	12	38
	5	3	63
11	1	91	0
	2	68	3
	3	38	12
	4	16	30
	5	5	53

Table A-4. Minimum Threshold Number of Exceedances to Identify a Concern for *Screening Level* Parameters (continued).

Number of Samples	CONCERN To identify a water body as a screening level concern with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 20% Exceedance	Actual Type-2 at 40 % Exceedance
12	1	93	0
	2	73	2
	3	44	8
	4	21	23
	5	7	44
13	1	95	0
	2	77	1
	3	50	6
	4	25	17
	5	10	35
	6	3	57
14	1	96	0
	2	80	1
	3	55	4
	4	30	12
	5	13	28
	6	4	49
15	1	96	0
	2	83	1
	3	60	3
	4	35	9
	5	16	22
	6	6	40
16	1	97	0
	2	86	0
	3	65	2
	4	40	7
	5	20	17
	6	8	33

Table A-4. Minimum Threshold Number of Exceedances to Identify a Concern for *Screening Level* Parameters (continued).

Number of Samples	CONCERN To identify a water body as a screening level concern with an intended Type-1 error rate of no more than about 20% at an exceedance rate of 20% and a Type-2 error rate of less than about 40% at an exceedance rate of 40%.		
	Number of Exceedances	Actual Type-1at 20% Exceedance	Actual Type-2 at 40 % Exceedance
17	1	98	0
	2	88	0
	3	69	1
	4	45	5
	5	24	13
	6	11	26
	7	4	45
18	1	98	0
	2	90	0
	3	73	1
	4	50	3
	5	28	9
	6	13	21
	7	5	37
19	1	99	0
	2	92	0
	3	76	1
	4	54	2
	5	33	7
	6	16	16
	7	7	31
20	1	99	0
	2	93	0
	3	79	0
	4	59	2
	5	37	5
	6	20	13
	7	9	25
	8	3	42

Table A-5. Minimum Threshold Number of Exceedances to List or to Identify a Concern for Use-Attainment of *Toxic* Parameters.								
LISTING						CONCERN		
Number of Samples	To identify a water body as impaired with an intended Type-1 error rate of no more than 40% at an exceedance rate of 10% and a Type-2 error rate of less than about 20% at an exceedance rate of 30%. A minimum number of two exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					To identify a water body as a concern for near non-attainment with an intended Type-1 error rate of no more than about 40% at an exceedance rate of 8% and a Type-2 error rate of less than about 20% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exceedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1at 8% Exceedance	Actual Type-2 at 20% Exceedance
4	1				2	1	28	41
	2					2	3	82
	3					3	0	97
5	1				2	1	34	33
	2					2	5	74
	3					3	0.1	94
6	1				2	1	39	26
	2					2	8	66
	3					3	1	90
7	1				2	1	44	21
	2					2	10	58
	3					3	1	85
8	1				2	1	49	17
	2					2	13	50
	3					3	2	80
9	1				2	1	53	13
	2					2	16	44
	3					3	3	74
10	1	65	11	3	2	1	57	11
	2	26	38	15		2	19	38
	3	7	68	38		3	4	68
11	1	69	9	2	2	1	60	9
	2	30	32	11		2	22	32
	3	9	62	31		3	5	62
12	1	72	7	1	2	1	63	7
	2	34	27	9		2	25	27
	3	11	56	25		3	7	56
13	1	75	5	1	2	1	66	5
	2	38	23	6		2	28	23
	3	13	50	20		3	8	50
	4	3	75	42		4	2	75

Table A-5. Minimum Threshold Number of Exceedances to List, or to Identify a Concern for Use-Attainment of *Toxic* Parameters (continued).

LISTING						CONCERN		
Number of Samples	To identify a water body as impaired with an intended Type-1 error rate of no more than 40% at an exceedance rate of 10% and a Type-2 error rate of less than about 20% at an exceedance rate of 30%. A minimum number of two exceedances are required for 303(d) listing. (Actual Type-2 at 20% exceedance rate is for information only).					To identify a water body as a concern for near non-attainment with an intended Type-1 error rate of no more than about 40% at an exceedance rate of 8% and a Type-2 error rate of less than about 20% at an exceedance rate of 20%.		
	Number of Exceedances	Actual Type-1 at 10% Exceedance	Actual Type-2 at 20 % Exceedance	Actual Type-2 at 30% Exceedance	Number of exceedances for listing in 2004	Number of Exceedances	Actual Type-1at 8% Exceedance	Actual Type-2 at 20% Exceedance
14	1	77	4	1	2	1	69	4
	2	42	20	5		2	31	20
	3	16	45	16		3	10	45
	4	4	70	36		4	2	70
15	1	79	4	1	2	1	71	4
	2	45	17	4		2	34	17
	3	18	40	13		3	11	40
	4	6	65	30		4	3	65
16	1	81	3	0	2	1	74	3
	2	49	14	3		2	37	14
	3	21	35	10		3	13	35
	4	7	60	25		4	3	60
17	1	83	2	0	3	1	76	2
	2	52	12	2		2	40	12
	3	24	31	8		3	15	31
	4	8	55	20		4	4	55
18	1	85	2	0	3	1	78	2
	2	55	10	1		2	43	10
	3	27	27	6		3	17	27
	4	10	50	16		4	5	50
19	1	86	1	0	3	1	79	1
	2	58	8	1		2	46	8
	3	29	24	5		3	19	24
	4	12	46	13		4	6	46
20	1	88	1	0	3	1	81	1
	2	61	7	1		2	48	7
	3	32	21	4		3	21	21
	4	13	41	11		4	7	41

Table A-6. Maximum Threshold Number of Exceedances to Delist a Water Body for *Toxic* Parameters.					
DELISTING					
Number of Samples	To identify a water body as attaining its use, and delisted with an exceedance rate of no more than 8%, resulting in a Type-1 error rate of no more than 71% at an exceedance rate of 9%, and no more than 27% at an exceedance rate of 20%; and a Type-2 error rate of 12 to 43% at an exceedance rate of 5%.				
	Number of Exceedances	Actual Type-1at 9% Exceedance	Actual Type-1at 20% Exceedance	Actual Type-2 at 5% Exceedance	Actual % Exceedance When Delisting
10	0 1 2	39 77 95	11 38 68	40 9 1	0
11	0 1 2	35 74 93	9 32 62	43 10 2	0
12	0 1 2	32 71 91	7 27 56	46 12 2	8
13	0 1 2	29 67 89	5 23 50	49 14 2	8
14	0 1 2	27 64 87	4 20 45	51 15 3	7
15	0 1 2	24 60 85	4 17 40	54 17 4	7
16	0 1 2	22 57 83	3 14 35	56 19 4	6
17	0 1 2	20 54 81	2 12 31	58 21 5	6
18	0 1 2	18 51 78	2 10 27	60 23 6	6
19	0 1 2	17 48 76	1 8 24	62 25 7	5
20	0 1 2	15 45 73	1 7 27	64 26 8	5

Appendix B
Number of Samples and Exceedances to Identify Impairment, Concerns, and to Delist Parameters by the Binomial Method- Graphic Tables

Figure B-1. Binomial Method for Listing and Delisting Conventional Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:	**General Use:**
DO grab minimum	Temperature
24-hour DO average	High/Low pH
24-hour minimum	Enterococcus for Segments 1006 and 1007

Fully Supporting (FS) | No concern (NC) | Concern for Near Non-Attainment but Supporting (CN) | Not Supporting (NS)

Note that fewer samples than illustrated are not assessed (NA). Exceedance ratios less than that indicated (≤ 10%) by the thick line can be delisted.

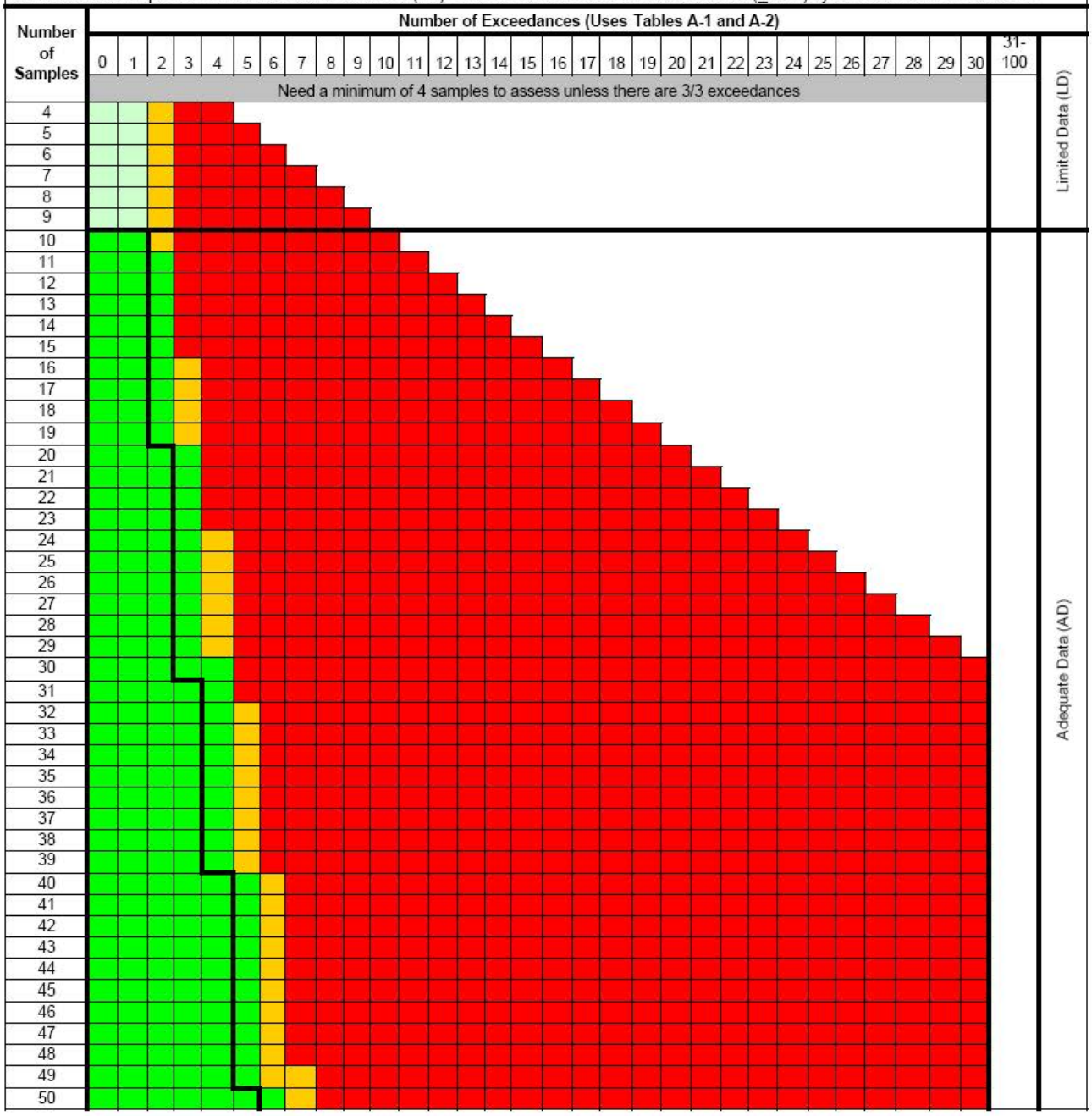

Figure B-1. Binomial Method for Listing and Delisting Conventional Parameter Use-Attainment and Concerns (continued)

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:	**General Use:**
DO grab minimum	Temperature
24-hour DO average	High/Low pH
24-hour minimum	Enterococcus for Segments 1006 and 1007

Fully Supporting (FS) | No concern (NC) | Concern for Near Non-Attainment but Supporting (CN) | Not Supporting (NS)

Note that fewer samples than illustrated are not assessed (NA). Exceedance ratios less than that indicated (≤ 10%) by the thick line can be delisted.

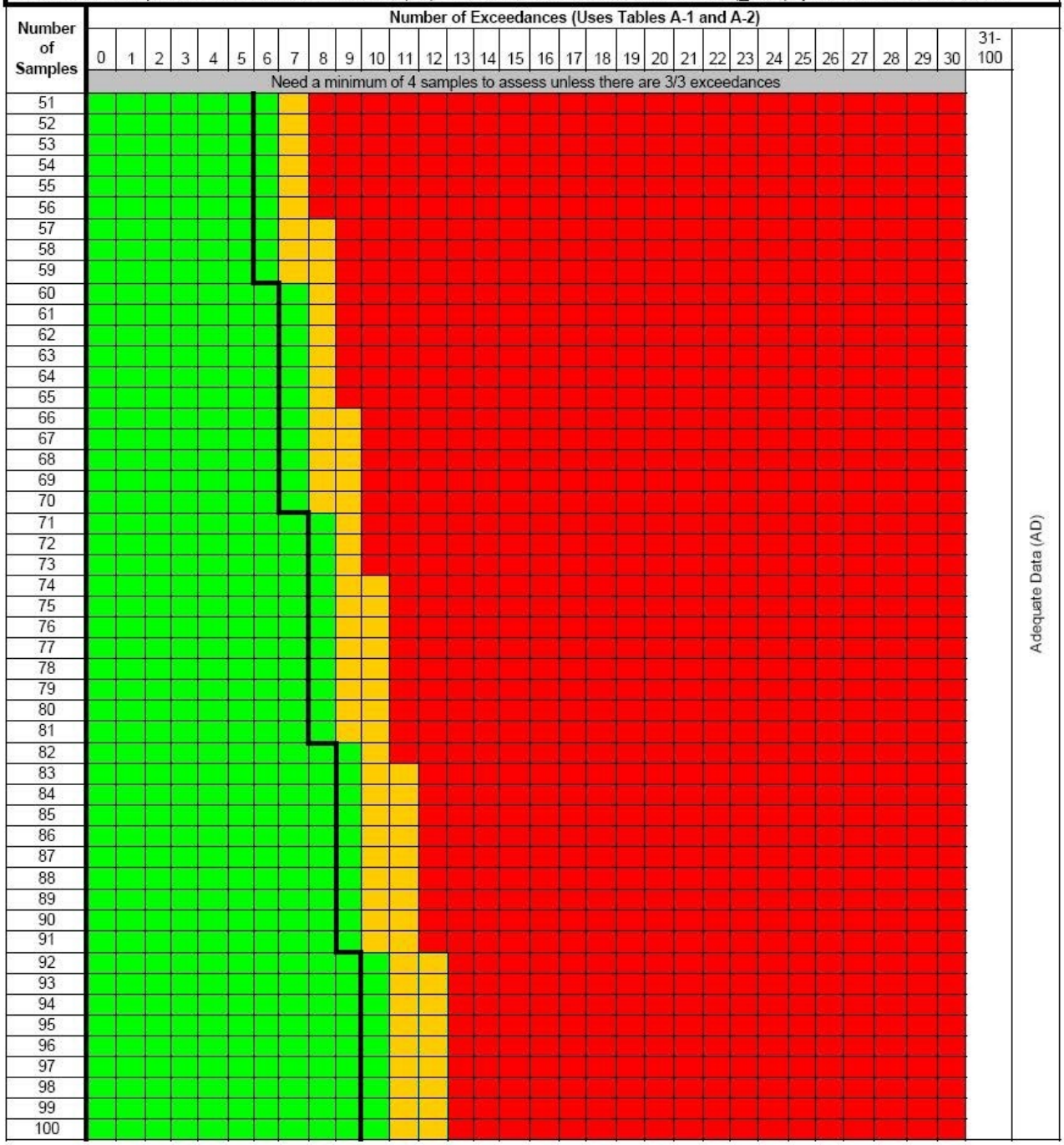

Figure B-2. Binomial Method for Determining Dissolved Oxygen Concerns

Use this look-up table for the following concern assessment method:

Aquatic Life Use:

DO grab screening level (against criteria for the 24-hr average)

No Concern (NC) | Concern (CS) | Note that fewer samples than illustrated are not assessed (NA).

Number of Samples	Number of Exceedances (Uses Table A-3)																																	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31-100	
4																																	Limited Data (LD)
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Figure B-2. Binomial Method for Determining Dissolved Oxygen Concerns (continued)

Use this look-up table for the following concern assessment method:

Aquatic Life Use:

DO grab screening level (against criteria for the 24-hr average)

No Concern (NC) | Concern (CS) | Note that fewer samples than illustrated are not assessed (NA).

Number of Samples	Number of Exceedances (Uses Table A-3)																																	Adequate Data (AD)
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31-100		
	Need a minimum of 4 samples to assess unless there are 3/3 exceedances																																	
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Figure B-3. Binomial Method for Determining Screening Level Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use: Toxic Substances in Sediment

General Use: Nutrient Screening Levels; Chlorophyll *a* Screening Levels

Fish Consumption Use: Bioaccumulative Toxics in Tissue

No Concern (NC) | Screening Levels Concern (CS) | Note that fewer samples than illustrated are not assessed (NA)

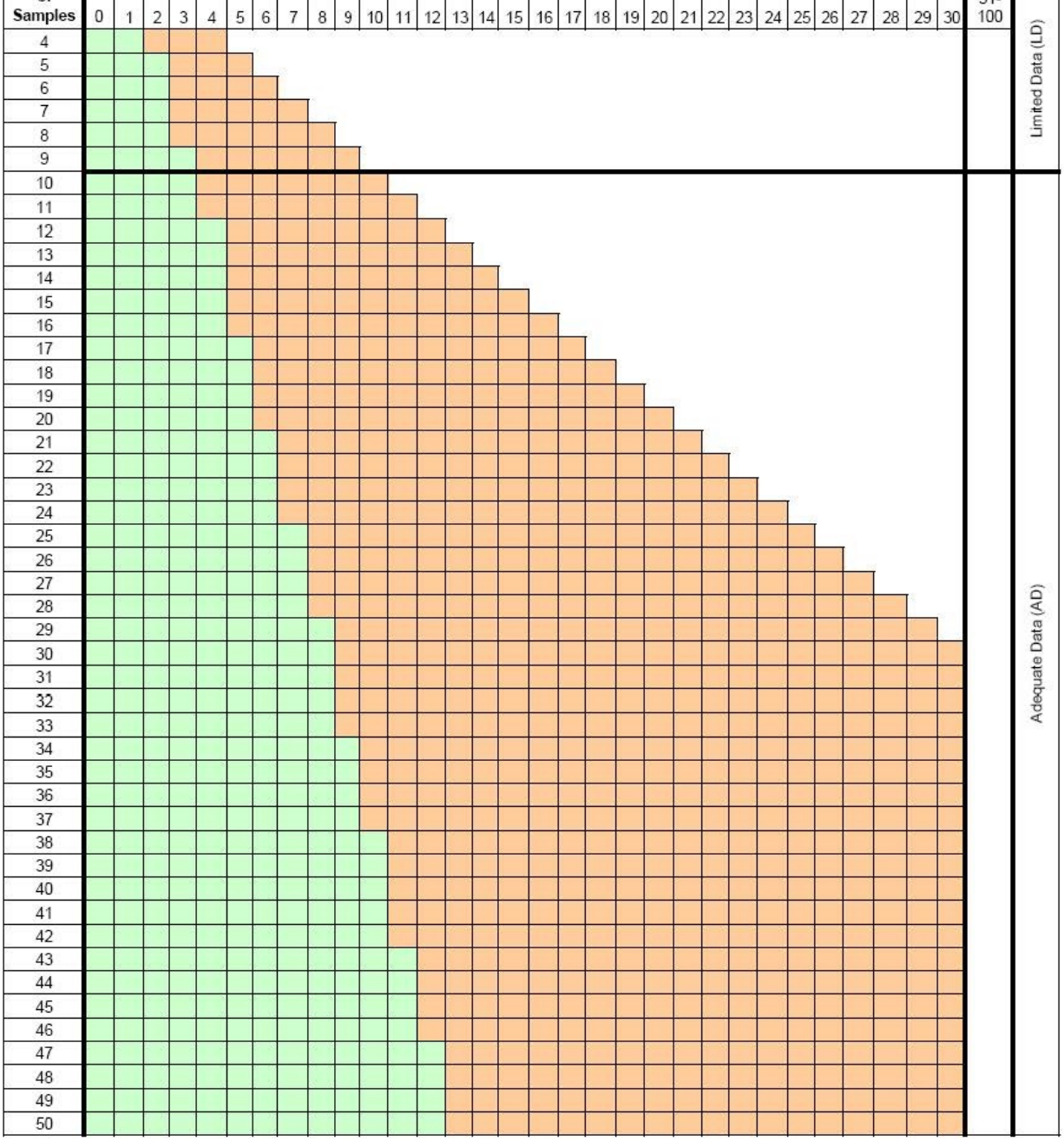

Figure B-3. Binomial Method for Determining Screening Level Concerns (continued)

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:	**General Use:**	**Fish Consumption Use:**
Toxic Substances in Sediment	Nutrient Screening Levels	Bioaccumulative Toxics in Tissue
	Chlorophyll *a* Screening Levels	

No Concern (NC) | Screening Levels Concern (CS) | Note that fewer samples than illustrated are not assessed (NA)

Number of Samples	Number of Exceedances (Uses Tables A-6)																																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31-100	
	Need a minimum of 4 samples to assess unless there are 3/3 exceedances																																
51																																	Adequate Data (AD)
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Figure B-4. Binomial Method for Listing and Delisting Toxic Parameter Use-Attainment and Concerns

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use:

Acute toxic substances in water

Acute and chronic ambient toxicity tests in water

LOE toxic sediment condition (individual samples or areas of sediment, based on lines of evidence

Fully Supporting (FS) | No concern (NC) | Concern for Near Non-Attainment but Supporting (CN) | Not Supporting (NS)

Note that fewer samples than illustrated are not assessed (NA). Exceedance ratios less than indicated (≤ 8%) by the thick line can be delisted.

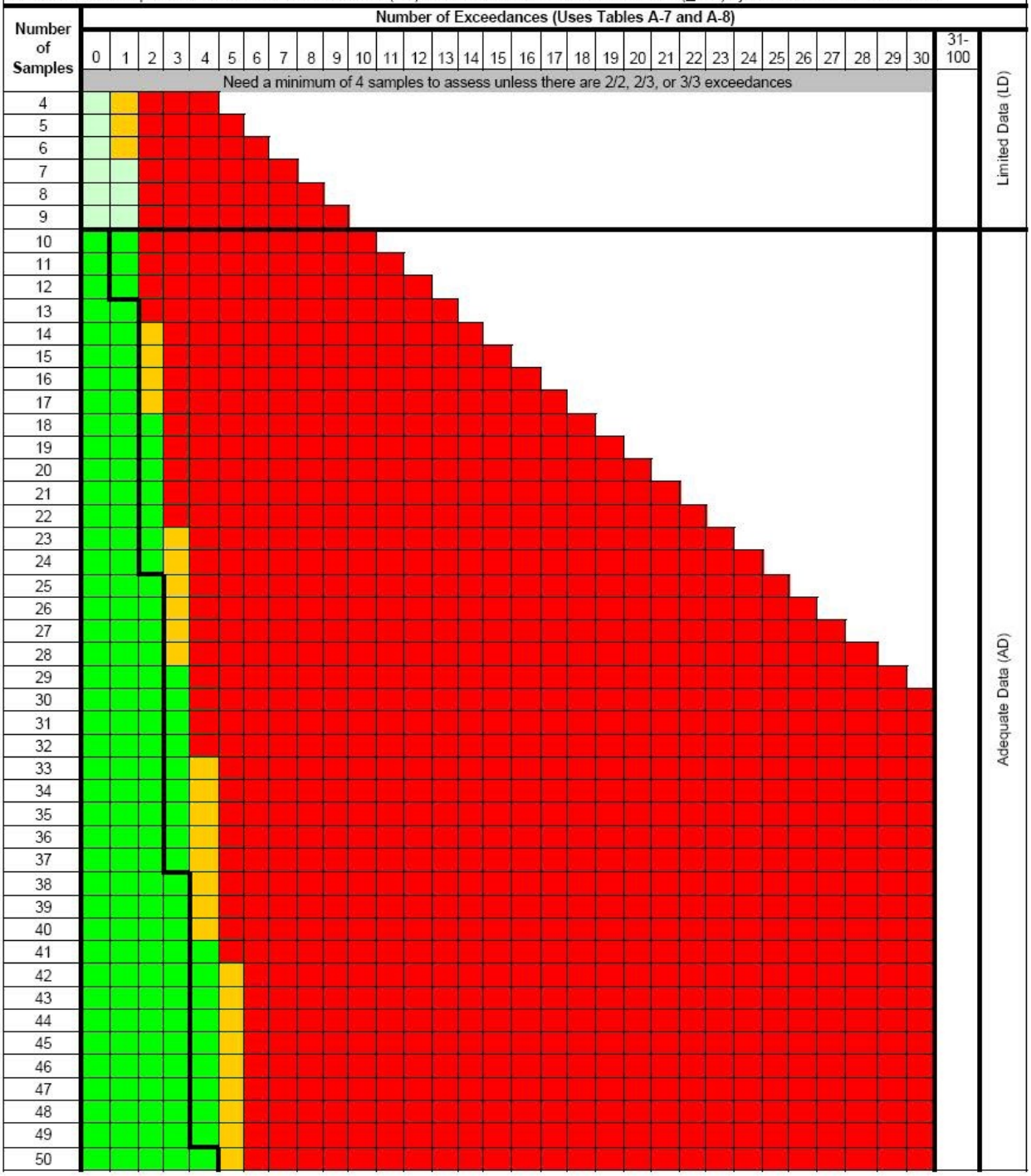


Figure B-4. Binomial Method for Listing and Delisting Conventional Parameter Use-Attainment and Concerns (continued)

Use this look-up table for the following use-attainment assessment methods:

Aquatic Life Use: **General Use:**

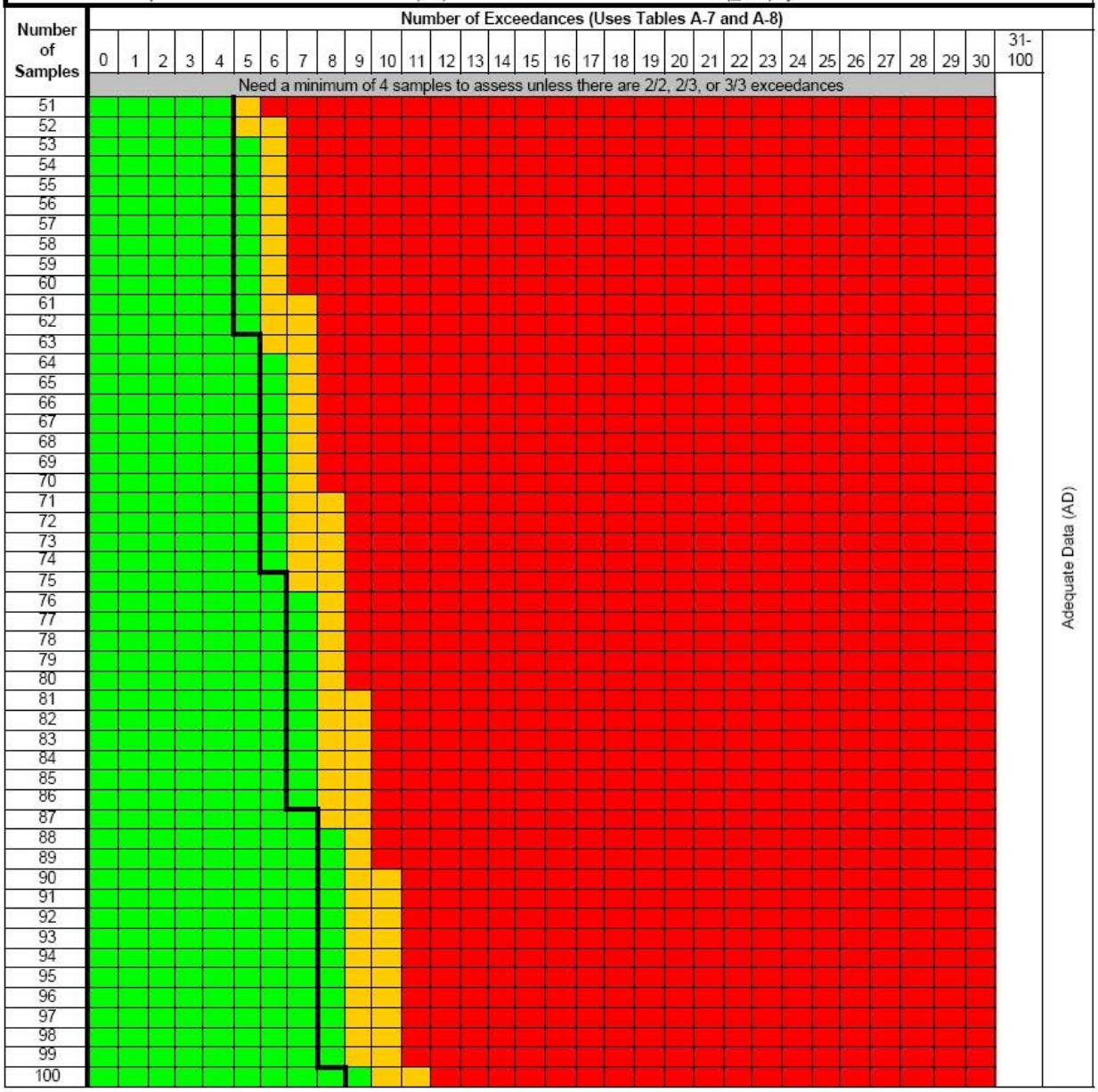
Acute toxic substances in water

Acute and chronic ambient toxicity tests in water

LOE toxic sediment condition (individual samples or areas of sediment, based on lines of evidence

Fully Supporting (FS) | No concern (NC) | Concern for Near Non-Attainment but Supporting (CN) | Not Supporting (NS)

Note that fewer samples than illustrated are not assessed (NA). Exceedance ratios less than indicated (≤ 8%) by the thick line can be delisted.



Appendix C

Evaluating Sediment Toxicity

Ambient sediment toxicity assessment is formulated upon multiple lines of evidence (LOE) to reach a decision on risk characterization leading to risk management. The LOE process described in this guidance document is appropriate for defining use support and listing or delisting on the 303(d) List. Planning water quality restoration and decisions about implementation will require additional sampling and information gathering.

The framework by which ambient sediments are to be assessed is considered a weight of evidence approach. This is commonly defined as a determination related to possible ecological impacts based upon multiple lines of evidence. This determination incorporates judgments concerning the quality, extent and congruence of the data contained in the different lines of evidence.

Whole Sediment Toxicity Tests

Sediment Toxicity. Sediment toxicity tests provide direct information on the effects of sediment at a site upon a representative benthic species at that site. In these tests, sediment collected from ambient sites is populated with benthic organisms (typically midges and/or amphipods) in a laboratory setting.

The sediment may exhibit toxicity from chemicals present, physical textural conditions, invasive predatory organisms, ammonia, chlorides, high sediment oxygen demand, pathogens, etc. It is the objective of the test assessment in the laboratory to eliminate superfluous information such as unexpected predation from transient organisms in the sediment or adverse test environmental conditions.

The laboratory sediment tests typically use whole sediment and are placed into test containers and covered with laboratory water. Whenever possible comparison to a reference sediment, collected at an uncontaminated site in the same or similar water body and having similar textural, organic and inorganic characteristics, is used to evaluate toxicity.

For purposes of assessment in the SWQM program, the test duration is usually not longer than 10 days and measures survival and growth. Longer tests can be conducted that include measurements of survival, growth (length/weight) and reproduction and this evidence will be considered. However, longer tests do not necessarily add more information to the assessment since at the ten-day exposure most chemicals have reached equilibrium in biological tissue and have had effects on survival of these short-lived organisms if concentrations and subsequent dosing are at toxic thresholds. Sediment tests should be supplemented with all available data on site conditions and water/sediment quality to enable judgment in interpretation of the results. Sediment characteristics such as texture, organic carbon, pH, and AVS are important in understanding the absence or presence of sediment toxicity. Acid volatile sulfide may bind some metals making them biologically unavailable and could account for the absence of toxicity expected at some contaminated sites.

Whole sediment toxicity tests provide a strong line of evidence for assessing ambient toxicity for the following reasons:

- Test organisms used are endemic to benthic habitats
- Test conditions attempt to reproduce the ambient conditions

Approved Methods. The following methods are approved for whole sediment toxicity tests: Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates (EPA/600/R-99/064)

Standard Test Methods for Measuring the Toxicity of Sediment Associated-Contaminants with Freshwater Invertebrates (ASTM, 2005, E1706-05)

Considerations. The following considerations should be taken into account when assessing sediment toxicity data:

- Adverse conditions during the test (presence of predatory organisms, high ammonia levels).
- Procedures employed, including modifications to standard protocols. Modifications to existing methods must be well documented within the published method and well described. Applications for alternate testing procedures will be made to the executive director.
- Temporal and spatial distribution of the samples which are representative of the assessment area.
- Porewater samples--Do these indicate elevated levels of contaminants?
- Potentially confounding effects of other constituents--acid volatile sulfide (AVS), total organic carbon (TOC), grain size.
- Although tests may be performed, confounding effects may necessitate that the assessor rely on other supporting data, information and best professional judgment (BPJ).

Evidence of Toxicity. The evidence of toxicity will depend exclusively on the toxicological endpoint of the tests employed. To determine the presence of toxicity, ambient samples will be compared whenever possible to a reference sediment. In the absence of suitable reference sediment, a "clean" laboratory sediment is used. The magnitude of the difference in either mortality (lethality) between the ambient samples and clean samples (control) will determine toxicity. Statistical tests used in the assessment of lethal toxicological endpoints for the typical 7 or 10 day test will employ an alpha level of 0.05.

The statistical tests used in the determination of toxicity will vary based upon the distribution of the data. The survival proportions will be transformed using Arcsine transformation (/p2 i), where pi = proportion surviving in replicates. The data will then be examined for homogeneity of variance and departure from normality using Bartlett's and Shapiro-Wilks tests, respectively. If the Bartletts and Shapiro tests indicate the transformed data are normally distributed, then the data will analyze using a one-way ANOVA. If the ANOVA is significant at the specified alpha level then Dunnett's Multiple Comparison Test will be used to identify specific significant differences between ambient and control sediments. Nonnormal data sets and\or data sets with nonhomogeneous variances will be analyzed using Steel's Many-one Rank Test to determine significant toxicity.

Elutriate Toxicity Tests

In these tests, sediments are vigorously mixed with laboratory test water for a specified period of time, the laboratory test water is then siphoned off and water column test organisms (typically minnows and/or water fleas) are introduced to the test water (the elutriate) in the absence of sediments. Contaminants associated with the sediments would thus be transferred to the water, exposing the aquatic organisms. These tests are useful for representing the exposure to chemicals that can occur after sediments have been resuspended into the water column or after they have passed through the water column as part of dredged material disposal operations. In terms of assessing ambient sediment toxicity, elutriate tests have been the subject of considerable debate as to their utility and will be used as evidence of potential toxicity which must be supported by other lines of evidence. In effect, they can identify a concern.

Results of these tests should be considered a weaker line of evidence when evaluating ambient sediment toxicity, indicating the potential for *in situ* sediment toxicity. The following aspects should be considered when using elutriate tests to evaluate ambient toxicity:

These tests were developed to evaluate the effects of dredge disposal on aquatic organisms. Sediment used in this method is prepared in a way which is not representative of ambient conditions (samples are often shaken for 24 hours). However, these tests may represent conditions experienced under high flow events where substantial amounts of sediment resuspension may occur.

- These tests are conducted on water column organisms which may be affected differently than the benthic organisms.
- Elutriate tests have shown correlation with whole sediment tests and serve well as a screening tool to indicate a need for additional lines of evidence.

Draft results from a comparative study of elutriate and whole sediment toxicity tests, conducted by EPA ORD and Region 6, demonstrated that acute elutriate tests are more likely to produce false negatives than false positives as compared to whole sediment tests. This suggests that the elutriate tests are less sensitive than whole sediment tests and, as such, would be indicative of toxic conditions at more acutely toxic sites. It would not be unreasonable to conclude that elutriate testing may provide meaningful results in the terms of identifying sites that need immediate attention. Elutriate tests have a place in the routine assessment of sites suspected of toxicity and the prioritization of acutely toxic sites for further testing or management action.

Approved Methods. The following methods adapted by the EPA Region 6 Ambient Toxicity Monitoring Program are approved as described in SOP B-01 Procedures for Aquatic Biology Revision 6.0, U.S. EPA Region 6, and October 2003.

Sediment elutriates are prepared by combining a subsample from the homogenized sediment sample with appropriate culture water. The sediment and water are combined in a sediment-to-water ratio of 1:4 by volumetric displacement. After combining, the mixture is tumbled end-over-end for approximately 24 hours, after which the mixture is allowed to settle for an additional 24 hours at 3-4 EC. After settling, the elutriate is siphoned off and filtered through a 1.5 micron glass fiber filter. Standard laboratory tests and statistical data analyses are conducted according to

- *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (U.S. EPA 1994).*
- *< Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms (U.S. EPA 1994).*
- *< Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms (U.S. EPA 1993).*

Considerations. The following considerations should be taken into account when assessing sediment elutriate data:

- Test organisms used in the tests.
- Procedures employed, including modifications to standard protocols. Modifications to existing methods must be well documented within the published method and well described. Applications for alternate testing procedures will be made to the executive director.
- Temporal and spatial distributions of the samples which are representative of the assessment area.
- Potentially confounding effects of other constituents--AVS, TOC, grain size.
- Sublethal toxicity should not be assessed.
- Some contaminants are released under elutriate test conditions, but may not be bioavailable under ambient conditions.

Evidence of Toxicity. The evidence of toxicity will depend exclusively on the toxicological endpoint of the tests employed. To determine the presence of toxicity, ambient samples will be compared to “clean” laboratory sediment samples. The magnitude of the difference in mortality

(lethality) between the ambient samples and clean samples (control) will determine toxicity. Statistical tests used in the assessment of lethal toxicological endpoints for the typical 7 or 10 day test will employ an alpha level of 0.05.

The statistical tests used in the determination of toxicity will vary based upon the distribution of the data. The survival proportions will be transformed using Arcsine transformation (/p2 i), where pi = proportion surviving in replicates. The data will then be examined for homogeneity of variance and departure from normality using Bartlett's and Shapiro-Wilks tests, respectively. If the Bartletts and Shapiro tests indicate the transformed data are normally distributed, then the data will analyze using a one-way ANOVA. If the ANOVA is significant at the specified alpha level then Dunnett's Multiple Comparison Test will be used to identify specific significant differences between ambient and control sediments. Nonnormal data sets and\or data sets with nonhomogeneous variances will be analyzed using Steel's Many-one Rank Test to determine significant toxicity.

Biological Communities

Benthic Community. In the presence of well defined indices of biotic integrity, direct measurement of the health of the biological community can be made at the site of interest. This important line of evidence can be a direct measure of toxic effects in the population to be protected. Prevailing conditions, however, such as ambient water temperature and salinity can affect the community more than chemical stressors. The reservoir and estuarine environments are more challenging to biological communities than freshwater streams or offshore environments.

The benthic community analysis is indicative of ambient conditions and should be compared to reference conditions that have been firmly established. Indices that are indicative of the condition of environmental health are preferred such as those used for wadeable Texas streams. For many ecosystems a defensible index with adequate reference conditions and site comparisons that can be used to determine biological condition is lacking. When such metrics are available and agreed upon, benthic analysis deserves considerable weight of evidence in any site assessment. Comparison to a site-specific reference location or water body can also be employed. Other factors for evaluating biological data can be based on the relationship between levels of contamination and fundamental measures of community structure such as species richness, abundance, and occurrence of tolerant and intolerant species.

Considerations. The following considerations should be taken into account when assessing biological community data:

- Communities assessed--nekton or benthos.
- Biological integrity assessment methods--Are there accepted indices by which to assess biological communities? Although TCEQ does not have established methods for assessment of estuarine and reservoir benthic biological integrity, scientifically valid methods to evaluate the health of biological communities should be considered, for example those using least-impacted reference conditions. Where the Agency determines methods proposed for a sediment toxicity evaluation project are acceptable, the methods may be used for evaluating the health of biological communities as a Line of Evidence.
- TCEQ's Index of Biotic Integrity (IBI), used to evaluate aquatic life use support in wadeable streams, and may not be sensitive enough to demonstrate toxicity to all sensitive species or life stages.

Sediment Contaminants

The level of contaminants in the sediment can be used to imply a cause for observed ambient toxicity. A toxicity identification evaluation (TIE) may be necessary to identify a specific pollutant for load reduction (regulatory activity). These tests, however, are expensive and may not be successful for some groups of pollutants.

Sediment Chemistry. Sediment chemistry may be indicative of toxic sediments if the chemicals present are responsible for toxicity. Ideally, elevated levels of chemicals should coincide spatially and temporally with observed toxicity. The chemical analyses should be structured to identify toxicants such as ammonia, which may be naturally occurring or the result of test conditions, and substrate texture that is physically harmful to test organisms. Chemistry can be compared to screening benchmarks for indications of relative sediment quality. Other approaches may consider equilibrium partitioning and presence of AVS (for metals) to account for expected toxicity or lack thereof.

Considerations. The following considerations should be taken into account when assessing sediment contaminant concentrations:

- Screening levels used--including probable effects concentrations (PECs), probable effects concentrations (PELs), effects range median (ERMs), effects range limits (ERLs). Current screening levels (secondary effects levels for sediment) were developed for the TCEQ Ecological Risk Assessment Program and can be found in Guidance for Conducting Ecological Risk Assessments, Remedition Sites in Texas RG-263 (Revised) located on the Web at < https://www.tceq.texas.gov/remediation/eco/eco.html>. Current sediment screening levels are outlined in Table 3.6 in the assessment guidance.
- Temporal and spatial distribution of the samples.
- Potentially confounding effects of other constituents--AVS, TOC, and grain size.

Best Professional Judgment

Best professional judgment (BPJ) comprises the use of expert opinion and judgment based on available data and site-specific conditions to determine, for example, environmental status or risk. For the assessment of ambient toxicity in sediment, BPJ will support other lines of evidence to provide final determinations of use support. In many cases, BPJ will provide insight to site specific conditions, biological assessment methodologies, toxicological test conditions and contaminant analyses.

Because the LOE approach relies on judgment of the assessor, the data set qualifier is reported as JQ (see Table 2.4 in the assessment guidance).

Applicability of Ambient Sediment Toxicity to Reservoirs and Intermittent Streams

In order for ambient sediment toxicity to be relevant, the aquatic community must be exposed and affected. Areas that are evaluated for toxicity should have overlying water and conditions which create the potential for an established benthic community.

Weight of Evidence for Determining Use Attainment

Evidence considered for determining ecological risk of areas assessed for ambient sediment toxicity will include: whole sediment toxicity test results, elutriate toxicity test results, biological community data, and contaminant concentrations and related parameters such as AVS and total organic carbon. The decisions will be supported by the interpretation of the data which will include the use of best professional judgment (BPJ), as discussed below and illustrated in Tables C.1 to C.4.

Each line of evidence used in the ecological risk assessment leading to decisions on impairment of the water body has strengths and limitations in data collection and interpretation. These factors for each parameter must be considered and weighted accordingly in the assessment for sediment in an area where data for lines of evidence are available.

As with any assessment determination for a water body or assessment area, the support status is ultimately made with professional judgment of the assessor.

Table C.1: Relative Weights of Lines of Evidence for Sediment Toxicity

Whole Sediment Tests indicate toxicity	Elutriate Tests indicate toxicity	Biological Community Indicates Effects of Toxicity		Level of Contaminants Indicates Potential for Toxicity	BPJ
		established IBI or method	observations but no accepted methods		
50	10	25	10	10	10, 0, or -10
Toxic if > 50 Concern if >15 to 50 No Concern, or Unassessed if < or = 15 No concern requires two of the following: 1). Whole sediment or elutriate tests 2). Sediment contaminants 3). Biological community data Otherwise, not assessed.					
If both whole sediment and elutriate tests are available, use only the whole sediment tests results. If BPJ indicates toxicity then value will be 10 If BPJ indicates a lack of toxicity then value will be -10 If BPJ does not indicate either toxic or not toxic condition, then BPJ value will be zero					

Table C.2. Line of Evidence--Example 1

Line of Evidence	Result	Points
Whole Sediment Tests indicate toxicity	No	0
Elutriate Tests indicate toxicity	No data	0
Biological community indicates effects of toxicity (established IBI)	Yes	25
Level of Contaminants Indicates Potential for Toxicity	Yes	10
BPJ (no toxicity in whole sediment tests)		-10
	Total	25
Identifies a Concern for Ambient Toxicity in Sediment		

Table C.3. Line of Evidence--Example 2

Line of Evidence	Result	Points
Whole sediment tests indicate toxicity	No data	0
Elutriate tests indicate toxicity	Yes	10
Biological community indicates effects of toxicity (no established IBI)	Yes	10
Level of contaminants indicates potential for toxicity	Yes	10
BPJ (levels of contaminants in sediment ranked as highest in the state for that water body type. Additional whole sediment tests will confirm or refute impairment)		10
	Total	40
Identifies a Concern for Ambient Toxicity in Sediment		

Table C.4. Line of Evidence--Example 3

Line of Evidence	Result	Points
Whole sediment tests indicate toxicity	Yes	50
Elutriate tests indicate toxicity	No data	0
Biological community indicates effects of toxicity (no established IBI)	No	0
Level of contaminants indicates potential for toxicity	Yes	10
BPJ (toxicity tests and contaminant levels indicated toxicity, limited biological data available)		10
	Total	70
Identifies Aquatic Life Use Impairment for Ambient Toxicity in Sediment		

Appendix D

Determining Aquatic Life Use Attainment

Introduction

Aquatic systems provide habitat for a variety of biotic assemblages, including fishes, benthic macroinvertebrates, algae, fungi, etc. Each of these assemblages tends to require a unique set of ecological conditions, at the micro- and macro- scale. As a result, the characteristics of each assemblage, in terms of species present, relative dominance, trophic organization, etc. vary as a result of change in ecological conditions, both natural and/or non-natural. Such changes in the characteristics of the biotic assemblages may be reflected in the results of assessments of biotic integrity (Index of Biotic Integrity or IBI). Thus, it is important to monitor more than one assemblage, since human-induced changes as well as natural variation in instream ecological conditions, and biotic interactions, can affect each assemblage in a different way with subsequent differences in IBI results for each.

For example, an initial analysis of biological data collected as part of the TCEQ/TPWD least disturbed streams study, indicates that it is not unusual for the ALU category indicated by the fish IBI to differ from that indicated by the benthic macroinvertebrate IBI. The finding that the ALU category may differ between assemblages in the same least disturbed stream, demonstrates that this may occur due to natural variation. Despite the apparent differences, all of the IBI results for both fish and benthics met or exceeded the designated or presumed use for the water body where the samples were collected.

The TCEQ currently uses fish and benthic macroinvertebrate assemblages as the primary biotic indicators of water quality. Both assemblages, along with physical habitat data, are used to establish the appropriate ALU Category for unclassified water bodies, and both assemblages are used to assess support of designated aquatic life use for the 305(b) assessment. Historically, when establishing the appropriate ALU for a previously unclassified water body, fish have been the primary indicator, with benthic macroinvertebrate and physical habitat evaluations used as complementary information.

Biological Assessments: Water Bodies with Benthic Macroinvertebrate and Fish Assemblages in Different ALU Categories

When assessing a water body for which the ALU Category was established without bioassessments, the highest ALU category indicated by either the fish or benthic macroinvertebrates will be compared to the designated or presumed use, to determine support. In this scenario, if results from aquatic life monitoring (ALM) for both assemblages indicate support of the designated or presumed use, the water body will be considered fully supporting. If results from ALM for either assemblage indicate non-support of the designated or presumed use, the water body will be identified as fully supporting, but with a concern, and an effort will be undertaken to properly define the ALU category for both assemblages for future assessments. If results from ALM indicate that neither assemblage supports the designated, or presumed use, the water body will be listed. This is consistent with findings in the least disturbed streams study sampling, that the ALU indicated by each assemblage may differ from the other, and reduce the possibility of inappropriately listing a water body as a result of natural inherent differences between the integrity of the fish and benthic assemblages.

When the ALU category was established based on a UAA including biological data, and the methods used in the UAA are current, the assessment should be consistent with the findings of the UAA for each assemblage. For example, if a high ALU category was established based primarily on fish, and the benthic macroinvertebrate IBI results were in the intermediate ALU category, then the fish will be assessed against the criterion for high ALU, and the benthics will be assessed against the criterion for intermediate ALU. This will reduce the likelihood of missing a source of impairment that is affecting primarily one of the assemblages, but not the other.

Assessing Attainment of Aquatic Life Use Category

To assess attainment of the designated or presumed ALU category for an AU, the mean of a minimum of two samples collected from each of one or more representative sites within the AU will be used in conjunction with the ecoregion/ALU specific coefficient of variation (CV) for the designated ALU and appropriate assemblage (Tables 1 & 2). All samples from all of the sites in the AU will be used to calculate the mean for that AU. If it is determined that a site is not representative of aquatic habitat in the AU, then results for bioassessments conducted at that site will not be included in the calculation of the mean.

To establish the interval about the mean, the appropriate CV will be multiplied by the mean. The resultant product will be added to the mean, to delineate the upper limit of the interval. The highest ALU category included in the interval described about the mean using the CV will be used to determine attainment. The water body will be determined to be attaining the designated or presumed use, if the CV interval includes the designated or presumed use, or if the interval is entirely contained in a higher ALU category (Table 3, Examples 1 & 2; Figures 1 & 2). The water body will be determined as not attaining the existing use if the CV interval is entirely in a lower ALU category or catagories (Table 3, Example 3; Figure 3).

Table 1. Ecoregion/Aquatic Life Use Category Specific Coefficients of Variation (CV) for Use with Fish.

Aquatic Life Use	Ecoregion						
	24	25,26	27,29,32	30	31	33,35	34
Exceptional	2.22%(2)	2.70%(1)	6.28%(6)	4.41%(9)	1.39%(4)	3.87%(6)	-
High	6.13%(46)	-	6.94%(115)	5.05%(138)	12.27%(4)	5.65%(276)	6.04%(9)
Intermediate	7.6%(25)	4.1%(5)	6.38%(164)	7.46%(41)		5.86%(211)	3.3%(6)
Limited	8.25%(42)	14.29%(1)	12.96%(75)	-		6.75%(87)	3.85%(1)

Samples are collected according to sampling protocols described in Chapter 3 of the TCEQ Surface Water Quality Monitoring Procedures, Volume 2 and evaluated using the Regionalized Index of Biotic Integrity as described in the same document. Each CV represents the average of all ecoregion/aquatic life use category specific pairwise comparisons used to derive the CV's. The number of pairwise comparisons used to calculate the average is given in parentheses.

Table 2. Ecoregion/Aquatic Life Use Category Specific Coefficients of Variation for Use with Benthic Macroinvertebrates.

Aquatic Life Use	Ecoregion				
	27, 29, 32	30	31	33, 35	34
Exceptional	-	6.47% (6)	-	4.45% (6)	-
High	5.22% (24)	5.95% (40)	6.90% (1)	6.28% (56)	5.09% (9)
Intermediate	6.06% (23)	6.43% (13)	8.76% (2)	8.98% (76)	6.31% (7)
Limited	9.78% (5)	-	-	7.42% (12)	-

Samples are collected according to sampling protocols described in Chapter 5 of the TCEQ Surface Water Quality Monitoring Procedures, Volume 2 and evaluated using the benthic macroinvertebrate Index of Biotic Integrity as described in the same document. Each CV represents the average of all ecoregion/Aquatic Life Use Category specific pairwise comparisons used to derive the CV's. The number of pairwise comparisons used to calculate the average is given in parentheses.

Table 3. Example Scenarios for Application of Coefficient of Variation for Interpreting Multiple Samples for Benthic Macroinvertebrates and Fish.

Example 1. Two samples collected from Juniper Creek (Designated High ALU) in ER 30, results for IBI for all samples fall within high ALU.

Juniper Creek: Designated High ALU; Central Texas Plateau Ecoregion (ER 30)

Sample Date	Benthic IBI Score	Regional Fish IBI Score
5/15/2006	34	46
8/15/2006	32	44
Mean	33	45
Std. Dev.	1.414213562	1.414213562
Sample Coefficient of Variation	4.285495644	3.142696805
ER/ALU Category specific CV	5.95	5.14
CV adjusted mean	34.9635	47.313

Example 2. Two samples collected from Agarita Creek (Designated High ALU) in ER 30, results for IBI for one of two samples fall in Intermediate ALU, un-adjusted mean falls in Intermediate ALU.

Agarita Creek: Designated High ALU; Central Texas Plateau Ecoregion (ER 30)

Sample Date	Benthic IBI Score	Regional Fish IBI Score
5/15/2006	29	42
8/15/2006	26	40
Mean	27.5	41
Std. Dev.	2.121320344	1.414213562
Sample Coefficient of Variation	7.713892158	3.449301372
ER/ALU Category specific CV	5.95	5.14
CV adjusted mean	29.13625	43.1074

Example 3. Two samples collected from Yaupon Creek (Designated High ALU) in ER 30, results for IBI for both samples fall in Intermediate ALU, un-adjusted mean falls in Intermediate ALU.

Yaupon Creek: Designated High ALU; Central Texas Plateau Ecoregion (ER 30)

Sample Date	Benthic IBI Score	Regional Fish IBI Score
5/15/2006	23	32
8/15/2006	22	30
Mean	22.5	31
Std. Dev.	0.707106781	1.414213562
Sample Coefficient of Variation	3.142696805	4.561979233
ER/ALU Category specific CV	5.95	5.14
CV adjusted mean	23.83875	32.5934

Example 4. Two samples collected from Yucca Creek (Designated High ALU) in ER 30, results for IBI for one of two samples fall in High ALU, un-adjusted mean falls in High ALU, sample CV greater than 2X Ecoregion/ALU specific CV.

Sample Date	Benthic IBI Score	Regional Fish IBI Score
5/15/2006	36	51
8/15/2006	24	35
Mean	30	43
Std. Dev.	8.485281374	11.3137085
Sample Coefficient of Variation	28.28427125	26.31095
ER/ALU Category specific CV	5.95	5.14
CV adjusted mean	31.785	45.2102

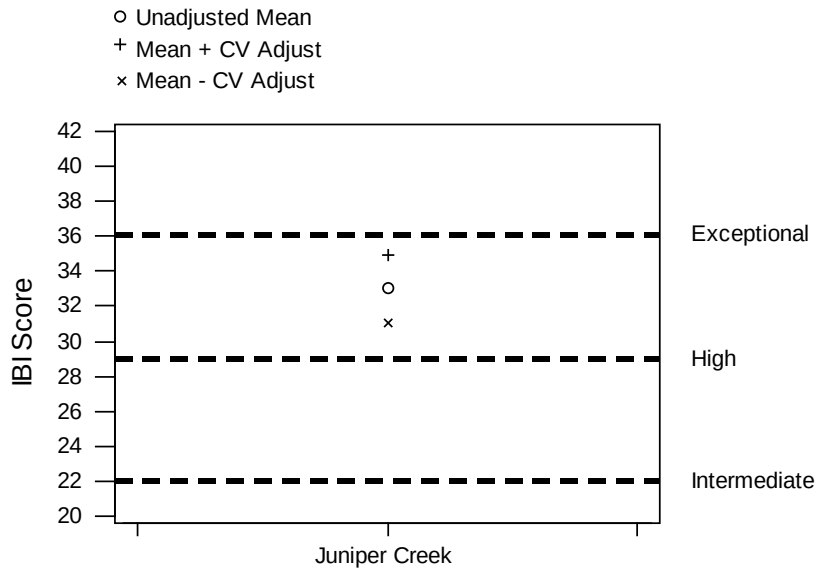


Figure D.1. Example data from Juniper Creek with Unadjusted Mean within Designated High ALU. Unadjusted mean + CV adjust falls in high ALU. Indicates high ALU is appropriate for benthic macroinvertebrates in Juniper Creek.

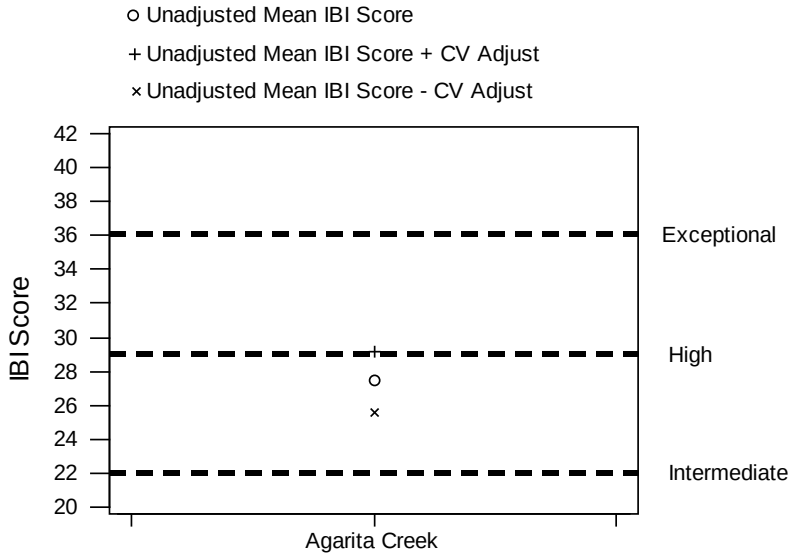


Figure D.2. Example data from Agarita Creek with Unadjusted Mean IBI Score in Intermediate ALU. Unadjusted mean + CV adjust falls in high ALU. Indicates high ALU is appropriate for benthic macroinvertebrates in Agarita Creek, designated high ALU supported.

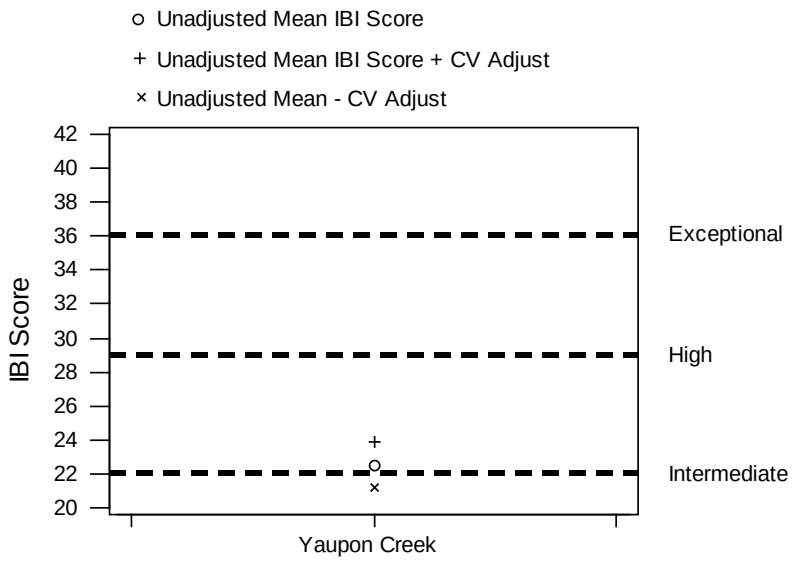


Figure D.3. Example data from Yaupon Creek with Unadjusted Mean IBI Score in Intermediate ALU. Unadjusted Mean + CV adjust Falls in Intermediate ALU. Indicates intermediate ALU is appropriate for benthic macroinvertebrates in Yaupon Creek, designated high ALU not supported.

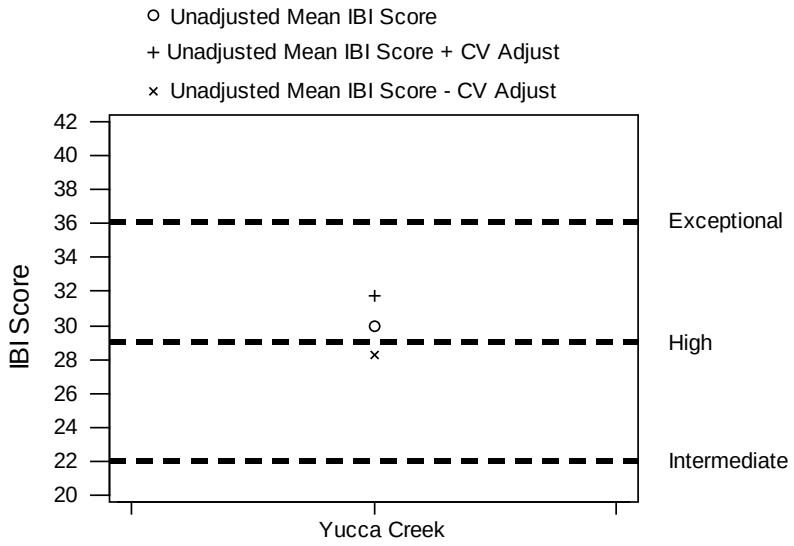


Figure D.4. Example data from Yucca Creek with Unadjusted Mean IBI Score in High ALU. Unadjusted mean + CV adjust falls in high ALU. Indicates high ALU is appropriate for benthic macroinvertebrates in Yucca Creek, designated high ALU supported.

Appendix E

Use of the National Drought Mitigation Center Drought Index in the Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)

Past efforts to evaluate the potential effects of drought on water quality have relied to a great extent on the availability of anecdotal information (instream flow measurement data and local precipitation records). These previous efforts have been revised to make more informed decisions on the potential for persistent drought to impact surface water quality as part of the Integrated Report by using the drought severity classification system developed by the National Drought Mitigation Center (DMC). The goal is to identify when use impairments are the result of changes in water quality due to persistent drought conditions. Such extreme hydrologic conditions may not be representative of the waterbody, alter the applicability of water quality standards, and should be considered when making attainment determinations. TCEQ will continue to engage stakeholders to further refine the approach to incorporate drought information as part of use attainment determinations.

When used in conjunction with other information (water quality, reservoir hydrology, flow, knowledge of the local watershed, and other available resources) the Drought Severity Index (DSI) is a useful tool to evaluate the potential impacts of drought on water quality as part of the IR. This information will also be helpful to other data users in need of recent or long-term drought histories for a specific monitoring station. Within the context of use attainment determinations, the DSI is considered primarily as an indicator of surrounding drought conditions, rather than as an indicator of water quality or quantity. Recent analyses have revealed statistically quantifiable relationships between the DSI and water quality parameters; indicating that for some streams and/or lakes in some regions, the DSI seems to be correlated with instream water quality. Due to site-specific conditions and regional watershed management, this may certainly not be the case at every monitoring station in every region. In other words, the DSI will not be solely used to determine available water or as a conclusive indicator of use attainment, but will provide additional information on nearby drought conditions.

In the current method, the weekly drought index score (from the Drought Monitor map) for each monitoring station during a given period of suspected drought will be reviewed to evaluate the potential for drought effects. Data from weekly US Drought Monitor maps and water quality monitoring stations are associated to develop an Excel spreadsheet with all the water quality monitoring stations and the weekly drought scores during the period of interest. This process consists of adding all the Drought Monitor data for the period of interest to a map document, along with the SWQM stations data, and then adding the drought score for the region to the table of SWQM stations.

The current method follows these general steps to use the DSI in the Integrated Report:

- For waterbodies where new use impairments are identified:
    - Review Excel spreadsheets with monitoring stations and weekly DSI values for the waterbody during the period of interest;
    - Calculate weighted DSI values based on the spatial extent of each waterbody that falls within a severity index, since DSI scores from the Drought Monitor may represent broad areas and overlap waterbodies. Below is the scale for weighted DSI scores, which include the absence of drought:
        - D0: No Drought
        - D1: Abnormally Dry

        - D2: Moderate Drought
        - D3: Severe Drought
        - D4: Extreme Drought
        - D5: Exceptional Drought;
    - Determine if any of the weighted DSI values from the geographic region surrounding the monitoring station/waterbody indicate the presence of persistent drought conditions (e.g. values for the weighted DSI = D4 (extreme) or D5 (exceptional drought));
    - Review the weekly values of weighted DSI values antecedent to the date of collection for water quality samples that exceed criteria;
    - Evaluate hydrologic information that could reflect the impact of persistent drought conditions on the waterbody;
    - Determine if the temporal extent and severity of drought indicated by the weighted DSI (extended time with DSI = 4, or DSI = 5). If warranted, a relationship between the water quality parameter of concern and weighted DSI will be examined further by developing graphs that provide a visualization of this relationship.

If impacts on water quality are identified, then sample results during the affected period will be addressed accordingly.

Evaluation of Drought Impacts in Reservoirs

Drought evaluations for the 2016 Integrated Reported will focus exclusively on assessment of nutrients in reservoirs. Each new listing of nutrients in reservoirs will be evaluated for drought influence based on the DSI reported by the DMC and the reservoir historical percent full numbers reported by the Texas Water Development Board (TWDB). This information will be used to evaluate extreme drought as a possible cause of unrepresentative conditions within the reservoir. In accordance with §307.9(b) of the Texas Surface Water Quality Standards (TSWQS), sample results that are used to assess standards attainment must not include samples that are collected during extreme hydrologic conditions. The onset of the extreme hydrologic conditions caused by persistent drought will be identified as the period when the weighted DSI reached at least the "Extreme" category and the reservoir percent full indicated a significant decline towards a historic low. According to the U.S. Drought Monitor, extreme drought events have a 2-5% chance of occurring in any given year out of 100 years (Svoboda et al., 2002). The end of the extreme hydrologic condition caused by drought will be demarked by a period in which the reservoir percent full rose above the historic average and the DSI fell below "Moderate." In some cases, due to the inherent variability in the data it will be necessary to implement some degree of judgement when establishing these boundaries.

To evaluate drought impacts in reservoirs, DSI values, water quality data, and reservoir capacity (percent full) are plotted over the assessment period of record.

The point at which weighted DSI=5 (Exceptional Drought) preceding an appreciable drop in reservoir capacity is identified as the initiation of the extreme hydrological event. An appreciable drop is determined by considering historic reservoir capacity data as reported by the Texas Water Development Board.

The conclusion of an extreme hydrologic event is identified when the capacity reaches or exceeds the historic average for the reservoir (calculated up to the end of the assessment period of record), and the weighted DSI has remained below two for an amount of time for water quality to be considered recovered from extreme condition to an ambient state. In some cases, this point may extend beyond the end of the assessment period.

All data within this timeframe is removed and the dataset is reassessed. It may be necessary to go into the 10-year period of record if insufficient data is available to conduct an assessment, once the drought-impacted data is removed. If the parameter is found to be meeting the use or not assessed, then it will be placed in Category 3. If the impairment remains after removing the data, then it will be placed in Category 5c.

Appendix F

Assessing Chlorophyll *a* in Reservoirs

Goal

In 2013, the EPA approved 39 of 75 chlorophyll *a* criteria for reservoirs adopted by TCEQ in the 2010 revisions to the Texas Surface Water Quality Standards (TSWQS). The EPA requested the TCEQ "incorporate its plans and timeline for revising the disapproved chlorophyll *a* criteria" for the remaining 36 reservoirs (Table 1). The following procedures were developed to achieve this goal, and establish a consistent framework to evaluate reservoirs with or without EPA-approved chlorophyll *a* criteria. Reservoirs which did not have chlorophyll *a* criteria adopted as part of the 2010 TSWQS may be evaluated using the framework developed for reservoirs without approved chlorophyll *a* criteria.

To accomplish this, TCEQ established a protocol to assess numeric nutrient criteria for chlorophyll *a*, and developed an alternative protocol to identify concerns for nutrients as part of the Texas Integrated Report of Surface Water Quality (IR). Potential impacts to existing, designated, presumed or attainable uses from excessive nutrients are evaluated in accordance with the narrative and numeric criteria for nutrients in the TSWQS. These criteria are protective of multiple uses such as contact recreation, aquatic life, and public water supplies.

Line of Evidence Framework

While assessing chlorophyll *a* concentrations provides a more meaningful status of the health of a waterbody than simply examining total nitrogen (TN) and total phosphorus (TP), the evaluation of chlorophyll *a* concentration alone does not allow for a holistic analysis of nutrient enrichment in a reservoir. To better assess whether a reservoir is meeting existing, designated, presumed or attainable uses in relation to nutrients, more parameters must be considered. A line of evidence approach using a mix of numeric criteria and numeric translators of narrative criteria allows for the evaluation of impacts from excessive algae caused by nutrients on protected uses. In accordance with §307.7(b)(4)(E) of the TSWQS, numeric and narrative nutrient criteria are intended to protect multiple uses such as recreation, aquatic life and public water supply.

TCEQ staff developed a line of evidence approach for nutrient assessment in lakes and reservoirs which involves the use of numeric translators of narrative criteria as "thresholds", in addition to numeric chlorophyll *a* criteria approved by EPA. Multiple lines of evidence corroborate adverse nutrient conditions before a water body will be identified as impacted, with chlorophyll *a* serving as the primary indicator. This methodology provides a more robust assessment of reservoir conditions, and increases certainty that excessive algae caused by nutrients are impacting factors like water clarity, increased algae biomass and dissolved oxygen attainment.

Causative parameters evaluated as potential stressors include TN and TP. Indicators of biological response include Secchi depth, dissolved oxygen, and the primary response variable of chlorophyll *a*. In addition to water quality data, TCEQ will consider information provided by stakeholders that documents localized effects of excessive algae caused by nutrients. This information will be considered on a case-by-case basis, using best professional judgement.

Table 1. Reservoirs Included as Part of Nutrient Assessments

Segments with Numeric Criteria (EPA Approved Chlorophyll *a* Criteria)		Other Segments, Including Those with Numeric Chlorophyll *a* Criteria Disapproved by EPA	
Segment ID	Segment Name	Segment ID	Segment Name
0208	Lake Crook	0199A	Palo Duro Reservoir
0209	Pat Mayse Lake	0212	Lake Arrowhead
0213	Lake Kickapoo	0229A	Lake Tanglewood
0217	Lake Kemp	0302	Wright Patman Lake
0223	Greenbelt Lake	0507	Lake Tawakoni
0405	Lake Cypress Springs	0509	Murvaul Lake
0510	Lake Cherokee	0512	Lake Fork Reservoir
0603	B.A. Steinhagen Lake	0605	Lake Palestine
0610	Sam Rayburn Reservoir	0803	Lake Livingston
0613	Lake Tyler	0807	Lake Worth
0613	Lake Tyler East	0809	Eagle Mountain Reservoir
0614	Lake Jacksonville	0815	Bardwell Reservoir
0811	Bridgeport Reservoir	0818	Cedar Creek Reservoir
0813	Houston County Lake	0823	Lewisville Lake
0816	Lake Waxahachie	0826	Grapevine Lake
0817	Navarro Mills Lake	0827	White Rock Lake
1207	Possum Kingdom Lake	0830	Benbrook Lake
1216	Stillhouse Hollow Lake	0836	Richland-Chambers Reservoir
1220	Belton Lake	1012	Lake Conroe
1228	Lake Pat Cleburne	1203	Whitney Lake
1231	Lake Graham	1205	Lake Granbury
1233	Hubbard Creek Reservoir	1208A	Millers Creek Reservoir
1234	Lake Cisco	1212	Somerville Lake
1235	Lake Stamford	1222	Proctor Lake
1240	White River Lake	1225	Waco Lake
1249	Lake Georgetown	1237	Lake Sweetwater
1403	Lake Austin	1247	Granger Lake
1404	Lake Travis	1252	Lake Limestone
1405	Marble Falls Lake	1254	Aquilla Reservoir
1406	Lake Lyndon B. Johnson	1412A	Lake Colorado City
1408	Lake Buchanan	1416B	Brady Creek Reservoir
1419	Lake Coleman	1423	Twin Buttes Reservoir
1422	Lake Nasworthy	1425	O.C. Fisher Lake
1426A	Oak Creek Reservoir	2103	Lake Corpus Christi
1429	Lady Bird Lake	2312	Red Bluff Reservoir
1433	O.H. Ivie Reservoir	2454	Cox Lake
1805	Canyon Lake		
1904	Medina Lake		
2116	Choke Canyon Reservoir		

Assessment Protocol

Results of water quality data are compared to numeric thresholds and criteria in step-wise flow charts. Multiple lines of evidence are evaluated in the flow charts to identify (1) attainment of numeric criteria for chlorophyll *a* in reservoirs with chlorophyll *a* criteria approved by EPA; and (2) assessment of other reservoirs for identification of concerns. Separate flow charts were established and are depicted in Figures 1 and 2 respectively. Exceedances of thresholds for biological response variables and nutrient stressors are assessed to identify nutrient enrichment. This assessment protocol uses medians of chlorophyll *a*, Secchi depth, TN, and TP data collected from monitoring sites indicated in Appendix F of the TSWQS for those reservoirs with approved chlorophyll *a* criteria (or comparable station); or from sites closest to the dam or main body for reservoirs without approved criteria. Comparable stations in the main pool of the reservoir may be evaluated in accordance with §307.9(e)(7) of the TSWQS. Sources of information evaluated to determine comparability may include: stations used as part of previous water quality evaluations (such as the Trophic Classification of Texas Reservoirs), geo-spatial information, and input from data providers. When multiple stations for a single reservoir are evaluated, data will be pooled (combined) to provide a single median for purposes of comparing to the criteria or threshold to determine attainment

In reservoirs without chlorophyll *a* criteria approved by EPA, 10 year trends of the chlorophyll *a* Trophic Status Index (TSI) will also be used, when available. If a 10 year trend for a reservoir is not available, the median of chlorophyll *a* should be evaluated using an upper threshold of > 40 ug/L, to determine if the reservoir is approaching hypereutrophic status and as an indication of potential nuisance conditions. Concerns or impairments for dissolved oxygen are considered from any portion (assessment unit) reported for the reservoir. The assessment will only be conducted for lakes or reservoirs where the full suite of parameters was monitored and reported. If a full suite of parameters is not available, the outcome will be "Not Assessed."

Compare water quality results to the associated threshold or criteria in Table 3 and Table 4 to determine which variables indicate potential nutrient enrichment. Indicators of nutrient concentrations (TP and TN) are considered causal variables. Chlorophyll *a*, Secchi depth, and dissolved oxygen are considered response variables. Possible attainment outcomes are listed below:

- Attainment of Numeric Criteria for Chlorophyll *a* (Figure 1)
    - Not Assessed (NA), limited data.
    - Fully Supporting (FS)
    - Concern-near nonattainment (CN)
    - Not Supporting (NS)
- Other Reservoirs Assessed for the Concerns List (Figure 2)
    - Not Assessed (NA), limited data.
    - No Concern (NC)
    - Concern-screening level (CS)

In order to accurately characterize reservoir condition, the line of evidence approach uses thresholds based on site specific and statewide data. For the 2016 IR, the line of evidence approach will only be applied to reservoirs included in Table 1 and nutrient impairments and concerns identified accordingly.

Previous nutrient assessment methods in reservoirs used statewide screening values representing the 85th percentile of individual nutrient constituents (chlorophyll *a*, ammonia, nitrite + nitrate, ortho-phosphorus and TP). Water quality concerns were identified for those areas where elevated levels of nutrients were based on exceedances of individual samples with the screening levels. These screening levels will only continue to be evaluated in reservoirs without numeric criteria and thresholds for narrative criteria, to provide a broad screening of available data. A final assessment outcome

will not be determined for these reservoirs. See Chapter 3, Assessment of Beneficial Uses for additional information regarding screening levels for nutrient parameters.

Table 2. Threshold (T) and Criteria (C) Value Determination

Reservoirs with chlorophyll *a* criteria APPROVED by EPA		
Parameter	**Standard Source**	**Notes**
Secchi Depth[T]	Rule Project no. 2007-002-307-PR (2010 proposed revisions to the Texas Surface Water Quality Standards)	Calculated from historical sampling data, set at the upper parametric prediction interval, 90% confidence level (site-specific).
Dissolved Oxygen [C]	Texas Surface Water Quality Standards, Appendices A and D	Site-specific or presumed.
Total Nitrogen[T]	Database Analysis to Support Nutrient Criteria Development, University of Arkansas 2013 Report	Concentration of TN at which statistically significant changes in magnitude and variability of Secchi depth occur (statewide).
Total Phosphorus[T]	Rule Project no. 2007-002-307-PR (2010 proposed revisions to the Texas Surface Water Quality Standards)	Calculated from historical sampling data, set at the upper parametric prediction interval, 90% confidence level (site-specific).
Chl-a[C]	Texas Surface Water Quality Standards, Appendix F	Calculated from historical sampling data, set at the upper parametric prediction interval, 99% confidence level, (site-Specific).
Reservoirs with chlorophyll *a* criteria DISAPPROVED by EPA or numeric criteria not adopted		
Parameter	**Standard Source**	**Notes**
Secchi Depth[T]	Rule Project No. 2007-002-307-PR (2010 proposed revisions to the Texas Surface Water Quality Standards)	Calculated from historical sampling data, set at the upper parametric prediction interval, 90% confidence level (site-specific).
Dissolved Oxygen[C]	Texas Surface Water Quality Standards, Appendices A and D	Site-specific or presumed.
Total Nitrogen[T]	Database Analysis to Support Nutrient Criteria Development, University of Arkansas 2013 Report	Concentration of TN at which statistically significant changes in magnitude and variability of Secchi depth occur.
Total Phosphorus[T]	Rule Project No. 2007-002-307-PR (2010 proposed revisions to the Texas Surface Water Quality Standards)	Calculated from historical sampling data, set at the upper parametric prediction interval, 90% confidence level (site-specific).
Chl-a[T]	Rule Project No. 2007-002-307-PR (2010 proposed revisions to the Texas Surface Water Quality Standards). If >30 ug/L, 30 ug/L is used.	Calculated from historical sampling data, set at the upper parametric prediction interval, 95% confidence level.
Chl-a Trend	Trophic Classification of Texas Reservoirs, 10-year trend of Chl-a Trophic Status Index (TSI) points.	Change in calculated Chl-a TSI over a 10-year period, as reported in the Trophic Classification of Texas Reservoirs during each Integrated Report Cycle.

Table 3. Criteria and Threshold Values for Reservoirs with Numeric Criteria (EPA-Approved Chlorophyll *a* Criteria). Numerical thresholds for TN and TP as indicated in Table 3 are to be used for assessment purposes only, and are not to be used as water-quality based effluent limits in wastewater discharge permits for wastewater permitting.

Segment	Segment Name	Station	Chl-a (ug/L) Criteria (>)	TN (mg/L) Threshold (>)	TP (mg/L) Threshold (>)	Secchi (m) Threshold (<)
0208	Lake Crook	10137	7.38	0.8	0.2	0.19
0209	Pat Mayse Lake	10138 16343	12.4	0.8	0.04	1.12
0213	Lake Kickapoo	10143	6.13	0.8	0.09	0.28
0217	Lake Kemp	10159	8.83	0.8	0.03	1.08
0223	Greenbelt Lake	10173	5	0.8	0.03	1.73
0405	Lake Cypress Springs	10312	17.54	0.8	0.03	1.19
0510	Lake Cherokee	10445 15514	8.25	0.8	0.02	1.21
0603	B.A. Steinhagen Lake	10582	11.67	0.8	0.08	0.37
0610	Sam Rayburn Reservoir	14906	6.22	0.8	0.03	1.82
0613	Lake Tyler	10637	13.38	0.8	0.03	1.06
0613	Lake Tyler East	10638	10.88	0.8	0.03	1.06
0614	Lake Jacksonville	10639	5.6	0.8	0.03	1.34
0811	Bridgeport Reservoir	10970	5.32	0.8	0.06	1.01
0813	Houston County Lake	10973	11.1	0.8	0.03	1.27
0816	Lake Waxahachie	10980	19.77	0.8	0.03	0.63
0817	Navarro Mills Lake	10981	15.07	0.8	0.08	0.37
1207	Possum Kingdom Lake	11865	10.74	0.8	0.05	2.22
1216	Stillhouse Hollow Lake	11894	5	0.8	0.03	2.84
1220	Belton Lake	11921	6.38	0.8	0.03	1.81
1228	Lake Pat Cleburne	11974	19.04	0.8	0.08	0.45
1231	Lake Graham	11979	6.07	0.8	0.05	0.61
1233	Hubbard Creek Reservoir	12002	5.61	0.8	0.04	1.16
1234	Lake Cisco	12005	5	0.8	0.02	1.33
1235	Lake Stamford	12006	16.85	0.8	0.07	0.42
1240	White River Lake	12027	13.85	0.8	0.06	0.42
1249	Lake Georgetown	12111	5	0.8	0.04	1.86
1403	Lake Austin	12294	5	0.8	0.03	1.82
1404	Lake Travis	12302	5	0.8	0.03	3.13
1405	Marble Falls Lake	12319	10.48	0.8	0.03	1.24
1406	Lake Lyndon B. Johnson	12324	10.29	0.8	0.03	1.23
1408	Lake Buchanan	12344	9.82	0.8	0.03	1.64
1419	Lake Coleman	12398	6.07	0.8	0.02	1.08
1422	Lake Nasworthy	12418	16.91	0.8	0.05	0.46
1426	Oak Creek Reservoir	12180	6.93	0.8	0.03	0.59
1429	Lady Bird Lake	12476	7.56	0.8	0.04	1.69
1433	O.H. Ivie Reservoir	12511	5.77	0.8	0.03	1.74
1805	Canyon Lake	12597	5	0.8	0.03	2.17
1904	Medina Lake	12826 12825	5	0.8	0.01	2.49
2116	Choke Canyon Reservoir	13019 13020	12.05	0.8	0.05	0.99

Table 4. Threshold Values for Reservoirs with Chlorophyll *a* Criteria Disapproved by EPA or Numeric Criteria not Adopted. Numerical thresholds for TN and TP as indicated in Table 4 are to be used for assessment purposes only, and are not to be used as water-quality based effluent limits in wastewater discharge permits for wastewater permitting.

Segment	Segment Name	Station	Chl-a (ug/L) Threshold (>)	TN (mg/L) Threshold (>)	TP (mg/L) Threshold (>)	Secchi (m) Threshold (<)
0199A	Palo Duro Reservoir	10005	19.02	0.8	0.24	0.3
0212	Lake Arrowhead	10142	9.93	0.8	0.16	0.55
0229A	Lake Tanglewood	10192	30	0.8	1.23	0.57
0302	Wright Patman Lake	10213 14907	18.74	0.8	0.11	0.52
0507	Lake Tawakoni	10434	30	0.8	0.05	0.89
0509	Murvaul Lake	10444	30	0.8	0.07	0.55
0512	Lake Fork Reservoir	10458	13.1	0.8	0.04	1.46
0605	Lake Palestine	16159	24.29	0.8	0.03	0.82
0803	Lake Livingston	10899	20.64	0.8	0.16	0.67
0807	Lake Worth	10942	30	0.8	0.09	0.65
0809	Eagle Mountain Reservoir	10944 10945	22.94	0.8	0.07	0.8
0815	Bardwell Reservoir	10979	20.44	0.8	0.05	0.56
0818	Cedar Creek Reservoir	10982 16748 16749	27.81	0.8	0.07	0.8
0823	Lewisville Lake	11027 17830	16.39	0.8	0.06	0.6
0826	Grapevine Lake	11035 16113 17827	10.48	0.8	0.1	0.84
0827	White Rock Lake	11038	29.73	0.8	0.1	0.4
0830	Benbrook Lake	15151 11046	24.42	0.8	0.07	0.75
0836	Richland-Chambers Reservoir	15168	13.88	0.8	0.04	1.13
1012	Lake Conroe	11342	21.72	0.8	0.05	0.82
1203	Whitney Lake	11851	16.18	0.8	0.03	1.32
1205	Lake Granbury	11860	20.15	0.8	0.07	0.99
1208A	Millers Creek Reservoir	11679	14.02	0.8	0.08	0.24
1212	Somerville Lake	11881	30	0.8	0.09	0.63
1222	Proctor Lake	11935	25.22	0.8	0.1	0.52
1225	Waco Lake	11942	21.07	0.8	0.09	0.76
1237	Lake Sweetwater	12021	11.81	0.8	0.74	0.74
1247	Granger Lake	12095	10.43	0.8	0.06	0.41
1252	Lake Limestone	12123	17.4	0.8	0.08	0.7
1254	Aquilla Reservoir	12127	12.48	0.8	0.04	0.58
1412A	Lake Colorado City	12167	13.94	0.8	0.05	0.67
1416B	Brady Creek Reservoir	12179	21.97	0.8	0.03	0.59
1423	Twin Buttes Reservoir	12422	12.7	0.8	0.09	0.55
1425	O.C. Fisher Lake	12429	30	0.8	0.14	0.28
2103	Lake Corpus Christi	12967	15.01	0.8	0.18	0.41
2312	Red Bluff Reservoir	13267	21.96	0.8	0.04	0.78
2454	Cox Lake	12514	11.9	0.8	0.29	0.12

Additional notes for chlorophyll *a*:

- Numerical thresholds for TN and TP as indicated in Tables 3 and 4 are to be used for assessment purposes only, and are not to be used as water-quality based effluent limits in wastewater discharge permits for wastewater permitting. Information regarding the establishment of effluent limits for nutrients in wastewater permitting is located in the *Procedures to Implement the Texas Surface Water Quality Standards* (RG-194).
- The thresholds used in place of criteria disapproved by EPA are more stringent than criteria adopted by TCEQ in the 2010 TSWQS. Statistical calculations of prediction intervals for chlorophyll *a* thresholds were based on a 0.05 (95th) confidence level; prediction intervals for chlorophyll *a* criteria approved by EPA were based on a 0.01 (99th) confidence level. For more information, see Notes provided in Table 2.
- For reservoirs with criteria disapproved by EPA: If a reservoir whose TCEQ-adopted chlorophyll *a* criterion was greater than 30ug/L, then the criterion was capped at 30ug/L. This decision was based on published literature of chlorophyll *a* trends, and EPA's Technical Support Document EPA Review of Reservoir-specific Chlorophyll *a* Criteria for 75 Texas Reservoirs. Current literature suggests that chlorophyll *a* concentrations greater than 30ug/L can result in nuisance algal blooms, toxic cyanobacteria and toxin production, taste and odor compound production and generation of disinfection byproducts in finished drinking water. Therefore, no reservoirs have thresholds above 30ug/L.
- In reservoirs without numeric nutrient criteria, the 10 year change in chlorophyll *a* TSI as reported in this Integrated Reporting Cycle's Trophic Classification of Texas Reservoirs will be evaluated for increasing chlorophyll a trends and identify reservoirs experiencing a high rate of enrichment. The chlorophyll *a* TSI may increase gradually due to natural conditions, particularly from reservoir aging. However, a change of 10 chlorophyll *a* TSI points within a ten year period may indicate cultural eutrophication, and rapid transition toward un-desirable trophic conditions.

Table 5. Data Sources

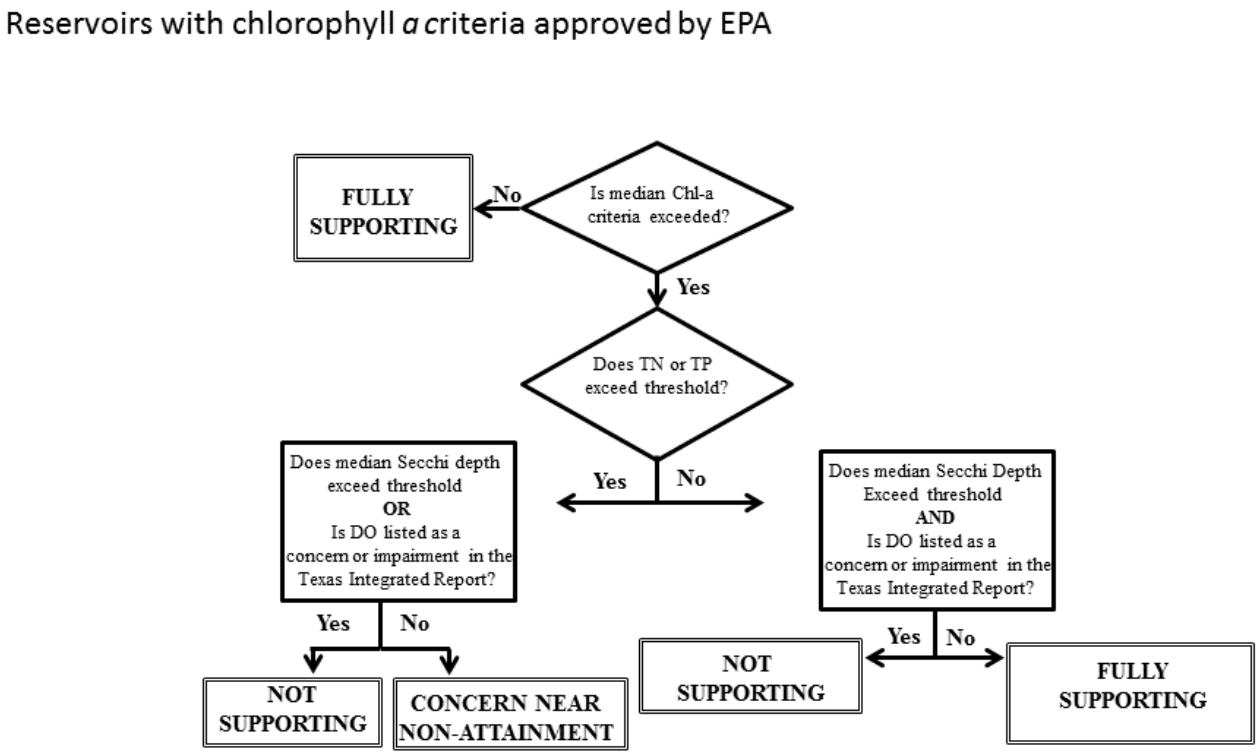
Reservoirs with Chl-a criteria APPROVED and DISAPPROVED by EPA		
Parameter	Data Source	Notes
Secchi depth	SWQMIS - Median	Station in Appendix F of Texas Surface Water Quality Standards, or comparable station
Dissolved Oxygen	Integrated Report	Level of Support (LOS) from assessed grab and diurnal dissolved oxygen methods in all assessment units of reservoir
Total Nitrogen	SWQMIS - Median	Calculated by parameter availability: 00625 + 00630, 00625 + 00593; or 00625 + 00615+00620. Reported at station in Appendix F of Texas Surface Water Quality Standards, or comparable station.
Total Phosphorus	SWQMIS - Median	Reported at station in Appendix F of Texas Surface Water Quality Standards, or comparable station.
Chl-a	SWQMIS - Median	Reported at station in Appendix F of Texas Surface Water Quality Standards, or comparable station.

Parameter Codes			
00078	Secchi Depth	00630	Nitrate + Nitrite
00300	Dissolved Oxygen	00625	TKN
00593	Total Nitrate + Nitrite	00665	Total Phosphorus
00615	Nitrite	32211	Chl-a spec
00620	Nitrate	70953	Chl-a fluoro

Notes about the data:

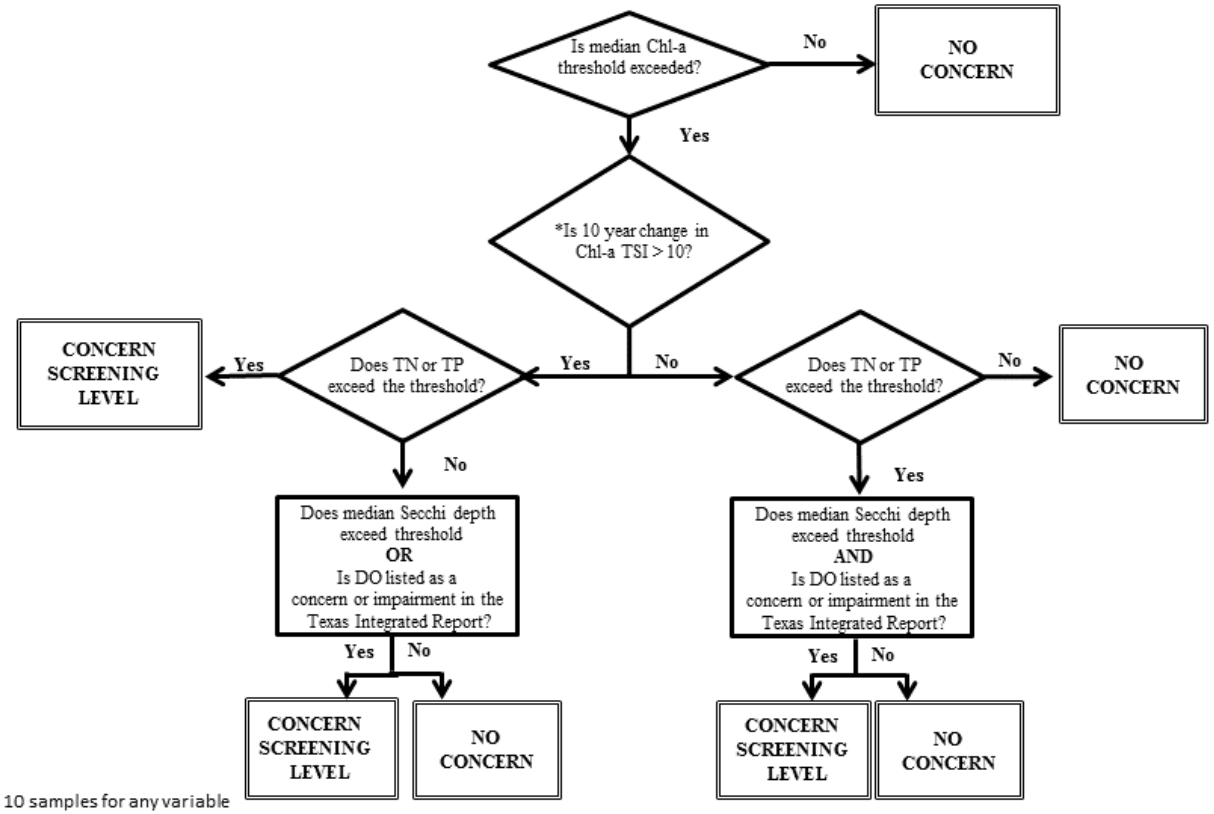
- When values were reported below the analytical reporting level, ½ of the reported value is substituted in the analysis.
    - SWQM typically substitutes ½ the reported value during assessments and the criteria were developed with ½ the reported value substituted.
- Standards for the attainment of dissolved oxygen and chlorophyll *a* criteria are applicable to the mixed surface layer. Additional procedures regarding depth of water quality measurements are described in the Guidance for Assessing and Reporting Surface Water Quality in Texas.

Figure 1. Attainment of Numeric Criteria for Chlorophyll *a*



Not Assessed: < 10 samples for any variable
Support: adequate data (>= 10 samples for all variables)
The process for reservoirs with EPA approved chlorophyll *a* criteria begins with evaluation of chlorophyll a, then uses a weight of evidence approach to evaluate association with elevated nutrients (TN and TP) and observed ecosystem response (DO and Secchi).

Figure 2. All Other Reservoirs will be Assessed for the Concerns List



Not Assessed: < 10 samples for any variable
Adequate Data: >= 10 samples for all variables

*If a 10 year trend for a reservoir is not available, the median of chlorophyll a should be evaluated using an upper threshold of > 40 ug/L, to determine if the reservoir is approaching hypereutrophic status and as an indication of potential nuisance conditions.

Narrative criteria §307.4(f): Nutrients from permitted discharges or other controllable sources must not cause excessive growth of aquatic vegetation that impairs an existing, designated, presumed, or attainable use.