Nutrient Criteria Development Plan

Texas Commission on Environmental Quality

Texas Surface Water Quality Standards

06/27/2014

This document is produced for review by the Nutrient Criteria Development Advisory Workgroup, TCEQ staff, and EPA. A final version will be published on TCEQ's Nutrient Criteria Development webpage following mutual agreement between TCEQ and EPA. Information and content presented is for planning purposes only and is subject to change.

Executive Summary

The Texas Surface Water Quality Standards (TSWQS) include narrative nutrient criteria that apply to all waters of the state. The Texas Commission on Environmental Quality (TCEQ) adopted site-specific numerical nutrient criteria for chlorophyll a for 75 reservoirs in June 2010 and the United States Environmental Protection Agency (EPA) approved select numerical chlorophyll a criteria for reservoirs in July 2013.

The TCEQ will continue to develop and evaluate additional criteria for nutrients and related parameters for consideration in future additions of the TSWQS. The TCEQ will also continue to develop and improve procedures to monitor and evaluate nutrient conditions in water bodies of the state, identify areas with nutrient-related water quality problems, assess compliance with narrative and numerical nutrient criteria, and evaluate and control potential nutrient impacts through wastewater permits and other regulatory actions.

Future nutrient criteria development efforts will focus on reviewing and revising existing reservoir criteria adopted by the TCEQ in 2010 and considering criteria for selected streams and rivers, estuaries, wetlands, and additional reservoirs. These efforts will be staged over several years, and the TCEQ will provide drafts of criteria for review by the public and the EPA throughout the process. Newly developed criteria for selected water bodies will be considered in subsequent triennial revisions of the TSWQS.

Purpose

This plan is intended to provide a framework for the continued development of numeric nutrient criteria for the state of Texas. TCEQ staff, in conjunction with the Surface Water Quality Standards Advisory Workgroup (SWQSAWG) and the Nutrient Criteria Development Advisory Workgroup (NCDAWG), are evaluating options for consideration by the EPA in future revisions of the TSWQS (Chapter 307 in Title 30 of the Texas Administrative Code). This plan outlines the work to be performed, status of data analyses, options for criteria development, and preliminary estimates of time frames for developing and considering nutrient criteria. The information in this plan is subject to

revision as more information is collected, evaluated, and reviewed by the TCEQ, stakeholders, and the EPA.

History of Nutrient Criteria Development in Texas

Historical Planning and Stakeholder Coordination

TCEQ initially established a nutrient criteria development plan in 2001. The plan was revised in 2004 and in November 2006. EPA concurred that the 2006 plan was "mutually acceptable" in a letter dated February, 2007.

The TCEQ convened the NCDAWG in 2002 to encourage stakeholder discussion and to obtain input on the development of nutrient criteria (see Section K and Appendix A for additional information). The NCDAWG is in addition to the TCEQ's long-term SWQSAWG for water quality standards.

Historical Monitoring and Data Availability to Assess Nutrients

Over the past 40 years, the TCEQ and the agency's monitoring partners have been collecting routine monitoring data, including nutrients, at approximately 1,800 fixed, active monitoring stations located in reservoirs, streams, rivers, and estuaries. Sampling frequencies are often quarterly; and nutrient related parameters can include total phosphorus (TP), species to calculate total nitrogen (TN), water-column chlorophyll a, transparency (Secchi), and 24-hour dissolved oxygen average and minima. Composition and abundance of fish and benthic invertebrates have also been collected at selected sites. As a result of this extensive monitoring network large quantities of statewide data are available.

The TCEQ staff consistently works with monitoring partners to improve sampling methodologies. Improvements that occurred from 2000 – present include:

- changing to fluorometric methods for chlorophyll a determinations between 2000-2003 enabling lower quantification limits,
- improving lab methodologies to achieve lower quantification limits for TN and TP from 2010 to present, and
- developing procedures to implement routine estimates of algal coverage in wadeable streams based on the results of a comparative study of methods in Texas streams from 2012 to present.

Historical Studies

In addition to long-term, routine monitoring, the TCEQ and others have conducted a wide variety of short-term, nutrient-related special studies over the past 40 years.

Approximately 230 TCEQ Intensive Surveys have provided longitudinal gradient measurements of nutrients, 24-hour dissolved oxygen, flow, and other parameters in streams, reservoirs, and tidal rivers/estuaries. Reports are available from the TCEQ's Surface Water Quality Monitoring (SWQM) team (swqm@tceq.texas.gov).

The TCEQ and the Texas Parks and Wildlife Department (TPWD) conducted synoptic surveys of 72 "least-impacted" streams that included a variety of nutrient, water quality, habitat, and biological measurements (Twidwell & Davis, 1989; Bayer et al, 1992). These studies provided the basis for the development of fish and invertebrate Indices of Biotic Integrity (IBI's) in Texas. Twenty years later, TCEQ is conducting follow-up studies on these streams (see Section G, Current Studies and Data Collection Efforts for Future Nutrient Criteria Development, for details).

TPWD also conducted fisheries assessments over a number of years for approximately 160 reservoirs. These studies included estimates of the percent coverage of attached vegetation and can be found on the TPWD's website. http://www.tpwd.state.tx.us/publications/pwdpubs/lake_survey/.

Several synoptic studies have been conducted on nutrients, attached algae, and water quality in streams in large-scale watersheds. These include a TCEQ sponsored study of 15 streams in Central Texas by the U.S. Geological Survey (USGS) (Mabe 2007), and a

study by Baylor University and Texas AgriLife Research which sampled and evaluated nutrient impacts in 64 streams in the North Central Brazos and Trinity River Basins (King et al, 2009). Additionally, EPA Region 6 funded and coordinated a study of 26 wadeable streams in the Cross Timbers Level III Ecoregion of the Brazos River (King et al, 2009). TPWD conducted additional nutrient studies on six streams in the Central Brazos River Basin (Contreras 2007).

Recent and ongoing nutrient-related monitoring studies for seagrasses and specific estuaries are further described in Section G of this document.

Reference information for these studies is listed in Appendix B.

Historical Nutrient Evaluations

Some of the sampling studies described above, such as the large-scale watershed studies included statistical analyses of ecological responses to nitrogen and phosphorus.

Nutrient impacts were also evaluated in:

- the recommended procedures to evaluate eutrophication in Texas reservoirs by the Center for Research in Water Resources (Armstrong et al, 1987),
- the Total Maximum Daily Loads (TMDL) for phosphorus in the North Bosque River, and the TMDL to protect dissolved oxygen (and phosphorus) in Lake O' the Pines,
- the biennial Texas Integrated Report of Surface Water Quality (IR), which identifies statewide concerns for phosphorus, nitrogen, and chlorophyll a for individual streams, reservoirs, and estuaries,
- trophic assessments of major reservoirs in Texas conducted as part of the IR, and
- the permitting process in accordance with the TCEQ Procedures to Implement the Texas Surface Water Quality Standards (IPs) to evaluate and control potential nutrient impacts from wastewater discharges.

Additional descriptions of evaluations to implement criteria and assess nutrient impacts are in Section F of this document.

Current Status of Nutrient Regulation in Texas

TCEQ has adopted chlorophyll a criteria for 75 reservoirs. The site-specific numeric nutrient criteria for selected reservoirs are described in Section E of this document. In addition to adopting numeric nutrient criteria, the TCEQ regulates nutrients by applying narrative criteria to address permitted nutrient loadings at sites of concern, developing watershed rules which require nutrient reductions in wastewater discharges in or near specified water bodies, and employing the TCEQ's antidegradation policy to new and increased discharge loads of nutrients. The TCEQ also considers monitoring data for phosphorus, nitrogen, and chlorophyll a to identify areas of concern in the IR.

Adopting Reservoir Nutrient Criteria in 2010

Criteria Development for Reservoirs

Under the previous development plan, the TCEQ and stakeholders evaluated options and developed the following analyses to support the development of reservoir criteria:

1. Recalculated EPA's national regional criteria using only data for Texas reservoirs,
2. Combined user surveys with water quality data to evaluate the potential for chlorophyll a concentrations that supported recreational/aesthetic uses (Texas Water Conservation Association, Trinity River Authority),
3. Calculated and combined chlorophyll a, total phosphorus, and transparency (Secchi) criteria as upper prediction intervals based on historical data for individual reservoirs,
4. Divided reservoirs into three groups depending on the potential for human-induced nutrient loadings (low, moderate, high),
5. Evaluated other ways to group and categorize reservoirs based geographic, physical, and hydrologic factors (with USGS), and
6. Evaluated various statistical approaches to define the relationship of nutrients to chlorophyll a and transparency (with USGS and the nutrient criteria advisory workgroup).

Based on these analyses, it was determined that statistically robust groupings of Texas reservoirs were not identifiable, indicating that the initial set of nutrient criteria needed to be based on historical data for individual reservoirs. It was also determined that the best statistical relationships (regressions) relating chlorophyll a with total phosphorus were obtained using long term reservoir means, rather than individual sampling dates or other aggregations.

Based on this information, the NCDAWG recommended the criteria be based on water-column chlorophyll a with consideration of other parameters as appropriate. The NCDAWG also suggested the criteria be adopted for as many reservoirs as possible using the available historical data.

The TPWD suggested alternative criteria calculations using nonparametric calculations based on statistical control charts to assess compliance with a relatively high percentile of historical data. The TCEQ will continue to evaluate nonparametric options and other ways to better address non-detect data in future criteria development, as discussed in subsequent sections.

During proposal of the TSWQS in 2010, the TCEQ requested public comment on two options for nutrient criteria: 1) "stand-alone" chlorophyll a criteria, and 2) chlorophyll a criteria with confirmation by an exceedance of a screening value for either transparency or for total phosphorus in order to list a reservoir as impaired for nutrients. Following public comment and EPA input, the TCEQ adopted "stand-alone" chlorophyll a criteria. The initial set of criteria for 75 reservoirs was adopted by TCEQ in 2010, as described in the following section.

The Adopted 2010 Reservoir Nutrient Criteria

In June 2010, TCEQ adopted site-specific Nutrient Criteria for Selected Reservoirs in Appendix F of the 2010 TSWQS1. These reservoir nutrient criteria are in the form of chlorophyll a and represent the upper prediction interval of historical data collected at the main pool site in 75 reservoirs. The reservoir segment, segment description, main pool site identifier, and corresponding criteria are listed in Appendix F. The basic procedures that were used to calculate criteria, and notes on applying the criteria, are also available in Appendix F. Substantial additional documentation was provided to EPA in August 2010, July 2011, October 2011, and February 2012 in response to their review of the 2010 TSWQS. This additional documentation is available. The EPA approved select numeric reservoir nutrient criteria in July 2013.

[1] Appendix F – Site-specific Nutrient Criteria for Selected Reservoirs, 2010 TSWQS
http://www.tceq.texas.gov/waterquality/standards/2010standards.html

Implementation of Narrative and Numeric Nutrient Criteria

General Process

Narrative criteria are implemented in Clean Water Act activities such as wastewater permitting and the IR. Narrative criteria in Title 30 Texas Administrative Code (30 TAC) §307.4 (e) of the TSWQS state that nutrients from controllable sources must not cause excessive growth of aquatic vegetation that impairs a use. Procedures to implement narrative and numeric criteria for wastewater permitting are described in the TCEQ IPs. Procedures to evaluate the narrative nutrient criteria and identify in the IR concerns for nutrient-related parameters are described in the TCEQ Guidance for Assessing and Reporting Surface Water Quality in Texas.

Assessing Water Bodies Using the Narrative Criteria for Nutrients

The TCEQ implements narrative criteria by examining indicators of nutrient enrichment. Indicators include excessive vegetation (i.e. algae), low dissolved oxygen and dissolved oxygen swings, and changes in ambient conditions of turbidity or color. Nutrient enrichment is typically addressed by management actions through the listing of water bodies for dissolved oxygen, development of TMDLs or Watershed Protection Plans (WPP).

Water bodies are assessed against screening levels for nutrients in order to identify concerns for water quality. Screening levels are statistically-derived from SWQM monitoring data. They are based on the 85th percentile values for nitrogen and phosphorus species and chlorophyll a in freshwater streams, tidal streams, reservoirs, 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.

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 dissolved oxygen criteria. When the minima are exceeded, an

impairment of the dissolved oxygen criteria is identified. If a TMDL or WPP identifies excessive algae growth as a potential cause for dissolved oxygen impairment, then the TMDL or WPP may include a target for nutrients.

Water color can be addressed both quantitatively by running the platinum-cobalt method on water samples and qualitatively through the use of photographic evidence, local or regional knowledge and best professional judgment on the part of the assessor.

Under the narrative criteria for nutrients, two segments of the North Bosque River (1226 and 1255) were listed as impaired in 1998, and a TMDL with phosphorus targets was adopted in 2001 for these watersheds. There have not been any other specific listings for phosphorus or nitrogen because of eutrophication impacts. However, the Lake O' the Pines was initially listed in 2000 as impaired because of low dissolved oxygen concentration. Further assessment of the impairment identified excessive algal growth as a primary cause. The resulting TMDL included targets for phosphorus, and was adopted by TCEQ in 2006.

Assessing Water Bodies Using Numeric Criteria for Nutrients

30 TAC §307.9 of the TSWQS includes basic procedures for assessing monitoring data to determine compliance with the numeric nutrient criteria (chlorophyll a) for reservoirs. These procedures include 1) basing assessments on a long-term median concentration of chlorophyll a, and 2) using samples collected in the mixed surface layer, or near the surface, at site locations listed in Appendix F of the TSWQS. The TCEQ's Guidance for Assessing and Reporting Surface Water Quality in Texas will be amended to include the methodology to assess these criteria.

Implementing Narrative Nutrient Criteria for Permitted Wastewater Discharges

To assess a water body with respect to the narrative nutrient criteria, the TCEQ evaluates site-specific screening factors which are indicative of eutrophication. The level of eutrophication in a water body is evaluated in terms of low, medium and high. Procedures for considering narrative nutrient criteria during permitting are described in the TCEQ IPs. To implement the narrative nutrient criteria, the TCEQ evaluates

potential nutrient impacts for new or expanded wastewater discharge applications on a case-by-case basis.

Evaluations are typically conducted for:

- discharges in or near reservoirs,
- relatively clear streams and rivers,
- areas where there were known occurrences of nuisance levels of algae or other aquatic vegetation, or
- areas where there is public concern.

In addition, watershed rules (30 TAC Chapter 311) have been adopted specifically for eight sensitive watersheds. These rules either prohibit domestic discharges or require specified effluent limits. Permit reviews performed in areas where watershed rules are applicable are performed on a case by case basis. Permit evaluations and application of the watershed rules have resulted in effluent limits for total phosphorus in about 50 permits for domestic wastewater discharges.

Implementing Numeric Nutrient Criteria for Permitted Wastewater Discharges

Concurrent with the adoption of numeric nutrient criteria, new procedures to assess potential nutrient impacts from proposed wastewater discharges were established in the 2010 revisions to the TCEQ IPs. These new procedures incorporate basic water quality models to ensure that proposed new and increasing domestic discharges will utilize a relatively small portion of the remaining assimilative capacity of chlorophyll a in an affected reservoir. Potential changes in chlorophyll a are predicted from modeled changes in phosphorus concentration by applying a regression equation.

In addition to an evaluation of numerical criteria, these procedures also establish a more defined framework for reviewing the potential localized impacts of new and expanding domestic discharges on streams and reservoirs. This review is based on the narrative criteria to protect for adverse nutrient impacts, in addition to the evaluation of numerical criteria described above. For this evaluation, a variety of site-specific "sensitivity" factors including water clarity, aquatic vegetation and canopy cover are

assessed and individually weighted as low, moderate, or high concern. A composite score for all factors is used to indicate whether effluent limits for phosphorus are needed for a particular discharge. These procedures to assess nutrient impacts were approved for implementation in TPDES permitting by EPA in July 2013.

Current Studies and Data Collection Efforts for Future Nutrient Criteria Development

Clean Water Act Section 106 Grant Funded

Several recent studies funded by EPA 106 grant money will aid in the continuation of nutrient criteria development.

The Texas Nutrient Data Collection Study Project, completed by the University of Houston-Clear Lake in 2011, produced a report summarizing national and statewide nutrient criteria development efforts. The report provided a historical review of all nutrient data collected in Texas and conclusions of major nutrient/eutrophication studies performed on all water body types, excluding reservoirs. In addition, the report included a detailed review of numerical nutrient criteria plans developed by other states for all water body types (Guillen, Mokrech & Wrast, 2011).

A second major study was performed by Texas AgriLife Research – Stephenville, and the Texas Institute of Applied Environmental Research. This study, known as the Texas Nutrient Data Collection Project, involved the collection of attached periphyton and low-level nutrient species from 30 stream sites in the Lower Brazos, Lower Colorado, and Brazos/Colorado Coastal river basins. The project compared the use of quantitative and qualitative periphyton collection techniques, and evaluated the relationship of nutrient concentrations and occurrence of periphyton (AgriLife, Parsons & TIAER, 2011). Study results will assist in the development of rapid methods to estimate periphyton coverage that can be incorporated into future TCEQ SWQM sampling protocols.

The third major project is a Database Analysis to Support Nutrient Criteria Development with the University of Arkansas. This project was initiated in 2011 and is scheduled through 2015. It provides advanced statistical analyses of historical water quality data and watershed information from Texas streams, rivers, and estuaries.

Results will assist the TCEQ in the development of numerical nutrient criteria by identifying potential groupings of water bodies with similar water quality and watershed characteristics, and establishing and applying statistical methodologies to identify nutrient concentrations that cause significant changes in response variables of concern (such as water-column chlorophyll a, dissolved oxygen, indices of biotic integrity, secchi transparency). In addition, this study will investigate thresholds at which stressor-response changes occur and examine the potential effects of censored data on median and mean calculations of subsequent threshold analyses.

EPA 106 grant funds were also allocated to the TCEQ's Clean Rivers Program partners to collect additional nutrient species at lower levels of detection, particularly total Kjeldahl nitrogen (TKN), TP, and chlorophyll a. Data at lower detection levels is needed statewide to better characterize ambient nutrient concentrations in Texas water bodies and to relate nutrient parameters such as nitrogen and phosphorus with response variables such as aquatic vegetation and dissolved oxygen.

Other TCEQ Studies

The TCEQ SWQM Team is re-initiating the Texas Aquatic Ecoregion Project: Water Quality, In-stream Habitat, Biotic Integrity and Riparian Characteristics of Least Disturbed Streams in Texas. This project is a continuation of the Texas Aquatic Ecoregion Project that originated in the early to mid-1980s. Since the late 1980's, sampling in least disturbed ecoregion reference streams has decreased. This updated study will consolidate and evaluate data collected since the original study and conduct additional surveys to better describe the current condition of least disturbed streams in Texas. In the future, periphyton survey techniques may be incorporated into the study, increasing the availability of periphyton data for use in criteria development.

Other Texas Studies

Numerous special-purpose studies have been conducted to monitor and assess nutrient impacts and eutrophication in individual Texas water bodies – particularly reservoirs. These studies were conducted by the TCEQ, TPWD, the Texas Water Development Board (TWDB), river authorities, cities, environmental consultants, academic institutions, and others. Studies of Texas estuaries conducted by the TWDB and Texas

marine research institutes have assessed nutrient effects and the role of nutrient loadings. Some estuarine studies have addressed seagrass ecology, and nutrient-related impacts on seagrasses. TPWD documents and maps seagrass distribution along the entire Texas coast, and both TPWD and TCEQ have increased efforts to sample abundance and ecological condition of seagrasses. In coordination with the Gulf of Mexico Program, studies on nutrient and algal relationships in Texas are being conducted by Edward Buskey at the University of Texas Marine Science Institute and by Antonietta Quigg at Texas A&M University at Galveston.

Future Nutrient Criteria Development Plans and Methodology

The relationship of nutrient parameters to response variables are complex and require advanced statistical analyses to develop defensible criteria for the diverse array of water bodies in Texas. As part of the development of nutrient criteria and methodology the TCEQ will explore a variety of statistical analyses of water quality data and watershed characteristics to develop and consider criteria options for selected streams and rivers, tidal streams, and estuaries. TCEQ may also use these techniques to develop site-specific reservoir criteria and, review and revise adopted site-specific reservoir criteria as needed.

General strategies and options for nutrient criteria development which are being investigated include:

- basing criteria on historical “ambient” averages or percentiles of nitrogen and phosphorus, with a statistical allowance for variability,
- assessing criteria on historical direct eutrophication response indicators, such as chlorophyll a and secchi transparency, potentially in combination with “translator” procedures that relate response indicators to concentrations of nitrogen and phosphorus,
- developing criteria or screening levels for phosphorus and nitrogen based on statistically defined effect levels (stressor response relationships) in historical

data for indicators such as chlorophyll a, extent of attached algae, daily dissolved oxygen flux, indices of biotic integrity for fish and benthic macroinvertebrates,

- developing criteria based on the effect of nutrients or indicators of eutrophication on other designated uses, such as aquatic life and/or public water supply, and
- evaluating logical groupings of similar water bodies so that criteria can be considered.

All of these options will consider the use of multiple parameters and "weight-of-evidence" to develop and implement criteria. Additionally, the development and implementation options will consider the relationship of the criteria to overall watershed and basin characteristics, and to downstream designated uses.

Recent EPA guidance documents on applying various criteria development methodologies are listed in Appendix C.

In addition to statistical analyses of water quality and other variables by water body type, the relationships and groupings of overall basin and watershed attributes will be examined to ensure consideration of watershed characteristics and downstream designated uses. The analyses, which will be described in the subsequent sections for reservoirs, freshwater streams and rivers, estuaries, and tidal streams will be conducted congruently and considered together at the conclusion of the statistical study described in this section. The organization by water body type in Section J describes the aspects of analyses specific to each water body type.

A preliminary schedule of target dates for nutrient criteria development is presented in Appendix D. Major steps and time frames for revisions of the TCEQ's TWSQS are noted in Appendix E.

General Approach by Water Body Type

Due to the large number and varying characteristics of water bodies in Texas, water bodies will be selected for nutrient criteria development based on the following:

- water bodies with the greatest amounts of available data,

- water bodies with existing management strategies (i.e. TMDLs, watershed management plans),
- sensitive and relatively least impacted water bodies,
- water bodies with high recreational use and public drinking water supplies,
- water bodies that have or are currently exhibiting symptoms of eutrophication.

TCEQ staff and contractors will follow these key steps on selected water bodies during the criteria development process:

1.) Identify the availability and limitations of data,

2.) Identify potential water body groups,

3.) Statistical analyses and characterize of data,

4.) Historical analyses and response variable selection,

5.) Identify nutrient stressor response relationships.

These steps are described in detail in the following sections.

Identify the Availability and Limitations of Data

For analyses of nutrient criteria, the TCEQ will use data readily available in the Surface Water Quality Monitoring Information System (SWQMIS)2 database. A list of parameters of interest is provided in Appendix F. Data will include:

- information on water body type (estuaries, rivers and streams, and lakes/reservoirs),
- segment and station identifiers and geographical locations of sampling stations, and

[2] SWQMIS http://www.tceq.texas.gov/waterquality/data-management/wdma_data.html

- results for water quality parameters such as chlorophyll a, total phosphorus, total nitrogen and nitrogen components, transparency (if applicable), dissolved oxygen (e.g., 24-hour mean, min and max), pH, temperature, conductivity, total suspended solids, and data on fish, benthos, and algal communities, as well as other available ancillary data (as applicable).

The TCEQ's SWQMIS data base contains monitoring data from the early 1970s. Despite the availability of long term data, there are limitations in the data set. The TCEQ has identified the following data related issues to consider during the criteria development process:

- Parameters important to nutrient criteria development such as nitrogen, phosphorus, chlorophyll a, transparency, and 24 hour dissolved oxygen were often not collected as paired samples, or were intermittently reported;
- Total nitrogen was not often directly measured and needs to be calculated using the individual nitrogen species (i.e., nitrate, nitrite, and total Kjeldahl nitrogen); and
- Quality indicators to identify the level of detection vary in type and reporting level within the data set, limiting the range of sensitivity in the data reported.

Many of these issues are being addressed by the TCEQ and its Clean Rivers Program partners. Future data analyses will target lower detection levels for nutrient species, and efforts are being implemented to collect paired parameters as part of routine monitoring. These changes will result in a more useful dataset for criteria development.

Water quality data for wetlands are also very limited. Basic sampling for nutrient concentrations, water column chlorophyll a, attached vegetation, and 24-hour dissolved oxygen is needed to describe water quality for wetlands in Texas. Baseline data would provide a means to determine the following:

- wetland nutrient and vegetative characteristics under relatively un-impacted conditions,
- nuisance levels of enrichment and aquatic vegetation,
- the relationship between nutrients and growth of wetlands vegetation,
- appropriate ambient concentrations on which to base criteria with the goal of preserving existing conditions, and
- the point at which enrichment impairs wetlands functions and values.

Additionally, data showing the effect of nutrients on attached algae or rooted macrophytes in Texas streams are limited. Not only are there limited data on concentrations of chlorophyll a and nutrients in attached vegetation, there are also sparse data on the coverage of the attached vegetation, including algae and rooted macrophytes. Additional information on attached vegetation, chlorophyll a, and nutrients will allow the TCEQ to use the substantial data available on water column chlorophyll a and nutrients. In smaller streams and rivers, (and in some shallow, larger rivers dominated by macrophytes), chlorophyll a in the water column does not appear to be as useful an indicator of nutrient enrichment as chlorophyll a in attached algae (periphyton). More information is needed to determine if chlorophyll a in attached algae is a more suitable response variable in Texas streams.

Identify Potential Water Body Groups

Watershed characteristics and water quality data will be used to identify statistically significant groupings of water bodies. Information considered will include: type of water body, river basin boundary, level III and/or IV ecoregion, percent land use, hydrologic unit code watershed boundaries, and presence of permitted activities such as wastewater discharges and confined animal feeding operations. Example characteristics for grouping rivers and streams include river basins, ecoregions, average depth, wadeable versus non-wadeable flow, average and dry-weather flows, percent of flow from wastewater discharges, extent of spring-fed flow, tidal influence, water chemistry, land use, substrate type (e.g., gravel, incised sand/clay bottom, sand, bedrock), and extent of tree canopy.

Additionally, reference groupings, which will identify water bodies with relatively low impact, will be evaluated for each water body type. Evaluations will include geographic, hydrologic, physical, chemical, and biological characteristics, using statistical analyses such as regression tree analyses. The influence of factors such as land use distribution (urban development and broad agricultural classifications), location and size of domestic wastewater discharges, number of confined animal feeding operations, catchment area, and stream flow on nutrient concentration will be examined. If relationships are found, categories of related nutrient concentrations (low, medium or high) may be determined.

The variability in nutrient parameters within each potential grouping will be evaluated to determine the significance of each grouping. Additional evaluations will be performed to determine the effectiveness of grouping similar water bodies, and extrapolating results from least impacted (reference) groups to other water bodies. Groupings of reference estuaries in Texas will also be evaluated, but the small number of estuary systems may limit this approach.

Statistical Analyses and Characterize of Data

The TCEQ will use descriptive statistics to characterize available data, and investigate statistical methods to address data results below reported detection limits.

Descriptive statistical analyses will be performed on individual water bodies and within groupings. Data characterization will include determining the amount of censored data in the dataset, addressing censored values through substitution or estimation, and calculation of new variables (i.e., calculating total nitrogen, salinity, etc.). Summary analysis of these datasets will include calculation of descriptive statistics, frequency distributions, and data transformations.

Potential methods to address censored data include estimating descriptive statistics using robust regression on ordered statistics, maximum likelihood estimations and non-parametric Kaplan-Meier analysis. Use of these methods could minimize the effect of censored data on future analyses, and describe the impact of censored data on existing criteria development efforts. Additional methods may be identified as a result of the University of Arkansas's Database Analysis to Support Nutrient Criteria Development

project referenced in Section G. This project will investigate the most efficient method to address censored data.

Historical Analyses and Response Variable Selection

The TCEQ will examine historical data from each water body type to investigate the statistically significant variability of water quality collected from representative sites. Water quality parameters of interest include water-column chlorophyll a, transparency, total phosphorus, and nitrogen parameters. Statistical evaluations to incorporate variability at single sites may include parametric and nonparametric prediction intervals (dependent upon the distribution of data), and upper confidence intervals.

Potential options for criteria development, based solely on historical analyses of available data, will incorporate a "weight of evidence" approach using multiple parameters to develop criteria and determine attainment. The evaluation may include a comparison of data collected year-round, versus data from only warm seasons.

Analyses will be performed at individual monitoring sites, within water bodies, and in groupings of similar water bodies for each major water body type, including reference groups.

Identify Nutrient Stressor Response Relationships

The TCEQ will evaluate the statistical relationships between nutrient concentrations (stressors) and response variables for individual water bodies and within groupings for each water body type. Specific stressor variables to consider will include total phosphorus and total nitrogen (or surrogate nitrogen components). Specific response variables will vary for each water body type. Examples of combinations of response variables for different water body types include:

Reservoirs and estuaries – water column chlorophyll a, transparency, and 24-hour range of dissolved oxygen fluctuations (where available).

Large streams and rivers - water column chlorophyll a, transparency, 24-hour range of dissolved oxygen fluctuations, biological indices for fish and benthic invertebrates.

Small streams and rivers - periphyton (where available), transparency, and 24-hour range of dissolved oxygen fluctuations (where available), biological indices for fish and benthic invertebrates.

Nutrient Criteria Development by Water Body Type

The general approach to develop nutrient criteria for each water body type is described below.

Reservoirs

Numeric nutrient criteria were adopted for 75 reservoirs in the 2010 TSWQS. EPA acted upon these criteria in July, 2013. Review of both the disapproved and approved reservoir criteria will be conducted with input from stakeholders in the NCDAWG. This review may include the following considerations:

- incorporation of multiple lines of evidence to develop and possibly include in the expression or attainment of criteria,
- consideration of additional parameters, including nutrient stressors such as nitrogen and phosphorus, and/or response variables such as water clarity and dissolved oxygen,
- evaluation of alternative statistical methods to develop criteria,
- evaluation of procedures to determine standards attainment.

In August 2013, the University of Arkansas, on behalf of the TCEQ, re-evaluated the statistical analyses used to calculate the currently adopted criteria. The University of Arkansas assessed the possibility of incorporating parameters, in addition to chlorophyll a, into the reservoir criteria development process and examined the impacts of censored data on the adopted criteria.

Freshwater Streams and Rivers

Rivers and streams directly receive point and non-point source nutrient loads that impact downstream reservoirs and estuaries. Nutrient criteria for least-impacted streams and rivers will be developed to maintain and protect existing designated uses. Due to the large number of streams and rivers receiving point and non-point source nutrient loads, it will be challenging to identify and prioritize least impacted groupings.

Potential methods to identify and select least-impacted rivers are similar to those identified for reservoirs.

In select larger rivers, where phytoplankton are an important component of eutrophication, the statistical relationship between nutrient concentrations and water-column chlorophyll a will be evaluated. The evaluation will begin with the existing historical data on phosphorus, nitrogen, and chlorophyll a.

In select small streams and in rivers, where rooted macrophytes are the primary form of eutrophication, there are limited data available which could define the nutrient/vegetation relationship. These data are available only from special-purpose studies on a limited number of streams and rivers.

Estuaries and Tidal Streams

When Texas estuaries receive high nutrient loads from their contributing upstream watersheds the excess nutrients may contribute to a number of concerns including increased hypoxia and turbidity, development of harmful algal blooms, and decreased productivity of seagrasses due to reduced light penetration. However, nutrients remain an essential component of estuarine systems. A balance of nutrients is necessary to maintain ecologically sound communities and support commercial shellfish and fishery production.

To develop criteria for estuaries and tidal streams, the TCEQ will follow the criteria development process previously described for select reservoirs and rivers. However, due to the complexity of estuarine systems, criteria development will require consideration of several additional factors including:

- the high variability of ambient nutrient concentrations,
- the effects of freshwater inflows
- the role of nutrients in excessive phytoplankton blooms
- the complexity of the relationship between nutrients and response variables
- the complexity of the relationship between estuaries and their contributing watersheds,

- nutrients needed to support fishery and shellfish production,
- the larger watershed scale and the diverse contributions of nutrients to tidal rivers and estuaries,
- the limited information and studies available to relate nutrient concentrations and loads to eutrophic conditions and
- the uniqueness of estuarine features including: tidal rivers, shallow transitional estuaries, and the transition zone between advective rivers and open estuaries.

These factors will be considered holistically in the context of the contributing basin and its characteristics. Existing and desired conditions based on geography and land use, physical, chemical and biological characteristics (including fisheries), recommended instream flows, designated uses, the presence of seagrass beds and the location of oyster waters will be emphasized on select estuaries during criteria development. The evaluation may also include classification of the estuaries, which will serve as the organizational framework for further analyses.

The TCEQ currently evaluates nutrient additions from wastewater discharges on a case-by-case basis in accordance with narrative provisions in 30 TAC §307.4(e) of the TSWQS. The TCEQ currently has three nitrogen effluent limits from discharges to locally-sensitive estuarine areas. The TCEQ intends to continue to evaluate the narrative criterion for nutrients during triennial revisions of the standards to ensure these criteria facilitate implementation of interim control measures for nutrient loads to estuaries.

To continuously gather knowledge on estuaries in Texas, the TCEQ has participated in Gulf of Mexico Alliance (GOMA) projects that address nutrient loadings to the Gulf of Mexico. Water resource agency and research staff from Louisiana, Mississippi, Alabama, Florida, and Texas have participated in conferences, workgroups and conference calls to share information and the status of project development and progress. Information shared in this forum and from GOMA studies will assist in TCEQ's efforts to develop estuary nutrient criteria.

Wetlands

EPA published a final guidance document for wetlands in 2008, The Nutrient Criteria Technical Guidance Manual: Wetlands[3] in support of the National Nutrient Strategy to develop water body specific nutrient criteria. This guidance suggests categorizing wetlands based on a reference condition approach, geography, environmental conditions, the Cowardin Classification System and/or some combination. Once a grouping system is established, the guidance recommends developing nutrient criteria using a percentile approach or a stressor/response relationship; however, it also points out the difficulty in defining these relationships. As mentioned in Section I, more data collection is needed to define these relationships for Texas wetlands.

Wetland construction and wetland enhancement projects have involved the collection of data that could be useful for determining nutrient impacts. One example is a study funded by the City of Corpus Christi to assess the effects of an experimental wastewater diversion on a coastal wetland. Additionally, the 2011 National Wetland Condition Assessment (NWCA), which included Texas wetlands, may provide useful data. The projected date for completion of the final NWCA report is 2013.

[3] The *Nutrient Criteria Technical Guidance Manual: Wetlands Fact sheet* http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/wetlands/index.cfm

Boundary Waters

Texas shares boundary waters with New Mexico, Oklahoma, Arkansas, Louisiana, and Mexico. The TCEQ recognizes that any criteria for shared boundary waters needs to be developed in close coordination with adjacent states, EPA, and the International Boundary and Water Commission (for reaches and reservoirs on the Rio Grande). The EPA's Regional Technical and Assistance Group (RTAG) for nutrient development will be utilized as a preliminary point of coordination for criteria developed for boundary waters. In addition, the TCEQ anticipates that separate interstate workgroups may be needed to establish nutrient criteria for shared waters. The TCEQ is currently participating in the EPA Region VI effort to consolidate and assess nutrient data on the Red River in order to establish a framework for coordinated development of nutrient criteria for this shared boundary water. Other boundary water bodies will be addressed on a case-by-case basis due to their unique geopolitical situations.

Public Participation

Nutrient Criteria Development Advisory Workgroup

The TCEQ formed the NCDAWG6 to obtain ongoing stakeholder input specifically about nutrients. The group is comprised of stakeholders from state and federal agencies, Texas river authorities, cities, industry, environmental groups, agriculture representatives, and other interested parties. The NCDAWG met six times leading up to the 2010 TSWQS revision. The workgroup convened on June 20, 2011 and November 7, 2012 to update stakeholders on the site-specific reservoir criteria adopted by the commission, national criteria development, and plans for the triennial revision of the TSWQS. Information regarding joint meetings leading up to the each triennial revision and dates for future meetings can be accessed at the SWQSAWG documents webpage.

Appendix A –Completed and Scheduled Milestones

Table A-1 Nutrient Criteria Development Plan Milestones

Task5	Date	Done
Send initial nutrient criteria development plan to EPA	11/30/2001	Y
Send revised draft Plan to EPA	1/31/2005	Y
Send revised draft Plan to EPA	12/1/2006	Y
Send revised draft Plan to EPA	Winter 2014	

Table A-2 Nutrient Criteria Development Milestones

Task	Date	Done
Complete initial reservoir, and streams and rivers data base (USGS)	10/31/2001	Y
NCDAWG meeting 16,7	5/8/2002	Y
NCDAWG meeting 26,7	2/24/2003	Y
Establish final nutrient data base: 110 reservoirs; Jan 1970 - Apr 2003	12/19/2003	Y
Review scientific literature that links levels of algae and vegetation with impacts on water quality uses	12/31/2003	Y
NCDAWG meeting 36,7	1/29/2004	Y
Develop draft list of least-impacted reservoirs	4/1/2004	Y

Task	Date	Done
Evaluate trends over time of nutrients and chlorophyll a	4/21/2004	Y
Calculate preliminary draft criteria for selected least impacted reservoirs, based on confidence intervals for the means of chl a, TN, TP (80, 90, 95, and 99th confidence levels)	8/1/2004	Y
NCDAWG meeting 46,7	3/15/2005	Y
NCDAWG meeting 56,7	7/12/2005	Y
Send EPA preliminary staff draft of reservoir criteria	8/31/2005	Y
Conduct preliminary evaluation of criteria for selected rivers based on historical average conditions using EPA methodology	8/31/2005	Y
NCDAWG meeting 66,7	9/26/2005	Y
Search peer reviewed literature for articles on nutrients and their impact on rivers and streams	4/30/2006	Y
Design and populate ACCESS relational data base with reservoir data	7/31/2006	Y
Stream data added to nutrient data base	7/31/2006	Y
Finish data collection on dissolved oxygen, biota, nutrients, and attached algae for 33 East Texas streams	8/31/2006	Y
Present current status of draft criteria to workgroup	3/1/2007	Y
Update workgroup on status of stream studies	3/1/2007	Y

Task	Date	Done
SWQSAWG meeting for 2010 TSWQS #18	3/7/2007	Y
SWQSAWG meeting for 2010 TSWQS #28	5/16/2007	Y
SWQSAWG meeting for 2010 TSWQS #38	6/26/2007	Y
Finish data collection on dissolved oxygen, biota, nutrients, and attached algae for Central Texas streams	7/31/2007	Y
SWQSAWG meeting for 2010 TSWQS #48	9/6/2007	Y
Evaluate stream data on East and Central Texas streams, and apply results to consideration of nutrient criteria for streams. Deliverables from USGS due 7-31-07 for Central Texas streams.	9/30/2007	Y
SWQSAWG meeting for 2010 TSWQS #58	5/5/2008	Y
SWQSAWG meeting for 2010 TSWQS #68	1/6-1/7/2009	Y
SWQSAWG meeting for 2010 TSWQS #78	4/27/2009	Y
Propose and Adopt numerical nutrient criteria for Reservoirs, implementation procedures to be used in permitting, and updates on assessment procedures during triennial standards revision	6/21/2010	Y

[5] Nutrient Criteria Development Plan 2001 and 2006
http://www.tceq.texas.gov/waterquality/standards/stakeholders/nutrient_criteria_group.html
[6] Nutrient Criteria Advisory Workgroup
http://www.tceq.texas.gov/waterquality/standards/stakeholders/nutrient_criteria_group.html
[7] Information and documentation for these tasks are available on the NCDAWG webpage
http://www.tceq.texas.gov/waterquality/standards/stakeholders/nutrient_criteria_group_summaries.html
[8] SWQSAWG meeting materials
http://www.tceq.texas.gov/waterquality/standards/stakeholders/swqsawg_docs.html
[9] Procedures to Implement the TSWQS http://www.tceq.texas.gov/waterquality/standards/WQ_stds

Task	Date	Done
NCDAWG meeting to update workgroup on 2010 TSWQS and upcoming plans	6/20/2011	Y
Revise 2012 implementation procedures to interpret the narrative nutrient criteria to be used in permitting9	1/21/2011	Y
NCDAWG meeting to discuss criteria development research topics	11/7/2012	Y

Appendix B –Studies Applicable to Nutrient Criteria Development

- Armstrong et al. 1987. Eutrophication Analysis Procedures for Texas Lakes and Reservoirs. Center for Research in Water Resources.
- Bayer et al. 1992. Texas Aquatic Ecoregion Project: An Assessment of Least Disturbed Streams. Texas Water Commission, Texas Parks and Wildlife Department, and USEPA Region 6.
- Brock, D.A., R.S. Solis, and W.L. Longley. 1996. Guidelines for Water Resources Permitting: Nutrient Requirements for Maintenance of Galveston Bay Productivity. Final Report to US EPA Region VI, Near Coastal Waters Program. Texas Water Development Board.
- Contreras, Cindy. 2007. Nutrient Effects in Small Brazos Basin Streams Historical Data Review. Texas Parks and Wildlife Department & U.S. Fish and Wildlife Service.
- Guillen, G., M. Mokrech and J. Wrast. 2011. Texas Nutrient Criteria Development Support Project. University of Houston Clear Lake.
- King et al. 2009. Development of Biological Indicators of Nutrient Enrichment for Application in Texas Streams. Baylor University & Texas AgriLife Research.
- King et al. 2009. Linking Observational and Experimental Approaches for the Development of Regional Nutrient Criteria for Wadeable Streams. Baylor University.
- Mabe, J.A. 2007. Nutrient and biological conditions of selected small streams in the Edwards Plateau, Central Texas, 2005–06, and implications for development of nutrient criteria. U.S. Geological Survey Scientific Investigations Report 2007–5195. p.46.

- Texas AgriLife, TIAER Texas A&M and Parsons Consulting. 2011. Data Collection Methods for Periphyton in Texas Streams.
- Twidwell, S. and J. Davis. 1989. An Assessment of Six Least Disturbed Unclassified Texas Streams. Texas Commission on Environmental Quality LP 89-04.

Appendix C – EPA Relevant Guidance and Important Reports

- Nitrogen and Phosphorus Pollution Data Access Tool
  http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/npdat_index.cfm
- State Development of Numeric Criteria for Nitrogen and Phosphorous Pollution
  http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/progress.cfm
- Resources for Developing State Criteria for Nitrogen and Phosphorus Pollution
  http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/criteria.cfm
- Memo: Working in Partnership with States to Address Phosphorus and Nitrogen through Use of a Framework for State Nutrient Reductions, March 2011
  http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/memo_nitrogen_framework.pdf
- Nutrients in Estuaries, November 2010
  http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/Nutrients-in-Estuaries-November-2010.pdf
- Using Stressor-response Relationships to Derive Numeric Nutrient Criteria, November 2010
  http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/finalstressor2010.pdf
- Science Advisory Board Review of Empirical Approaches for Nutrient Criteria Derivation, April 2010 EPA-SAB-10-006

- http://yosemite.epa.gov/sab/sabproduct.nsf/95eac6037dbee075852573a00075f732/5972E2A88464D45E85257591006649D0/$File/Final+Draft+Empirical+Approaches+08-17-2009+for+EPEC+Sept+9-11+2009+Meeting.pdf
- Empirical Approaches for Nutrient Criteria Derivation – Science Advisory Board Draft, August 2009
- http://yosemite.epa.gov/sab/sabproduct.nsf/95eac6037dbee075852573a00075f732/5972E2A88464D45E85257591006649D0/$File/Final+Draft+Empirical+Approaches+08-17-2009+for+EPEC+Sept+9-11+2009+Meeting.pdf
- Nutrient Innovations Task Group Report, August 2009
- http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/2009_08_27_criteria_nutrient_nitgreport.pdf

Appendix D – Nutrient Criteria Schedule*

Table D-1 Nutrient Criteria Development Plan Schedule

Task	Estimated Timeframe	Completed Date
Update SWQSAWG 2013 meeting #1 of plan to update plan	Spring 2012	3/28/2012
Provide rough draft of plan at SWQSAWG 2013 meeting #2	Spring 2012	5/25/2012
Provide updated draft of plan on NCDAWG Webpage.	Summer 2012	11/7/2012
Draft plan mutually agreed upon by the TCEQ, NCDAWG, and EPA	Summer 2013	In Progress
Revise draft plan as needed	Ongoing	

Table D-2 Reservoir Criteria Development Schedule

Task	Estimated Timeframe	Completed Date
Statistical analysis of potential groupings, historical data, and stressor/response relationships (including boundary waters)	September 2013	August 2013
Addition of nutrient parameters to reservoir criteria, dependent upon EPA approval or disapproval	Ongoing	
Re-evaluate reservoir criteria disapproved by EPA	Ongoing	

Table D-3 Stream and Rivers Nutrient Criteria Development Schedule

Task	Estimated Timeframe	Completed Date
Statistical analysis of potential groupings, historical data, and stressor/response relationships (including boundary waters)	September 2013	August 2013
Incorporate additional information on individual streams and rivers	Ongoing	
Expand/revise nutrient development plan and schedule for rivers and streams as needed	Ongoing	
During triennial standards revisions, consider expanded narrative criterion and new implementation procedures to address nutrient impacts in rivers and streams	Ongoing	
Consider numerical nutrient criteria for selected streams and rivers in the TSWQS, consider revisions as needed to the standards implementation procedures to be used in permitting, and update assessment procedures for nutrients as appropriate.	2017	

Table D-4 Estuary (Tidal Stream) Nutrient Criteria Development Schedule

Task	Estimated Timeframe	Completed Date
Statistical analysis of potential groupings, historical data, and stressor/response relationships (including boundary waters)	September 2013	August 2013
Incorporate additional information on individual estuaries and tidal streams as needed	Ongoing	
Expand/revise nutrient development plan and schedule for estuaries as needed	Ongoing	
During triennial standards revisions, consider expanded narrative criterion and new implementation procedures to address nutrient impacts in estuaries	Ongoing	
Consider numerical nutrient criteria for selected estuaries and tidal streams in the TSWQS, consider revisions as needed to the standards implementation procedures to be used in permitting, and update assessment procedures for nutrients as appropriate.	2017	

Table D-5 Wetlands Nutrient Criteria Development Schedule

Task	Estimated Timeframe	Completed Date

Task	Estimated Timeframe	Completed Date
Review EPA guidance for wetland nutrient criteria	TBD	
Search for available data on Texas wetlands	Ongoing	
Update workgroup on status of wetlands database	TBD	
Review available data for data gaps	TBD	
Formulate needs and ways to fill data gaps and if necessary contracts	TBD	
Conduct preliminary evaluation of criteria for selected wetlands based on available data	TBD	
Expand/revise nutrient development plan and schedule for wetlands as needed	Ongoing	
Consider numerical nutrient criteria for selected wetlands in the TSWQS, consider revisions as needed to the standards implementation procedures to be used in permitting, and update assessment procedures for nutrients as appropriate.	TBD	

Table D- 6 Boundary Waters Nutrient Criteria Development Schedule

Task	Estimated Timeframe	Completed Date
Statistical analysis of potential groupings, historical data, and stressor/response relationships	September 2013	
Incorporate additional information on individual boundary waters and coordinate criteria development with Arkansas, Louisiana, Oklahoma, and the International Boundary and Water Commission.	Ongoing	
Expand/revise nutrient development plan and schedule for boundary waters as needed	Ongoing	
During triennial standards revisions, consider expanded narrative criterion and new implementation procedures to address nutrient impacts in boundary waters	Ongoing	
Consider numerical nutrient criteria for selected boundary waters in the TSWQS, consider revisions as needed to the standards implementation procedures to be used in permitting, and update assessment procedures for nutrients as appropriate.	Ongoing	

*All dates presented in this schedule are tentative and subject to change, and will be adjusted in future revisions to this plan as needed.

Appendix E: Timeline for Revising the Standards

The TCEQ timeline from initiation of rulemaking to adoption for a triennial revision of Texas Surface Water Quality Standards Title 30, Chapter 307, Texas Administrative Code. The exact number of days will vary based upon calendar year; however, a maximum of 6 months is allotted from the time a rule is proposed to the time it is adopted. If the 6 month time table is not met the rule revision will not proceed. All dates before proposal of the rule have no strict timeline and in a large revision year there may be additional workgroups before proposal.

Days	TASKS
0	Request for preliminary public comments
240	TCEQ initiates rulemaking
420	TCEQ convenes stakeholders workgroup
730	Preliminary draft of revisions for informal review
730	Revised draft revisions, preamble, and fiscal note
820	Draft revisions publicly approved by TCEQ Commissioners at Agenda
850	Notice of hearing in Texas Register and mail out (45 day comment period must close before the hearing can be held)
895	Public hearing
925	Draft of final revisions and responses to comments
985	Standards revisions adopted as state rule at TCEQ Agenda. Adopted standards published in Texas Register (third Friday after agenda)
1000	TCEQ sends adopted revisions to EPA for review and approval

Appendix F –Nutrient Criteria Development Parameters

Table F- 1 Nutrient Parameters

Parameter Code	Parameter Description	Parameter Measurement Unit
00620	Nitrate Nitrogen, Total (Mg/L As N)	MG/L
00615	Nitrite Nitrogen, Total (Mg/L As N)	MG/L
00630	Nitrite Plus Nitrate, Total 1 Det. (Mg/L As N)	MG/L
00610	Nitrogen, Ammonia, Total (Mg/L As N)	MG/L
00625	Nitrogen, Kjeldahl, Total (Mg/L As N)	MG/L
00593	No2 Plus No3-N, Total, Whatman Gf/F Filt (Mg/L)	MG/L
00665	Phosphorus, Total, Wet Method (Mg/L As P)	MG/L

Table F- 2 Response Variable Parameters

Parameter Code	Parameter Description	Parameter Measurement Unit
32211	Chlorophyll-A Spectrophotometric Acid.	UG/L
70953	Chlorophyll-A, Fluorometric Method	UG/L
89858	Dissolved Oxygen, # Of Measurements In 24-Hrs	NU
89857	Dissolved Oxygen, 24-Hour Avg. (Mg/L) Min. 4 Mea	MG/L
89856	Dissolved Oxygen, 24-Hour Max. (Mg/L) Min. 4 Mea	MG/L

Parameter Code	Parameter Description	Parameter Measurement Unit
89855	Dissolved Oxygen, 24-Hour Min. (Mg/L) Min. 4 Mea	MG/L
00301	Dissolved Oxygen, Percent of Saturation	%
20388	Dissolved Oxygen, 24 Hour, % Saturation, Minimum	%
20389	Dissolved Oxygen, 24 Hour, % Saturation, Maximum	%
20390	Dissolved Oxygen, 24 Hour, % Saturation, Average	%
20391	Dissolved Oxygen, % Saturation, # Measure in 24Hr	NU
00400	pH (Standard Units)	S.U.
00403	pH (Standard Units) Lab	S.U.
00223	pH # OF MEASUREMENTS IN 24-HRS	NU
00215	pH S.U., 24hr Maximum Value	S.U.
00216	pH, S.U., 24hr, Minimum Value	S.U.
89077	Transparency, Secchi Disc (Feet)	FT
00077	Transparency, Secchi Disc (Inches)	IN
00078	Transparency, Secchi Disc (Meters)	M
00222	Specific Conductance, # Of Measurements 24-Hr	NU
00212	Specific Conductance, Umhos/Cm, Field, 24hr Avg	uS/cm
00213	Specific Conductance, Umhos/Cm, Field, 24hr Max	uS/cm
00214	Specific Conductance, Umhos/Cm, Field, 24hr Min	uS/cm

Parameter Code	Parameter Description	Parameter Measurement Unit
00094	Specific Conductance,Field (Umhos/Cm @ 25c)	uS/cm
00095	Specific Conductance,Lab (Umhos/Cm @ 25c)	uS/cm
00010	Temperature, Water	DEG Centigrade
00211	Temperature, Water 24hr Min	DEG Centigrade
00209	Temperature, Water , 24hr Avg	DEG Centigrade
00011	Temperature, Water	DEG Fahrenheit
00221	Water Temperature, # Of Measurements In 24-Hrs	NU
00210	Water Temperature, 24hr Max	DEG Centigrade

Table F- 3 Potential Grouping Parameters

Parameter Code	Parameter Description	Parameter Measurement Units
00062	Elevation, Reservoir Surface Water In Feet	FT
00061	Flow Stream, Instantaneous (Cubic Feet Per Sec)	CFS
01351	Flow:1=No Flow,2=Low,3=Normal,4=Flood,5=High,6=Dry	NS
00065	Stage, Stream (Feet)	FT
74069	Stream Flow Estimate (Cubic Feet Per Second)	CFS

Parameter Code	Parameter Description	Parameter Measurement Units
00055	Stream Velocity (Feet Per Second)	FT/SEC
00004	Stream Width (Feet)	FT
NA	Fish Regional Index Of Biotic Integrity (Fish IBI)	Category
NA	Benthic Index Of Biotic Integrity (RBIBI)	Category
NA	Habitat Quality Index (HQI)	Category

Table F- 4 Other Grouping Variables

Other Variables	Reasoning
Basin	Logical grouping of Segments and unique characteristics by basin
Ecoregion III	Biological data is examined on an Ecoregional Scale
Permitted Dischargers number and flow to receiving water upstream	Effect of permitted flow and potential point source of nutrients
USGS land use data	Potential non-point source of nutrients