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TEXAS PARKS & WILDLIFE

July 01, 2004

Ms. L'Oreal Stepney
Director, Water Quality Division (MC 122)
Texas Commission on Environmental Quality
P. O. Box 13087
Austin, Texas 78711-3087

Re: TPWD Proposed Approach for Establishing Reservoir Nutrient Criteria

Dear Ms. Stepney:

Texas Parks and Wildlife Department (TPWD) appreciates the opportunity to participate in the Texas Commission on Environmental Quality's (TCEQ's) Nutrient Criteria Development Advisory Work Group. Development of nutrient criteria is an area of critical importance to TPWD. Our Resource Protection Division has historically worked closely with TCEQ biologists in developing and evaluating the scientific research used in establishing water quality standards. Our Inland Fisheries Division is responsible for managing the state's diverse freshwater fisheries resources, providing the best possible angling while protecting and enhancing freshwater aquatic resources. We are responsible for managing approximately 800 public impoundments covering 1.7 million acres and 80,000 miles of rivers and streams. Our State Parks Division oversees more than 600,000 acres of land owned or leased by the department, including 123 state parks, historic sites and natural areas, many of which provide a venue for swimming, boating and other outdoor recreational opportunities, as well as operating public water supply systems and/or wastewater treatment systems.

By letter of February 9, 2004, we provided an initial response to TCEQ regarding various ideas that were under consideration. Today, we offer our recommendations in the form of an explicit proposal for establishing reservoir nutrient criteria for Texas. TPWD scientists have reviewed current TPWD needs and TCEQ practices in arriving at this approach.

We would be happy to meet with you or your staff if you would like to discuss any of these matters. Please contact Dr. Pat Radloff at (512) 912-7030 if you have any questions or need further information.

Sincerely,

Scott Boruff
Deputy Executive Director

SB:PR:dh

Enclosure

cc: Dr. James Davenport, TCEQ Water Quality Standards Team (MC150)

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A Proposed Approach for Establishing Reservoir Nutrient Criteria for Texas

June 30, 2004

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Background

The Environmental Protection Agency (EPA) has tasked the states with developing numeric criteria for nutrients in surface water by December 2004. The Texas Commission on Environmental Quality (TCEQ) is the agency in Texas charged with carrying out the requirements of the Clean Water Act, such as setting water quality standards, assessing state waters, and issuing permits. Currently, the state has only a narrative standard for nutrients, at 30 TAC 307.4(e), which states that *"Nutrients from permitted discharges or other controllable sources shall not cause excessive growth of aquatic vegetation which impairs an existing, attainable, or designated use."* Based on EPA's direction, TCEQ will ultimately need to establish numeric criteria for nutrients for all state waters – rivers, streams, reservoirs, and estuaries. For now, TCEQ is approaching this task in stages, beginning with reservoirs.

Development of nutrient criteria is an area of critical importance to the Texas Parks and Wildlife Department (TPWD) because the department is responsible for conserving aquatic systems. TPWD's Resource Protection Division has historically worked closely with TCEQ biologists in developing and evaluating the scientific research used in establishing water quality standards. TPWD's Inland Fisheries Division is responsible for managing the state's diverse freshwater fisheries resources, which includes approximately 800 public impoundments covering 1.7 million acres and 80,000 miles of rivers and streams. TPWD's State Parks Division oversees more than 600,000 acres of land owned or leased by the department, including 123 state parks, historic sites and natural areas, many of which provide a venue for swimming, boating and other outdoor recreational opportunities, as well as operating public water supply systems and/or wastewater treatment systems.

Because the development of numeric criteria for nutrients can impact the mission of TPWD, the department has actively participated in TCEQ's Nutrient Criteria Development Advisory Work Group. Over the course of the past year, TCEQ and other entities have made various proposals and suggestions regarding the development of nutrient criteria. TPWD followed these discussions with an initial response, provided to TCEQ in a letter dated February 9, 2004. Within that letter, it was recommended that the anti-degradation intent of the Clean Water Act be specifically considered. TPWD noted that it could manage Texas reservoirs for multiple uses under a diversity of nutrient levels; however, it could not work effectively with a hypereutrophic situation. Thus, it is desirable to avoid a process that leads to a decline in water quality. The material that follows is TPWD's further contribution to the state's efforts to develop numeric nutrient criteria for reservoirs. Specifically, it demonstrates how an anti-degradation approach could be implemented.

To address the anti-degradation intent of the Clean Water Act, TPWD proposes a no-degradation policy. This policy refers to the prevention of degradation in water quality from additional nutrients. Thus, under this policy, water quality could not be degraded from current levels, although short-term variations in water quality could be allowed.

Current nutrient levels are not limiting TPWD's ability to manage most Texas reservoirs from a fisheries perspective. In a recent survey of TPWD Inland Fisheries biologists, very few of the 251 reservoirs larger than 100 acres were considered to suffer from excessive nutrient levels (i.e., decreasing nutrient levels would improve the fishery or the ability to manage it). However, at this time, TPWD biologists believe that there are numerous reservoirs that are borderline hypereutrophic. Thus, TPWD believes it is an appropriate time to implement a no-degradation policy. Such an approach would not only prevent further nutrient enrichment of Texas reservoirs, but would also allow numeric criteria to be developed that fully reflect localized conditions and would protect current uses, thus meeting EPA's recommendations for establishing numeric standards. This approach could also be practical and cost efficient, as it works within current regulatory guidance established by TCEQ.

Relevant Guidance and Constraints

Because TCEQ is only developing numeric nutrient criteria for the most downstream portions of reservoirs, coves and embayments were not considered in this approach. At some later date, TCEQ will develop criteria for rivers and streams, estuaries, wetlands and, presumably, coves and embayments in reservoirs. Constraints relevant to implementation of the approach follow.

Monitoring

- Data must be collected under an approved Quality Assurance Project Plan or be of demonstrable, comparable quality.
- Sampling must be representative, covering at least two seasons and spanning at least two years.
- Sampling frequency varies. Monthly or quarterly monitoring is typical, but available resources (staff and funds for laboratory analyses) may limit monitoring frequency.

Assessment

- Assessments are conducted every two years using the last five years of data.
- Surface measurements, typically collected at a depth of approximately 1 foot below the water surface, are generally used to assess nutrients and chlorophyll-a.
- A monitoring site may not represent more than 5,120 acres of a water body.
- Data are assessed using binomial statistics (i.e., pass/fail) and at least 10 samples are required for assessment. If < 10 samples are available, then a water body may be placed on a concerns list, but will not be placed on the state's list of impaired waters. A water body fully supports its use if $\leq 10\%$ of samples exceed the criteria. A water body partially supports its use if > 10 and $\leq 25\%$ of samples exceed criteria, and is nonsupporting if $> 25\%$ of samples exceed criteria.

In a situation without these constraints, or with a different set of constraints, it is likely that TPWD would develop different recommendations.

Proposed Approach

A no-degradation policy would require the establishment of baseline, reservoir-specific criteria for nutrient parameters. All future assessments would involve comparisons using these values. Because these criteria will be the basis for future decisions, selected nutrient parameters must reflect nutrient levels within the reservoir and incorporate temporal variability. Monitored variables should include both nitrogen and phosphorus because nutrient-related problems could arise from either. In addition, measurement of chlorophyll-a is recommended. The use of both causal and response variables reflects EPA's stance that "Nitrogen and phosphorus are the primary causes of overenrichment and are obvious nutrient criteria variables, but biological response variables are also important in addressing the consequences of overenrichment" (EPA 2000). Specifically, it is recommended that orthophosphorus, nitrate-nitrite and chlorophyll-a be measured. The use of orthophosphorus is proposed, rather than total phosphorus, because orthophosphorus more accurately accounts for phosphorus directly used by algae (Lee and Jones-Lee 2002). Using the TCEQ 2002 Draft Water Quality Inventory Summary of Water Bodies with Water Quality Concerns, it was noted that the majority (79%) of the reservoirs with nitrogen-related issues were impaired because of nitrate-nitrite, hence the nitrate-nitrite recommendation.

The central premise of a no-degradation approach is that current nutrient levels are not limiting TPWD's ability to manage fisheries in most Texas reservoirs. The goal of the approach is to have the mean values of future measurements of ortho-phosphorus, nitrate-nitrite and chlorophyll-a be the same as or better than the mean values of past data, for each non-degraded reservoir. To accomplish this, one could set the criteria as the means of the appropriate data. However, given that TCEQ has allowed up to 10% of values to exceed criteria in the assessment process, it is more appropriate to use 90th percentile values as the criteria. Setting the criteria at the 90th percentile and using the assessment process described below will ensure that the current mean values are protected. It is appropriate to use an empirical, rather than a theoretical, 90th percentile value, because use of the empirical 90th percentile value does not require one to assume a distributional form for the data. Reservoir-specific criteria for each of these three parameters should be established by calculating empirical 90th percentile values based on the last ten years of data (1994-2003) for non-degraded reservoirs (Appendix 1).

To determine if increased nutrient inputs have degraded water quality, reservoir assessments should occur every two years. At the time of the assessment, values for orthophosphorus, nitrate-nitrite, and chlorophyll-a would be evaluated using the last five years of data compared to the criteria described above. For data sets having TCEQ's required number of sampling events, orthophosphorus, nitrate-nitrite, and chlorophyll-a would be assessed individually, as independent criteria. If $\leq$ 10% of samples exceed

the criterion for each variable, the reservoir will be considered as fully compliant with numeric nutrient standards. However, if > 10 and ≤ 25% of samples exceed the criterion for any variable, the reservoir will be considered in partial compliance with numeric nutrient standards, and placed on the list of water bodies with concerns for use attainment. If > 25% of samples exceed the criterion for any of the three variables, the reservoir will be considered as noncompliant with numeric nutrient standards, and will be included on the 303(d) list. Once a reservoir is considered partially compliant or noncompliant, removal from either the concerns or 303(d) list would require ≤ 10% of the samples to exceed the criterion for each variable during an assessment.

TPWD has listed a limited number of degraded reservoirs (Appendix 2) identified by TCEQ in the 2002 and 2004 Draft Water Quality Inventory Summaries of Water Bodies with Water Quality Concerns that had elevated orthophosphorus, nitrate-nitrite, or chlorophyll-a concentrations throughout the entire reservoir or at the sampling site nearest the dam. For these reservoirs, determination of criteria for orthophosphorus, nitrate-nitrite, and chlorophyll-a should be guided by, in order of preference, a) calculating historic values based on the lowest nutrient values for five consecutive years of data since 1978, b) calculating values from similar (in terms of geography, size, function, etc.), non-degraded reservoirs, or c) using the 2002 TCEQ 85th percentile screening levels, which are 50 µg/L for orthophosphorus, 320 µg/L for nitrate-nitrite, and 21.4 µg/L for chlorophyll-a. Region-specific criteria may be calculated in lieu of these statewide values. For examples of establishing criteria for degraded reservoirs, see Appendix 1. After criteria are established, the reservoir would be considered degraded until ≤ 10% of the samples exceed the criterion for each variable.

Discussion

The no-degradation policy described represents a logical approach for several reasons, including:

- it maintains current water quality and prevents further degradation of reservoirs from nutrients.
- it protects current reservoir uses from being negatively impacted by nutrient enrichment.
- numeric criteria reflect localized conditions.
- it is relatively simple to implement.
- it can be accomplished within current regulatory guidance established by TCEQ.

Utilization of orthophosphorus, nitrate-nitrite, and chlorophyll-a measurements at a sampling site near the dam serves several goals, including:

- Selection of these three variables addresses many of the major causes for degraded water quality. Certainly other parameters could also be examined, but

these cover the most significant without creating additional demands on time and budgets.

- TCEQ, river authorities, United States Geological Survey, and other monitoring agencies already measure these parameters. No new types of tests would be required. Parameters with little or no major importance to nutrients are not included.
- Measurement of these three variables at the dam can be indicative of the quality of the water being discharged downstream for reservoirs with spillways or other "top-release" mechanisms.

Unfortunately, the proposed approach has some limitations, including the following:

- Dealing with a single, standardized location (i.e., at the dam) in a reservoir for monitoring and assessment purposes is best from a simplicity and standardization standpoint. However, a single sampling location at the dam limits the ability to assess changes in nutrient input from upstream that may negatively impact the reservoir. Thus, nutrients may cause problems within specific embayments, yet not reduce water quality at the dam site. In addition, nitrogen and phosphorus can be reduced by passage through a reservoir (caused by a variety of mechanisms) and there may be a time lag in detection of increased nutrient inputs because of dilution. Although these problems may somewhat limit the ability of the proposed approach to identify nutrient problems in the short-term, we suggest that future development of nutrient criteria by the TCEQ for rivers and streams, estuaries, wetlands, and coves and embayments in reservoirs should incorporate temporal and spatial variability and allow sources of nutrient inputs to be better identified.
- Surface sampling ignores any effects of reservoir stratification.
- Identification of degraded reservoirs may be affected because of limited data. Using the 2002 and 2004 TCEQ Inventory Summaries of Water Bodies with Water Quality Concerns lists to establish the initial list of degraded reservoirs limits the list to those reservoirs for which there are sufficient data to perform an assessment.
- Limiting monitoring to nitrogen, phosphorus and chlorophyll-a may miss impairment from:

    a. excessive benthic algae - in some cases, benthic algae (periphyton) may cover the substrate and other structures so extensively that major ecological problems occur, yet nutrient and chlorophyll-a levels in the water column above show no excess (reflecting excessive nutrients tied up in the benthic algae).
    b. excessive macrophytes - dense beds of rooted or floating macrophytes can tie up nutrients within a reservoir resulting in clear waters with reduced nitrogen, phosphorus, and chlorophyll-a levels in the water column, again masking the presence of excessive nutrients. Aquatic vegetation provides important fish habitat and may result in improved water clarity; however, non-native, invasive or excessive aquatic vegetation may cause fisheries management and recreation problems.

c. blue-green algae - using chlorophyll-a as the only measure of phytoplankton biomass may not address situations where blue-green and other non-green planktonic algae dominate the plankton community. Chlorophyll-a levels may be very low, but plankton densities supported by excessive nutrients may be high enough to degrade water quality and threaten ecosystem stability.

High densities of algae or macrophytes supported by excessive nutrients often result in exaggerated diurnal dissolved oxygen (D.O.) variability. Under such conditions, D.O. levels often drop below those lethal to fishes, resulting in fish kills.

The limitations discussed above may be demonstrated by considering some reservoirs that TPWD Inland Fisheries biologists have identified as degraded that are not captured in the 2002 and 2004 TCEQ Inventory Summaries of Water Bodies with Water Quality Concerns lists:

- Lake LBJ (Segment 1406) has been identified by TPWD biologists as having excessive filamentous algae. While Lake LBJ is screened routinely for nutrient parameters, this approach fails to identify nutrient impacts due to benthic algae.
- TPWD biologists have identified several reservoirs as degraded by nutrients, where insufficient or no data exist to perform an assessment. These include:
    - Lake Wichita (Segment 0219) has heavy algal blooms. The most recent TCEQ assessment shows no data for this water body.
    - Rita Blanca Lake (Segment 0105) is known to have extremely high nutrient levels. However, the most recent TCEQ assessment shows that there are insufficient data to assess the water body.
    - Mitchell Lake (in the drainage of Segment 1903) has been identified by the San Antonio River Authority and TPWD as a water body that has been impacted by nutrients. It may have been part of a sewage treatment plant at one time. The most recent TCEQ assessment shows no data for this water body.

- Bowie City Lake (in the drainage of Segment 0204) is impacted by macrophytes and algae. Relying solely on criteria for nitrate-nitrite nitrogen, orthophosphorus and chlorophyll-a may lead to missing impacts resulting from macrophytes. In addition, the most recent TCEQ assessment shows no data for this water body.

Summary

The proposed approach for establishment of reservoir nutrient criteria in Texas supports a no-degradation policy. If adopted, it would provide for reservoir-specific protection from nutrient overloading of public waters, thus assuring continued quality water-based habitat and recreation for future generations.

References

Lee, G. F., and A. Jones-Lee. 2002. Developing nutrient criteria/TMDLs to manage excessive fertilization of waterbodies. Proceedings of the Water Environmental Federation, TMDL 2002 Conference, Phoenix, AZ.

EPA (U. S. Environmental Protection Agency). 2000. Nutrient criteria technical guidance manual: lakes and reservoirs. 1st edition, EPA-822-B00-001.

Appendix 1. Examples Showing Establishment of Reservoir Nutrient Criteria

Note: Although it is recognized that most nutrient data are collected monthly or quarterly, data presented in Figures 1-4 have been condensed, for illustrative purposes, into fewer points per annum and, again for illustrative purposes, only chlorophyll-a is shown. Data are hypothetical, though based on actual reservoir values.

Non-degraded reservoirs (maintain current conditions)

When historic data are available and these suggest a non-degraded state, it is recommended that data from the reservoir be used to establish its criteria. Use the empirical 90th percentile of the data from 1994 through 2003 to calculate criteria to maintain the current condition. (Reservoir A1, Figure 1).

Degraded reservoirs

A limited number of reservoirs that are currently considered degraded by nutrients have been identified. Because a reservoir is degraded, use of data from 1994 through 2003 would establish inappropriate criteria. For these degraded reservoirs, calculation of criteria should be guided by the following three options, in order of preference:

a. Use Five Consecutive Years of Historical Records with the Lowest Nutrient Values

Some reservoirs that are currently degraded will have extensive historical data sets depicting adequate water quality in the past (Reservoir A2, Figure 2). To establish criteria, it is recommended that data from those five consecutive years with the lowest nutrient values since 1978 be used, in this example, data from 1981 through 1986. The criterion is calculated as the empirical 90th percentile of the data from 1981 through 1986.

In some instances, the historic record will be too short or all the data will have been collected during the time the reservoir has been degraded. Two potential approaches to setting the criteria under these data-limiting situations follow.

b. Use Similar Reservoirs

Although data may be limited for the degraded reservoir, it may be possible to locate sufficient data for non-degraded reservoirs within close geographic proximity. Selection of reservoirs for comparison should be based on expert opinion, and include consideration of such factors as ecoregion, drainage area, and hydrology. The water quality data from these reservoirs could be used to provide criteria for the degraded reservoir. In this example, data from a degraded reservoir (Reservoir A3) for ten years

is presented (Figure 3). However, the data suggest the use of the ten years with the lowest nutrient levels would set criteria that are influenced by a period when the reservoir was becoming degraded. Data collected from four non-degraded reservoirs in close geographic proximity suggest that the regional average chlorophyll-a level between 1993 and 2003 was about 4.5 µg/L. The recommended criterion for Reservoir A3 is 7.2 ug/l, the empirical 90th percentile of the monthly/quarterly 1993-2003 data from the non-degraded reservoirs.

c. Use TCEQ 2002 Screening Levels

In this example, data from a degraded reservoir (Reservoir A4) is presented for twenty-six years (Figure 4). However, the data suggest that the reservoir was hypereutrophic during the entire period since 1978. As such it is inappropriate to calculate a criteria using any period of data. Further, insufficient data exist from surrounding reservoirs to allow a geographic comparison. Under such a scenario, it is recommended that the TCEQ 2002 85th percentile screening levels be used to establish criteria. These values are 50 µg/L for orthophosphorus, 320 µg/L for nitrate-nitrite, and 21.4 µg/L for chlorophyll-a.

Figure 1. To establish the criterion to maintain the current status of Reservoir A 1, the empirical 90th percentile of the monthly/quarterly data from 1994 through 2003 was used.

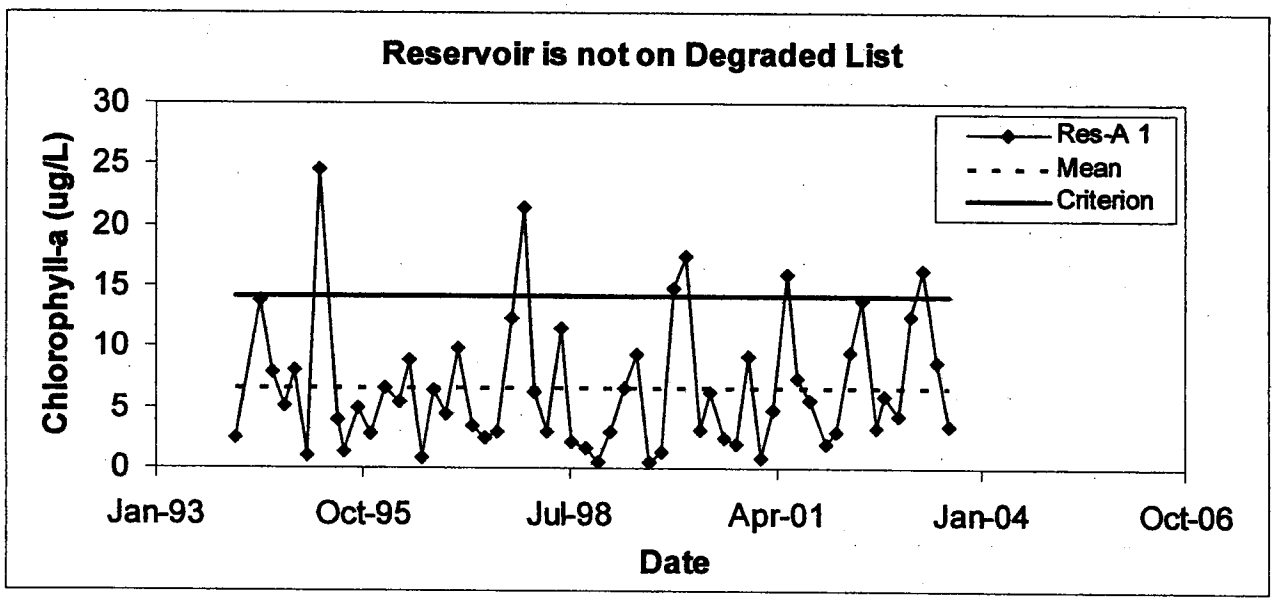


Figure 2. To establish the criterion for a degraded reservoir with historic data (Res-A 2), the empirical 90th percentile of the five consecutive years of monthly/quarterly historical data with the lowest nutrient levels (1981-1986) was used.

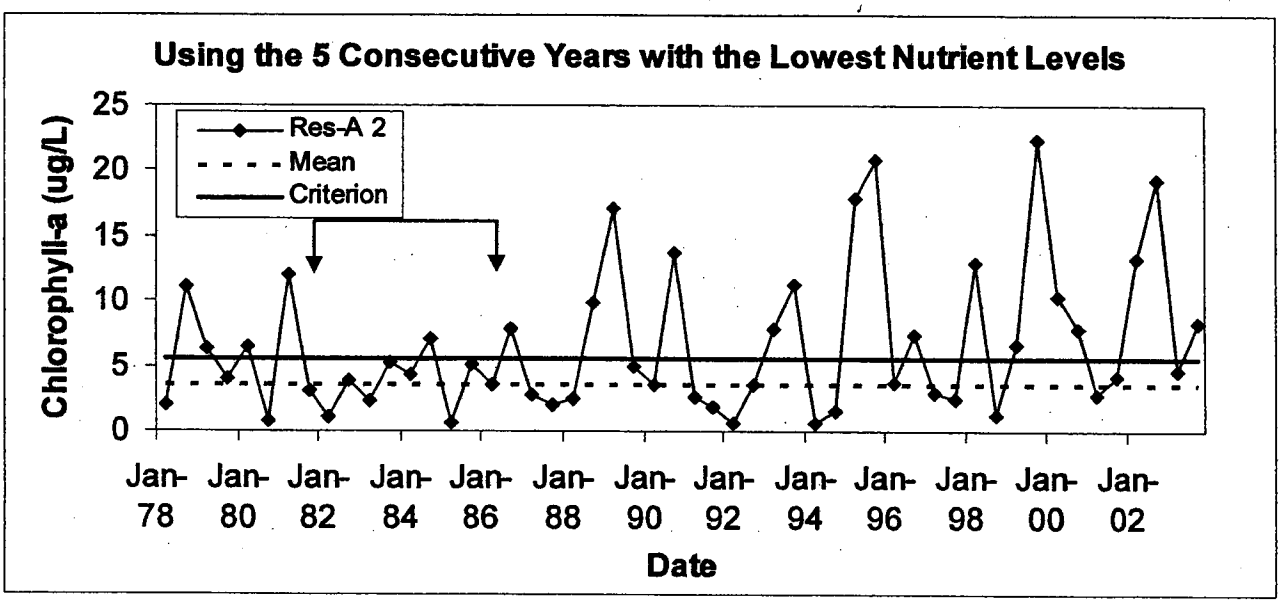


Figure 3. To establish the criterion for the degraded reservoir (Res-A 3), data from four reservoirs in close geographic proximity (Res B through Res E) were used. Using the monthly/quarterly 1993-2003 data, the criterion was established as the empirical 90th percentile for all four non-degraded reservoirs.

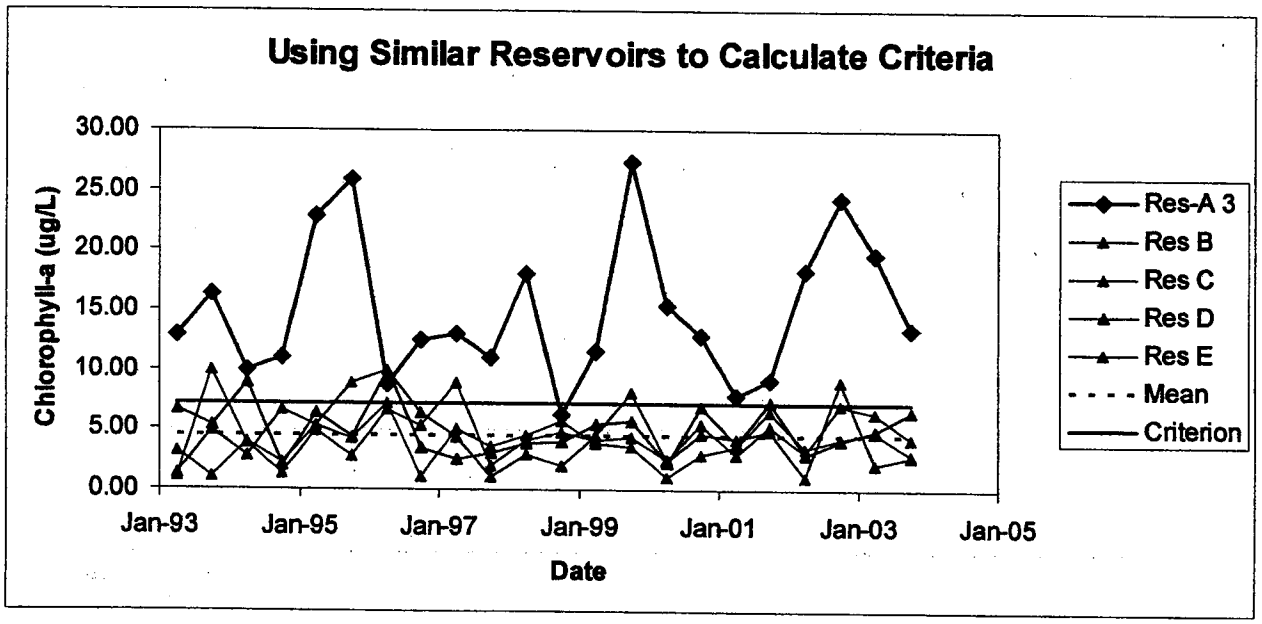
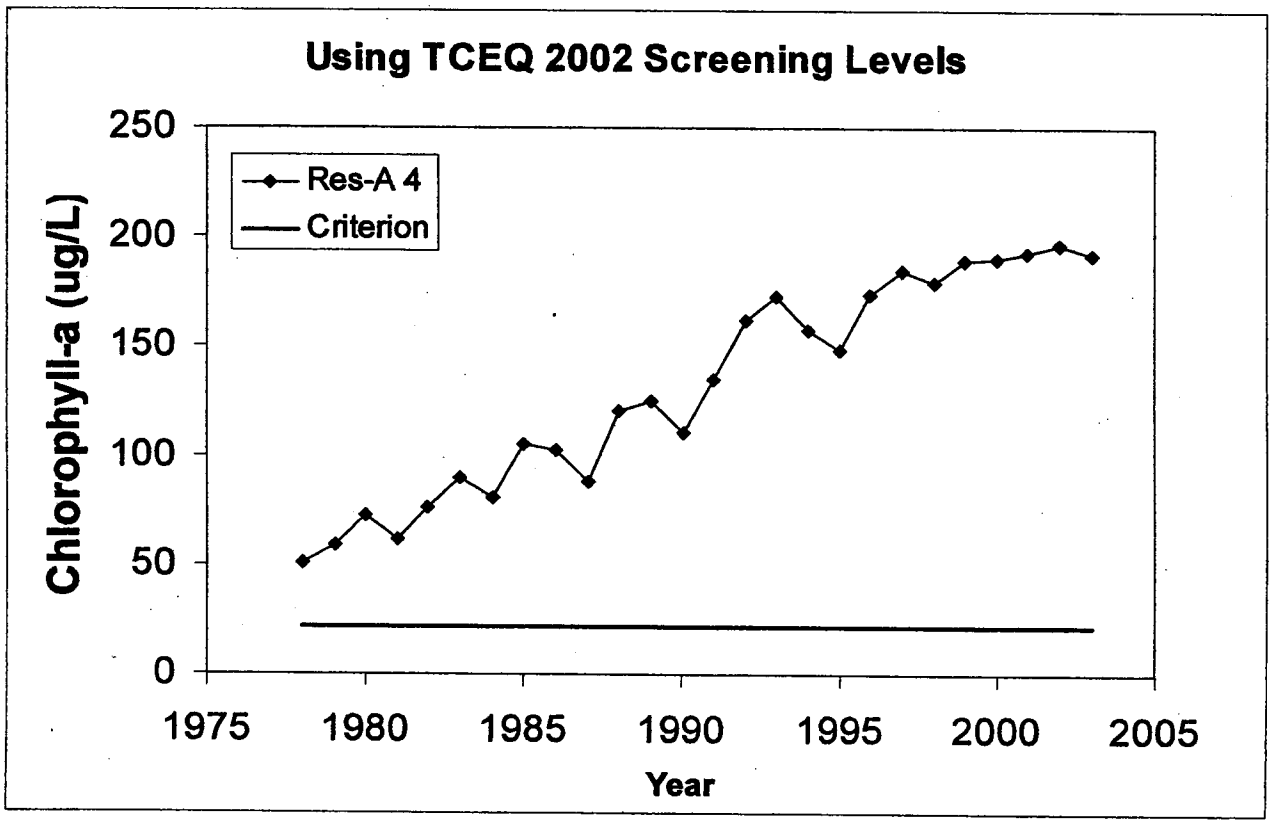


Figure 4. To establish the criterion for the degraded reservoir (Res-A 4), the TCEQ 2002 85th percentile screening criteria of 21.4 µg/L was used for Res-A 4.



Appendix 2. List of Currently Degraded Reservoirs

The list is a subset of the TCEQ's 2002 and 2004 Draft Water Quality Inventory Summaries of Water Bodies with Water Quality Concerns. Only reservoirs that had a nutrient concern for orthophosphorus, nitrate-nitrite, or chlorophyll-a throughout the entire reservoir or at the sampling site nearest the dam are included.

		TCEQ Concern		
Water Body	Segment	OP	nitrate-nitrite	algal (chl a)
Palo Duro Reservoir	199A		x	
Lake Tanglewood	0229A	x	x	x
Lake Tawakoni	507			x
Lake Livingston	803	x		x
Eagle Mountain Reservoir	809			x
Bardwell Reservoir	815		x	
Cedar Creek Reservoir	818			x
Lake Lavon	821		x	
Benbrook Lake	830			x
Richland-Chambers Reservoir	836		x	
Lake Houston	1002	x	x	
Waco Lake	1225		x	x
Lake Limestone	1252		x	
Aquilla Reservoir	1254		x	
Fayette Reservoir	1402G			x
Town Lake	1429		x	
Lake Texana	1604		x	x