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Implementation Plan for Lake Austin Dissolved Oxygen TMDL

For Segment 1403

Prepared by the:
Strategic Assessment Division, TMDL Team

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TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

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Introduction

In keeping with the Texas commitment to restore and maintain water quality in impaired water bodies, the Commission recognized from the inception of the Total Maximum Daily Load (TMDL) Program that implementation plans would need to be established for each TMDL developed.

The TMDL is a technical analysis that:

1) determines the maximum loadings of the pollutant a water body can receive and still both attain and maintain its water quality standards, and
2) allocates this allowable loading to point and non-point source categories in the watershed.

Based on the TMDL, an implementation plan is then developed. An implementation plan is a detailed description and schedule of regulatory and voluntary management measures that will be effective and appropriate to achieve the pollutant reductions identified in the TMDL.

The implementation plan contained herein will provide the following components:

1) a description of control actions and management measures[1] that generally will be implemented to achieve the water quality target;
2) legal authority for implementation of the control actions;
3) a schedule for implementing specific activities determined necessary to achieve TMDL objectives;
4) a follow-up surface water quality monitoring plan to determine the effectiveness of the control actions and management measures undertaken;
5) reasonable assurances that the implementation of voluntary management measures will achieve the load allocations for nonpoint sources; and
6) measurable outcomes for determining whether the implementation plan is properly executed and water quality standards are being achieved.

This implementation plan is designed to increase the seasonal dissolved oxygen levels in Lake Austin as defined in the adopted TMDL.

[1] Control actions refer to point source pollutant reduction strategies, generally TPDES permits. Management measures refer to nonpoint source pollutant reduction strategies, generally voluntary best management practices.

This implementation plan was prepared by:

- the TMDL Team in the Strategic Assessment Division of the Office of Environmental Policy, Analysis, and Assessment of the Texas Natural Resource Conservation Commission.

Technical assistance was provided by:

- the Lower Colorado River Authority (LCRA).

This implementation plan was approved by the Texas Natural Resource Conservation Commission on July 13, 2001. This implementation plan, combined with the TMDL, establishes a Watershed Action Plan (WAP). A WAP provides local, regional, and state organizations a comprehensive strategy for restoring and maintaining water quality in an impaired water body. The TNRCC has ultimate responsibility for ensuring that water quality standards are restored and maintained in impaired water bodies.

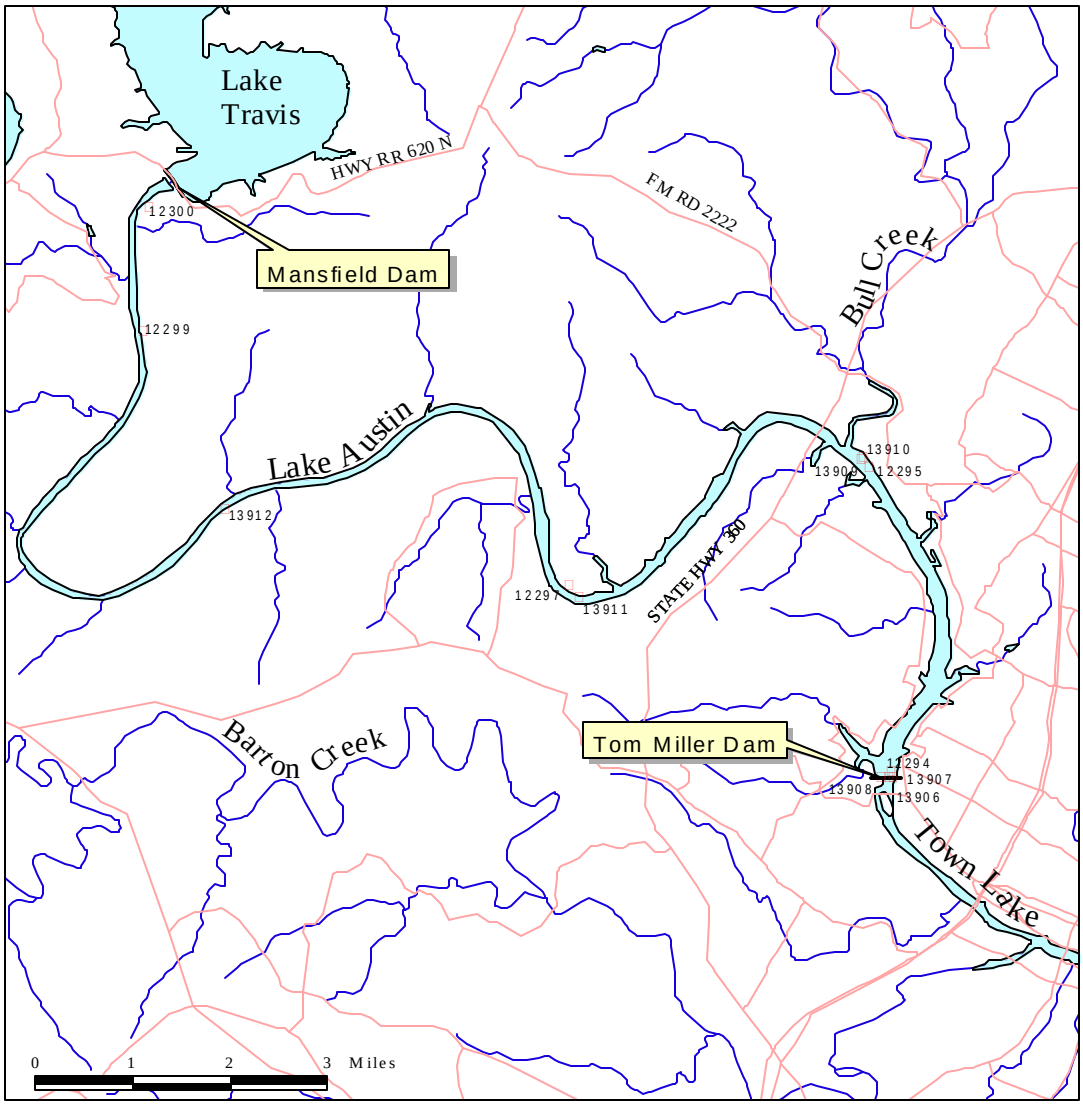
Summary of the TMDL

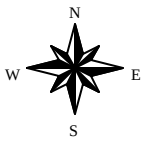
Lake Austin, Segment 1403 (see Figure 1) is designated in the Texas Surface Water Quality Standards for high aquatic life use with an associated dissolved oxygen numeric criterion of 5.0 milligrams per liter (mg/L). The criterion was established to assure optimum habitat conditions for aquatic life. Lake Austin was placed on Texas' Clean Water Act §303(d) List because dissolved oxygen concentrations were occasionally below the numeric criterion at a site (12300) immediately below Mansfield Dam at the upstream end of the lake.

The approach chosen for establishing this TMDL does not fit with the typical mathematical equation generally used to express a TMDL: WLA + LA + MOS = TMDL.[2] Since neither point source or nonpoint source loadings are causing the low levels of dissolved oxygen, this TMDL does not assign specific loads to pollutant sources. Instead, the TMDL is based on the need to increase dissolved oxygen levels to ensure that water quality standards will be restored and maintained.

The endpoint for the TMDL is the criterion for dissolved oxygen of 5.0 mg/L. The TMDL for dissolved oxygen in Lake Austin was adopted by the Commission on November 17, 2000.

[2] WLA is the Waste Load Allocation which represents loading from point sources; LA is the Load Allocation which represents loading from nonpoint sources; and MOS is the Margin of Safety.





Lake Austin Dissolved Oxygen
Total Maximum Daily Load

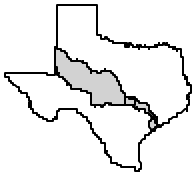


Figure 1. Lake Austin

Management Measures

Low levels of dissolved oxygen may occur in lakes as a result of natural conditions, as well as from eutrophication caused by human activities. The lowest concentrations tend to occur in the deeper waters of the hypolimnion during thermal stratification in late summer (Novotny et al., 1994). The hypolimnion of a water body is the bottom zone of colder, non-circulating water in a thermally-stratified lake. This bottom zone of the reservoir is characterized by depleted dissolved oxygen, with no oxygen replenishment from photosynthesis or circulation with the atmosphere.

Upon examination of available data for Lake Austin, most violations of the dissolved oxygen criterion occurred during the months of July, August, and September, which correspond to the stratified season of Lake Travis. The source of Lake Austin's headwater is Lake Travis, via penstocks in Mansfield Dam approximately 45 meters below the conservation pool. The approximate penstock and conservation pool elevations are 163 and 208 meters above mean sea level, respectively. During summer stratification, the penstock elevation is in the hypolimnion layer of Lake Travis. As stratification develops, microbial respiration induces anoxia. Water released from the hypolimnetic zone of Lake Travis into Lake Austin is naturally low in dissolved oxygen.

Based on this information, the violations of the dissolved oxygen standard appear to be due to this process rather than oxygen demand by pollutants. Attaining the dissolved oxygen standard in the upper end of Lake Austin is not likely without some modification to counteract the deleterious effects of hypolimnetic water releases. The TMDL analysis indicates the need for a reversal of anoxic conditions. The endpoint for the TMDL is the criterion for dissolved oxygen of 5.0 mg/L instream. Considering the dissolved oxygen levels which led to the identification of the impairment in 1998, the dissolved oxygen levels in the headwaters must be raised by approximately 1.5-2.5 mg/L in order to attain the standard of 5 mg/L instream.

Hypolimnetic aerators can be used to increase oxygen levels in waters from the hypolimnion as they pass through the dam without disturbing the lake's thermal stratification and habitat (Novotny et al., 1994). Aeration of anoxic water released into Lake Austin can mitigate the seasonal trend of low dissolved oxygen.

For aerating anoxic water, the LCRA has installed an aerator on one of the three turbines operating at the Mansfield Dam. The idea of improving levels of dissolved oxygen in the headwaters of Lake Austin through the use of special modifications to the turbine equipment was first proposed in 1996 as part of an $11.5 million hydroelectric modernization project. Construction began on this project in October 1999, and was coordinated with an extensive overhaul of the turbine unit. The LCRA began these voluntary efforts many years prior to the adoption of the TMDL (2000), and even prior to initial listing of the water body on the 303(d) List (1996).

Improvements are expected in the dissolved oxygen conditions during the summer months in the headwaters of Lake Austin as a result of the implementation of this TMDL over the next five years.

Installation of Air Induction System

The LCRA has installed an induction aerating system (aerator) in Unit 2, a hydroelectric turbine-generator located at Mansfield Dam. The purpose of the aeration system is to improve dissolved oxygen concentrations immediately below Mansfield Dam by introducing additional oxygen downstream of the powerhouse during the summertime periods of low dissolved oxygen. This system is designed to admit atmospheric air through modifications to the draft tube liner and consists of a specially-designed turbine pit interface consisting of a 10-inch pipe, air induction valves, and associated control equipment. It does not require special air scoops or hoods within the water passageways, which would have to be removed when not in use.

This system involves passive air induction; therefore, aeration can only occur when hydroelectric generation is 70 to 100 percent of unit capacity and sufficient differential is maintained behind the turbine blades. At lower turbine outputs, there is not enough negative pressure differential produced to draw air into the water stream. At higher turbine outputs, air induction results in a turbine flow disturbance with an associated reduction in hydrogeneration efficiency. While the air quantities admitted are large (on the order of 100 cubic feet per second), the influence on turbine performance is generally not significant, typically less than 10 percent.

It is anticipated that this system will be used only in the months when dissolved oxygen levels are historically below 5.0 mg/L; that is the months of July, August and September. When the system is not in use, there is no impact on turbine performance and therefore no loss in efficiency occurs during normal operation of the unit. Despite the expense incurred to install this system and despite the predicted lost revenue during operation of the system, the LCRA installed this aeration system to help alleviate periods of reduced dissolved oxygen in Lake Austin. Currently, the LCRA has spent approximately $445,000 on the installation of this system.

Modifications to the Air Induction System

As part of the Marshall Ford Unit 2 Hydroelectric Rehabilitation Project, the LCRA incorporated an aeration system into the unit that allows atmospheric air to be drawn into the turbine by utilizing the pressure differentials created by the turbine at the top of the draft tube. The initial tests on this system modification concluded that it did not meet LCRA' expectations for uptake in the dissolved oxygen of water passed through the turbine. To supplement this system, a blower was added to the system to increase the airflow into the turbine. Once again, tests showed that the system with the added blower did not meet LCRA's expectations. One of the critical issues affecting dissolved oxygen uptake is the air mass flow rate.

In November and December 2000, to further enhance air flow into the system, another modification was undertaken to provide additional aeration into the runner chamber by drilling 13 3-inch holes through the runner crown into the low-pressure zone of the runner. This air is introduced into the mixing chamber at high volumes. This modification is utilized year round as compared to the other modifications that can be taken out of service, thus reducing the losses to the performance of the machine.

The LCRA tested all of the above combined system modifications and concluded that these modifications still did not meet LCRA's expectations.

In May 2001, the LCRA installed an additional mixing chamber located at the bottom of the runner. The design of this system required the removal of a large section of the draft tube and concrete in order to allow an 18-inch tall and 135-inch diameter mixing chamber to be placed in a low pressure area of the draft tube, resulting in a minimal loss to operating performance and efficiency of the unit. This system draws naturally aspirated air. The LCRA completed the modification in June 2001 and currently is monitoring the results.

Voith-Siemens, LCRA's contractor for the air induction system, provided an aeration system similar to those used for dissolved oxygen uptake at the Tennessee Valley Authority's Norris and Douglas Dams. The air induction systems used in these dams have proven to be successful and have met the TVA's expectations.

Legal Authority

In Texas, state statutory provisions require the Commission to establish water quality standards and to implement them for waters in the state (Texas Water Code (TWC) §26.011). Texas fulfills its obligations under §303(d) to list impaired segments and establish TMDLs through functions assigned by the legislature to TNRCC. The Clean Water Act §303(d) list is prepared by TNRCC as part of its monitoring, planning and assessment duties (TWC §26.0135).

TMDLs themselves are part of the state water quality management plans that TNRCC is charged by statute to prepare (TWC § 26.036). As the state environmental regulatory body, the Commission has primary responsibility for implementation of water quality management functions within the State (TWC §§26.0136, 26.127). The Executive Director of the TNRCC must prepare and develop, and the Commission must approve, a comprehensive plan for control of water quality in the state (TWC § 26.012). The list of impaired segments and resulting TMDLs are tools in water quality planning.

Procedures for implementing the Texas Surface Water Quality Standards are described in *Implementation of the Texas Natural Resource Conservation Commission Standards Via Permitting* (RG-194, August 1995). However, this implementation plan does not involve a water quality permit from the TNRCC. Instead, it will be performed entirely by the LCRA

under its legal authority to operate the Mansfield Dam and manage the Lower Colorado River, which encompasses Lake Austin.

Implementation Schedule

The following schedule has been established for specific actions, management measures, and monitoring and assessment.

Action	Time Line
1. Install and test aerator on Mansfield Dam Turbine Number 2.	August 2000
2. Install and test blower to enhance flow rate into the aerator.	November 2000. Additional testing planned in Summer 2001
3. Perform peripheral modifications (modified aerator).	December 2000.
4. Perform additional modifications to draft tube and air induction systems.	March - May 2001
5. For monitoring the tailrace and the immediate effects of adjustments to the aerator: conduct continuous 24 hr dissolved oxygen monitoring during testing of the aerator.	July - September 2001
6. For instream monitoring: conduct continuous 24 hr. dissolved oxygen monitoring on a schedule to comply with 305(b) guidance; continue grab samples.	September 2001 - August 2003
7. Evaluate (1) instream dissolved oxygen data using 305(b) methodology and (2) fish kill data. Revise monitoring program/schedule if necessary.	November 2003 (midway mark)
8. Continue 24-hour and grab sampling of dissolved oxygen.	September 2003 - August 2006
9. Evaluate (1) instream dissolved oxygen data using 305(b) methodology and (2) fish kill data. Reevaluate effectiveness of implementation actions.	Summer of 2006

Follow-up Monitoring Plan

The TNRCC will collaborate with the LCRA to determine if the TMDL target is met after installation and operation of the aerator. Dissolved oxygen concentrations will be monitored at site 12300 and at least one other site in order to determine attainment of the TMDL target. At least five years of instream dissolved oxygen data will be collected in accordance with the most current 305(b) methodology, with a focus on the summer season when low dissolved oxygen levels have been observed historically. The LCRA and the TNRCC's Surface Water Quality Monitoring Program will conduct the monitoring. LCRA collects and reports their data under the TNRCC-approved Clean River Program's quality assurance project plan. Each year at the annual coordinated monitoring meetings conducted among TNRCC and its monitoring partners, the TNRCC and the LCRA and other stakeholders will revisit the details of the monitoring plan for Lake Austin and revise the monitoring if necessary.

Data used to determine post-implementation standards attainment will be collected from the LCRA's routine reservoir monitoring program. The LCRA plans to maintain and continue its collection of water quality data at site 12300. The current program calls for collecting instantaneous dissolved oxygen measurements (grab samples) every other month. In addition, beginning in fiscal year 2002, the LCRA will incorporate diel (24-hour continuous) monitoring. Two sampling events will occur: one in the critical period (July 1 - September 30), and one in the index period (March15 - October 15), but outside of the critical period. In addition, the TNRCC will conduct two additional diel sampling events at site 12300 and four diel sampling events at one or more additional sites. All sampling will conform to the 305(b) methodology. Data from both types of sampling will be assessed using the 305(b) methodologies to determine attainment of the standard.

Roughly halfway through the project (November 2003), an initial evaluation of the instream dissolved oxygen data will be conducted by the TNRCC using the methods established in the 305(b) guidance. In addition, the TNRCC will request a download from the Texas Parks and Wildlife Department fish kill database and use that information to support the assessment of the dissolved oxygen impairment. As a result of this mid-term assessment, further modifications may be made to the air induction system or to the monitoring regime, or alternative measures may be recommended.

In addition to the instream monitoring at site 12300 which will determine standards attainment, the LCRA will also monitor the efficiency of the aerator. Dissolved oxygen concentrations will be monitored immediately below the powerhouse. Testing during winter months will likely show minimal changes in dissolved oxygen, because water passing through the dam is fully saturated in winter. Testing will, however, continue in the summer months. Further modifications in the aerator may be made based on these data. The LCRA will not routinely provide any aerator testing data to the TNRCC, but the data will be maintained and available upon request by the TNRCC or other stakeholders.

As stated earlier, the air induction process does not work until generation is occurring at greater than 70 percent of capacity. The exact amount of time the dam will be operating at sufficient capacity to provide air induction can not be predicted. Based on the previous year's data for July, August, and September, generation occurred between 25 to 40 percent of the time. To evaluate the effectiveness of this air induction system and provide an accurate description of the oxygen environment at this location, measurements will be taken during periods of hydroelectric generation. The LCRA will maintain several datasondes near the tailrace during the summer months.

Reasonable Assurance

The reasonable assurance that the needed management measures will be implemented is provided by the fact that most of the modifications are already in place and testing is in progress to determine whether improvements occur in the dissolved oxygen conditions. In addition, LCRA has already spent almost half a million dollars on these measures.

The reasonable assurance is also provided by the LCRA mission statement:

> The mission of the Lower Colorado River Authority (LCRA) is to provide reliable, low cost utility and public services in partnership with our customers and communities and to use our leadership role and environmental authority to ensure the protection and constructive use of the area's natural resources.

Measurable Outcomes

The instream target of 5.0 mg/L is the most important measurable outcome. Both the 24-hour and the grab sample data will be assessed in accordance with the 305(b) methodology. The mean of the 24-hour data is compared to the criteria. In addition, both the 24-hour and grab sample data are compared to the minimum criteria. Other intermediate outcomes include the installation and modifications of the aerator.

The implementation plan will be reevaluated after five years. If it is determined that the TMDL target has not been met, the plan will incorporate further management measures.

References

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