TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AGENDA ITEM REQUEST

AGENDA REQUESTED: May 11, 2011

DATE OF REQUEST: April 21, 2011

NAME & NUMBER OF PERSON TO CONTACT REGARDING CHANGES TO THIS REQUEST, IF NEEDED: Chip Morris, 239-6686.

CAPTION: Docket No. 2011-0103-TML. Consideration for approval to publish and solicit public comment on Two Total Maximum Daily Loads for Indicator Bacteria in Cottonwood Branch and Grapevine Creek, Segments 0822A and 0822B of the Trinity River Basin, in Dallas and Tarrant counties.
(Ron Stein, Robert Brush)
Project No. 2011-012-TML-NR

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Kelly Holligan, Director, Water Quality Planning Division

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L'Oreal Stepney, P.E., Deputy, Office of Water

Texas Commission on Environmental Quality

INTEROFFICE MEMORANDUM

To: Commissioners **Date:** April 21, 2011

Thru: LaDonna Castañuela, Chief Clerk
Mark R. Vickery, P.G., Executive Director

From: L'Oreal W. Stepney, P.E., Deputy Director
Office of Water

Subject: Docket No. 2011-0103-TML Project No. 2011-012-TML-NR
Proposal for Two Total Maximum Daily Load for Indicator Bacteria in Cottonwood Branch and Grapevine Creek, Segments 0822A and 0822B of the Trinity River Basin, in Dallas and Tarrant counties for Public Comment.

Issue Consideration for approval to publish and solicit public comment on two draft total maximum daily loads (TMDLs) corresponding to two assessment units (AUs) for indicator bacteria in Cottonwood Branch and Grapevine Creek, Segments 0822A and 0822B of the Trinity River Basin, in Dallas and Tarrant counties.

Background and Current Practice Two draft TMDLs have been prepared as required by Section 303(d) of the Clean Water Act. TMDLs must be submitted to the U.S. EPA for approval as certified updates to the State of Texas Water Quality Management Plan (WQMP). The Water Quality Planning Division requests approval from the commission to propose the TMDLs for a formal public review and comment period. After the public comment period, staff will make appropriate changes to the draft TMDLs and respond to public comments. The next step will be to request that the commission consider adoption and certification of the final TMDLs as an update to the State of Texas WQMP. The commission approved TMDLs are then forwarded to U.S. EPA for its final action.

Watershed Information This project addresses elevated levels of indicator bacteria related to the contact recreation use in fresh water. The impaired streams are tributaries to Elm Fork Trinity River Below Lewisville Lake (Segment 0822). Cottonwood Branch (0822A) consists of two AUs; is six miles long; with an approximately five square mile watershed. The contact recreation use impairment applies to the upstream area, AU 0822A_02. Grapevine Creek (0822B) consists of one AU; is approximately ten miles long; with a fourteen square mile watershed. The contact recreation use impairment applies to the entire stream, AU 0822B_01.

Problem Definition *Escherichia coli* (*E. coli*) is the preferred indicator bacteria for assessing the contact recreation use in fresh water. Elevated levels of bacteria have been a persistent issue in the watersheds of the impaired AUs. Both the geometric mean and single-sample criteria are exceeded at most sampling locations.

Endpoint Identification The endpoint for the TMDLs for freshwater segments is to maintain the geometric mean of concentrations of *E. coli* below the geometric mean criterion of 126 most probable number (MPN) per 100 milliliter (mL).

Source Analysis The most probable sources of indicator bacteria within the watersheds of the impaired AUs are storm water runoff from permitted storm sewer sources, dry weather

the impaired AUs are storm water runoff from permitted storm sewer sources, dry weather discharges (illicit discharges) from storm sewers, sanitary sewer overflows, and unregulated sources such as wildlife, unmanaged animals and pets.

Linkage Load duration curve (LDC) analyses were used to examine the relationship between instream water quality and the source of indicator bacteria loads over the complete range of flow conditions (categorized as highest flows, mid-range flows, and lowest flows). The LDC analysis showed that bacteria concentrations exceeded the geometric mean criterion in all AUs under all flow conditions.

TMDL Calculation The bacteria TMDLs for the Section 303(d)-listed AUs covered in this report were derived using LDCs. The estimated maximum allowable loads of *E. coli* for each of the AUs was determined as that corresponding to the median loading of the high flow regime.

Margin of Safety (MOS) The TMDLs covered by this report incorporate an explicit MOS by setting a target for indicator bacteria loads that is 5 percent lower than the geometric mean criterion. The explicit MOS was used because of the limited amount of data for some of the sampling locations.

Wasteload Allocations (WLAs) Currently, there are no Texas Pollutant Discharge Elimination System (TPDES)-permitted wastewater treatment facilities (WWTFs) in the TMDL watersheds.

Load Allocation (LA) The load allocation is the sum of loads from unregulated sources.

TMDL The TMDLs were calculated based on the median flow in the 0-10 flow exceedance percentile range. This percentile corresponds to the high flow range.

Future Capacity To account for the probability that new flows from WWTFs may occur in any of the segments, a provision for future growth was included in the TMDL calculations. Future growth was based on the projected population increase from year 2005 to year 2030 and an estimate of the amount of wastewater generated per person per day or gallons per capita per day (gpcd) in the wastewater collection service area.

Allocations The final TMDL allocations needed to comply with the requirements of Title 40 of the Code of Federal Regulations Section 130.7 are presented in Table 1. In this table the future capacity for WWTFs has been added to the WLA_{WWTF}. The allocations in this table are based on the criteria for *E. coli* (geometric mean of 126 MPN/100 mL) in freshwater.

Public Participation TCEQ and the Texas Institute for Applied Environmental Research are jointly providing coordination for public participation in this project. A series of three public meetings have been conducted since 2008 to keep the public aware of the TMDL process and to engage public participation. The meetings introduced the TMDL process, identified the impaired AUs and the reason for the impairment, reviewed historical data, and described potential sources of bacteria within the watershed. In addition, the meetings gave TCEQ the opportunity to solicit input from all interested parties within the study area.

Implementation The North Texas Council of Governments (NCTCOG) is working with the TCEQ to lead development of the Implementation Plan (I-Plan). Through the advisory group led by the NCTCOG, the resources and expertise of the local organizations and individuals will be brought together to set priorities, provide flexibility, and consider appropriate social and economic factors.

Table 1. Final TMDL allocations for Cottonwood Branch (AU 0822A_02) and Grapevine Creek (AU 0822_01)

(all units in Billion MPN per day)

AU	Stream Name	TMDL	WLA_{WWTF}*	WLA_{SW}	LA	MOS
0822A_02	Grapevine Creek	37.04	0.21	34.97	0	1.85
0822B_01	Cottonwood Branch	196.22	0.46	157.60	28.34	9.81

$TMDL = WLA_{WWTF} + WLA_{SW} + LA + MOS$

Where:

WLA_{WWTF} = wasteload allocation for WWTFs

WLA_{SW}= wasteload allocation for all permitted storm water

LA = load allocation, the amount of pollutant allowed by unregulated sources

MOS = margin of safety load

* $WLA_{WWTF} = WLA_{WWTF}$ + Future Growth

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Attachments

cc: Chief Clerk, 7 copies

Proposed for Public Comment
May 2011

Two Total Maximum Daily Loads for Indicator Bacteria in Cottonwood Branch and Grapevine Creek

Segments 0822A & 0822B

Assessment Units: 0822A_02 and 0822B_01

Prepared by the
Office of Water, Water Quality Planning Division

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Distributed by the
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TMDL project reports are available on the TCEQ Web site at
<www.tceq.state.tx.us/implementation/water/tmdl/66_cottongrape_bacteria.html/>

The preparation of this report was financed in part through grants from
the U.S. Environmental Protection Agency.

This TMDL report is based in part on the reports titled
"Technical Support Document for Bacteria TMDLs:
Segment 0822A– Cottonwood Branch & Segment 0822B – Grapevine Creek"
and
"Allocation Support Document for Two Total Maximum Daily Loads for Bacteria
in Cottonwood Branch and Grapevine Creek"
Prepared by the Texas Institute for Applied Environmental Research

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List of Acronyms

AU	assessment unit
AVMA	American Veterinary Medical Association
BMP	best management practice
CFR	Code of Federal Regulations
cfs	cubic feet per second
cms	cubic meters per second
DMR	Discharge Monitoring Report
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
FDC	flow duration curve
GIS	geographic information system
gpcd	gallons per capita per day
ha	hectare
I/I	inflow and infiltration
I-Plan	implementation plan
km	kilometer
LA	load allocation
LDC	load duration curve
MGD	million gallons per day
mm	millimeter
mL	milliliter
MOS	margin of safety
MPN	most probable number
MS4	municipal separate storm sewer system
NCTCOG	North Central Texas Council of Governments
NDEP	Nevada Division of Environmental Protection
NEIWPCC	New England Interstate Water Pollution Control Commission
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
OSSF	on-site sewage facility
SSO	sanitary sewer overflow
SWPPP	Storm Water Pollution Prevention Plan
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TIAER	Texas Institute for Applied Environmental Research
TMDL	total maximum daily load
TPDES	Texas Pollutant Discharge Elimination System
TRA	Trinity River Authority
USGS	United States Geological Survey
WLA	wasteload allocation
WQMP	Water Quality Management Plan
WWTF	wastewater treatment facility

Two Total Maximum Daily Loads for Indicator Bacteria in Cottonwood Branch and Grapevine Creek

Executive Summary

This document describes total maximum daily loads (TMDLs) for Cottonwood Branch and Grapevine Creek, where concentrations of indicator bacteria exceed the criteria used to evaluate attainment of the contact recreation use. The Texas Commission on Environmental Quality (TCEQ) first identified the impairments in the 2006 version of the Texas Water Quality Inventory and 303(d) List.

Cottonwood Branch and Grapevine Creek (Segments 0822A and 0822B) are urban creeks located in the north central portion of the Dallas-Fort Worth metroplex. Both are tributaries to the Elm Fork Trinity River below Lake Lewisville (Segment 0822). Grapevine Creek (0822B) is the larger of the two creeks with a drainage area of 9,295 acres, while Cottonwood Branch (0822A) has a drainage area of 2,964 acres. Cottonwood Branch is divided into two assessment units (AUs) while Grapevine Creek consists of a single AU. The drainage area of both AUs for Cottonwood Branch and the sole AU for Grapevine Creek lie entirely within Dallas County with the exception of the upstream portion of the AU for Grapevine Creek that lies within Tarrant County.

Escherichia coli (*E. coli*) are the preferred indicator bacteria for assessing the contact recreation use in freshwater, and were used for development of the TMDL. The criteria for assessing attainment of the contact recreation use are expressed as the number (or "counts") of *E. coli* bacteria, typically given as the most probable number (MPN) per hundred milliliters (100 mL) of water. The contact recreation use is not supported when the geometric mean of all *E. coli* samples exceeds 126 MPN per 100 mL, or if individual samples exceed 394 MPN per 100 mL more than 25 percent of the time.

Historical ambient water quality data for indicator bacteria (November 2001 - October 2004) were analyzed on select TCEQ monitoring stations in the Cottonwood Branch and Grapevine Creek watersheds. The geometric means of *E. coli* exceeded the standard in the upstream AU of Cottonwood Branch, 0822A_02, and in the single AU of Grapevine Creek, 0822B_01, with the geometric means calculated as 786 MPN/100 mL and 411 MPN/100 mL, respectively.

The most probable sources of indicator bacteria within the watersheds of the impaired AUs are storm water runoff from permitted storm sewer sources, dry weather discharges (illicit discharges) from storm sewers, sanitary sewer overflows, and unregulated sources such as wildlife, unmanaged feral animals and pets.

A load duration curve analysis was used to quantify allowable pollutant loads and specific TMDL allocations for point and nonpoint sources of indicator bacteria. The TMDL allocations are discussed in the section "TMDL Calculations."

Compliance with these TMDLs is based on keeping the indicator bacteria concentrations in the selected waters below the geometric mean criterion of 126 MPN/100 mL.

Future growth of existing or new point sources was determined using population projections. The TMDL calculations in this report will guide determination of the

assimilative capacity of each stream under changing conditions, including future growth. Wastewater discharge facilities will be evaluated on a case-by-case basis.

Introduction

Section 303(d) of the federal Clean Water Act requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. States must develop a TMDL for each pollutant that contributes to the impairment of a listed water body. The TCEQ is responsible for ensuring that TMDLs are developed for impaired surface waters in Texas.

A TMDL is like a budget—it determines the amount of a particular pollutant that a water body can receive and still meet its applicable water quality standards. TMDLs are the best possible estimates of the assimilative capacity of the water body for a pollutant under consideration. A TMDL is commonly expressed as a load with units of mass per time period, but may be expressed in other ways. TMDLs must also estimate how much the pollutant load must be reduced from current levels in order to achieve water quality standards.

The TMDL Program is a major component of Texas' overall process for managing the quality of its surface waters. The program addresses impaired or threatened streams, reservoirs, lakes, bays, and estuaries (water bodies) in, or bordering on, the state of Texas. The primary objective of the TMDL Program is to restore and maintain the beneficial uses—such as drinking water supply, recreation, support of aquatic life, or fishing—of impaired or threatened water bodies. This TMDL addresses impairments to the contact recreation use due to exceeding indicator bacteria criteria in Cottonwood Branch and Grapevine Creek, two tributaries to the Elm Fork Trinity River below Lake Lewisville (Segment 0822) in north-central Texas.

Section 303(d) of the Clean Water Act and the implementing regulations of the U.S. Environmental Protection Agency (EPA) in Title 40 of the Code of Federal Regulations (CFR), Part 130 (40 CFR 130) describe the statutory and regulatory requirements for acceptable TMDLs. The EPA provides further direction in its *Guidance for Water Quality-Based Decisions: The TMDL Process* (EPA, 1991). This TMDL document has been prepared in accordance with those regulations and guidelines.

The TCEQ must consider certain elements in developing a TMDL. They are described in the following sections of this report:

- Problem Definition
- Endpoint Identification
- Source Analysis
- Linkage Analysis
- Seasonal Variation
- Margin of Safety
- Pollutant Load Allocation
- Public Participation
- Implementation and Reasonable Assurance

Upon EPA approval, these TMDLs will become an update to the state's Water Quality Management Plan (WQMP).

Problem Definition

TCEQ first identified the impairment to the contact recreation use for Cottonwood Branch (Segment 0822A) and Grapevine Creek (Segment 0822B) in the 2006 Texas Water Quality Inventory and 303(d) List (TCEQ, 2008b). All or part of each water body was subsequently included on the 2008 and Draft 2010 §303(d) Lists under category 5a, indicating that they are a priority for developing a TMDL.

The impaired AUs in Segments 0822A and 0822B on the 303(d) list are 0822A_02 and 0822B_01 (TCEQ, 2008b) (see Figure 1). An AU is the smallest geographic area of use support reported in the Texas Integrated Report. These AUs define the TMDL area addressed in this report.

The standards for water quality are defined in the *Texas Surface Water Quality Standards* (TSWQS) (TCEQ 2000). Contact recreation is the presumed use in Cottonwood Branch and Grapevine Creek under the current TSWQS. *E. coli* are the preferred indicator bacteria for assessing the contact recreation use in freshwater, and were used for analysis and modeling to support TMDL development for the watershed. The criteria for assessing attainment of the contact recreation use are expressed as the number (or "counts") of *E. coli* bacteria, typically given as the most probable number (MPN). For the *E. coli* indicator, if the minimum sample requirement is met, the contact recreation use is not supported when:

- the geometric mean of all *E. coli* samples exceeds 126 MPN per 100 mL;
- and/or individual samples exceed 394 MPN per 100 mL more than 25 percent of the time.

Ambient Indicator Bacteria Concentrations

Table 1 presents a historical summary of ambient indicator bacteria data from the TCEQ surface water database, Surface Water Quality Monitoring Information System (SWQMIS) for November 2001 through October 2004. All AUs in Segments 0822A and 0822B are included in the data summary. As indicated in Table 1, only the AUs associated with TCEQ stations 17165 and 17166 (in AU 0822A_02) and 17531 and 17939 (in AU 0822B_01) exceeded the geometric mean criterion of 126 MPN/100 mL.

Watershed Overview

Cottonwood Branch lies within the jurisdictional area of the City of Irving, Dallas County (Figure 1). The creek is defined in the Draft *2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)* (formerly the Water Quality Inventory and List) as starting at Valley View Lane, at the south end of Dallas-Fort Worth (DFW) International Airport and extending approximately six miles eastward to the confluence with Hackberry Creek. The creek consists of two AUs (see Figure 1) defined in the Draft 2010 Texas Integrated Report as follows.

- AU 0822A_01 is the downstream portion of Cottonwood Branch, from the confluence with Hackberry Creek at the downstream end to the upstream end at North Story Road.
- AU 0822A_02 is the upstream portion of Cottonwood Branch, from 0.5 miles downstream of North Story Road to the upstream end at Valley View Lane.
- AU 0822A_02 is the focus of TMDL development.

The drainage area encompassing AU 0822A_02 of Cottonwood Branch is 723 hectares (ha), about three square miles. Dominant land uses in the watershed include residential (31%), undeveloped (22%), commercial/industrial (22%); and infrastructure (19%) (Figure 2, Table 2). The remaining land use categories comprise 7% of the land cover.

Grapevine Creek flows approximately ten miles from its headwaters west of International Parkway in Tarrant County, downstream to its confluence with the Elm Fork Trinity River (Segment 0822) in Dallas County (Figure 1; TCEQ, 2010). The Grapevine Creek drainage area lies within the jurisdictional areas of the City of Irving, City of Coppell, City of Grapevine, and DFW International Airport. The entire reach of Grapevine Creek, from the headwaters to the confluence with the Elm Fork Trinity River, consists of one AU, defined as follows:

> AU 0822B_01 is the portion of Grapevine Creek from the confluence with the Elm Fork Trinity River in Dallas County upstream to its headwaters west of International Parkway at the DFW Airport in Tarrant County.

Table 1. Summary of routine monitoring *E. coli* data for November 2001 - October 2004

(Downloaded from SWQMIS July – August 2009)
Stations provided in an upstream to downstream order.
Only AUs 0822A_02 and 0822B_01 indicate nonsupport of contact recreation use.

AU	Station ID	Location	No. of Samples	Range of Measured *E. coli* Concentrations (MPN/100mL)	Station Geometric Mean (MPN/100mL)	AU Geometric Mean (MPN/100mL)
0822A_01	18359	433 m upstream of N. MacArthur Blvd / Dallas Co.	16	2 – 2,600	37	47
	17167	N. MacArthur Blvd / Dallas Co.	7	3 – >2,400	154	
	17168	Spur 348 (Northwest Hwy) / Dallas Co.	31	<1 – 977	41	
0822A_02	17165	N. Beltline Rd. / Dallas Co.	32	19 – >4,838	764	786
	17166	N. Story Rd. / Dallas Co.	30	99 – >4,840	811	
0822B_01	17531	Airfield North upstream of bridge / Tarrant Co.	12	21 – >2,419	121	411
	17939	Regent Blvd. 535 m upstream of I-635 / Dallas Co.	22	48 – 4,838	799	

In the Grapevine Creek watershed, North Lake, a cooling reservoir for a recently closed power plant, has a storage capacity of approximately 17,000 acre-feet and drains via an unnamed tributary into Grapevine Creek approximately 300 meters upstream of TCEQ station 20311 at MacArthur Blvd. (Figure 1). North Lake and its drainage area are considered a non-contributing portion of the Grapevine Creek watershed from the perspective of both

bacteria loading and streamflow. Power company staff report that North Lake rarely releases into Grapevine Creek, with discharges typically occurring a few years apart (personal communication, John Mummert, TCEQ, December 1, 2009). Consequentially, for the remainder of this report the Grapevine Creek watershed will be defined to exclude the drainage area of North Lake resulting in a remaining watershed area of 3,073 ha (about 12

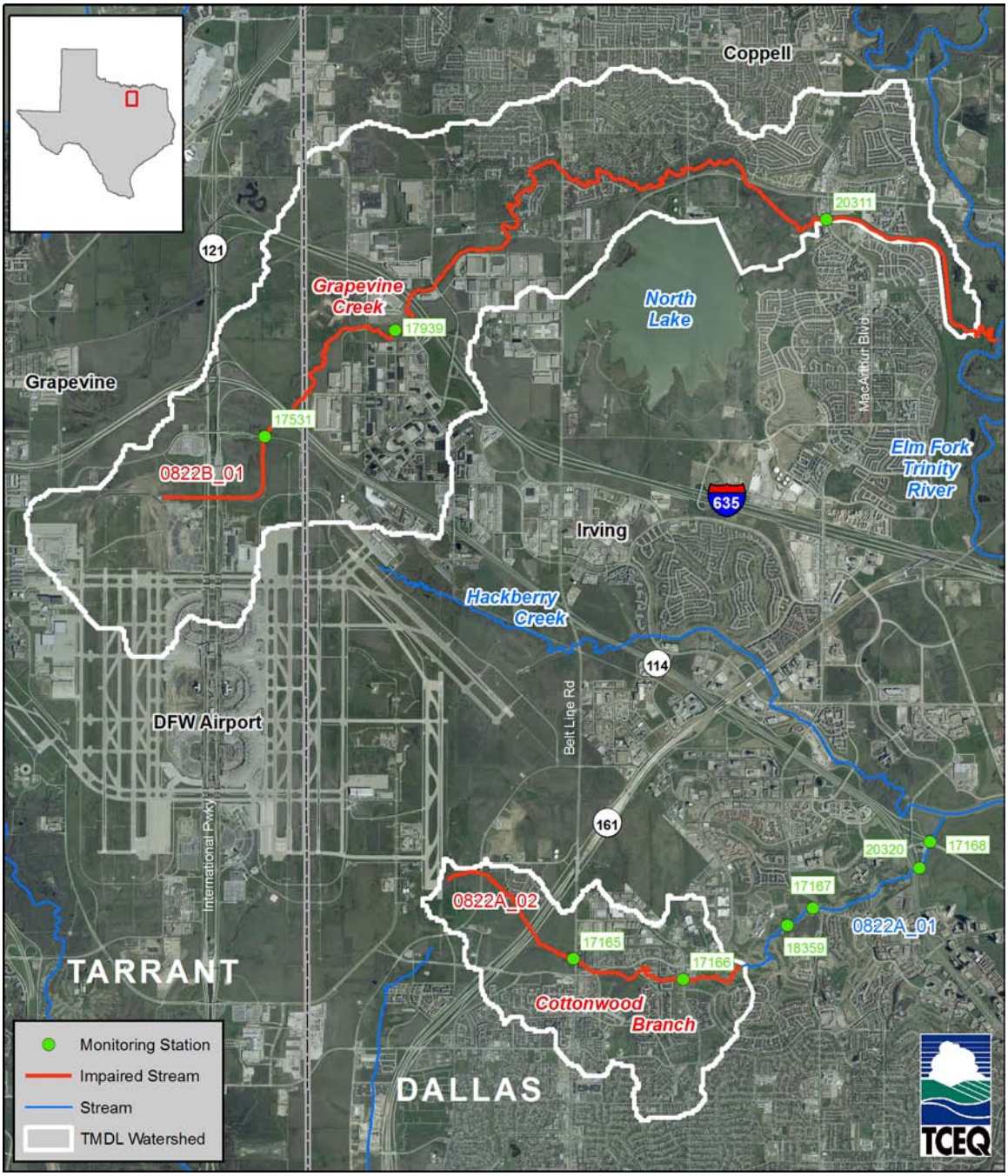

Figure 1. Cottonwood Branch and Grapevine Creek study area showing locations of AUs and monitoring stations.

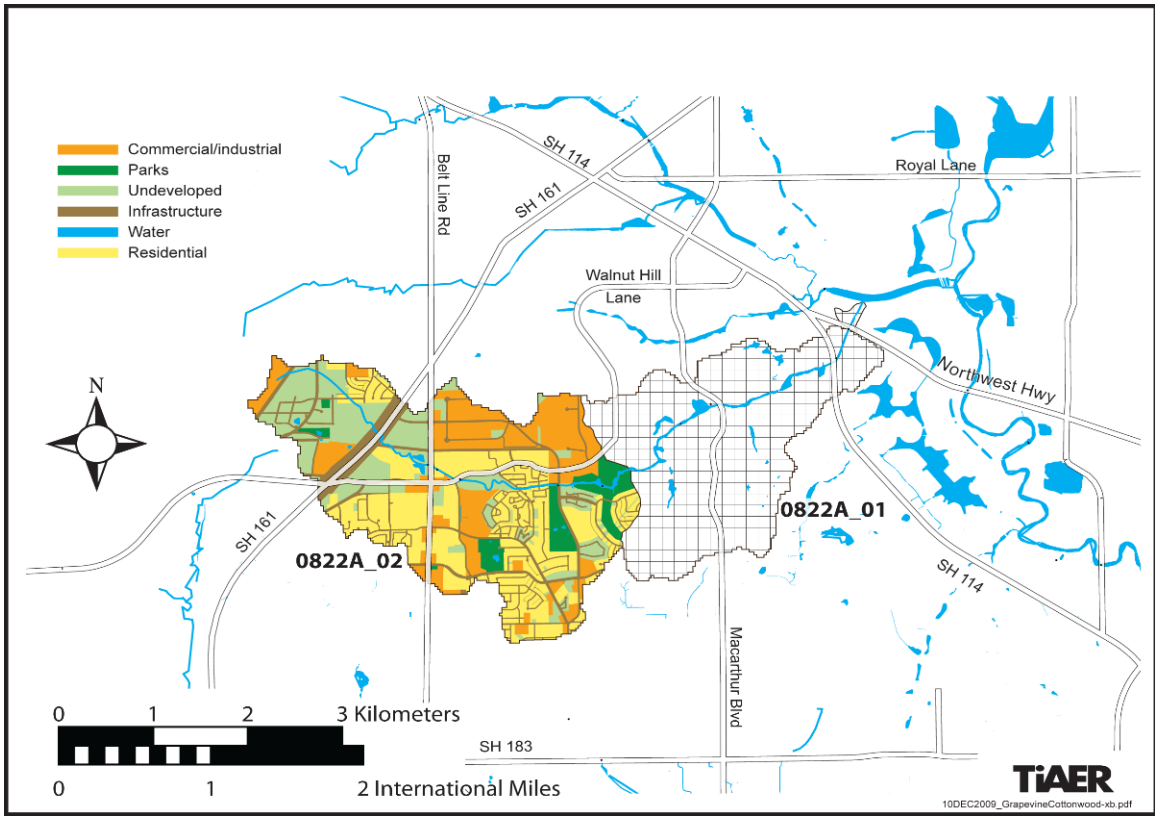

Figure 2. Map of land use for impaired AU 0822A_02 of Cottonwood Branch

(Source: North Central Texas Council of Governments (NCTCOG) GIS Data Clearinghouse website <www.dfwmaps.com/clearinghouse/metadata.asp>. Represents land use/cover estimates for 2005.)

Table 2. Land use summary for Cottonwood Branch, impaired AU 0822A_02, and Grapevine Creek, impaired AU0822B_01.

Aggregated Land Use Category	Cottonwood Branch (0822A_02) Area	% of Total	Grapevine Creek (0822B_01) Area	% of Total
Residential	224	31.01	1,027	33.43
Undeveloped	156	21.56	789	25.68
Commercial/Industrial	156	21.53	770	25.04
Infrastructure	138	19.12	423	13.75
Parks	45	6.17	56	1.82
Water	4	.61	8	.28
TOTALS	723 hectares	100%	3,073 hectares	100%

square miles). Dominant land uses in the Grapevine Creek watershed include infrastructure (33%), undeveloped (26%), commercial/ industrial (25%), and residential (14%). The remaining land use categories comprise 2% of the land cover (Figure 3; Table 2).

In the Grapevine Creek watershed, North Lake, a cooling reservoir for a recently closed power plant, has a storage capacity of approximately 17,000 acre-feet and drains via an unnamed tributary into Grapevine Creek approximately 300 meters upstream of TCEQ station 20311 at MacArthur Blvd. (Figure 1). North Lake and its drainage area are considered a non-contributing portion of the Grapevine Creek watershed from the perspective of both bacteria loading and streamflow. Power company staff report that North Lake rarely releases into Grapevine Creek, with discharges typically occurring a few years apart (personal communication, John Mummert, TCEQ, December 1, 2009). Consequentially, for the remainder of this report the Grapevine Creek watershed will be defined to exclude the drainage area of North Lake resulting in a remaining watershed area of 3,073 ha (about 12 square miles). Dominant land uses in the Grapevine Creek watershed include infrastructure (33%), undeveloped (26%), commercial/ industrial (25%), and residential (14%). The remaining land use categories comprise 2% of the land cover (Figure 3; Table 2).

Cottonwood Branch and Grapevine Creek lie within North Central Texas, which has a subtropical climate characterized by hot summers and mild winters, resulting in a wide annual temperature range (National Weather Service (NWS), 2009). Average high temperatures generally reach their peak of 96° F between late July and mid August. Fair skies generally accompany the highest temperatures of summer, which are often above 100° F; however, the low temperature rarely exceeds 80° F at night (NWS, 2009). During winter, the average low temperature is 33° F in early to mid January and periods of extreme cold generally do not last long (NWS, 2009). Annual average precipitation is 34.7 inches (881 mm) of rain and 2.5 inches (64 mm) of snow.

Endpoint Identification

All TMDLs must identify a quantifiable water quality target that indicates the desired water quality condition and provides a measurable goal for the TMDL. The TMDL endpoint serves to focus the technical work to be accomplished and as a criterion against which to evaluate future conditions.

The endpoint for the TMDLs in this report is to maintain concentrations of *E. coli* below the geometric mean criterion of 126 MPN/100 mL in Cottonwood Branch (impaired AU 0822A_02) and Grapevine Creek (impaired AU 0822B_01).

Source Analysis

Potential sources of indicator bacteria pollution can be divided into two primary categories: *regulated* and *unregulated*. Pollution sources that are regulated have permits under the Texas Pollutant Discharge Elimination System (TPDES) and the National Pollution Discharge Elimination System (NPDES). Examples of regulated sources include:

- municipal and private domestic wastewater treatment facility (WWTF) discharges;
- industrial facilities with individual storm water permits and/or discharging treated industrial wastewater and/or groundwater; and
- storm water discharges from industries, construction, and municipal separate storm sewer systems (MS4s).

Nonpoint source pollution originates from multiple locations, usually carried to surface waters by rainfall runoff. It is not regulated by permit under the TPDES or NPDES.

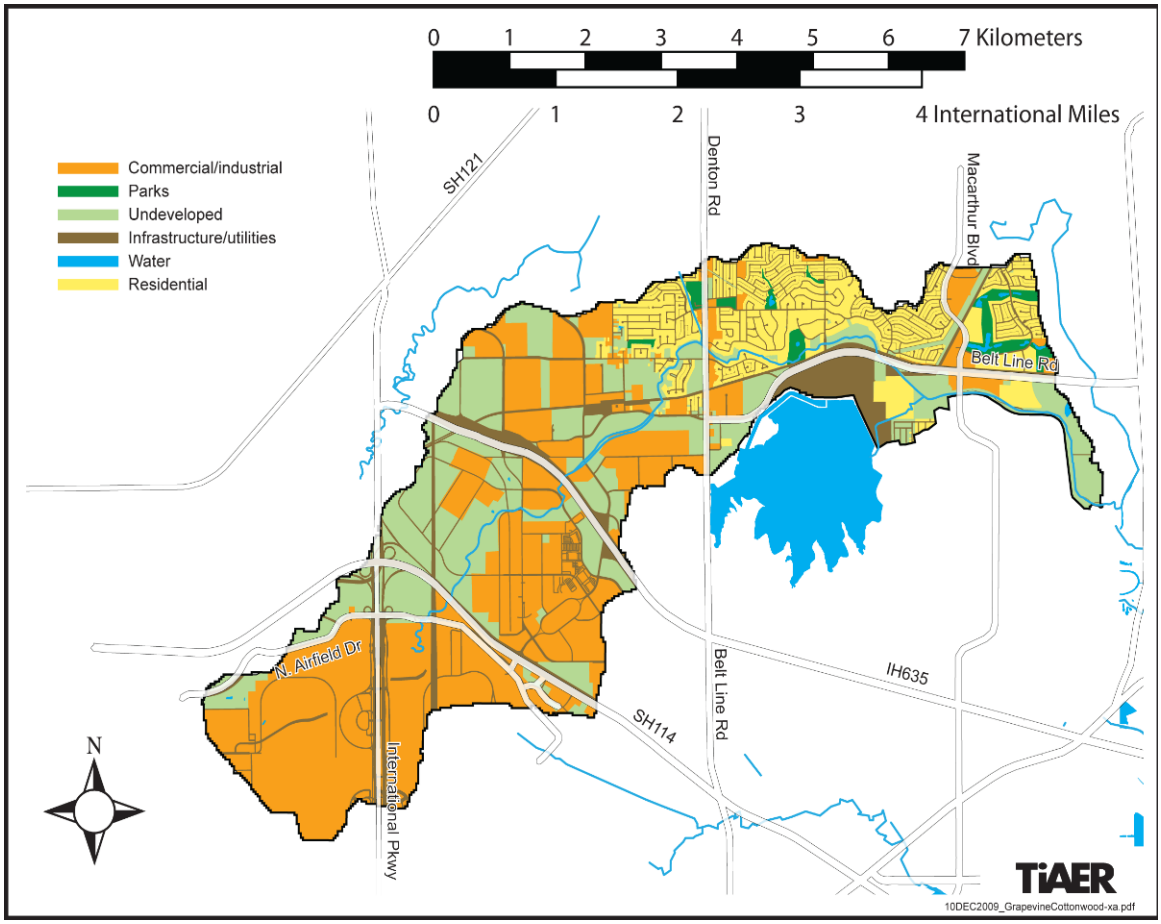

Figure 3. Map of land use for Grapevine Creek watershed

(Source: (NCTCOG GIS Data Clearinghouse website <www.dfwmaps.com/clearinghouse/metadata.asp> and represents land use/land cover estimates for 2005.)

Permitted Sources

Permitted sources are regulated by permit under the TPDES and the NPDES. Storm water discharges from industries, construction sites, and MS4s represent the permitted sources in impaired AUs 0822A_02 and 0822B_01.

Domestic and Industrial Wastewater Facilities

Currently there are no individually authorized domestic or industrial WWTF dischargers located within the watershed of either stream. The entire watersheds of both impaired AUs are located within the wastewater and sewered collection system area served by the Trinity River Authority (TRA) Central Regional WWTF (Figure 1).

DFW Airport has an individual storm water permit (WQ0001441) that includes one outfall (059) that discharges to Grapevine Creek. The permit is targeted at the control of runoff following aircraft de-icing operations. The discharge is considered intermittent and variable (subject to precipitation and runoff), and no flow limit is specified in the permit. In addition, the Airport is also covered under the TPDES Phase II General Storm Water Permit. Given

the circumstances of the permit, this outfall will be treated as part of the TPDES-permitted storm water discharge load.

Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) are unauthorized discharges that must be addressed by the responsible party, either the TPDES permittee or the owner of the collection system that is connected to a permitted system. SSOs in dry weather most often result from blockages in the sewer collection pipes caused by tree roots, grease, and other debris. Inflow and infiltration (I/I) are typical causes of SSOs under conditions of high flow in the WWTF system. Blockages in the line may exacerbate the I/I problem. Other causes, such as a collapsed sewer line, may occur under any condition.

Determination of the importance of SSOs as a source of bacteria loadings is typically difficult to assess. A damaged sewer line near TCEQ station 17166 in Cottonwood Branch (Figure 1) is suspected of being a major source of high *E. coli* values determined for samples collected at this station in 2008 during TMDL bacteria data collection. The sewer line has since been repaired. The TCEQ-maintained database of SSO data reported by responsible entities in the Dallas-Fort Worth Metroplex was reviewed for the period September 2003 – February 2009. The database contains entries that appear to be within the Cottonwood Branch and Grapevine Creek watersheds, though most of these entries are the result of relatively minor line blockages. Based on available information it is concluded that SSOs are not a widespread source of bacteria to the two creeks; however, they may at times be a significant source in localized portions of either creek.

TPDES-Regulated Storm Water

When evaluating storm water for a TMDL allocation, a distinction must be made between storm water originating from an area under a TPDES-regulated discharge permit and storm water originating from areas not under a TPDES-regulated discharge permit. Storm water discharges fall into two categories:

- storm water subject to regulation, which is any storm water originating from TPDES Phase I and Phase II MS4-permitted discharges (Table 3), permitted industrial storm water areas, and permitted construction site areas; and
- storm water not subject to regulation.

Table 3. Regulated storm water discharges in AUs 0822A_02 and 0822B_01

Impaired AU	Regulated Entity Name [a]	NPDES Permit Number	TPDES Permit Number
0822A_02	North Texas Tollway Authority	TXS000703	WQ0004400
0822A_02 and 0822B_01	City of Irving	TXS001301	WQ0004691
0822B_01	City of Coppell	TXR040375	TXR040000
0822B_01	City of Dallas	TXS000701	WQ0004396
0822B_01	DFW International Airport	TXR040044	TXR040000

[a] Although the jurisdictional boundary of the City of Grapevine is within the Grapevine Creek watershed, that portion of the city boundary is not within the City of Grapevine MS4 and thus is not a permittee in the Grapevine Creek TMDL.

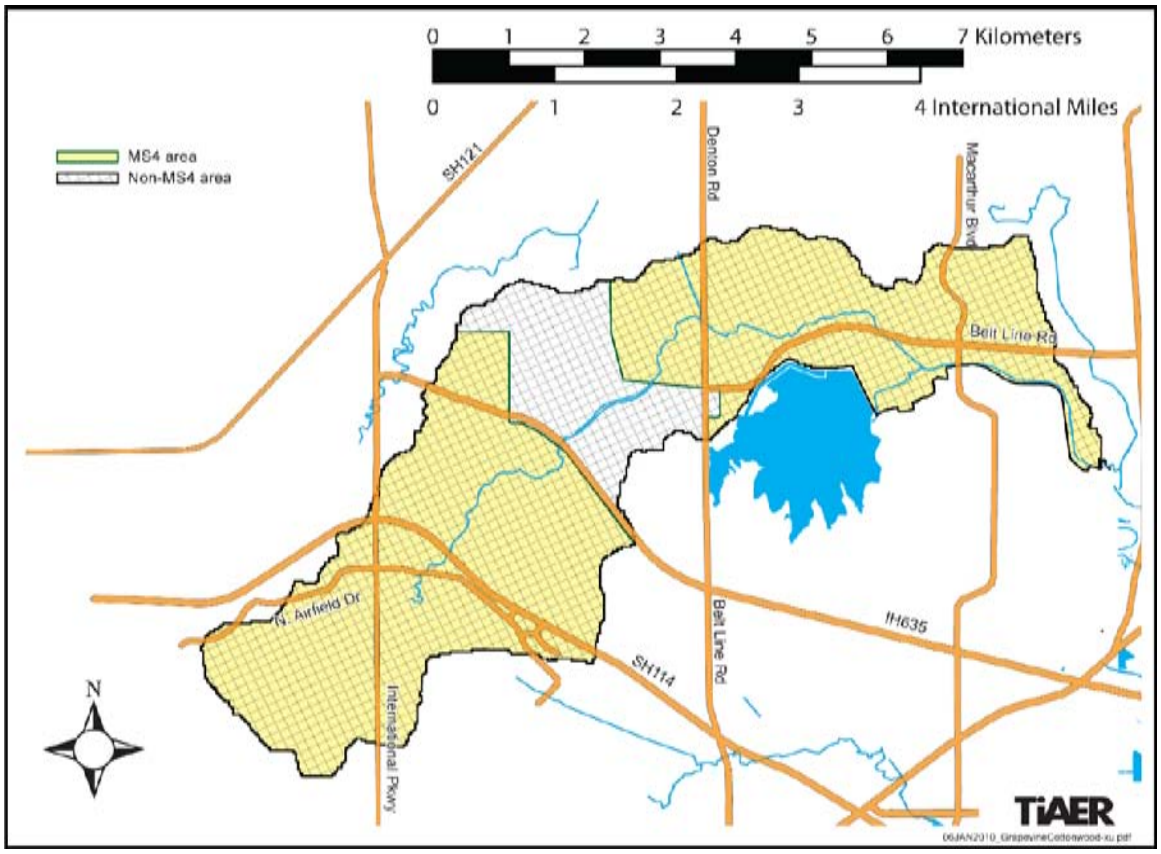

Figure 4. Grapevine Creek watershed (regulated/unregulated storm water areas)

The geographic region of Cottonwood Branch and Grapevine Creek covered by Phase I and II MS4 permits is that portion of the study area within the jurisdictional boundaries of the regulated entity. For Phase I permits, the jurisdictional area is defined by the city limits. For Phase II permits, the jurisdictional area is defined as the intersection or overlapping areas of the city limits and the 2000 Census Urbanized Area. Of the MS4 permitted entities in the two watersheds, the City of Dallas, City of Irving, and North Texas Tollway Authority have a Phase I permit (Table 3). The entire watershed of the impaired AU of Cottonwood Branch (0822A_02) is regulated under MS4 permits, and 84.8 percent of the Grapevine Creek (AU 0822B_01) watershed is within the regulated area of MS4 permits (Figure 4). As noted previously, Outfall 059 in the individual storm water permit for DFW Airport will be treated as part of the MS4 loading for AU 0822B_01 in Grapevine Creek.

Illicit Discharges

Bacteria loads from regulated storm water can enter the streams from permitted outfalls and illicit discharges under both dry and wet weather conditions. The term “illicit discharge” is defined in TPDES General Permit No. TXR040000 for Phase II MS4s as, “Any discharge to a municipal separate storm sewer that is not entirely composed of storm water, except discharges pursuant to this general permit or a separate authorization and discharges resulting from emergency fire fighting activities.” Illicit discharges can be categorized as either direct or indirect contributions. New England Interstate Water Pollution Control Commission (NEIWPCC) provides examples of illicit discharges identified in the *Illicit*

Discharge Detection and Elimination Manual: A Handbook for Municipalities (NEIWPCC, 2003) including:

- **Direct illicit discharges**:
  - sanitary wastewater piping that is directly connected from a home to the storm sewer;
  - materials (e.g., used motor oil) that have been dumped illegally into a storm drain catch basin;
  - a shop floor drain that is connected to the storm sewer; and
  - a cross-connection between the municipal sewer and storm sewer systems.
- **Indirect illicit discharges**:
  - an old and damaged sanitary sewer line that is leaking fluids into a cracked storm sewer line; and
  - a failing septic system that is leaking into a cracked storm sewer line or causing surface discharge into the storm sewer.

Unregulated Sources

Unregulated sources of indicator bacteria are generally nonpoint and can emanate from wildlife, various agricultural activities, agricultural animals, land application fields, urban runoff not covered by a permit, failing onsite sewage facilities (OSSFs), unmanaged feral animals, and domestic pets. Most of these unregulated sources are limited in scale in the TMDL study area because of the highly urban nature of the area.

Wildlife and Unmanaged Animal Contributions

E. coli bacteria are common inhabitants of the intestines of all warm-blooded animals, including wildlife such as mammals, birds, and unmanaged feral animals. In developing bacteria TMDLs, it is important to identify by watershed the potential for bacteria contributions from wildlife, birds, and unmanaged feral animals. Wildlife are naturally attracted to riparian corridors of streams and rivers. With direct access to the stream channel, the direct deposition of wildlife waste can be a concentrated source of bacteria loading to a water body. Fecal bacteria from wildlife are also deposited onto land surfaces, where it may be washed into nearby streams by rainfall runoff. There are currently insufficient data available to estimate populations and spatial distribution of wildlife and avian species in the watershed. Consequently, it is difficult to assess the magnitude of bacteria contributions from wildlife species as a general category. Studies in other watersheds have found avian species to be important contributors to the bacteria load (e.g., Hussong et al., 1979; Hyer and Moyer, 2003). There is also little information available on contributions from feral animals in the watershed.

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can also be sources of fecal bacteria loading. Given the fact that the Cottonwood Branch and Grapevine Creek watersheds are highly urbanized, livestock and other domesticated animals are either not found in the watershed or exist in very small numbers. Therefore, livestock and other domesticated animals are not considered a significant contributor of bacteria loads in the two impaired AUs.

Failing On-site Sewage Facilities

Failing OSSFs are not considered a major source of bacteria loading in the TMDL study area because the entire watersheds of Cottonwood Branch and Grapevine Creek are served by centralized wastewater collection and treatment systems of the Trinity River Authority Central Regional WWTF. Although it is possible that small portions of the areas included in the centralized collection and treatment areas could still be serviced by OSSFs, the likelihood of many OSSFs in these two watersheds is remote. Because of this, further consideration of OSSFs as significant sources of bacteria is unnecessary.

Domestic Pets

Based on the urban nature of this project and the availability of relevant data, dogs and cats are the only pets considered in calculating loads for domestic pets. Fecal matter from dogs and cats is transported to streams by runoff from urban and suburban areas and can be a potential source of bacteria loading. Table 4 summarizes the estimated number of dogs and cats for the AUs of the TMDL area watershed and provides an estimate of the fecal coliform load from domestic dogs and cats.

Table 4. Estimated numbers of pets in the TMDL area watershed and their estimated fecal coliform daily production (x 10^9)

AU	Estimated Number of Households[a]	Number Dogs [b]	Number Cats [b]	Daily Production Dogs [c]	Daily Production Cats [c]
0822A_02	5,602	3,540	3,994	11,683	2,157
0822B_01	11,673	7,377	8,323	24,344	4,494

[a] 2005 NCTCOG population district-based estimate

[b] 2008 AVMA national per-household estimate: 0.632 dogs; 0.713 cats

[c] Schueler (2000) estimated fecal coliform load per animal per day: 3.3 x 109 dogs and 5.4 x 108 cats

The estimated loadings are based on estimated fecal coliform production rates of 5.4×10^8 per day for cats and 3.3×10^9 per day for dogs (Schueler 2000). Pet population estimates were calculated based on American Veterinary Medical Association (AVMA) estimated number of dogs (0.632) and cats (0.713) per household (AVMA, 2009).

The number of households was determined using North Central Texas Council of Governments (NCTCOG) 2005 household numbers by population districts (NCTCOG, 2009a&b) with the estimate based on the percentage of each district located inside each AU and an assumed even spatial distribution of households within each district. The actual contribution and significance of fecal coliform loads from pets reaching the impaired reaches of Cottonwood Branch and Grapevine Creek is unknown.

Linkage Analysis

Establishing the relationship between instream water quality and the source of loadings is an important component in developing a TMDL. It allows for the evaluation of management options that will achieve the desired endpoint. The relationship may be established through a variety of techniques.

Generally, if high bacteria concentrations are measured in a water body at low to median flow in the absence of runoff events, the main contributing sources are likely to be point sources or direct deposition. During ambient flows, these constant inputs to the system will increase pollutant concentrations depending on the magnitude and concentration of the sources. As flows increase in magnitude, the impact of point sources is typically diluted, and is therefore a smaller part of the overall concentrations.

Bacteria contributions from regulated and unregulated storm water sources are greatest during runoff events. Rainfall runoff, depending upon the severity of the storm, has the capacity to carry bacteria from the land surface into the receiving stream. Generally, this loading follows a pattern of low concentration in the water body just before the rain event, followed by a rapid increase in bacteria concentrations in the water body as the first flush of storm runoff enters the receiving stream. Over time, the concentrations diminish because the sources of bacteria are attenuated as runoff washes them from the land surface and the volume of runoff decreases following the rain event.

Load and Flow Duration Curve Analyses

Load duration curve (LDC) analyses were used to examine the relationship between instream water quality, the broad sources of bacteria loads (i.e., regulated point source and regulated/unregulated storm water), and are the basis of the TMDL allocations. The strength of this TMDL is the use of the LDC method to determine the TMDL allocations.

LDCs are a simple statistical method that provides a basic description of the water quality problem. This tool is easily developed and explained to stakeholders, and uses available water quality and flow data. The LDC method does not require any assumptions regarding loading rates, stream hydrology, land use conditions, and other conditions in the watershed. The U.S. EPA supports the use of this approach to characterize pollutant sources. The TCEQ and the Texas State Soil and Water Conservation Board, identified this method as a tool for TMDL development. In addition, many other states are using this method to develop TMDLs.

The weaknesses of this method include the limited information it provides regarding the magnitude or specific origin of the various sources. Only limited information was gathered regarding point and nonpoint sources in the watershed. The general difficulty in analyzing and characterizing *E. coli* in the environment is also a weakness of this method.

The LDC method provides a tool for estimation of existing and allowable loads by utilizing the cumulative frequency distribution of streamflow and measured pollutant concentration data (Cleland, 2003). In addition to estimating stream loads, this method allows for the determination of the hydrologic conditions under which impairments are typically occurring, can give indications of the broad origins of the bacteria (i.e., point source and storm water), and provides a means to allocate allowable loadings.

Data requirements for the LDC are minimal, consisting of continuous daily streamflow records and historical bacteria data. While the number of observations required to develop a flow duration curve is not rigorously specified, the curves are usually based on more than five years of observations, and encompasses inter-annual and seasonal variation. Ideally, the drought of record and flood of record are included in the observations. Daily average stream flows over a period of 15 years (08 August 1993 – 07 August 2008) were used for this project.

It was necessary to estimate flows within the TMDL area since there is a lack of long-term flow data at several needed locations. Daily average flows from the past 48 years were obtained from U.S. Geological Survey (USGS) gage 08057200 on White Rock Creek. This creek is located in north Dallas, roughly 14 miles to the east of the TMDL study area, and was chosen based on proximity and the similarity of land use to that of Cottonwood Branch and Grapevine Creek. Flows were estimated within AUs 0822A_02 and 0822B_01 based on application of drainage area ratios. For purposes of the pollutant load computations, the hydrologic records were adjusted to reflect future capacity estimates that account for the probability that additional flows from WWTF discharges may occur due to of future population increases.

Flow duration curves (FDCs) and LDCs for AU 0822A_02 were developed for the two TCEQ monitoring stations in the study area (17165 and 17166). FDCs and LDCs for AU 0822B_01 were developed for the three TCEQ monitoring stations in the study area (17531, 17939, and 20311). The daily flow data in units of cubic meters per second (cms) were used to first develop a FDC for each station.

The FDC was generated by (1) ranking the daily flow data from highest to lowest, (2) calculating the percent of days each flow was exceeded (rank ÷ quantity of the number of data points + 1), and (3) plotting each flow value (y-axis) against its exceedance value (x-axis). Exceedance values along the x-axis represent the percent of days that flow was at or above the associated flow value on the y-axis. Exceedance values near 100% occur during low flow or drought conditions while values approaching 0% occur during periods of high flow or flood conditions.

Bacteria LDCs were then developed based on the current numeric water quality criterion (126 MPN/100 mL) and the data from the streamflow duration curves. LDCs were developed by multiplying each streamflow value along the flow duration curves by the *E. coli* criterion (126 MPN/100 mL) and by the conversion factor to convert to loading in colonies per day. This effectively displays the LDC as the TMDL curve of maximum allowable loading:

TMDL (MPN/day) = criterion * flow (cms) * conversion factor

Where:

Criterion = 126 MPN/100 mL (*E. coli*)

Conversion factor (to MPN/day) = 864,000,000 100 mL/m^3 * seconds/day

The resulting curve plots each bacteria load value (y-axis) against its exceedance value (x-axis). Exceedance values along the x-axis represent the percent of days that the bacteria load was at or above the allowable load on the y-axis.

Historical bacteria data were then superimposed on the allowable bacteria LDC. Historical *E. coli* data from November 2001 – August 2008 were obtained from two sources: (1) routine data collected under the TCEQ Surface Water Quality Monitoring Program and the Texas Clean Rivers Program and obtained from the TCEQ SWQMIS database, and (2) various additional data collected by the TMDL contractor, the Texas Institute of Applied Environmental Research (TIAER). Each historical *E. coli* measurement was associated with the streamflow on the day of measurement and converted to a bacteria load.

The associated streamflow for each bacteria loading was compared to the FDC data to determine its value for "percent days flow exceeded," which becomes the "percent of days load exceeded" value for purposes of plotting the *E. coli* loading. Each load was then plotted

on the load duration curve at its percent exceedance. This process was repeated for each *E. coli* measurement at each station. Points above a curve represent exceedances of the bacteria criterion and its associated allowable loadings.

The flow exceedance frequency can be subdivided into hydrologic condition classes to facilitate the diagnostic and analytical uses of FDCs and LDCs. The hydrologic classification scheme utilized for the Cottonwood Branch and Grapevine Creek TMDLs is as follows: high flows (0 – 10%), mid-range flows (10 – 50%), and low flows (50 – 100%). These three flow regimes were based on hydrology (slope of the FDCs). Additional information explaining the LDC method may be found in Cleland (2003) and NDEP (2003).

Load Duration Curve Results

FDCs and LDCs were developed for the two TCEQ monitoring stations within AU 0822A_02 and the three TCEQ monitoring stations within AU 0822B_01. LDCs and FDCs were developed for all stations for which adequate historical *E. coli* data existed in order to present a complete representation of conditions in each impaired AU. However, only the median loading of the high flow regime (5% exceedance) for the most downstream site within each impaired AU was used for the Cottonwood Branch and Grapevine Creek TMDL calculations. The most downstream station within AU 0822A_02 was station 17166, and the most downstream station within AU 0822B_01 was station 20311. The median loading of the high flow regime (or the 5% exceedance point) is used for the TMDL calculations, because it represents a reasonable yet high value for the allowable pollutant load allocation.

At the TCEQ, monitoring station locations (Figure 1), load relationships and possible sources were defined through LDCs created with historical *E. coli* data and the associated daily average flow for the flow duration curves. Load duration curves developed for stations within impaired AU 0822A_02 of Cottonwood Branch (Figures 5 and 6) indicate *E. coli* loadings often exceeded allowable loadings under all flow conditions, including those not influenced by rainfall runoff. Similar patterns were also found at stations on Grapevine Creek, for which exceedances were often reported under all flow conditions, and during both dry- and wet-weather conditions (Figures 7 – 9).

Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. *E. coli* data were examined and no statistically significant seasonal variation was found in Cottonwood Branch and Grapevine Creek (Millican and Hauck, 2010). E. coli data are thus not considered in the TMDL calculations.

Margin of Safety

The margin of safety (MOS) is used to account for uncertainty in the analysis used to develop the TMDL and thus provide a higher level of assurance that the goal of the TMDL will be met. According to EPA guidance (EPA, 1991), the MOS can be incorporated into the TMDL using two methods:

- Implicitly incorporating the MOS using conservative model assumptions to develop allocations; or
- Explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

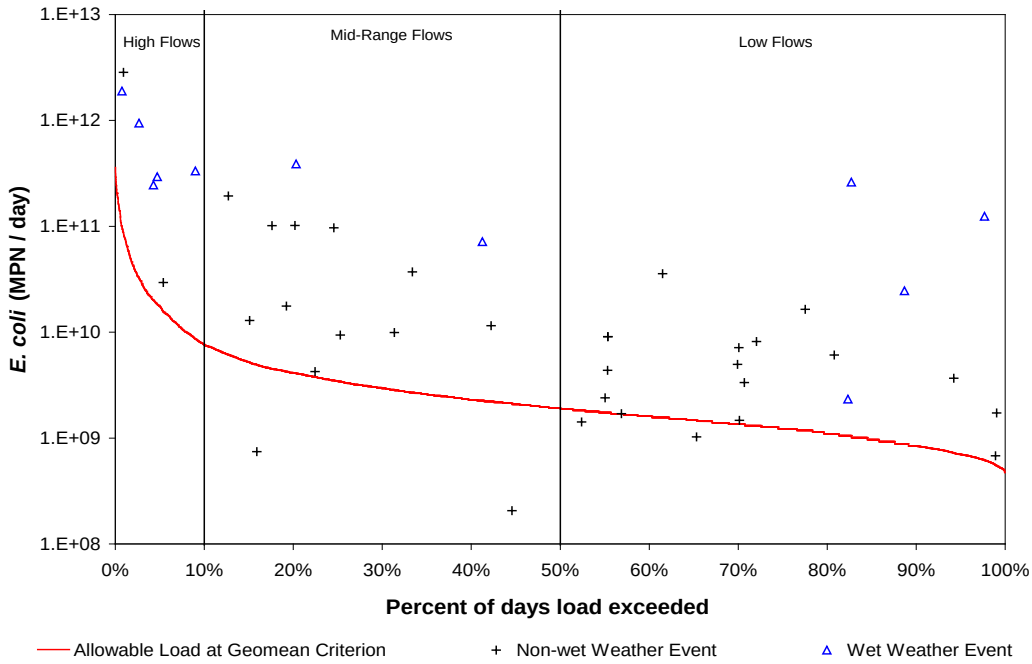

Figure 5. Load duration curve for station 17165 (AU 0822A_02)

E. coli samples collected within 24 hours of a precipitation event are designated as triangles. Median flows in each range at this station are: High = 5.71 cfs (0.162 cms); Mid-range = 0.962 cfs (0.027 cms); Low= 0.403 cfs (0.011 cms)

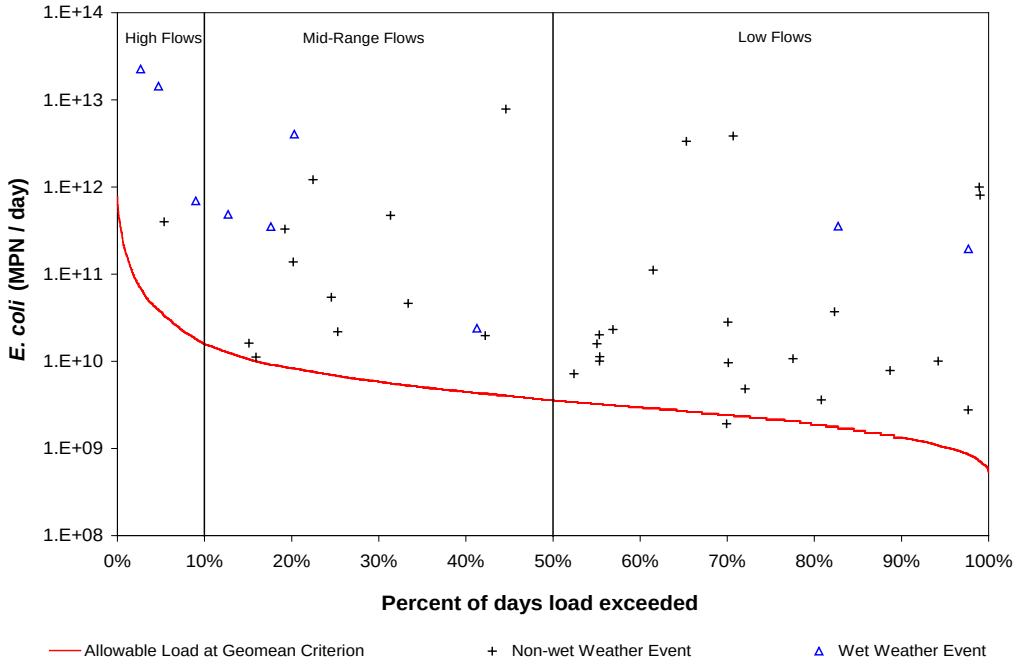

Figure 6. Load duration curve for station 17166 (AU 0822A_02.

E. coli samples collected within 24 hours of a precipitation event are designated as triangles. Median flows in each range at this station are: High = 12.01 cfs (0.340 cms); Mid-range = 1.89 cfs (0.054 cms); Low = 0.703 cfs (0.020 cms).

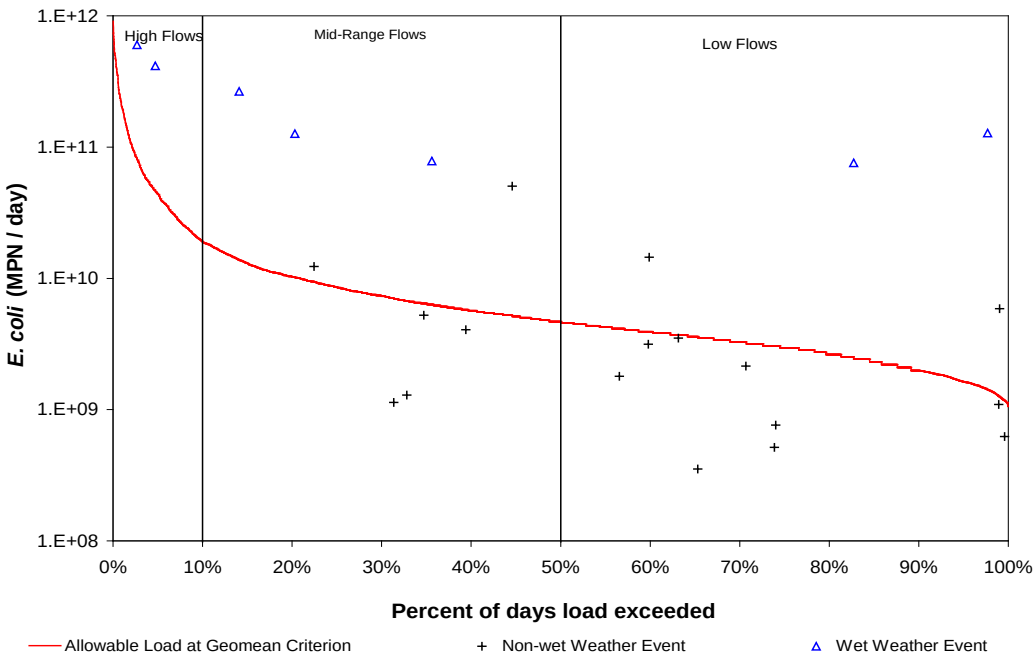

Figure 7. Load duration curve for station 17531 (AU 0822B_01)

E. coli samples collected within 24 hours of a precipitation event are designated as triangles. Median flows in each range at this station are: High = 14.35 cfs (0.406 cms); Mid-range = 2.38 cfs (0.067 cms); Low = 0.970 cfs (0.027 cms).

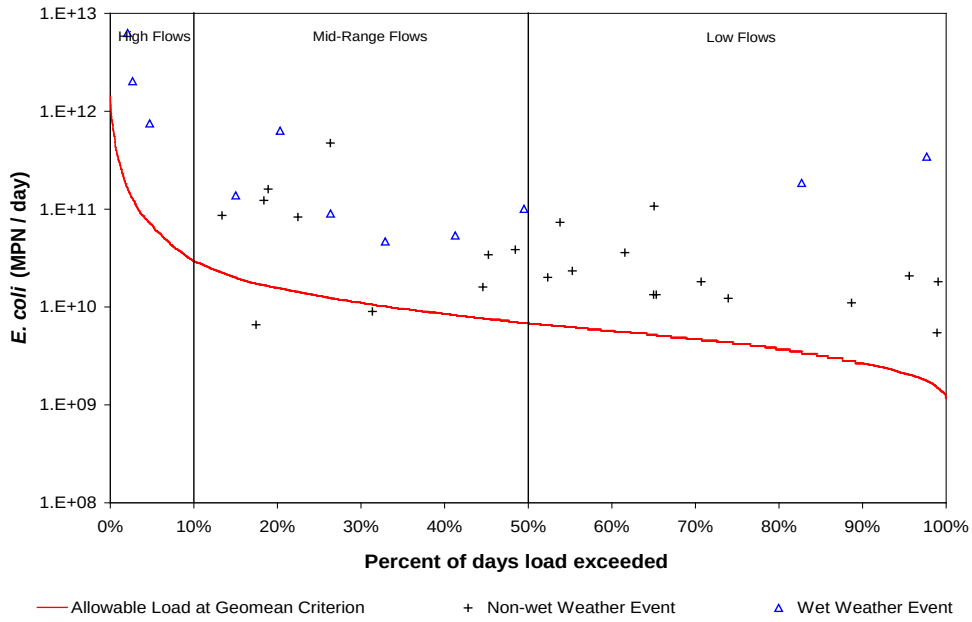

Figure 8. Load duration curve for station 17939 (AU 0822B_01)

E. coli samples collected within 24 hours of a precipitation event are designated as triangles. Median flows in each range at this station are: High = 22.34 cfs (0.632 cms); Mid-range = 3.56 cfs (0.101 cms); Low = 1.35 cfs (0.038 cms).

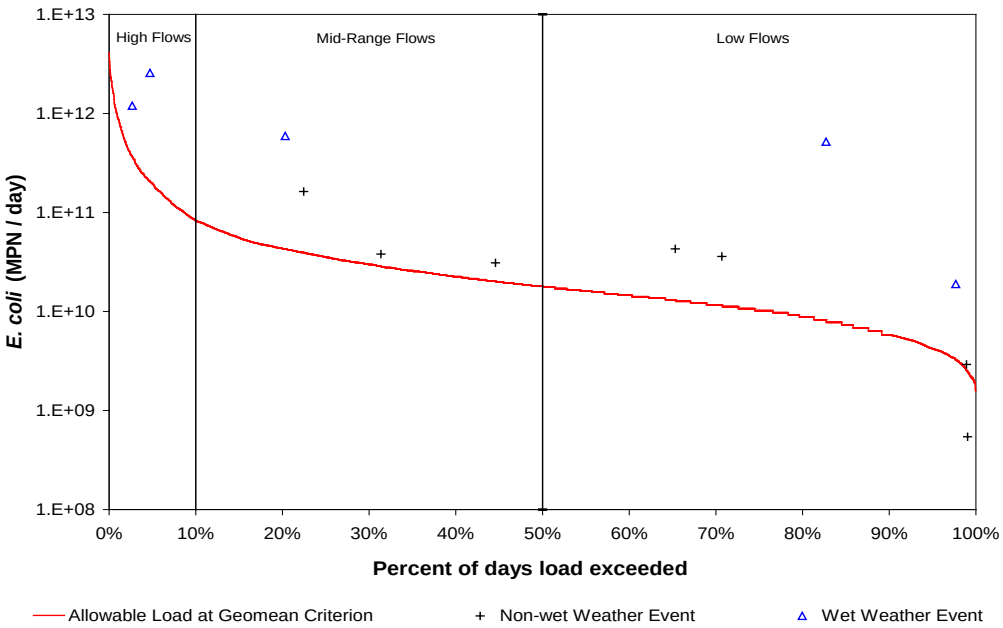

Figure 9. Load duration curve for station 20311 (AU 0822B_01)

E. coli samples collected within 24 hours of a precipitation event are designated as triangles. Median flows in each range at this station are: High = 63.65 cfs (1.802 cms); Mid-range = 9.67 cfs (0.274 cms); Low = 3.32 cfs (0.094 cms).

The MOS is designed to account for any uncertainty that may arise in specifying water quality control strategies for the complex environmental processes that affect water quality. Quantification of this uncertainty, to the extent possible, is the basis for assigning a MOS.

The TMDLs covered by this report incorporate an explicit MOS by setting a target for indicator bacteria loads that is 5 percent lower than the geometric mean criterion. For contact recreation, this equates to a geometric mean target of 120 MPN/100 mL of *E. coli*. The net effect of the TMDL with MOS is that the assimilative capacity or allowable pollutant loading of each water body is slightly reduced.

The explicit MOS is computed as 5 percent of the allowable loading entering each AU. This is expressed in the following equation:

$$MOS = 0.05 * TMDL$$

Where:

TMDL = total maximum allowable load

Pollutant Load Allocation

The TMDL represents the maximum amount of a pollutant that the stream can receive in a single day without exceeding water quality standards. The pollutant load allocations for the selected scenarios were calculated using the following equation:

$$TMDL = \Sigma WLA + \Sigma LA + \Sigma FG + MOS$$

Where:

WLA = wasteload allocation, the amount of pollutant allowed by permitted or regulated dischargers
LA = load allocation, the amount of pollutant allowed by unregulated sources
FG = loadings associated with future growth from potential permitted facilities
MOS = margin of safety load

As stated in 40 CFR, 130.2(1), TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For *E. coli*, TMDLs are expressed as MPN/day, and represent the maximum one-day load the stream can assimilate while still attaining the standards for surface water quality.

Wasteload Allocation

TPDES-permitted wastewater treatment facilities are allocated a daily wasteload (WLA_{WWTF}) calculated as their full permitted discharge flow rate multiplied by one-half of the instream geometric mean criterion. One-half of the water quality criterion (63 MPN/100mL) is used as the WWTF target to provide instream and downstream load capacity. This is expressed in the following equation:

$$WLA_{WWTF} = \text{Criterion}/2 * \text{flow (MGD)} * \text{conversion factor}$$

Where:

Criterion = 126 MPN/100 mL
Flow (MGD) = full permitted flow
Conversion factor = 37,854,000 100 mL / MGD

As previously discussed, there are currently no permitted wastewater treatment facilities within the TMDL study area. DFW Airport is the only facility with an individual permit; however, that permit authorizes the discharge of only storm water during periods of de-icing activity and will be treated as part of the waste load allocation for TPDES-permitted storm water discharges (discussed below). The Airport is also covered under the TPDES Phase II General Permit.

No individual WLA_{WWTF} was calculated for the DFW Airport permit, and the total WLA_{WWTF} is set to zero. In the event that the permitting process for a new WWTF is initiated in either watershed, a future growth component has been included in this TMDL that will allow for the allocation of loads based on an estimate of the future WWTF discharge requirements for both watersheds.

Additional storm water dischargers represent additional flow that is not accounted for in the current allocations. In urbanized areas currently regulated by an MS4 permit, development and/or re-development of land in urbanized areas must implement the control measures/programs outlined in an approved Storm Water Pollution Prevention Plan (SWPPP). Although additional flow may occur from development or re-development, loading of the pollutant of concern should be controlled and/or reduced through the implementation of best management practices (BMPs) as specified in both the NPDES permit and the SWPPP.

An iterative, adaptive management approach will be used to address storm water discharges. This approach encourages the implementation of structural or non-structural controls, implementation of mechanisms to evaluate the performance of the controls, and finally,

allowance to make adjustments (e.g., more stringent controls or specific BMPs) as necessary to protect water quality.

Storm water discharges from MS4, industrial, and construction areas are considered permitted point sources. Therefore, the WLA calculations must also include an allocation for permitted storm water discharges (WLA_{SW}). A simplified approach for estimating the WLA for these areas was used in the development of these TMDLs due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of storm water loading. The percentage of each watershed that is under the jurisdiction of an entity required to comply with MS4 permit regulations (FDA_{SWP}) is used to estimate the amount of the overall runoff load that should be allocated in the WLA_{SW} as the permitted storm water contribution. Thus, WLA_{SW} is the sum of loads from regulated (or permitted) storm water sources and is calculated as follows:

$$\Sigma WLA_{SW} = (TMDL - \Sigma WLA_{WWTF} - \Sigma FG - MOS) * FDA_{SWP}$$

Where:

ΣWLA_{SW} = sum of all permitted storm water loads
TMDL = total maximum allowable load
ΣWLA_{WWTF} = sum of all WWTF loads = 0
ΣFG = sum of future growth loads from potential permitted facilities
MOS = margin of safety load = 0.05 * TMDL
FDA_{SWP} = fractional proportion of drainage area under jurisdiction of storm water permits

The TCEQ intends to implement the individual WLAs through the permitting process as monitoring requirements and/or effluent limitations as required by the amendment of 30 Texas Administrative Code Chapter 319 which became effective November 26, 2009. WWTFs discharging to the TMDL Segment AUs will be assigned an effluent limit based on the TMDL. Monitoring requirements are based on permitted flow rates and are listed in §319.9. The permit requirements will be implemented during the routine permit renewal process. However, there may be a more economical or technically feasible means of achieving the goal of improved water quality and circumstances may warrant changes in individual WLAs after this TMDL is adopted. Therefore, the individual WLAs, as well as the WLAs for storm water, are non-binding until implemented via a separate TPDES permitting action, which may involve preparation of an update to the state's Water Quality Management Plan. Regardless, all permitting actions will demonstrate compliance with the TMDL.

The executive director or commission may establish interim effluent limits and/or monitoring-only requirements at a permit amendment or permit renewal. These interim limits will allow a permittee time to modify effluent quality in order to attain the final effluent limits necessary to meet the TCEQ and EPA approved TMDL allocations. The duration of any interim effluent limits may not be any longer than three years from the date of permit re-issuance. New permits will not contain interim effluent limits because compliance schedules are not allowed for a new permit.

Where a TMDL has been approved, domestic WWTF TPDES permits will require conditions consistent with the requirements and assumptions of the wasteload allocations. For NPDES/ TPDES-regulated municipal, construction storm water discharges, and industrial storm water discharges, water quality-based effluent limits that implement the WLA for storm water may be expressed as BMPs or other similar requirements, rather than as numeric

effluent limits (November 12, 2010, memorandum from EPA relating to establishing WLAs for storm water sources). The EPA memo states that:

> "The CWA provides that storm water permits for MS4 discharges shall contain controls to reduce the discharge of pollutants to the "maximum extent practicable" and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants. CWA section 402(p)(3)(8)(iii). Under this provision, the NPDES permitting authority has the discretion to include requirements for reducing pollutants in storm water discharges as necessary for compliance with water quality standards. Defenders of Wildlife v. Browner, 191 F.3d 1159, 1166 (9th Cir. 1999).
>
> The permitting authority's decision as to how to express the WQBEL(s), either as numeric effluent limitations or BMPs, including BMPs accompanied by numeric benchmarks, should be based on an analysis of the specific facts and circumstances surrounding the permit, and/or the underlying WLA, including the nature of the storm water discharge, available data, modeling results or other relevant information. As discussed in the 2002 memorandum, the permit's administrative record needs to provide an adequate demonstration that, where a BMP-based approach to permit limitations is selected, the BMPs required by the permit will be sufficient to implement applicable WLAs. Improved knowledge of BMP effectiveness gained since 2002 should be reflected in the demonstration and supporting rationale that implementation of the BMPs will attain water quality standards and WLAs."

A November 22, 2002, memorandum from EPA relating to establishing WLAs for storm water sources states that:

> "...the Interim Permitting Approach Policy recognizes the need for an iterative approach to control pollutants in storm water discharges...[s]pecifically, the policy anticipates that a suite of BMPs will be used in the initial rounds of permits and that these BMPs will be tailored in subsequent rounds."

Using this iterative adaptive approach to the maximum extent practicable is appropriate to address the storm water component of this TMDL.

This TMDL is, by definition, the total of the sum of the WLA, the sum of the LA, and the MOS. Changes to individual WLAs may be necessary in the future in order to accommodate changing conditions within the watershed. These changes to individual WLAs do not ordinarily require a revision of the TMDL document; instead, changes will be made through updates to the TCEQ's WQMP. Any future changes to effluent limitations will be addressed through the permitting process and by updating the WQMP.

Load Allocation

The LA is the sum of loads from unregulated sources. Nonpoint sources within the Cottonwood Branch and Grapevine Creek watersheds include unregulated storm water runoff and direct deposition from warm-blooded animals. The LA term is calculated as:

$$LA = TMDL - \Sigma WLA_{WWTF} - \Sigma WLA_{SW} - \Sigma FG - MOS$$

Where:

LA = allowable load from unregulated sources entering the AU
TMDL = total maximum allowable load
ΣWLA_{WWTF} = sum of all WWTF loads = 0
ΣWLA_{SW} = sum of all permitted storm water loads
ΣFG = sum of future growth loads from potential permitted facilities
MOS = margin of safety load = 0.05 * TMDL

The TMDL equation can thus be expanded to show the components of WLA and LA:

$$TMDL = \Sigma WLA_{WWTF} + \Sigma WLA_{SW} + LA + \Sigma FG + MOS$$

In addition, the three-tiered antidegradation policy in the Standards prohibits an increase in loading that would cause or contribute to degradation of an existing use. The antidegradation policy applies to both point and nonpoint source pollutant discharges. In general, antidegradation procedures establish a process for reviewing individual proposed actions to determine if the activity will degrade water quality. The TMDLs in this document will result in protection of existing beneficial uses and conform to Texas's antidegradation policy.

Future Growth

To account for the probability that new flows from WWTF discharges may occur in both AUs, a provision for future growth was included in the TMDL calculations based on the population increase from year 2005 estimates to year 2030 projections and an estimate of the amount of wastewater generated per person per day or gallons per capita per day (gpcd).

Currently, no permitted WWTFs discharge into Segments 0822A and 0822B. Wastewater generated within Cottonwood Branch and Grapevine Creek is transported out of both watersheds to the TRA Central Regional WWTF located on the Lower West Fork Trinity River (Segment 0841).

Since both impaired watersheds lie within the much larger wastewater collection service area for the TRA Central Regional WWTF, it is infeasible to readily determine average wastewater generation per person for each watershed. The approach taken was to determine the year 2005 average daily discharge for the TRA Central Regional WWTF based on its discharge monitoring reports (DMRs) obtained from the EPA permit compliance system website (EPA, 2009) for that year. Next, the service population of the TRA WWTF for the year 2005 was determined using available GIS layers of the WWTF service area and NCTCOG population districts, and NCTCOG population estimates by population district (NCTCOG, 2009a&b). The population within the TRA Central Regional WWTF service area was estimated based on the 2005 NCTCOG population district estimates and the percentage of each district in the service area, further assuming even population distribution within each district. The wastewater flow per capita was then determined by dividing the TRA Central Regional WWTF 2005 annual daily discharge by its service population giving a wastewater flow of 107 gpcd.

Next, the population of the entire watersheds of Cottonwood Branch and Grapevine Creek were estimated using the GIS shape files of each watershed and the NCTCOG population districts and population data for 2005 and 2030. Assuming even distribution in each district, the population of each watershed was then determined based on percentage of each

population district in each watershed, the 2005 and 2030 population estimates for each district, and summing the computed populations by watershed. With this information, the future growth (FG) of each watershed is calculated as follows:

$$FG = criterion/2 * Flow_{2005} * (Pop_{30} - Pop_{05})$$

Where:

Criterion = 126 MPN/100 mL

$Flow_{2005}$ = 107 gallons per capita per day (gpcd) based on the average daily discharge of TRA WWTF from year 2005 DMR data divided by year 2005 TRA WWTF wastewater collection area population estimate

Pop_{30} = estimated watershed population for year 2030

Pop_{05} = estimated watershed population for year 2005

Conversion factor = 10^{-6} MGD/gpcd * 37,854,000 100 mL / MGD = 37.854 100mL/gpcd

Additional storm water dischargers represent additional flow that is not accounted for in the current allocations. Changes in MS4 jurisdiction or additional development associated with population increases in the watershed can be accommodated by shifting allotments between the WLA and the LA. This can be done without the need to reserve future-capacity WLAs for storm water. In non-urbanized areas, growth can be accommodated by shifting loads between the LA and the WLA (for storm water).

TMDL Calculations

The TMDL was calculated based on the median flow in the 0-10 percentile range (high flow regime) from the LDC developed for the most downstream station within each AU, which is station 17166 in AU 0822A_02 and station 20311 in AU 0822B_01 (Figure 1). Each term in the TMDL equation was determined based on the equations provided previously. Table 5 summarizes the calculation of the TMDL for each AU. Table 6 summarizes the computation of future growth for the combined AUs.

The entire drainage area of AU 0822A_02 is located within jurisdictional areas regulated by storm water permits, and 84.8% of the drainage area of AU 0822B_01 is located within the jurisdictional areas regulated by storm water permits (2,605 ha out of 3,073 ha are under storm water permit regulation). Table 7 summarizes the computation of term WLA_{SW}.

Since the entire drainage of AU 0822A_02 is within the jurisdictional areas regulated by storm water permits, the LA associated with this AU is zero. For AU 0822B_01, 468 ha or 15.2% of its drainage area is not regulated by storm water permits, and LA was computed from the value of terms in Table 7 (see Table 8).

Table 9 summarizes the TMDL calculations for AUs 0822A_02 and 0822B_01. The final TMDL allocations needed to comply with the requirements of 40 CFR 130.7 are presented in Table 10. The final TMDL allocations include the future growth component designated as WLA_{WWTF} while allocations to permitted MS4 entities are designated as WLA_{SW}. The allocations are based on the current geometric mean criterion for *E. coli* in freshwater of 126 MPN/100 mL, with the exception of the Future Growth component. The Future Growth component is based on ½ the current geometric mean criterion (63 MPN/100 mL) to account to provide instream and downstream capacity.

In the event that the criteria change due to future revisions in the state's surface water quality standards, Appendix A provides guidance for recalculating the allocations in Table

10. Figures A-1 and A-2 of Appendix A were developed to demonstrate how assimilative capacity, TMDL calculations, and pollutant load allocations change in relation to a number of hypothetical water quality criteria for *E. coli.* The equations provided, along with Figures A-1 and A-2, allow calculation of new TMDLs and pollutant load allocations based on any potential new water quality criterion for *E. coli*.

Table 5. Summary of TMDL calculation for Cottonwood Branch and Grapevine Creek

Segment	Stream Name	Station	Median Value of High Flow Regime	TMDL (Billion MPN/day)
0822A_02	Cottonwood Branch	17166	0.3402 cms (12.01 cfs)	37.04
0822B_01	Grapevine Creek	20311	1.802 cms (63.65 cfs)	196.22

Table 6. Future Growth computations for Cottonwood Branch and Grapevine Creek

Segment	Stream Name	2005 Population	2030 Population	Population Increase 2005 to 2030	Additional Wastewater Production (MGD)	Future Growth (Billion MPN/day) *
0822A	Cottonwood Branch	19,499	20,328	829	0.089	.212
0822B	Grapevine Creek	20,807	22,622	1,815	0.195	.464

* Future growth includes a reduction for MOS of 5%

Table 7. Regulated storm water computation for Cottonwood Branch (AU 0822A_02) and Grapevine Creek (AU 0822B_01)

(All loads expressed as Billion MPN/day)

AU	TMDL	WLA_{WWTF}	Future Growth	MOS	FD_{ASWP}	WLA_{SW}
0822A_02	37.04	0.00	0.21	1.85	1.000	34.97
0822B_01	196.22	0.00	0.46	9.81	0.848	157.60

Table 8. Non-regulated storm water computation for Cottonwood Branch (AU 0822A_02) and Grapevine Creek (AU 0822B_01)

AU	LA (Billion MPN/day)
0822A_02	0
0822B_01	28.34

Table 9. TMDL allocation summary for Cottonwood Branch and Grapevine Creek

(all units in Billion MPN per day)

AU	Stream Name	TMDL[a]	WLA_{WWTF}[b]	WLA_{SW}[c]	LA[d]	MOS[e]	Future Growth[f]
0822A_02	Cottonwood Branch	37.04	0.00	34.97	0	1.85	0.21
0822B_01	Grapevine Creek	196.22	0.00	157.60	28.34	9.81	0.46

[a] TMDL = Median flow (high flow regime) * 126 MPN/100 mL * Conversion Factor; where the Conversion Factor = 8.64E+08 100 mL/m^3 * seconds/day; Median Flow from Table 5

[b] No WWTF discharges into AUs 0822A_02 and 0822B_01

[c] WLA_{SW} = (TMDL - WLA_{WWTF} - FG - MOS) * FDA_{SWP}; (see Table 7 for equation values)

[d] LA = TMDL - WLA_{WWTF} - MOS - WLA_{SW} - FG; because the entire drainage area of 0822A_02 is covered by MS4 permits its LA = 0.000

[e] MOS = 0.05 * TMDL

[f] Future Growth = Criterion /2 (63 MPN/day) *$Flow_{2005}$ * (Pop_{30} – Pop_{05}) * Conversion Factor; where $Flow_{2005}$ = 107 gpcd, Pop_{30} is the estimated population within the watershed for year 2030 and Pop05 is the estimated population within the watershed for year 2005; and Conversion Factor = 37.854 100 ml/gpcd; (see Table 6 for population estimates)

Table 10. Final TMDL allocations for Cottonwood Branch (AU 0822A_02) and Grapevine Creek (AU 0822_01)

(all units in Billion MPN per day)

AU	Stream Name	TMDL	WLA_{WWTF}*	WLA_{SW}	LA	MOS
0822A_02	Grapevine Creek	37.04	0.21	34.97	0	1.85
0822B_01	Cottonwood Branch	196.22	0.46	157.60	28.34	9.81

* WLA_{WWTF} = WLA_{WWTF} + Future Growth

Public Participation

The TCEQ maintains an inclusive public participation process. From the inception of the investigation, the project team sought to ensure that stakeholders were informed and involved. Communication and comments from the stakeholders in the watershed strengthen TMDL projects and their implementation.

TCEQ and TIAER are jointly providing coordination for public participation in this project. A series of public meetings have been conducted over recent years to keep the public aware of the TMDL process and to engage public participation. Public meetings were held at the Valley Ranch Library in Irving on June 10, 2008, September 24, 2009, and April 22, 2010.

The meetings introduced the TMDL process, identified the impaired AUs and reason for the impairment, reviewed historical data, described potential sources of bacteria within the watershed, and presented the TMDL allocations. In addition, the meetings gave TCEQ the opportunity to solicit input from all interested parties within the study area. Information on past and future meetings for the Cottonwood Branch and Grapevine Creek TMDLs can be found on the TCEQ website at: <www.tceq.state.tx.us/implementation/water/tmdl/66_cottongrape_bacteria.html >.

Implementation and Reasonable Assurances

The issuance of permits consistent with TMDLs through TPDES provides reasonable assurance that wasteload allocations in this TMDL report will be achieved. Consistent with federal requirements, each TMDL is a plan element of an update to Texas' WQMP.

The TCEQ's WQMP coordinates and directs the state's efforts to manage water quality and maintain or restore designated uses throughout Texas. The WQMP is continually updated with new, more specifically focused plan elements, as identified in federal regulations 40 CFR. 130.6(c)). Commission adoption of a TMDL is the state's certification of the associated WQMP update.

Based on the TMDL and Implementation Plan (I-Plan), the TCEQ will propose and certify WQMP updates to establish required water-quality-based effluent limitations necessary for specific TPDES wastewater discharge permits.

For MS4 permits, the TCEQ will normally establish BMPs. BMPs are a substitute for effluent limitations, as allowed by federal rules, where numeric effluent limitations are infeasible (see November 22, 2002, memorandum from EPA relating to establishing TMDL WLAs for storm water sources). When such practices are established in an MS4 permit, the TCEQ will not identify specific implementation requirements applicable to a specific TPDES storm water permit through an effluent limitation update. Rather, the TCEQ might revise a storm water permit, require a revised Storm Water Management Program or Pollution Prevention Plan, or implement other specific revisions affecting storm water dischargers in accordance with an adopted I-Plan.

Strategies for achieving pollutant loads in TMDLs from both point and nonpoint sources are reasonably assured by the state's use of an I-Plan. The TCEQ is committed to supporting implementation of all TMDLs adopted by the commission.

I-Plans for Texas TMDLs use an adaptive management approach that allows for refinement or addition of methods to achieve environmental goals. This adaptive approach reasonably assures that the necessary regulatory and voluntary activities to achieve pollutant reductions will be implemented. Periodic, repeated evaluations of the effectiveness of implementation methods ascertain whether progress is occurring, and may show that the original distribution of loading among sources should be modified to increase efficiency. I-Plans will be adapted as necessary to reflect needs identified in evaluations of progress.

Key Elements of an I-Plan

An I-Plan includes a detailed description and schedule of the regulatory and voluntary management measures to implement the WLAs and LAs of particular TMDLs within a reasonable time. I-Plans also identify the organizations responsible for carrying out management measures, and a plan for periodic evaluation of progress. EPA does not approve I-Plans for Texas TMDLs.

Strategies to optimize compliance and oversight are identified in an I-Plan when necessary. Such strategies may include additional monitoring and reporting of effluent discharge quality to evaluate and verify loading trends, adjustment of an inspection frequency or a response protocol to public complaints, and escalation of an enforcement remedy to require corrective action of a regulated entity contributing to an impairment.

The TCEQ works with stakeholders and interested governmental agencies to develop and support I-Plans and track their progress. Work on the I-Plan begins during development of TMDLs, but the plan is not completed until sometime after the EPA approves the TMDLs. The cooperation required to develop an I-Plan for approval by the commission becomes a cornerstone for the shared responsibility necessary for carrying out the plan.

Ultimately, the I-Plan will identify the commitments and requirements to be implemented through specific permit actions and other means. For these reasons, the I-Plan that is adopted may not approximate the predicted loadings identified category-by-category in the TMDL and its underlying assessment. However, with certain exceptions, the I-Plan must nonetheless meet the overall loading goal established by the EPA-approved TMDL.

NCTCOG is working with the TCEQ to lead development of the I-Plan. Through the stakeholder group led by the NCTCOG, the resources and expertise of the local organizations and individuals will be brought together to set priorities, provide flexibility, and consider appropriate social and economic factors.

References

AVMA. 2009. U.S. Pet Ownership-2007. <www.avma.org/reference/marketstats/ownership.asp>. Accessed 28 October 2009.

Cleland, B. 2003. TMDL Development from the "Bottom Up"—Part III: Duration Curves and Wet-Weather Assessments. America's Clean Water Foundation, Washington, DC.

EPA. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. <www.epa.gov/OWOW/tmdl/decisions/>. Accessed 28 October 2009.

EPA. 2002. Memorandum: Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs. November 22, 2002 (Robert H. Wayland, III to Water Division Directors).

EPA. 2006. Memorandum: Clarification Regarding "Phased" Total Maximum Daily Loads. August 2, 2006 (Benita Best-Wong to Water Division Directors).

EPA 2009. (United States Environmental Protection Agency). 2009. <www.epa.gov/enviro/html/pcs/adhoc.html> Accessed December 8, 2009.

Millican, J. and L. Hauck. 2010. Allocation Support Document For Two Total Maximum Daily Loads for Bacteria in Cottonwood Branch and Grapevine Creek. Prepared for: Texas Commission on Environmental Quality, Prepared by: Texas Institute for Applied Environmental Research, Tarleton State University, Stephenville, TX.

Millican, J. and L. Hauck. 2010. Technical Support Document For Bacteria TMDLs Segments 0822A Cottonwood Branch and 0822B Grapevine Creek. Prepared for: Texas Commission on Environmental Quality, Prepared by: Texas Institute for Applied Environmental Research, Tarleton State University, Stephenville, TX.

NDEP (Nevada Division of Environmental Protection). 2003. Load duration curve methodology for assessment and TMDL development. <ndep.nv.gov/bwqp/loadcurv.pdf>. Accessed 08 December 2009.

NCTCOG (North Central Texas Council of Governments) 2009a. North Central Texas Demographic Forecast 2030 <www.nctcog.org/ris/demographics/forecast.asp>. Accessed October 16, 2009

NCTCOG (North Central Texas Council of Governments). 2009b. GIS Data Clearinghouse. <www.dfwmaps.com/clearinghouse/>. Accessed 18 November 2009.

NWS (National Weather Service) 2009. <www.srh.noaa.gov/fwd/?n=dnarrative>. Accessed 29 July 2009.

NEIWPCC (New England Interstate Water Pollution Control Commission). 2003. Illicit Discharge Detection and Elimination Manual. January 2003.

Schueler, T.R. 2000. Microbes and Urban Watersheds: Concentrations, Sources, and Pathways. In The Practice of Watershed Protection, T.R. Schueler and H.K. Holland, eds. Center for Watershed Protection, Ellicott City, MD.

TCEQ 2000. Texas Surface Water Quality Standards, 2000 update, 30 TAC 307. <www.tceq.state.tx.us/permitting/water_quality/wq_assessment/standards/WQ_standards_2000.html>. Accessed 28 October 2009.

TCEQ 2008a. 2008 Guidance for Assessing and Reporting Surface Water Quality in Texas (March 19, 2008). <www.tceq.state.tx.us/compliance/monitoring/water/quality/data/swqmgawg.html#documents>. Accessed 28 October 2009.

TCEQ. 2008b. Texas Water Quality Inventory and 303(d) <www.tceq.state.tx.us/compliance/monitoring/water/quality/data/08twqi/twqi08.html>. Accessed 28 October 2009.

TCEQ. 2010. Draft 2010 Texas 303(d) List (February 5, 2010). <www.tceq.state.tx.us/assets/public/compliance/monops/water/10twqi/2010_303d.pdf> Accessed February 16, 2010.

Appendix A.
Equations for Calculating TMDL Allocations for Changed Contact Recreation Standard

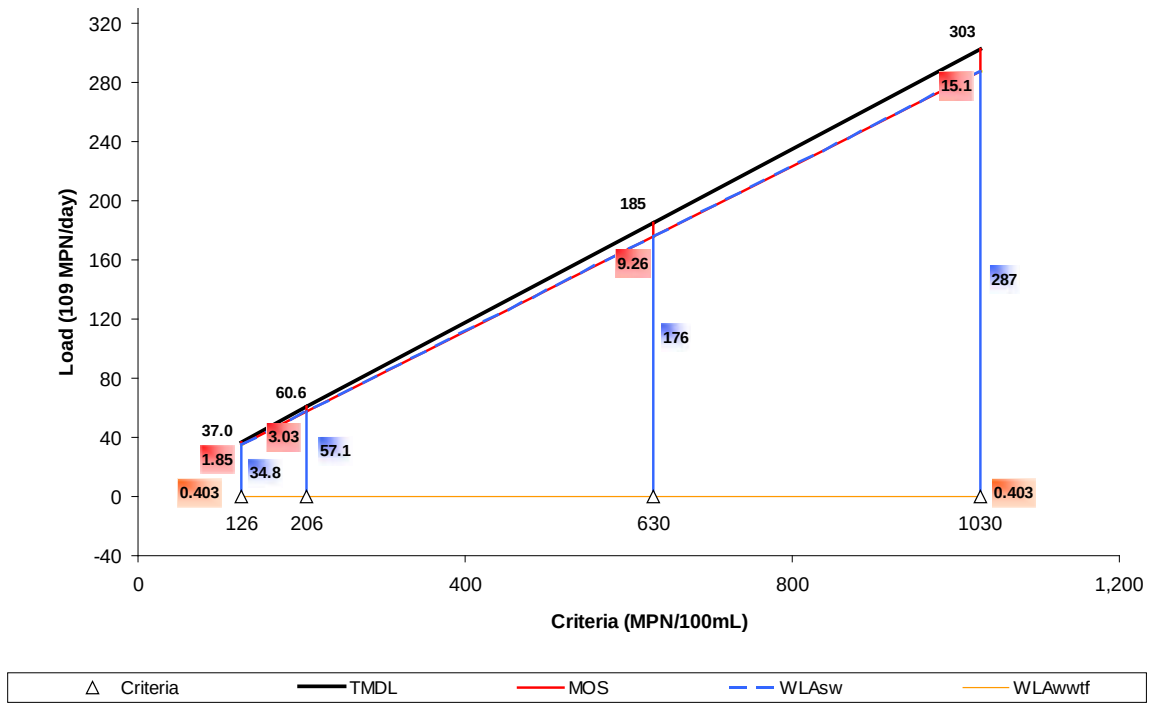

Figure A-1. Allocation Loads for Cottonwood Branch, AU 0822A_02, as a function of water quality criteria

Equations for calculating new TMDL and allocations for AU 0822A_02:

$$TMDL = WLA_{WWTF} + WLA_{SW} + LA + MOS$$

$$TMDL = 0.2939 * Std$$
$$WLA_{WWTF} = \text{Future Growth} * \text{Conversion Factor} * 63 * (1 - 0.05) = 0.2122$$
$$WLA_{SW} = 0.2792 * Std - 0.2122$$
$$LA = 0$$
$$MOS = 0.05 * TMDL$$

Where:

WLA_{SW} = Waste load allocation (permitted storm water)
WLA_{WWTF} = Potential future permitted WWTF discharge load allocation
LA = Load allocation (non-permitted storm water)
Future Growth = Potential future permitted WWTF discharge (MGD)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety

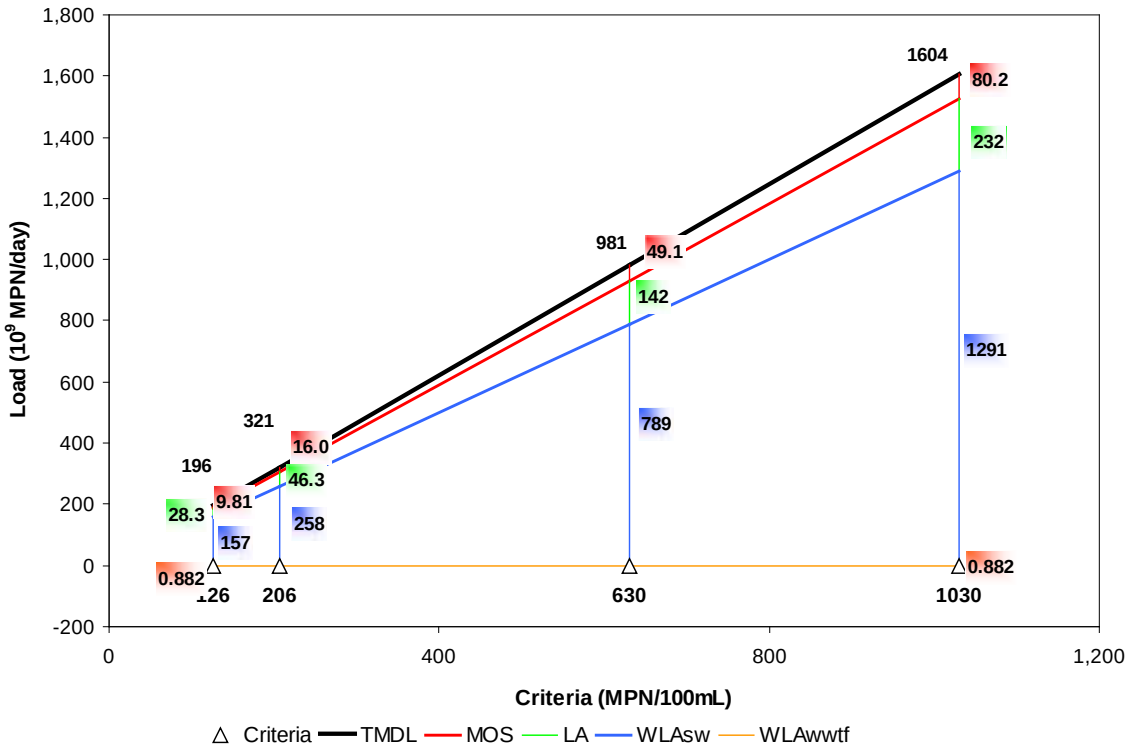

Figure A–2. Allocation Loads for Grapevine Creek, AU 0822B_01, as a function of water quality criteria

Equations for calculating new TMDL and allocations for AU 0822B_01:

$$TMDL = WLA_{WWTF} + WLA_{SW} + LA + MOS$$

$$TMDL = 1.5573 * Std$$
$$WLA_{WWTF} = \text{Future Growth} * \text{Conversion Factor} * 63 = 0.4643$$
$$WLA_{sw} = 1.2540 * Std - 0.3935$$
$$LA = 0.2255 * Std - 0.0708$$
$$MOS = 0.05 * TMDL$$

Where:

WLA_{WWTF} = Potential future permitted WWTF discharge load allocation
WLA_{sw} = Waste load allocation (permitted storm water)
LA = Load allocation (non-permitted storm water)
Future Growth = Potential future permitted WWTF discharge (MGD)
Std = Revised Contact Recreation Standard
MOS = Margin of Safety