Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds: Bacteria in Waters Used for Contact Recreation

- Seven TMDLs Adopted August 24, 2016
  Approved by EPA October 7, 2016
- **One TMDL Added by Addendum October 2018**
  Approved by EPA February 22, 2019 (scroll to view or print this addendum)

Prepared by the:
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Addendum One to Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds

One Total Maximum Daily Load for Indicator Bacteria in Mound Creek

For Segment 1015A

Assessment Unit 1015A_01

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted *Seven Total Maximum Daily Loads for Indicator Bacteria in Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds: Segments 1002, 1003, 1004, and 1004D* (TCEQ, 2016) on August 24, 2016. The total maximum daily loads (TMDLs) were approved by the United States Environmental Protection Agency (USEPA) on October 7, 2016. This document represents an addendum to the original TMDL document.

This addendum includes information specific to one additional assessment unit (AU) of one segment located within the watershed of the approved TMDL project for bacteria in the West Fork San Jacinto River. That TMDL project also included TMDLs for Lake Houston, the East Fork San Jacinto River, and Crystal Creek. Concentrations of indicator bacteria in this additional AU exceed the criteria used to evaluate attainment of the water quality standard for contact recreation. This addendum presents the new information associated with the additional AU. For background or other explanatory information, please refer to the *Technical Support Document for Total Maximum Daily Load for Indicator Bacteria for Mound Creek: Segment 1015A* (Millican, 2018). Refer to the original, approved TMDL document for details related to the overall Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek watershed as well as the methods and assumptions used in developing the original TMDLs.

The addendum watershed and the regulated facilities within it were addressed in the original TMDL or in subsequent updates to the state's Water Quality Management Plan (WQMP). This addendum provides the details related to developing the TMDL allocation for this additional AU, which was not specifically addressed in the original TMDL document.

Problem Definition

The TCEQ first identified the bacteria impairment within the Mound Creek segment included within this addendum in the 2014 edition of the *Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303 (d)* (2014 Integrated Report; TCEQ, 2015). Table 1 provides a summary for the 2014 Integrated Report (the most recent approved version). The impaired AU is Mound Creek (1015A_01), as shown in Figure 1. The Mound Creek segment has two AUs, and the upstream AU (1015A_02) is not impaired. The project watershed is located entirely within Montgomery County (Figure 2). Figure 2 also shows the Mound Creek watershed in relation to the entire watershed of the original TMDLs.

The Texas Surface Water Quality Standards (TSWQS; TCEQ, 2010) provide numeric and narrative criteria to evaluate attainment of designated uses. The basis for the water quality target for the TMDL developed in this report is the numeric criteria for indicator bacteria from the 2010 TSWQS. *Escherichia coli* (*E. coli*) are the preferred indicator bacteria for assessing contact recreation use in freshwater.

Table 1. Synopsis of the 2014 Integrated Report for Mound Creek.

Integrated Report Year	Segment	AU	Parameter	Contact Recreation Use	Year First Impaired	Category
2014	1015A	1015A_01	*E. coli*	Nonsupport	2014	5c

Table 2 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) station on Mound Creek, as reported in the 2014 Integrated Report. The data from the assessment indicate nonsupport of the primary contact recreation use for Mound Creek, because the geometric mean concentration for *E. coli* exceeds the geometric mean criterion of 126 most probable number (MPN)/100 milliliters (mL) of water. Recent environmental monitoring within the Mound Creek watershed has occurred at TCEQ monitoring station 17937 (Figure 3).

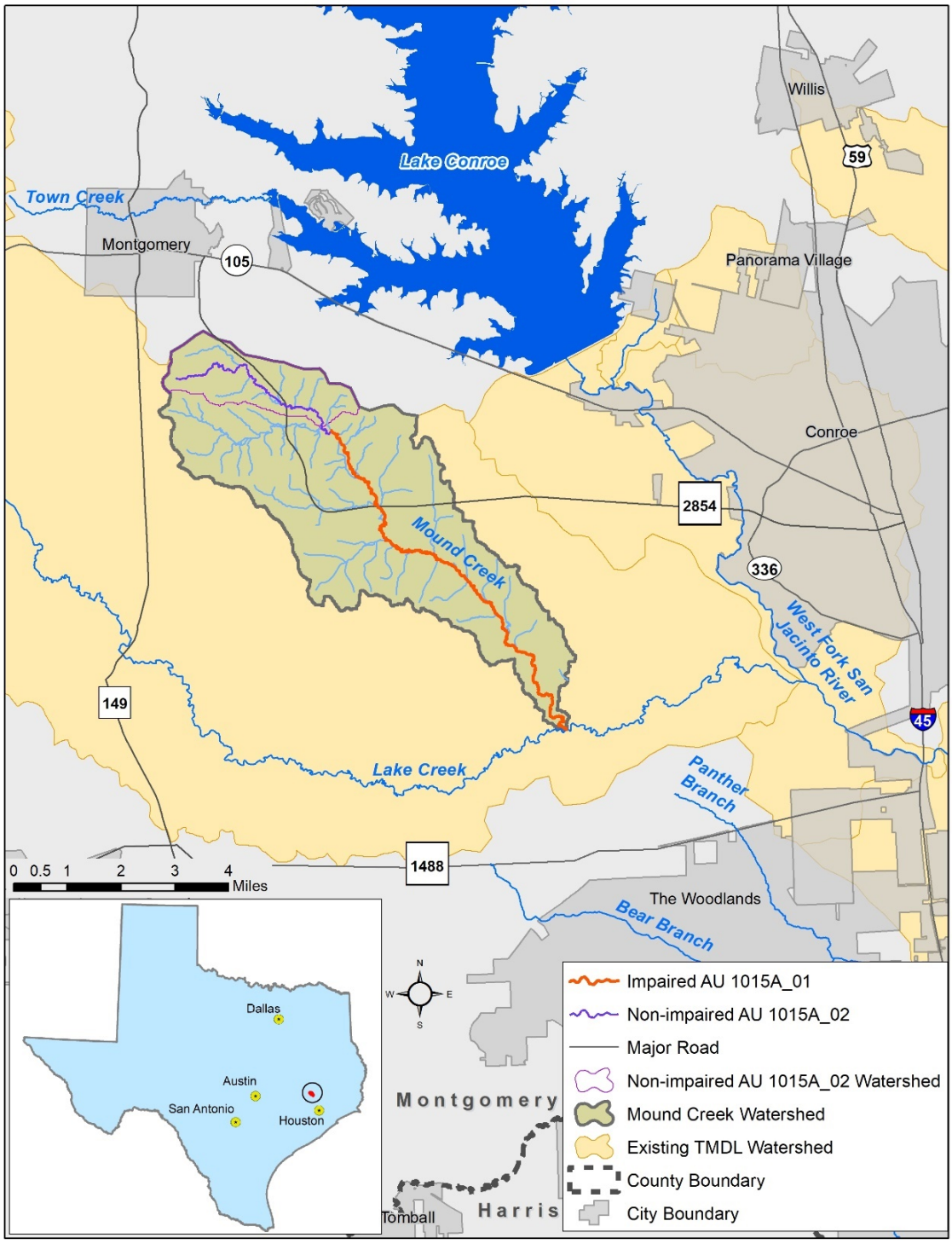

Figure 1. Overview map showing the total contributing drainage area for the Mound Creek watershed and separate drainage areas of its two AUs.

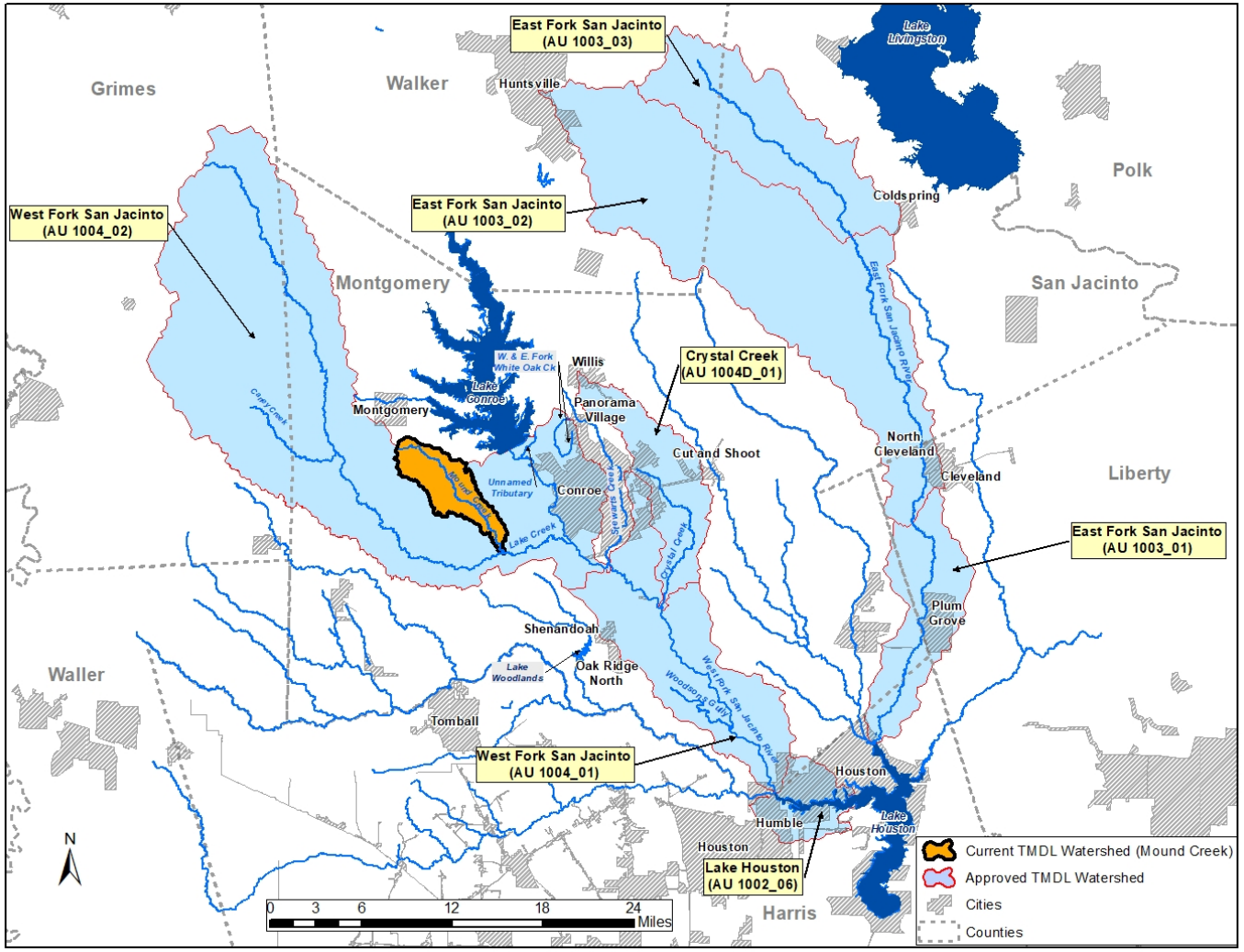

Figure 2. Map showing the seven approved TMDL watersheds and the current Mound Creek watershed considered in this addendum.

Table 2. 2014 Integrated Report summary for the Mound Creek watershed.

(The geometric mean criterion for *E. coli* for primary contact recreation use is 126 MPN/100 mL of water.)

Integrated Report Year	AU	Parameter	Station	Number of Samples	Data Range	*E. coli* Geometric Mean (MPN/100 mL)
2014	1015A_01	*E. coli*	17937	21	2005–2012	386.55

Description of the Study Area

The Mound Creek watershed is located in a predominantly rural area west of the City of Conroe. Mound Creek is a perennial freshwater stream that is a tributary of Lake Creek (Segment 1015), which in turn is a tributary of the West Fork San Jacinto River (Segment 1004). The Mound Creek watershed has a drainage area of 13,422 acres. Segment 1015A is 15.41 miles long and comprises two AUs. AU 1015A_01 has a stream length of 10.77 miles and AU 1015A_02 has a stream length of 4.64 miles.

The 2014 Integrated Report (TCEQ, 2015) provides the following segment and AU description for the water body considered in this document:

- Segment 1015A (Mound Creek) - From the confluence with Lake Creek to a point 0.69 km east of FM 149 near Conroe
    - 1015A_01 – Perennial stream from the confluence with Lake Creek upstream to the confluence with an unnamed tributary approximately 0.75 km downstream of Rabon-Chapel Road

Watershed Climate

The Mound Creek watershed is within the Upper Coast and East Texas climatic divisions. The Gulf of Mexico is the principal source of moisture that drives precipitation in the region. For the period from 1981 through 2010, average annual precipitation in the Mound Creek watershed was 47.8 inches (Prism, 2012).

For the more recent 15-year period from 2002 through 2016, weather data were obtained from the National Climatic Data Center for the Conroe North Houston Regional Airport (NOAA, 2017). Data from this 15-year period indicates that the average high temperatures typically peak in August (89.4 ˚F). During winter, the average low temperature generally occurs in January (36.8 ˚F). The wettest month is October (5.7 inches), while August (2.8 inches) is the driest month, with rainfall occurring throughout the year (Figure 4).

Figure 3. Mound Creek watershed showing TCEQ monitoring station used to assess primary contact recreation.

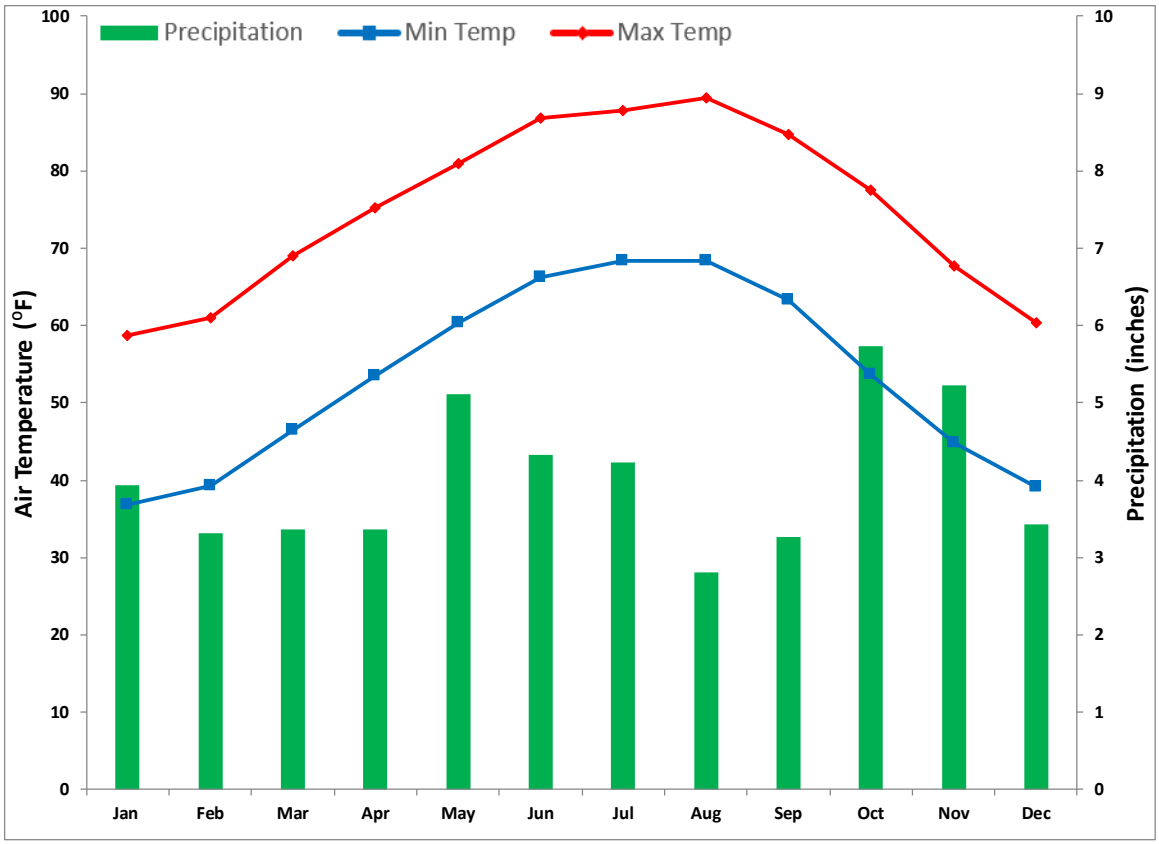

Figure 4. Average minimum and maximum air temperature and total precipitation by month from 2002 through 2016 for Conroe North Houston Regional Airport.

Land Use

The land use/land cover data for the Mound Creek watershed are from the National Oceanic and Atmospheric Association (NOAA) Coastal Change Analysis Program (C-CAP) as obtained from the Houston-Galveston Area Council (H-GAC). The data are for the year 2011 (NOAA, 2011) and are displayed in Figure 5.

A summary of the land use/land cover data for the Mound Creek watershed provided in Table 3 indicates that grassland/scrub/shrub and forest are the dominant land covers, comprising approximately 55 percent of the total land cover.

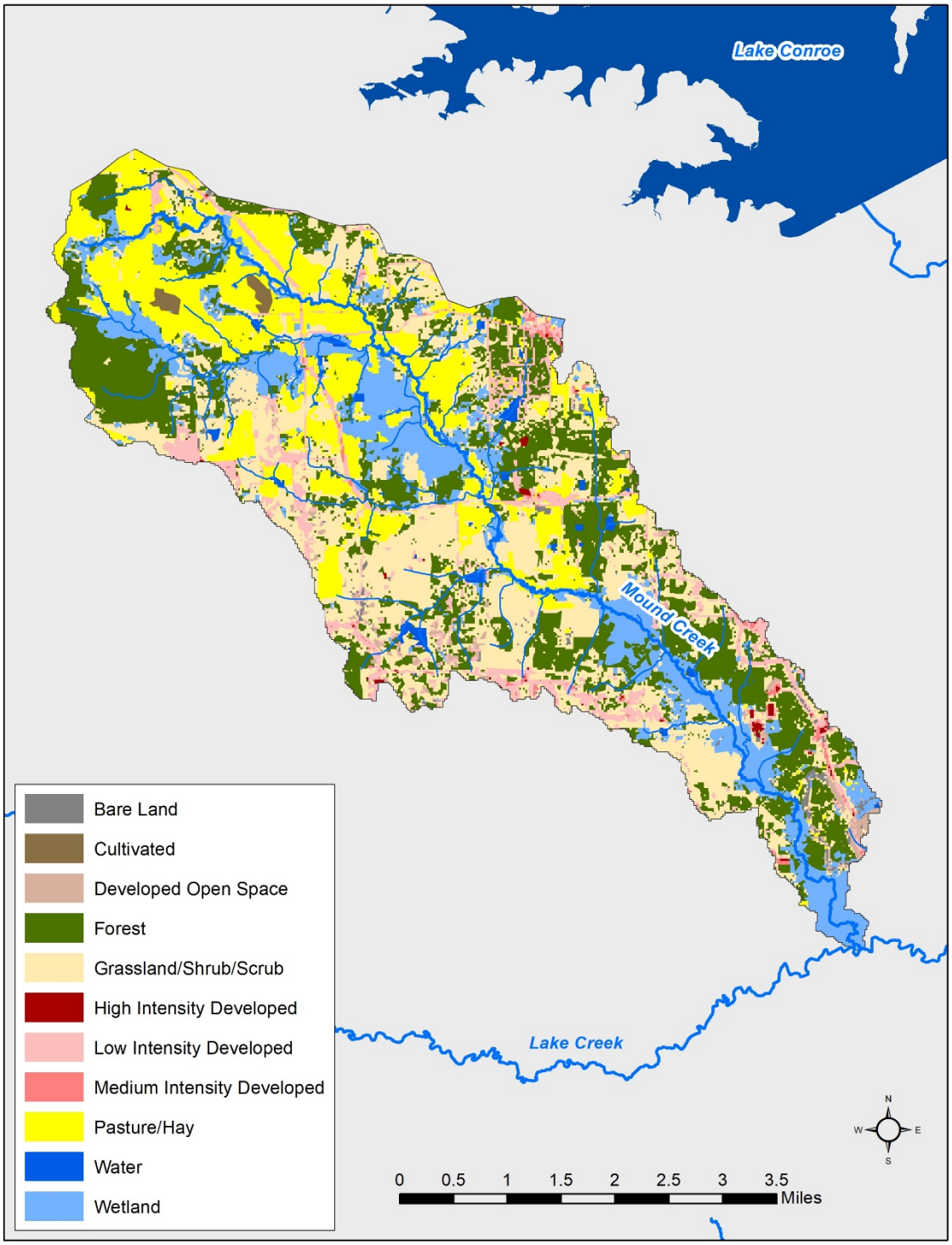

Figure 5. Land use/land cover within the Mound Creek watershed.

Table 3. Land use/land cover within the Mound Creek watershed.

Classification	Area (Acres)	Percent of Total
Grassland/Scrub/Shrub	3,917	29.2%
Forest	3,436	25.6%
Pasture/Hay	2,496	18.6%
Wetland	2,051	15.3%
Low Intensity Developed	957	7.1%
Developed Open Space	150	1.1%
Water and Unconsolidated Shore	137	1.0%
Bare Land	106	0.8%
Medium Intensity Developed	81	0.6%
Cultivated	56	0.4%
High Intensity Developed	35	0.3%
Total	13,422	100%

Watershed Population and Population Projections

As depicted in Figure 2, the Mound Creek watershed is geographically located entirely within Montgomery County, and outside of any municipal boundaries. The area is relatively rural, with a population density of zero to two people per acre through most of the watershed (Figure 6). According to the 2010 Census data (USCB, 2017), the Mound Creek watershed has an estimated population of 3,102 people.

Population projections from 2010 through 2040 were developed by using data from the 2010 U.S. Census and the H-GAC 2040 regional growth forecast (H-GAC, 2017). According to the growth projections, a population increase of 329.6 percent is expected in the Mound Creek watershed by 2040. Table 4 provides a summary of the 2010 population and 2040 population projection.

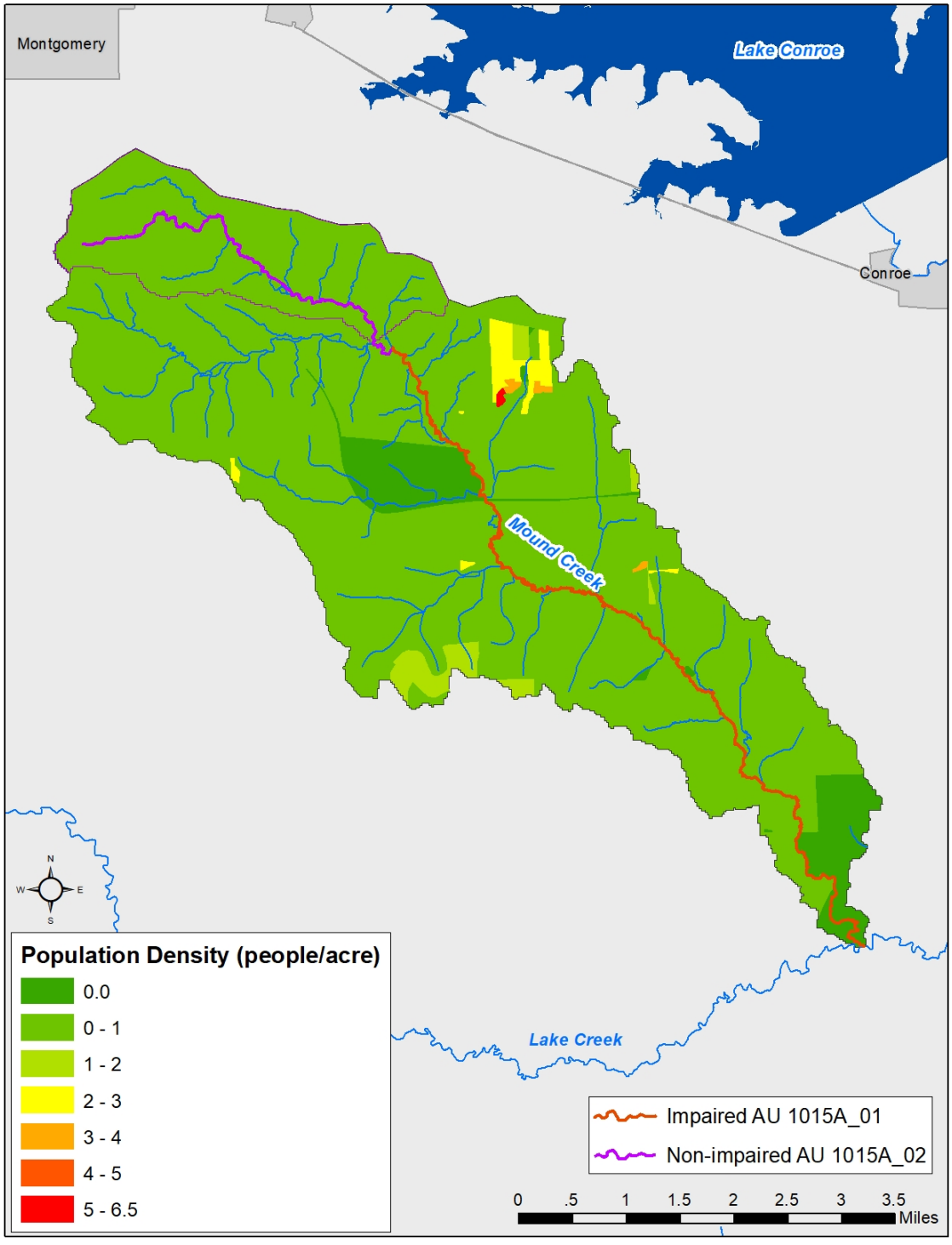

Figure 6. Population density for the Mound Creek watershed based on the 2010 U.S. Census blocks.

Table 4. 2010 population and 2040 population projections for the Mound Creek watershed.

Location	2010 U. S. Census	2040 Population Projection	Projected Population Increase (2010-2040)	Percent Change
Mound Creek Watershed	3,102	13,326	10,224	329.6%

Endpoint Identification

The endpoint for the TMDL is to maintain the concentration of *E. coli* below the geometric mean criterion of 126 MPN/100mL. This endpoint is identical to the geometric mean criterion for primary contact recreation in the 2010 TSWQS (TCEQ, 2010).

Source Analysis

Regulated Sources

Permitted sources are regulated under the Texas Pollutant Discharge Elimination System (TPDES) and the National Pollutant Discharge Elimination System (NPDES) programs.

Domestic and Industrial Wastewater Treatment Facilities

As of February 2018, there were three domestic wastewater treatment facilities (WWTFs) with TPDES/NPDES permits within the Mound Creek watershed and no industrial dischargers (Figure 7 and Table 5). Recent discharge data in million gallons per day (MGD) are presented in Table 5 (USEPA, 2018).

Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) are unauthorized discharges that must be addressed by the responsible party. A summary of SSO incidents that occurred during a two-year period from 2016 through 2017 in Montgomery County was obtained from the TCEQ Central Office in Austin. These SSO data typically contain estimates of the total gallons spilled, responsible entity, and a general location of the spill. The summary data indicated no SSO incidents were reported for any locations within the Mound Creek watershed.

Figure 7. Mound Creek watershed showing WWTFs.

Table 5. Permitted domestic WWTFS in the Mound Creek watershed.

Permittee	Facility	TPDES No.	NPDES No.	Permitted Discharge (MGD)	Recent Discharge: 2014 through 2017 (MGD)
Crane Co.	Crane Co. WWTF	12456-002	TX0138461	0.005	0.00003
MSEC Enterprises Inc.	MSEC WWTF No. 1	14638-001	TX0128121	0.02	0.0025
MSEC Enterprises Inc.	MSEC WWTF No. 2	15341-001	TX0136191	0.130	0.00275[1]

[1] Only the most recent seven months of data (June 2017 through December 2017) were available for this facility since it was just recently permitted to discharge.

TPDES-Regulated Stormwater

TPDES general permits cover stormwater discharges from Phase II Municipal Separate Storm Sewer Systems (MS4s; General Permit number TXR040000), industrial facilities (General Permit number TXR050000; also known as a multi-sector general permits (MSGPs)), concrete production facilities (General Permit number TXG110000), petroleum bulk stations and terminals (General Permit number TXG340000), and construction sites over one acre (General Permit number TXR150000).

Three of these permits (MS4, MSGP, and construction) pertain solely to stormwater discharges. The other two (concrete production facilities and petroleum bulk stations and terminals) also authorize the discharge of process wastewater. A review of active stormwater general permit coverage (TCEQ, 2017) in the Mound Creek watershed as of December 12, 2017, found one active industrial MSGP facility and 13 active construction permits. There are currently no Phase II MS4s, concrete production facilities, or petroleum bulk stations and terminals in the Mound Creek watershed. Table 6 summarizes the area covered by general stormwater permits in the Mound Creek watershed.

Table 6. Stormwater general permit areas (in acres) within the Mound Creek watershed.

AU	MS4 General Permit	Multi-sector General Permit	Construction Activities	Concrete Production Facilities	Petroleum Bulk Stations	Total Area of Permits	Watershed Area	Percent of Watershed Under Stormwater Permits
1015A_01	-	9	98.95	-	-	107.95	13,422	0.80%

Unregulated Sources

Unregulated sources of indicator bacteria are generally nonpoint and can originate from wildlife and feral hogs, various agricultural activities, agricultural animals, land application fields, urban runoff not covered by a permit, failing on-site sewage facilities (OSSFs), and domestic pets.

Wildlife and Unmanaged Animal Contributions

Indicator bacteria inhabit the intestines of all warm-blooded animals, including wildlife such as mammals and birds. In developing bacteria TMDLs, it is important to identify the potential for bacteria contributions from wildlife. Riparian corridors of streams and rivers naturally attract wildlife. With direct access to the stream channel, direct deposition of wildlife waste can be a concentrated source of bacteria loading to a water body. Wildlife also deposit fecal bacteria onto land surfaces, where rainfall runoff may wash bacteria into nearby streams.

Unfortunately, quantitative estimates of wildlife are rare, inexact, and often limited to discrete taxa groups or geographical areas of interest so that even county-wide approximations of wildlife numbers are difficult or impossible to acquire. However, population estimates for feral hogs and deer are readily available for the Mound Creek watershed.

For feral hogs, the Texas A&M Institute of Renewable Natural Resources (IRNR), recently renamed as the Texas A&M Natural Resources Institute, reported a range of feral hog densities within Texas of 1.33 to 2.45 hogs/square mile (IRNR, 2013). The average hog density (1.89 hogs/square mile) was multiplied by the hog habitat area in the Mound Creek watershed (18.7 square miles). Habitat deemed suitable for hogs followed as closely as possible to the land use selections of the IRNR study and include from the NOAA 2011 land use: forest, cultivated crops, wetlands, pasture/hay, and grasslands. Using this methodology, there are an estimated 35 feral hogs in the Mound Creek watershed.

For deer, the Texas Parks and Wildlife Department (TPWD) publishes data showing deer population-density estimates by deer management unit (DMU) across the state (TPWD, 2017). The Mound Creek watershed is located within

DMU 12, for which the deer density in 2016 was estimated to be 32.1 deer/square mile. Applying this value to the area of the entire watershed returns an estimated 674 deer within the Mound Creek watershed.

Domesticated Animals

Livestock are a potential source of bacteria in the project watershed. The number of livestock within the Mound Creek watershed was estimated from county level data obtained from the 2012 Census of Agriculture (USDA NASS, 2014). The county-level data were refined to better reflect actual numbers within the Mound Creek watershed. The refinement was performed by dividing the total area of the Mound Creek watershed by the total area of Montgomery County. This ratio was then applied to the county-level livestock data (Table 7). The livestock numbers in Table 7 are provided to demonstrate that livestock are a potential source of bacteria in the TMDL watersheds. These livestock numbers are not used to develop an allocation of allowable bacteria loading to livestock.

Table 7. Estimated distributed domesticated animal populations within the Mound Creek watershed, based on proportional area.

Cattle and Calves	Hogs and Pigs	Sheep and Lambs	Goats	Horses and Ponies	Mules, Burros, and Donkeys	Poultry	Deer (captive)
382	10	13	54	98	12	140	11

Table 8 summarizes the estimated number of dogs and cats within the Mound Creek watershed. Pet population estimates were calculated as the estimated number of dogs (0.584) and cats (0.638) per household according to data from the American Veterinary Medical Association (AVMA) 2012 U.S Pet Statistics (AVMA, 2015). The actual contribution and significance of indicator bacteria loads from pets reaching the water bodies of the Mound Creek watershed is unknown.

Table 8. Estimated households and pet populations for the Mound Creek watershed.

Estimated Number of Households	Estimated Dog Population	Estimated Cat Population
1,084	633	692

On-site Sewage Facilities

Estimates of the number of OSSFs in the Mound Creek watershed were determined using data supplied by H-GAC for Montgomery County. The H-GAC data indicate that there are 631 OSSFs located within the Mound Creek watershed (Figure 8).

Linkage Analysis

The load duration curve (LDC) method was used to examine the relationship between instream water quality and the source of indicator bacteria loads. Inherent to the use of LDCs as the mechanism of linkage analysis is the assumption of a one-to-one relationship between instream loadings and loadings originating from point sources and the landscape as regulated and non-regulated sources. Further, this one-to-one relationship was also inherently assumed when using LDCs to define the TMDL pollutant load allocation. The LDC method allows for estimation of existing and TMDL 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 stormwater), and provides a means to allocate allowable loadings. The technical support document (Millican, 2018) provides details about the linkage analysis and the LDC method and its application.

Margin of Safety

The margin of safety (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 an MOS. The TMDL covered by this report incorporates an explicit MOS of 5 percent of the total TMDL allocation.

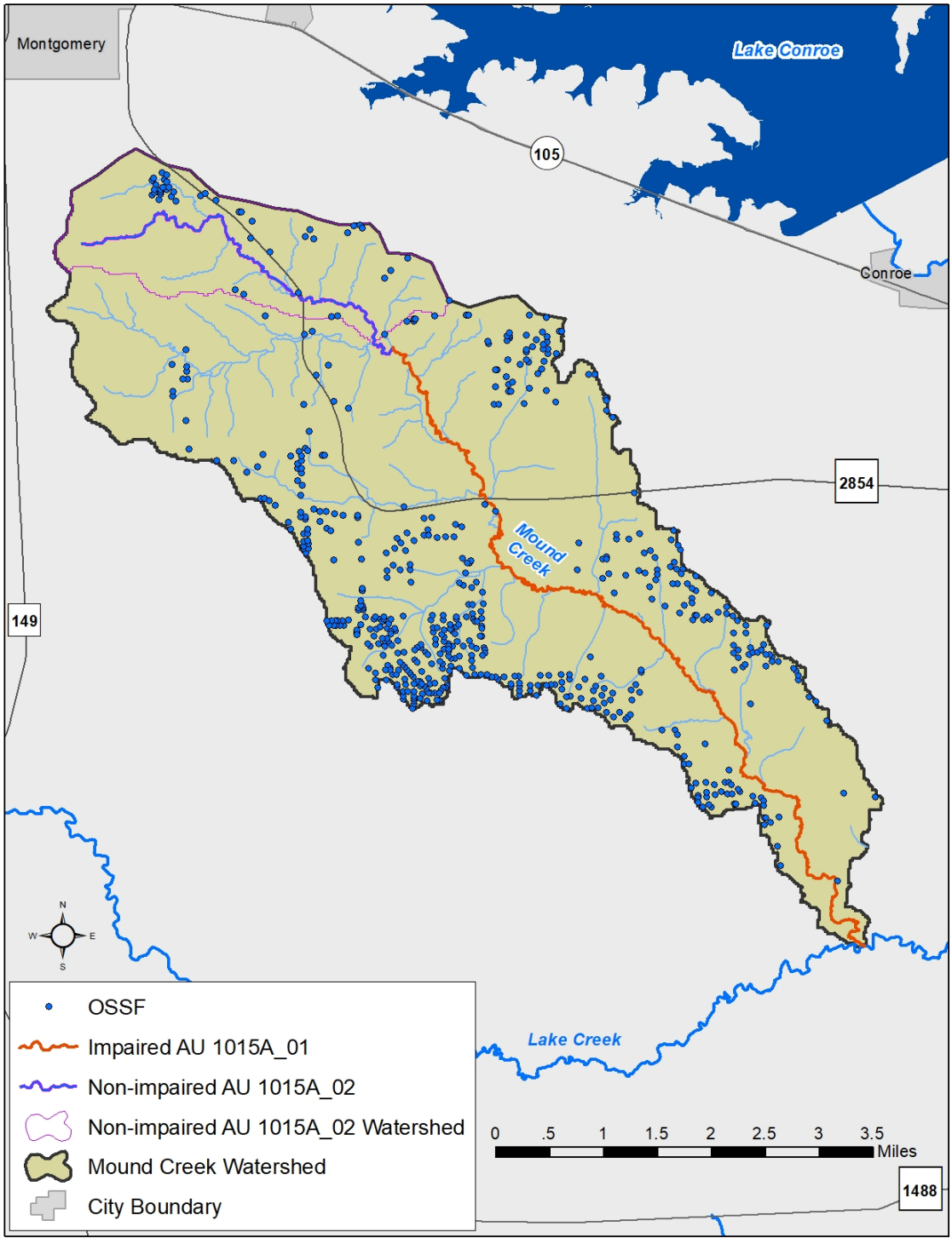

Figure 8. OSSF locations within the Mound Creek watershed.

Pollutant Load Allocation

The TMDL component for the impaired AU covered in this report was derived using the median flow within the Wet Conditions (highest flow) regime (or 15 percent flow) of the LDC developed for the sampling station located within the AU watershed.

Based on the LDC to be used in the pollutant load allocation process with historical *E. coli* data added to the graph (Figure 9), the following broad linkage statements can be made. For the Mound Creek watershed, the historical *E. coli* data indicate that elevated bacteria loadings occur under all three flow regimes. There is some moderation of the elevated loadings under moderate and dry conditions. On Figure 9, the geometric means of the measured data for each flow regime generally support these observations of decreasing concentration with decreasing flow.

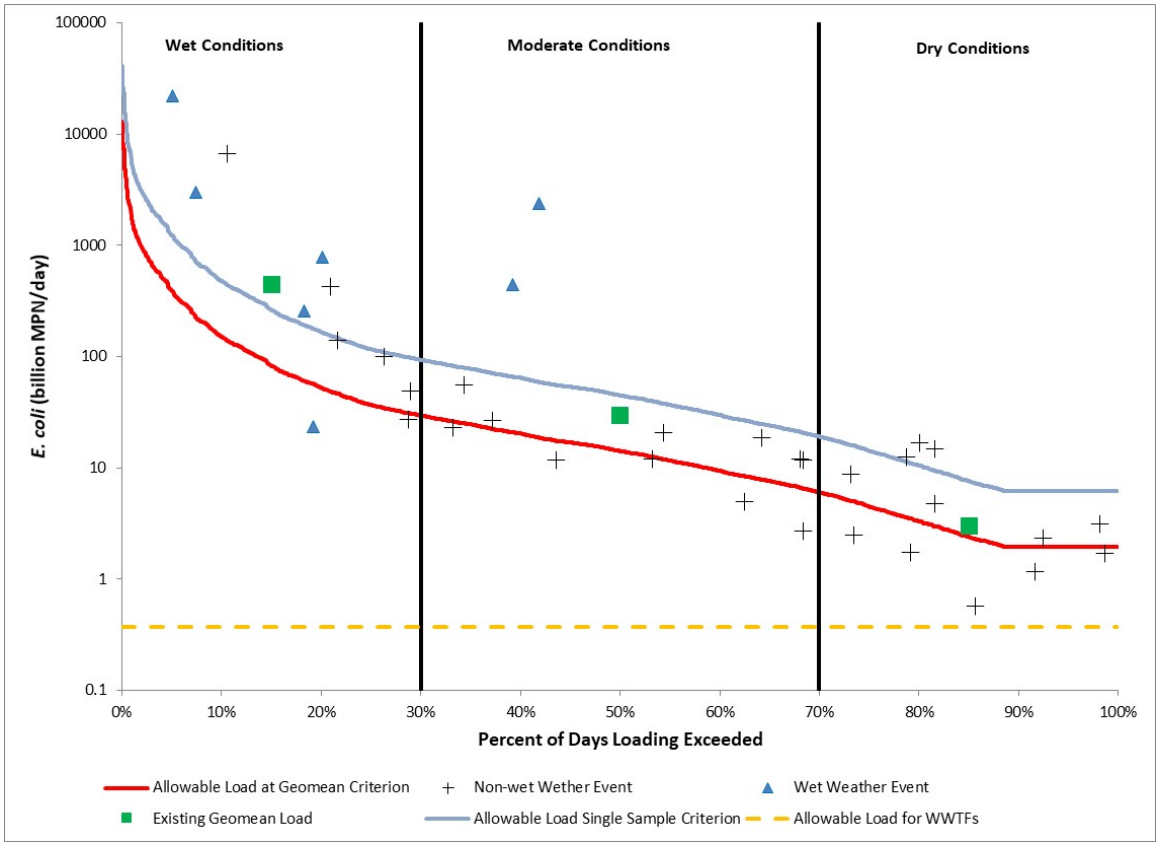

Figure 9. LDC for Mound Creek AU 1015A_01 (Station 17937)

Wasteload Allocation

The wasteload allocation (WLA) is the sum of loads from regulated sources, which are WWTFs and regulated stormwater.

Wastewater Treatment Facilities

TPDES-permitted WWTFs are allocated a daily wasteload (WLA_{WWTF}) calculated as their full permitted discharge flow rate multiplied by one-half the instream geometric mean criterion. One-half of the water quality criterion (63 MPN/100mL *E. coli*) is used as the WWTF target to provide instream and downstream load capacity. Table 9 presents the WLA for each WWTF in the Mound Creek watershed and the resulting total allocation for AU 1015A_01.

Table 9. Wasteload allocations for TPDES-permitted facilities in the Mound Creek watershed.

TPDES Permit No.	NPDES Permit No.	Facility	Full Permitted Flow (MGD)	*E. coli* WLA_{WWTF} (Billion MPN/day)
WQ0012456002	TX0138461	Crane Co. WWTF	0.005	0.012
WQ0014638001	TX0128121	MSEC WWTF	0.02	0.048
WQ0015341001	TX0136191	MSEC WWTF No. 2	0.130	0.310
			Total	0.370

Regulated Stormwater

Stormwater discharges from MS4, industrial, and construction sites are also considered regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater 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 stormwater loading. The percentage of the land area included in the Mound Creek watershed that is under the jurisdiction of stormwater permits is used to estimate the amount of the overall runoff load that should be allocated as the permitted stormwater contribution in the WLA_{SW} component of the TMDL. The percentage of land under the jurisdiction of stormwater permits in the Mound Creek watershed is 0.80 percent.

Load Allocation

The load allocation (LA) component of the TMDL corresponds to runoff from unregulated sources. It is calculated by subtracting the sum of the WLA_{WWTF}, WLA_{SW}, MOS, and future growth (FG) allocations from the total TMDL allocation.

Future Growth

The FG component of the TMDL equation addresses the requirement of TMDLs to account for future loadings that might occur as a result of population growth, changes in community infrastructure, and development. The assimilative capacity of streams increases as the amount of flow increases. Increases in flow

allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard.

The future growth component of impaired AU 1015A_01 was based on population projections and current permitted wastewater dischargers for the entire Mound Creek watershed. Recent population and projected population growth between 2010 and 2040 for the Mound Creek watershed are provided in Table 4. The projected population percentage increase within the watershed was multiplied by the corresponding WLA_{WWTF} to calculate future WLA_{WWTF}. The permitted flows were increased by the expected population growth between 2010 and 2040 to determine the estimated future flows.

The three-tiered antidegradation policy in the TSWQS 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 TMDL in this document will result in protection of existing designated uses and conform to Texas antidegradation policy.

TMDL Calculations

Table 10 summarizes the TMDL calculation for Mound Creek AU 1015A_01. The TMDL was calculated based on the median flow in the 0-30 percentile range (15 percent exceedance, Wet Conditions flow regime) for flow exceedance from the LDC developed for the monitoring station 17937. Allocations are based on the current geometric mean criterion for *E. coli* of 126 MPN/100 mL for each component of the TMDL (with the exception of the WLA_{WWTF} and FG terms, which used one-half the criterion).

The final TMDL allocations (Table 11) needed to comply with the requirements of 40 Code of Federal Regulations (CFR) Section 103.7 include the FG component within the WLA_{WWTF}.

In the event that the criterion changes due to a change in the designated recreational use, Appendix A provides guidance for recalculating the allocations in Table 11.

Table 10. TMDL allocation summary for Mound Creek AU 1015A_01.

All loads expressed as billion MPN/day *E. coli*

AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	FG	MOS
1015A_01	82.431	0.370	0.614	76.106	1.219	4.122

Table 11. Final TMDL allocations for Mound Creek AU 1015A_01.

All loads expressed as billion MPN/day *E. coli*

AU	TMDL	WLA_{WWTF}[1]	WLA_{SW}	LA	MOS
1015A_01	82.431	1.589	0.614	76.106	4.122

[1] WLA_{WWTF} includes the future potential allocation to WWTFs

Seasonal Variation

Federal regulations in 40 CFR Section 130.7(c)(1) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing *E. coli* concentrations obtained from eleven years (2007 through 2017) of routine monitoring collected in the warmer months (April through September) against those collected during the cooler months (October through March). Differences in *E. coli* concentrations obtained in warmer versus cooler months were then evaluated by performing a t-test on the natural log transformed dataset. This analysis of *E. coli* data indicated that there was no significant difference (α=0.05) in indicator bacteria between cool and warm weather seasons for Mound Creek AU 1015A_01 (α=0.7361).

Public Participation

The TCEQ maintains an inclusive public participation process. From the inception of the TMDL study, the TCEQ 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.

The technical support document for this TMDL addition (Millican, 2018) was posted on the TMDL project page at: <www.tceq.texas.gov/assets/public/waterquality/tmdl/82sanjacinto/82c-moundcreek-tsd-final.pdf> on July 19, 2018. A presentation on this addendum was given at the annual spring meeting of the Bacteria Implementation Group (BIG) in Houston on June 5, 2018. The public will have an opportunity to comment on this addendum during a 30-day WQMP update public comment period (November 9 through December 11, 2018). This is an ongoing process, so notice of the public comment period for this addendum will be sent to the stakeholders and posted on the TCEQ's TMDL Program online news page at <www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html>, and the document will be posted at <www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html>. TCEQ accepted public comments on the original TMDL during the period March 6 through April 4, 2016. Six comments were submitted, and none of them referred directly to the AU in this TMDL addendum.

Implementation and Reasonable Assurance

The segment covered by this addendum is within the existing bacteria TMDL watershed of Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek. That TMDL watershed is within the area covered by the Implementation Plan developed by the BIG for bacteria TMDLs throughout the greater Houston area, approved by the TCEQ on January 30, 2013. It outlines an adaptive management approach in which measures are periodically assessed for efficiency and effectiveness. The iterative process of evaluation and adjustment ensures continuing progress toward achieving water quality goals, and expresses stakeholder commitment to the process. Please refer to the original TMDL document for additional information regarding implementation and reasonable assurance.

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Appendix A

Equations for Calculating TMDL Allocations for Contact Recreation Standard Changes

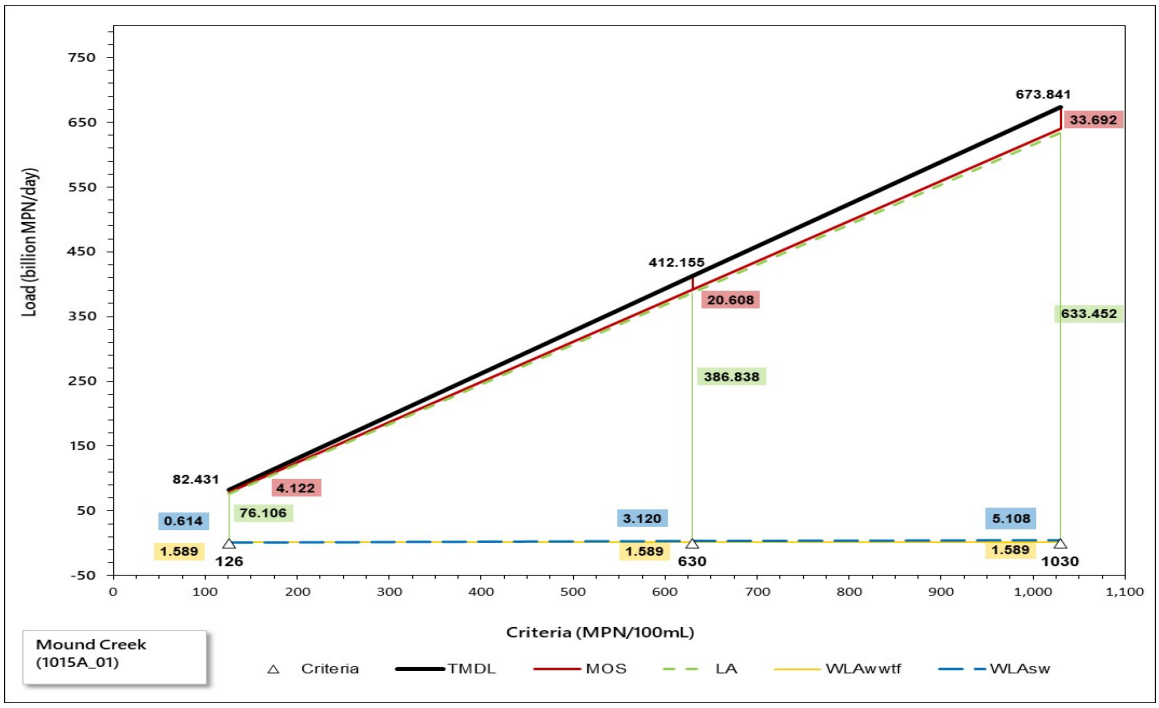

Figure A-1. Allocation loads for *E. coli* for the Mound Creek watershed (1015A_01) as a function of water quality criteria.

Equations for calculating new TMDL and allocations (in billion MPN/day *E. coli*):

TMDL = 0.6542146 * Std
MOS = 0.0327102 * Std + 0.0005377
LA = 0.6165331 * Std - 1.5773868
WLA_{WWTF} = 1.589
WLA_{sw} = 0.0049713 * Std - 0.0122358

Where:

Std = Revised contact recreation standard
MOS = Margin of safety
LA = Total load allocation (unregulated sources)
WLA_{WWTF} = Wasteload allocation (permitted WWTF load + future growth)
WLA_{SW} = Wasteload allocation (permitted stormwater)

Table A-1. TMDL allocations for the Mound Creek watershed for potential changed contact recreation standards.

All loads expressed as billion MPN/day *E. coli*

Std (MPN/100mL)	TMDL	WLA_{WWTF}[1]	WLA_{SW}	LA	MOS
126	82.431	1.589	0.614	76.106	4.122
630	412.155	1.589	3.120	386.838	20.608
1030	673.841	1.589	5.108	633.452	33.692

[1] WLA_{WWTF} includes the future potential allocation to WWTFs.