Guadalupe River Above Canyon Lake Watershed: A Community Project to Protect Recreational Uses

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One TMDL for Bacteria in the Guadalupe River Above Canyon Lake[1]

Adopted July 25, 2007.

Approved by EPA September 25, 2007.

Two TMDLs for Indicator Bacteria in Quinlan Creek and Town Creek Added By Addendum I, January 2018[2]

Via the January 2018 Update to the Texas Water Quality Management Plan.

Approved by EPA May 8, 2018.

One TMDL for Indicator Bacteria in Camp Meeting Creek Added by this Addendum II, April 2022

Via the April 2022 Update to the Texas Water Quality Management Plan (SFR-121/2022-03).

Approved by EPA August 11, 2022 (scroll to view or print this addendum).

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[1] https://www.tceq.texas.gov/downloads/water-quality/tmdl/guadalupe-river-recreational-65/65-guadalupe-tmdl-adopted.pdf
[2] https://www.tceq.texas.gov/downloads/water-quality/tmdl/guadalupe-river-recreational-65/65-guadalupe-addendum-one-jan-2018.pdf

Appendix VI. Addendum Two to One TMDL for Bacteria in the Guadalupe River Above Canyon Lake

Adding one Total Maximum Daily Load (TMDL) for AU 1806A_01

One TMDL for Indicator Bacteria in Camp Meeting Creek

Introduction

Texas Commission on Environmental Quality (TCEQ) adopted *One TMDL for Bacteria in the Guadalupe River Above Canyon Lake* (TCEQ, 2007) on July 25, 2007. The United States Environmental Protection Agency (EPA) approved the TMDL on September 25, 2007. This document is the second addendum to the original TMDL report.

This second addendum includes information specific to one additional assessment unit (AU) for Camp Meeting Creek (AU 1806A_01; also referred to in this addendum as the TMDL watershed). This AU is located within the watershed of the approved original TMDL for a portion of the Guadalupe River Above Canyon Lake. The concentration of indicator bacteria in this additional AU exceeds the criterion used to evaluate support of the primary contact recreation 1 use.

This addendum details the development of the added TMDL allocation for this additional AU, which was not specifically addressed in the original TMDL report. For background or other explanatory information, please refer to the *Technical Support Document for One Total Maximum Daily Load for Indicator Bacteria in Camp Meeting Creek*[3] (Brady et al., 2021). Refer to the original, approved TMDL document for details about the overall project watershed as well as methods and assumptions used in developing the original TMDL.

Problem Definition

TCEQ first identified the bacteria impairment for Camp Meeting Creek AU 1806A_01 in the *2018 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Texas Integrated Report; TCEQ, 2019), and then in the

[3] https://www.tceq.texas.gov/downloads/water-quality/tmdl/guadalupe-river-recreational-65/65-as225-camp-mtg-creek-tsd-addendum-2.pdf

subsequent 2020 Texas 303(d) List, the latest EPA-approved edition (TCEQ, 2020a). Camp Meeting Creek (1806A) includes three AUs; the impaired AU 1806A_01 is addressed in this addendum, while AUs 1806A_02 and 1806A_03 are located upstream of the impaired AU, and are included within the TMDL watershed. The TMDL watershed is located entirely within Kerr County. Figure VI-1 shows the watershed added in this addendum in relation to the entire watershed of the original TMDL, and also includes the area covered by the first addendum.

The Texas Surface Water Quality Standards (TCEQ, 2018) identify uses for surface waters and numeric and narrative criteria to evaluate attainment of those uses. The basis for the water quality target for the TMDL developed in this addendum is the numeric criterion for indicator bacteria from the 2018 Texas Surface Water Quality Standards. *Escherichia coli* (*E. coli*) is the indicator bacteria for assessing primary contact recreation 1 use in freshwater.

Table VI-1 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) station on AU 1806A_01, as reported in the 2020 Texas Integrated Report (TCEQ, 2020a). The data from the assessment indicate nonsupport of the primary contact recreation 1 use for the AU, because the geometric mean concentration for *E. coli* exceeds the freshwater geometric mean criterion of 126 colony forming units per 100 milliliters (cfu/100 mL) of water. Figure VI-2 shows the location of the TCEQ SWQM station that was used in evaluating water quality in the 2020 Texas Integrated Report for the AU added by this addendum.

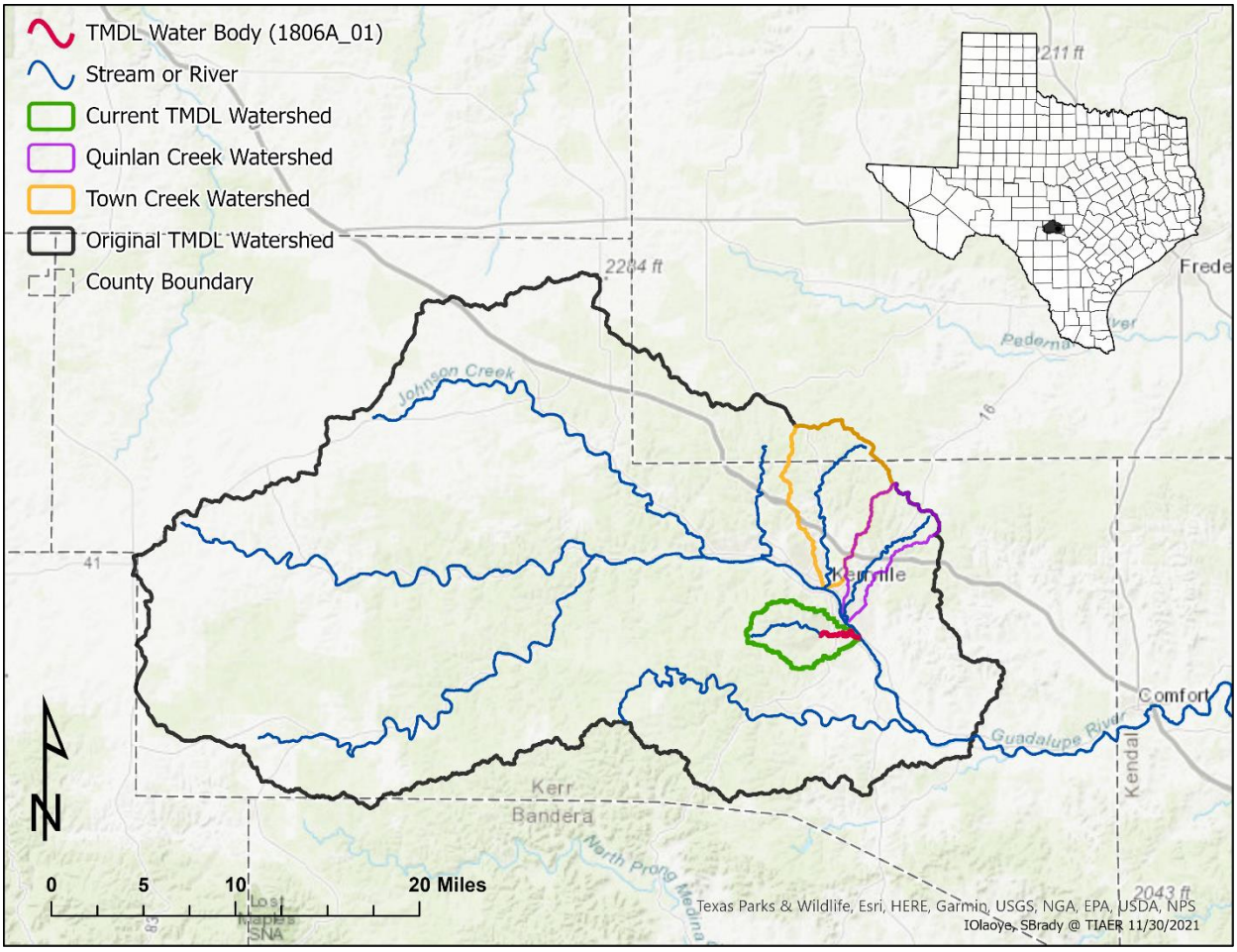

Figure VI-1. Map showing the previously approved TMDL watersheds and the Camp Meeting Creek AU 1806A_01 watershed added by this addendum

Table VI-1. 2020 Texas Integrated Report summary for TMDL addendum watershed

AU	Station	Parameter	Number of Samples	Date Range	*E. coli* Geometric Mean (cfu/100 mL)
1806A_01	12546	*E. coli*	67	12/01/2011 – 11/30/2018	263

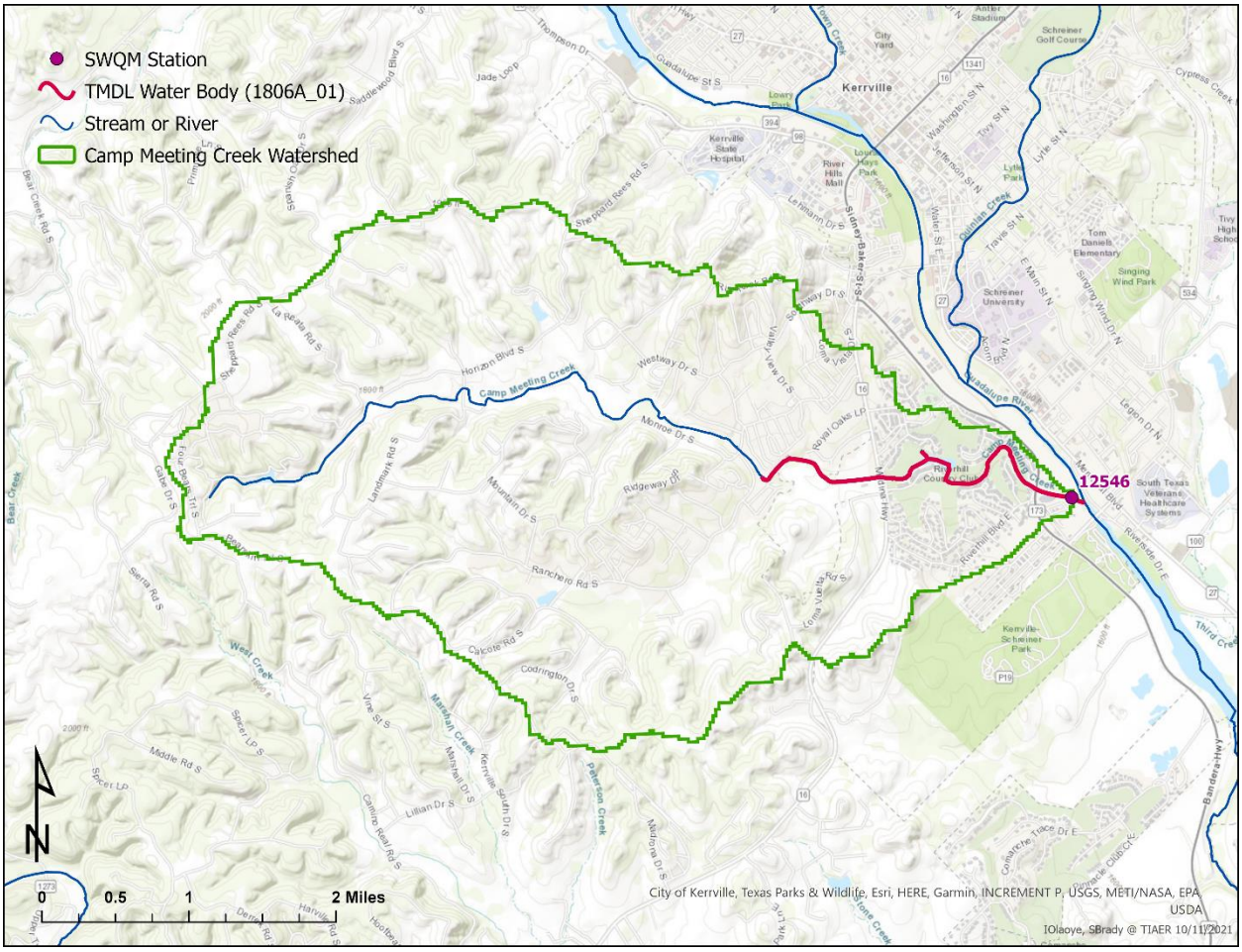

Figure VI-2. AU 1806A_01 watershed showing the TCEQ SWQM station

Watershed Overview

Camp Meeting Creek (1806A) is a tributary of the Guadalupe River Above Canyon Lake (Segment 1806) and flows approximately 6.7 miles. AU 1806A_01 is approximately 2.5 miles long. The entire AU 1806A _01 watershed, including the drainage area of upstream AUs 1806A _02 and 1806A _03, drains an area of 10.22 square miles (6,540.6 acres).

The following water body and AU descriptions have been updated since the publication of the 2020 Texas Integrated Report (TCEQ, 2020a). The updated descriptions are (TCEQ, 2020b):

- 1806A (Camp Meeting Creek) – From the confluence with the Guadalupe River up to the headwaters at Bear Skin Trail southwest of Kerrville in Kerr County.

- AU 1806A_01 – From the confluence with the Guadalupe River upstream to the dam on an unnamed impoundment, located 0.33 kilometers downstream of Ranchero Road in the City of Kerrville.

Watershed Climate

Weather data were obtained for the 15-year period from January 2006 through December 2020 from the National Oceanic and Atmospheric Administration (NOAA) U.S. Climate Normals Quick Access database. The Kerrville 3 NNE weather station (USC00414782) located a few miles northeast of the watershed was used to retrieve the precipitation and temperature data (NOAA, 2020; Figure VI-3). Data from this 15-year period indicate that the average monthly high temperature typically reaches a maximum of 93.6 °F in August, and the average monthly low temperature reaches a minimum of 33.1 °F in January. Annual rainfall averages 28.1 inches. The wettest month is May (5.3 inches), while February (1.1 inches) is the driest month, with rainfall occurring throughout the year.

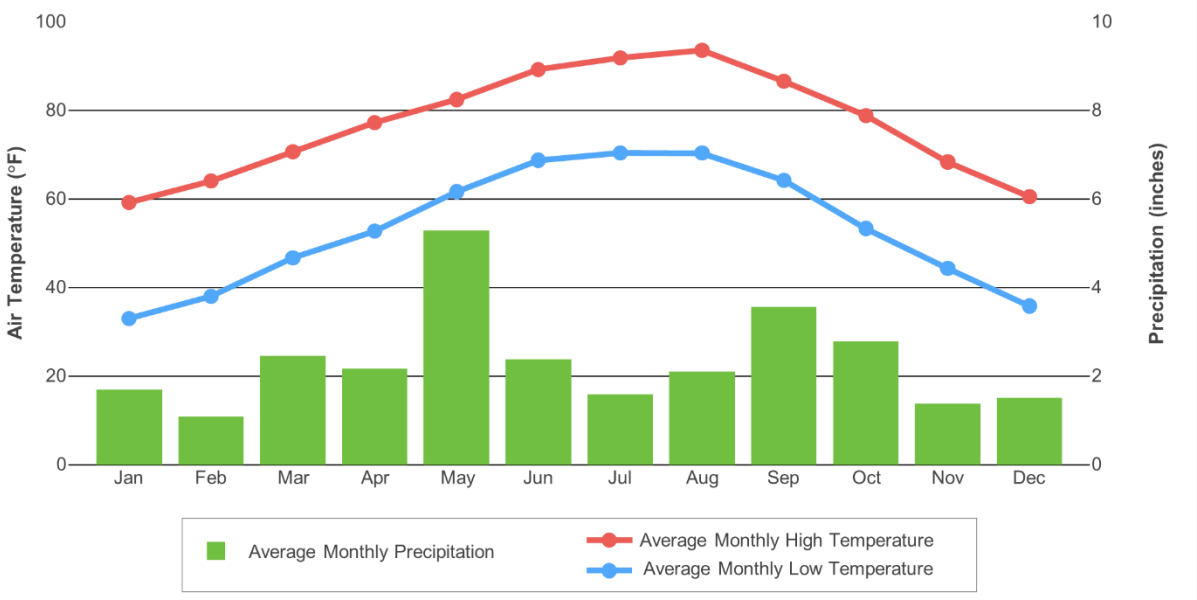

Figure VI-3. Average monthly air temperature and precipitation (2006–2020) at the Kerrville 3 NNE weather station

Watershed Population and Population Projections

The TMDL watershed is located within Kerr County, with about 14% of the watershed within the city limits of Kerrville. According to the United States Census Bureau (USCB) 2020 Census (USCB, 2021), the TMDL watershed had an estimated population of 5,417 people in 2020.

The population projection in Table VI-2 is estimated from the Texas Water Development Board (TWDB) 2021 Regional Water Plan Population and Water Demand Projection data (TWDB, 2019a; TWDB, 2019b).

Table VI-2. Estimated 2020 population and 2050 population projection for the TMDL watershed

Area	2020 Estimated Population	2050 Projected Population	Projected Population Increase	Percentage Change
Entire Camp Meeting Creek (AU 1806A_01) Watershed	5,417	5,966	549	10.1%

The following steps detail the method used to estimate the 2020 and projected 2050 populations in the TMDL watershed.

1. Obtained 2020 USCB data at the block level.
2. Developed the 2020 watershed population using the USCB block level data for the portion of Kerr County within the watershed.
3. For the census blocks that were partially located in the watershed, population was estimated by multiplying the block population to the proportion of its area in the watershed.
4. Obtained the TWDB Population Projections by Regional Water Planning Group for Region J. Projections for "County-Other" were used to determine population increases for the rural areas in Kerr County (TWDB, 2019a).
5. Located the relevant Water User Groups (WUGs) with areas within the Camp Meeting Creek watershed and Kerr County and determined the proportion of each WUG within the watershed (TWDB, 2019b).
6. Calculated decadal percentage increases in population using the TWDB (2019b) decadal population projections for Region J in TWDB Projections by Water User Group.
7. Summed the projected population increases obtained in steps 4 and 6 to the 2020 watershed population to obtain the decadal population projections out to 2050.

Land Cover

The land cover data were obtained from United States Geological Survey (USGS) 2016 National Land Cover Database (NLCD) (Dewitz, Jon, and USGS, 2021). The land cover for the TMDL watershed is shown in Figure VI-4. A summary of the land cover data is provided in Table VI-3 and indicates that the dominant land covers in the TMDL watershed are Shrub/Scrub (35%) and Evergreen Forest (30%).

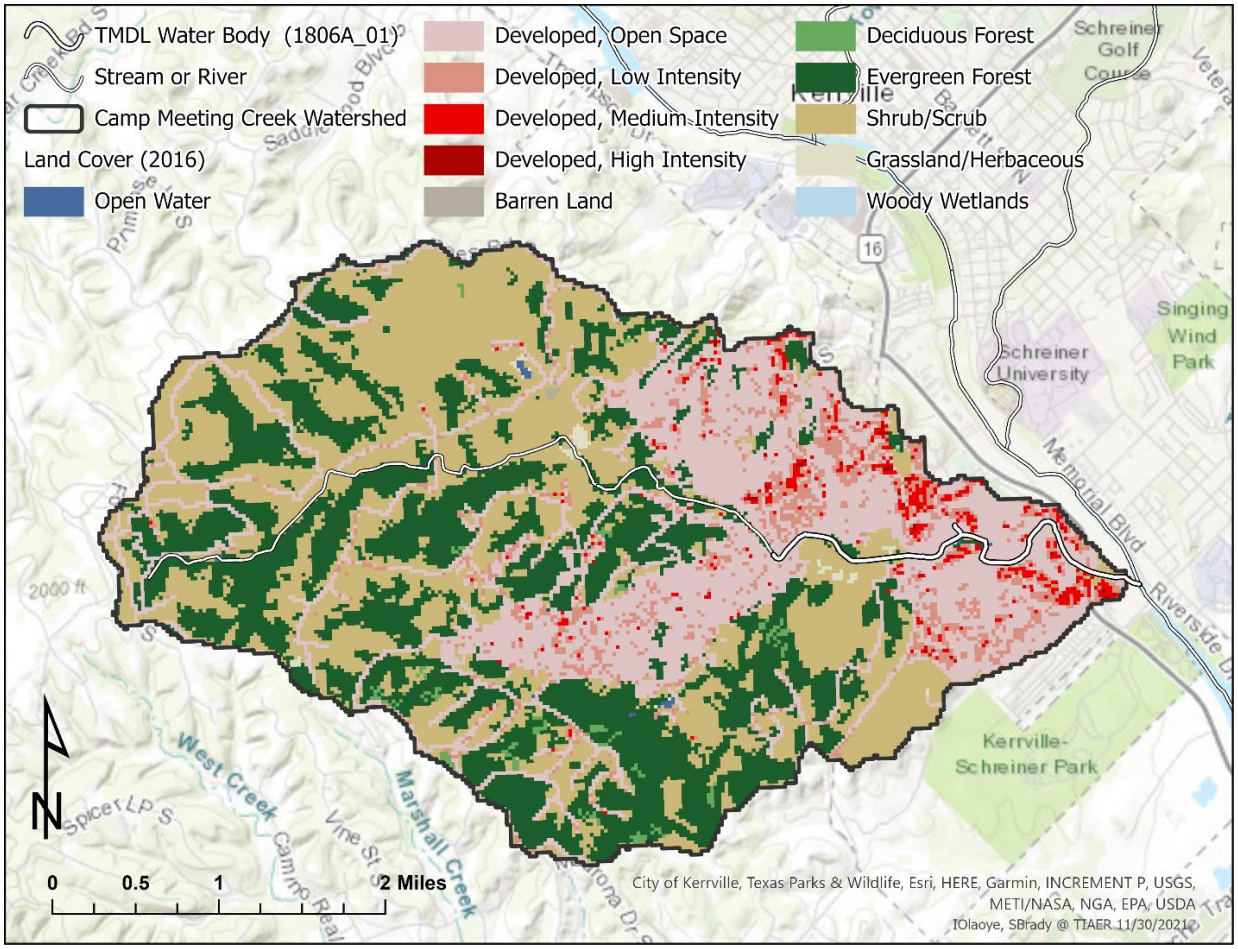

Figure VI-4. 2016 land cover

Table VI-3. Land cover summary

2016 NLCD Classification	Area (Acres)	Percentage of Total
Open Water	7.6	0.1%
Developed, Open Space	1,691.3	25.9%
Developed, Low Intensity	416.1	6.4%
Developed, Medium Intensity	114.1	1.7%
Developed, High Intensity	9.6	0.1%
Barren Land	2.0	0.0%
Deciduous Forest	42.7	0.7%
Evergreen Forest	1,960.4	30.0%
Shrub/Scrub	2,278.4	34.8%
Grassland/Herbaceous	18.2	0.3%
Woody Wetlands	0.2	0.0%
Total	**6,540.6**	**100%**

Endpoint Identification

The endpoint for the TMDL is to maintain the concentration of *E. coli* below the geometric mean criterion of 126 cfu/100 mL, which is protective of the primary contact recreation 1 use in freshwater.

Source Analysis

Pollutants may come from several sources, both regulated and unregulated. Pollutants in regulated discharges, referred to as "point sources," come from a single definable point, such as a pipe, and are regulated by permit under the Texas Pollutant Discharge Elimination System (TPDES) program. Wastewater treatment facilities (WWTFs) and stormwater discharges from industries, construction activities, and the separate storm sewer systems of cities are considered point sources of pollution.

Unregulated sources are typically nonpoint source in origin, meaning the pollutants originate from multiple locations and rainfall runoff washes them into surface waters. Nonpoint sources are not regulated by permit.

Except for WWTFs, which receive individual wasteload allocations (WLAs; see the Wasteload Allocation section), the regulated and unregulated sources in this section are presented to give a general account of the different sources of bacteria expected in the watershed. These are not meant to be used for allocating bacteria loads or interpreted as precise inventories and loadings.

Regulated Sources

Regulated sources are controlled by permit under the TPDES program. The regulated sources in the TMDL watershed include stormwater discharges from regulated construction activities.

Domestic and Industrial WWTFs

As of June 2021, there were no WWTFs with TPDES permits within the TMDL watershed.

TCEQ/TPDES Water Quality General Permits

Certain types of activities are required to be covered by one of several TCEQ/TPDES wastewater general permits:

- TXG110000 – concrete production facilities
- TXG130000 – aquaculture production
- TXG340000 – petroleum bulk stations and terminals
- TXG640000 – conventional water treatment plants
- TXG670000 – hydrostatic test water discharges
- TXG830000 – water contaminated by petroleum fuel or petroleum substances
- TXG870000 – pesticides (application only)
- TXG920000 – concentrated animal feeding operations
- WQG100000 – wastewater evaporation
- WQG200000 – livestock manure compost operations (irrigation only)

A review of active general permit coverage (TCEQ, 2021) in the TMDL watershed, as of June 2021 found no operations or facilities of the types described above.

Sanitary Sewer Overflows

A summary of sanitary sewer overflow (SSO) incidents that occurred during a six-year period from 2016 through 2021 in the TMDL watershed was obtained from TCEQ Region 13. The summary data indicated only one SSO incident had been reported within the TMDL watershed. The SSO had a total discharge of 500 gallons.

TPDES-Regulated Stormwater

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

1. Stormwater subject to regulation, which is any stormwater originating from TPDES-regulated municipal separate storm sewer system (MS4) entities,

stormwater discharges associated with regulated industrial activities, and construction activities.
2. Stormwater runoff not subject to regulation.

Discharges of stormwater from a Phase II MS4 area, regulated industrial facility, construction area, or other facility involved in certain activities must be covered under the following TCEQ/TPDES general permits:

- TXR040000 – Phase II MS4 General Permit for MS4s located in urbanized areas
- TXR050000 – Multi-sector General Permit (MSGP) for industrial facilities
- TXR150000 – Construction General Permit (CGP) for construction activities disturbing more than one acre or are part of a common plan of development disturbing more than one acre

A review of active stormwater general permit authorizations (TCEQ, 2021) in the TMDL watershed as of June 2021, found no Phase I MS4 permits or Phase II Ms4 authorizations, and no active MSGP authorizations within the watershed. Three CGP authorizations were located within the Camp Meeting Creek watershed, and two of the authorizations reference the same site location. The total area disturbed by these authorizations is 30.5 acres. Therefore, the total area of regulated stormwater is approximately 0.467% of the Camp Meeting Creek TMDL watershed.

Illicit Discharges

Pollutant loads can enter water bodies from MS4 outfalls that carry authorized sources as well as illicit discharges under both dry- and wet-weather conditions. The term “illicit discharge” is defined in TPDES General Permit TXR040000 for Phase II MS4s as “Any discharge to a municipal separate storm sewer system that is not entirely composed of stormwater, except discharges pursuant to this general permit or a separate authorization and discharges resulting from emergency firefighting activities.” Illicit discharges can be categorized as either direct or indirect contributions. The TMDL watershed does not include any area covered by active Phase II MS4 permits.

Unregulated Sources

Unregulated sources of bacteria are 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.

Unregulated Agricultural Activities and Domesticated Animals

A number of agricultural activities that do not require permits can be potential sources of fecal bacteria loading. Livestock are present throughout the more rural portions of the TMDL watershed.

Table VI-4 provides estimated numbers of selected livestock in the TMDL watershed based on the 2017 Census of Agriculture conducted by U.S. Department of Agriculture (USDA, 2019). The county-level estimated livestock populations for Kerr County were reviewed by Texas State Soil and Water Conservation Board staff and were distributed by dividing the suitable livestock land cover (Pasture/Hay and Grassland/Herbaceous) area of the watershed by the total suitable livestock land cover area of Kerr County. This ratio was then applied to the county-level livestock data. These livestock numbers, however, were not used to develop an allocation of allowable bacteria loading to livestock.

Table VI-4. Estimated livestock populations

AU	Cattle and Calves	Hogs and Pigs	Poultry	Goats and Sheep	Horses
1806A_01 (entire watershed)	32	1	111	55	4

Fecal bacteria from dogs and cats is transported to streams by runoff in both urban and rural areas and can be a potential source of bacteria loading. Table VI-5 summarizes the estimated number of dogs and cats within the TMDL watershed. Pet population estimates were calculated as the estimated number of dogs (0.614) and cats (0.457) per household (AVMA, 2018). The number of households in the TMDL watershed was estimated using 2020 Census data (USCB, 2021). The actual contribution and significance of bacteria loads from pets is unknown.

Table VI-5. Estimated households and pet population

Estimated Households	Estimated Dog Population	Estimated Cat Population
2,500	1,535	1,143

Wildlife and Unmanaged Animals

Fecal bacteria are common inhabitants of the intestines of all warm-blooded animals, including wildlife such as mammals and birds. In developing bacteria TMDLs, it is important to identify by watershed the potential for bacteria contributions from wildlife. Wildlife are naturally attracted to riparian corridors of water bodies. 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 they may be washed into nearby water bodies by rainfall runoff.

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 8.9 to 16.4 hogs/square mile (Timmons et al., 2012). The average hog density (12.65 hogs/square mile) was multiplied by the hog-habitat area in the Camp Meeting Creek watershed (6.72 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 2016 NLCD: Deciduous Forest, Evergreen Forest, Shrub/Scrub, Grassland/Herbaceous, and Woody Wetlands. Using this methodology, there are an estimated 85 feral hogs in the Camp Meeting 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). Spatial analysis using DMU and white-tailed deer range layers provided by TPWD reveals that the entire 6,541 acres are within DMU 7. The 2015 population density for that area was 7.16 acres/deer, returning an estimated 914 deer within the Camp Meeting Creek watershed. The bacteria contribution from feral hogs and wildlife in the TMDL watersheds could not be determined based on existing information.

Onsite Sewage Facilities

The estimated number of OSSFs in the Camp Meeting Creek watershed was determined using the 911 building locations that were available through the Texas Natural Resources Information System (TNRIS, 2019). Buildings that were located within the Kerrville city limits were assumed to have sewer collection and were removed from the estimate. Initially, an attempt was made to locate any CCN sewered areas within the watershed (PUC, 2021). Communications with staff at the Upper Guadalupe River Authority revealed an area within the Camp Meeting Creek watershed outside of the Kerrville city limits (in the Extra-Territorial Jurisdiction) where the properties are served by the city wastewater collection system (UGRA, 2021). The new sewer lines (Kerrville Public Works, 2021) were added to the map, and any 911 addresses that were within 40 meters of the sewer lines were removed from the estimate. These data indicate that there are 1,744 OSSFs within the TMDL watershed (Figure VI-5). Several pathways of the liquid waste in OSSFs afford opportunities for bacteria to enter ground and surface waters, if the systems are not properly operating. Properly designed and operated, however, OSSFs would be expected to contribute virtually no fecal bacteria to surface waters (Weiskel et al., 1996).

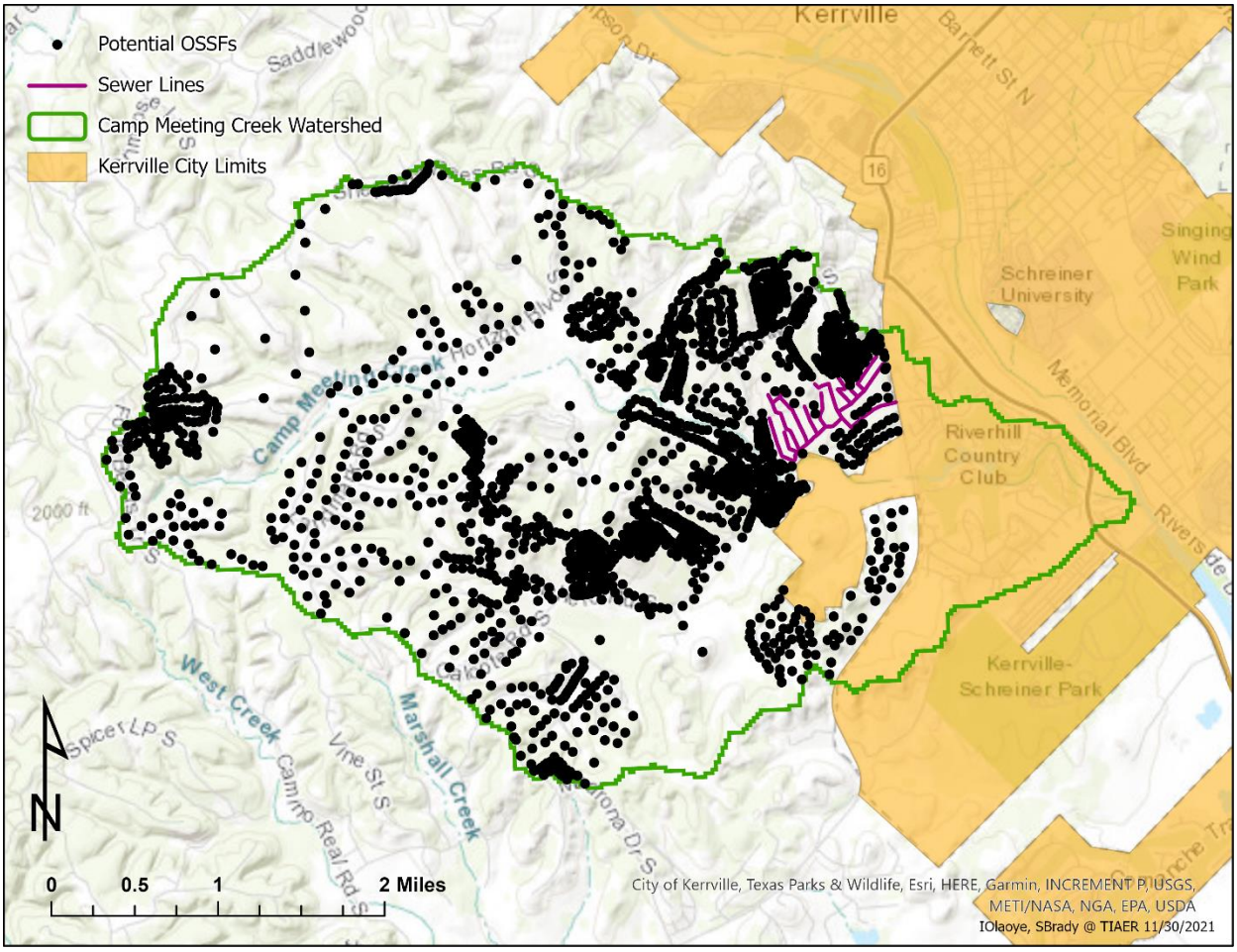

Figure VI-5. OSSFs located within the TMDL watershed

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 as regulated and from the landscape as unregulated sources. Further, this one-to-one relationship was also inherently assumed when using the LDC to define the TMDL pollutant load allocation. The LDC method allows for estimation of 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 or nonpoint source), and provides a means to allocate allowable loadings. The technical support document for this addendum (Brady et al., 2021) provides details about the linkage analysis along with the LDC method and its application.

The *E. coli* data plotted on the LDC for TCEQ SWQM Station 12546 in Figure VI-6 show that elevated bacteria loadings occur under all flow conditions, but the geometric mean becomes most elevated under the High, Mid-range, and Low Flows regimes. Regulated stormwater comprises a small portion of the watershed (0.47%) and must be considered only a minor contributor. There are currently no WWTFs in the watershed; therefore, other sources of bacteria loadings under lower flows and in the absence of overland flow contributions (i.e., without stormwater contribution) are most likely contributing bacteria directly to the water body as could occur through direct deposition of fecal material from wildlife and pets. Additionally, there are a significant number of septic systems concentrated within the watershed. The allowable load at the single sample criterion (399 cfu/100 mL) is included on the LDC for comparison with individual *E. coli* samples, although it is not used for assessment or allocation purposes.

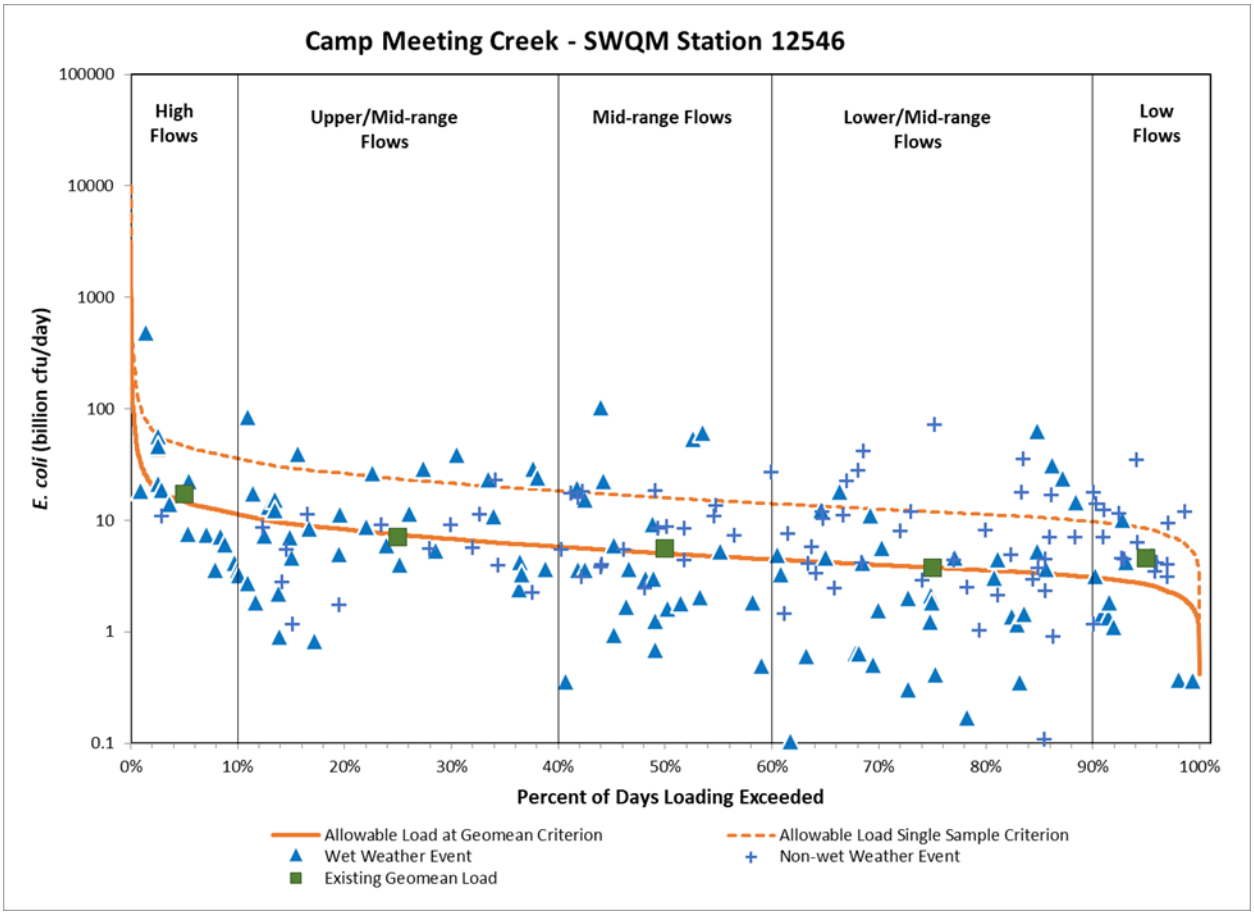

Figure VI-6. LDC at SWQM Station 12546

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 in this report incorporates an explicit MOS of 5% of the total TMDL allocation.

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 = WLA + LA + FG + MOS

Where:

WLA = wasteload allocations, the amount of pollutant allowed by regulated dischargers

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

FG = loadings associated with future growth from potential regulated facilities

MOS = margin of safety load

AU-Level TMDL Calculation

To be consistent with previously completed TMDLs in the original watershed, the TMDL for Camp Meeting Creek AU 1806A_01 was derived using the median flow in the 0-10 percentile range (or 5% load duration exceedance, High Flows regime) of the LDC developed for TCEQ SWQM Station 12546. This station represents the location within Camp Meeting Creek AU 1806A_01 where an adequate number of *E. coli* samples was collected.

Margin of Safety Calculation

The TMDL in this report incorporates an explicit MOS of 5%.

Wasteload Allocation

The 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 the instream geometric mean criterion. The water quality criterion (126 cfu/100 mL *E. coli*) is used as the WWTF target to be consistent with the original TMDL report. Due to the absence of any

permitted dischargers in the Camp Meeting Creek watershed, the WLA_{WWTF} component is zero.

Regulated Stormwater

Stormwater discharges from MS4, industrial, and construction areas are also considered regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). The percentage of the land area included in the TMDL 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.

The acreage associated with the "area disturbed" for CGP authorizations (30.5 acres) accounts for all regulated stormwater. The percentage of land under the jurisdiction of stormwater permits in the TMDL watershed is 0.467%.

Load Allocation

The load allocation (LA) component of the TMDL corresponds to runoff or direct deposition from unregulated sources.

Allowance for Future Growth

The future growth (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. Specifically, this TMDL component takes into account the probability that new flows from WWTF discharges may occur in the future. The assimilative capacity of water bodies increases as the amount of flow increases. The allowance for FG in this TMDL report will result in protection of existing uses and conform to Texas' antidegradation policy.

For this TMDL, the conventional FG calculation is hampered by the fact that there are no WWTFs within the watershed. By using TCEQ design guidance for domestic WWTFs, and assuming the potential for a residential development of a density sufficient to require centralized sewer collection, an alternative method was implemented.

A new WWTF must accommodate daily wastewater flow of 75-100 gallons per capita per day (gpcd) as required under Title 30, Texas Administrative Code, Chapter 217, Subchapter B, Section 217.32 (30 TAC 217.32; TCEQ 2015). Conservatively taking the higher daily wastewater flow capacity (100 gallons) and multiplying it by a potential population change would result in a permitted flow for FG. Based on the information in Table VI-2, the projected population change for the Camp Meeting Creek watershed for 2020 to 2050 is 549. Conservatively assuming a larger population consistent with a potential residential development—1,000 people—and multiplying that by the higher

daily wastewater flow capacity, yields a value of 0.10 million gallons per day. This value would be considered the full permitted discharge of a potential future WWTF.

FG of existing or new point sources is not limited by this TMDL as long as the sources do not cause bacteria to exceed the limits. The assimilative capacity of water bodies increases as the amount of flow increases. Consequently, increases in flow allow for increased loadings. The LDC and tables in this TMDL report will guide determination of the assimilative capacity of the water body under changing conditions, including FG.

Summary of TMDL Calculations

Table VI-6 summarizes the TMDL calculations for the TMDL watershed. The TMDL was calculated based on the median flow in the 0-10 percentile range (or 5% load duration exceedance, High Flows regime) from the LDC developed for TCEQ SWQM Station 12546. Allocations are based on the current geometric mean criterion for *E. coli* of 126 cfu/100 mL for each component of the TMDL.

Table VI-6. TMDL allocation summary for AU 1806A_01

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

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	FG
Camp Meeting Creek	1806A_01	14.712	0.736	0.000	0.063	13.436	0.477

The final TMDL allocations (Table VI-7) needed to comply with federal requirements include the FG component within the WLA_{WWTF} (40 CFR Section 103.7).

Table VI-7. Final TMDL allocation for AU 1806A_01

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

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA
Camp Meeting Creek	1806A_01	14.712	0.736	0.477	0.063	13.436

For the original TMDL on the Guadalupe River Above Canyon Lake (TCEQ, 2007), pollutant load allocations were determined from the median flow of each of the five flow regimes comprising the LDCs: 5 percent exceedance for High Flows (0–10%), 25% exceedance for Moist Conditions (10–40%), 50% exceedance for Mid-range Flow (40–60%), 75% exceedance for Dry Conditions (60–90%), and 95% exceedance for Low Flows (90–100%). For more recent bacteria TMDLs across Texas, TCEQ has considered only the median value of the highest designated flow regime in the pollutant load allocations. For consistency with the original Guadalupe River Above Canyon Lake TMDL, the pollutant load allocations for each of the five flow regimes are provided in Tables VI-8 and VI-9 in Appendix VI-1.

Seasonal Variation

Federal regulations require that TMDLs account for seasonal variation in watershed conditions and pollutant loading [40 CFR Section 130.7(c)(1)]. Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing *E. coli* concentrations obtained from 10 years (2011 through 2020) of routine monitoring data collected at TCEQ SWQM Station 12546 in the warmer months (May through September) against those collected during the cooler months (November through March). The months of April and October were considered transitional between warm and cool seasons and were excluded from the seasonal analysis. Differences in *E. coli* concentrations obtained in warmer versus cooler months were then evaluated by performing a Wilcoxon Rank Sum test (also known as the "Mann-Whitney" test). This analysis of *E. coli* data indicated that there was a significant difference in indicator bacteria between cool and warm weather seasons for Camp Meeting Creek (n=77, p=0.0125), with the warm season having the higher concentrations. Seasonal variation was also addressed by using all available flow and *E. coli* records (covering all seasons) from the period of record used in LDC development for this project.

Public Participation

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

The technical support document for this TMDL addendum (Brady et al., 2021) was published on TCEQ's website on March 11, 2021. Project staff presented information about this addendum at a Bacteria Reduction Plan update meeting coordinated by the Upper Guadalupe River Authority in Kerrville (held online) on August 31, 2021. The public had an opportunity to comment on this addendum during the public comment period (May 6 through June 7, 2022) for the Water Quality Management Plan (WQMP) update in which this addendum is included. Notice of the public comment period for this addendum was emailed to stakeholders and posted on the TCEQ's TMDL Program TMDL Program News webpage.[4] Notice of the comment period, along with the document, was also posted on the WQMP Updates webpage.[5] TCEQ accepted public comments on the original TMDL report from March 23 through April 23, 2007. Three comments were submitted, and none of them referred directly to the AU in this TMDL addendum.

[4] https://www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html
[5] https://www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html

Implementation and Reasonable Assurance

The AU covered by this addendum is within the existing bacteria TMDL watershed for the Guadalupe River Above Canyon Lake. That TMDL watershed, including Camp Meeting Creek AU 1806A_01, is within the area covered by the implementation plan (I-Plan) developed by stakeholders for the TMDL watershed, which was approved by the commission on August 31, 2011. The I-Plan outlines an adaptive management approach in which measures are assessed annually by the stakeholders 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 VI-1

Pollutant Load Allocations by Flow Regime for Camp Meeting Creek

For the original TMDL (TCEQ, 2007), pollutant load allocations were determined from the median flow of each of the five flow regimes comprising the LDCs:

- 5 percent exceedance for High Flows (0–10%),
- 25 percent exceedance for Upper/Mid-range Conditions (10–40%),
- 50 percent exceedance for Mid-range Flow (40–60%),
- 75 percent exceedance for Lower/Mid-range Conditions (60–90%), and
- 95 percent exceedance for Low Flows (90–100%).

For more recent bacteria TMDLs across Texas, TCEQ has considered only the median value of the highest designated flow regime in the pollutant load allocations. For consistency with the original TMDL and Addendum One (TCEQ, 2007), within this appendix is provided the pollutant load allocation information for each of the five flow regimes of Camp Meeting Creek. Tables VI-8 and VI-9 contain the TMDL allocation summaries comparable to what is provided in Tables VI-6 and VI-7 of this addendum (which only presented the High Flows regime), expanded to include the values for each of the five flow regimes.

Table VI-8. TMDL allocations summary by flow regime for AU 1806A_01

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

Water Body	AU	Flow Regime	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	FG
Camp Meeting Creek	1806A_01	High Flows	14.712	0.736	0.000	0.063	13.436	0.477
		Upper/Mid-range Flows	7.421	0.371	0.000	0.031	6.542	0.477
		Mid-range Flows	5.042	0.252	0.000	0.020	4.293	0.477
		Lower/Mid-range Flows	3.765	0.188	0.000	0.014	3.086	0.477
		Low Flows	2.660	0.133	0.000	0.010	2.040	0.477

Table VI-9. Final TMDL allocations by flow regime for AU 1806A_01

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

Water Body	AU	Flow Regime	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA
Camp Meeting Creek	1806A_01	High Flows	14.712	0.736	0.477	0.063	13.436
		Upper/Mid-range Flows	7.421	0.371	0.477	0.031	6.542
		Mid-range Flows	5.042	0.252	0.477	0.020	4.293
		Lower/Mid-range Flows	3.765	0.188	0.477	0.014	3.086
		Low Flows	2.660	0.133	0.477	0.010	2.040