April 2022 Update to the Texas Water Quality Management Plan

Prepared by
Water Quality Division, Office of Water

Final TCEQ SFR-121/2022-03
April 2022

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY • PO BOX 13087 • AUSTIN, TX 78711-3087

Prepared by the
Office of Water
Water Quality Division

WQMP updates are available on the TCEQ webpage:
www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html

Developed in accordance with Sections 205(j), 208,
and 303 of the Federal Clean Water Act
and applicable regulations thereto.

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Introduction

The Texas Water Quality Management Plan (WQMP) is the product of a wastewater treatment facility (WWTF) planning process developed and updated in accordance with provisions of Sections 205(j), 208, and 303 of the federal Clean Water Act (CWA), as amended. The WQMP is an important part of the State's program for accomplishing its clean water goals.[1]

The Texas Department of Water Resources, a predecessor agency of the Texas Commission on Environmental Quality (TCEQ), prepared the initial WQMP for waste treatment management during the late 1970s. The Clean Water Act mandates that the WQMP be updated as needed to fill information gaps and revise earlier certified and approved plans. Any updates to the plan need involve only the elements of the plan that require modification. The original plan and its subsequent updates are collectively referred to as the "State of Texas Water Quality Management Plan."

The WQMP is tied to the State's water quality assessments that identify priority water quality problems. WQMPs are used to direct planning for implementation measures that control and/or prevent water quality problems. Several elements may be contained in the WQMP, such as effluent limitations of wastewater facilities, total maximum daily loads (TMDLs), nonpoint source management controls, identification of designated management agencies, and groundwater and source-water protection planning. Some of these elements may be contained in separate documents, which are prepared independently of the current WQMP update process, but may be referenced as needed to address planning for water quality control measures.

This document, as with previous updates[2], will become part of the WQMP after completion of the public comment period, certification by TCEQ, and approval by the United States Environmental Protection Agency (EPA).

The materials presented in this document revise only the information specifically addressed in the following sections. Previously certified and approved WQMPs remain in effect.

[1] See the formal definition of a water quality management plan in Title 40 Code of Federal Regulations (CFR) 130.2(k).

[2] Fiscal Years 1974, 1975, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984/85, 1986/88, 1989, 1990, 1991, 1992, 1993/94, 1995, 1996, 1997/98, 02/1999, 05/1999, 07/1999, 10/1999, 01/2000, 04/2000, 07/2000, 10/2000, 01/2001, 04/2001, 07/2001, 10/2001, 01/2002, 04/2002, 07/2002, 10/2002, 01/2003, 04/2003, 07/2003, 10/2003, 01/2004, 04/2004, 07/2004, 10/2004, 01/2005, 04/2005, 07/2005, 10/2005, 01/2006, 04/2006, 07/2006, 10/2006, 01/2007, 04/2007, 07/2007, 10/2007, 01/2008, 04/2008, 07/2008, 10/2008, 01/2009, 04/2009, 07/2009, 10/2009, 01/2010, 04/2010, 07/2010,10/2010, 01/2011, 04/2011, 07/2011, 10/2011, BPUB 2011, 01/2012, 04/2012, 07/2012,10/2012, 01/2013, 04/2013, 07/2013,10/2013, 01/2014, 04/2014, 07/2014, 10/2014, 01/2015, 04/2015, 07/2015, 10/2015, 01/2016, 04/2016, 07/2016, 10/2016, 01/2017, 04/2017, 07/2017, 10/2017, 01/2018, 04/2018, 07/2018, 10/2018, 01/2019, Terra Verde 2019, 04/2019, 07/2019, 10/2019, 01/2020, 04/2020, 07/2020, 10/2020, 01/2021, 04/2021, 07/2021, and 10/2021.

The April 2022 WQMP update addresses the following topics for water quality planning purposes:

1. Projected Effluent Limits Updates
2. Service Area Population for Municipal WWTFs
3. Designation of Management Agencies for Municipal WWTFs
4. Total Maximum Daily Load (TMDL) Updates

The public comment period for the draft April 2022 WQMP update will be from May 6, 2022 through June 7, 2022.

The "Projected Effluent Limit Update" section provides information compiled from February 1, 2022 through April 30, 2022 and is based on Texas water quality standards (WQS). Projected effluent limits may be used for water quality planning purposes in Texas Pollutant Discharge Elimination System (TPDES) permit actions.

The "Service Area Population" and "Designation of Management Agencies" sections for municipal wastewater facilities were developed and evaluated by TCEQ in cooperation with the Texas Water Development Board (TWDB) and regional water quality management planning agencies.

The "Total Maximum Daily Load Update" section provides information on proposed wasteload allocations for new dischargers and revisions to existing TMDLs and was developed by the TCEQ TMDL Program in the Water Quality Planning Division.

Projected Effluent Limit Updates

Table 1 reflects proposed effluent limits for new dischargers and preliminary revisions to original proposed effluent limits for preexisting dischargers. Abbreviations used in the table heading include:

- BOD5–5-Day Biochemical Oxygen Demand
- CBOD5–5-Day Carbonaceous Biochemical Oxygen Demand
- DO–Dissolved Oxygen
- lbs/day–Pounds per Day
- MGD–Million Gallons per Day
- mg/L–Milligrams per Liter
- NH_3-N–Ammonia-Nitrogen

Effluent flows indicated in Table 1 reflect future needs and do not reflect current permits for these facilities. These revisions may be useful for water quality management planning purposes. The effluent flows and constituent limits indicated in the table have been preliminarily determined to be appropriate to satisfy the stream standards for dissolved oxygen in their respective receiving waters. These flow volumes and effluent sets may be modified at the time of permit action. These limits are based on the Texas WQS effective at the time of the production of this update. The WQS are subject to revision on a triennial basis.

Table 1. Projected Effluent Limit Updates

State Permit Number	Segment Number	EPA ID Number	Permittee Name and County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
10425-002	0507	TX0128392	City of Caddo Mills Hunt	0.75	10	62.55	3	18.77			4	
10443-002	0814	TX0047261	City of Ennis Ellis	4.0	5	166.80	2	66.72			6	Outfall 001 (Outfalls 001 and 002 total combined flow not to exceed 4.0 MGD)
10443-002	0815	TX0047261	City of Ennis Ellis	4.0	5	166.80	2	66.72			6	Outfall 002 (Outfalls 001 and 002 total combined flow not to exceed 4.0 MGD)
10698-002	0823	TX0123781	Upper Trinity Regional Water District Denton	1.7	5	56.7	1	14.18			6	April – September/ Outfall 001 (more stringent $CBOD_5$ loading limit required than that which would correspond to the concentration limit)
				1.7	7	99.25	3	42.53			6	October – March/ Outfall 001

State Permit Number	Segment Number	EPA ID Number	Permittee Name and County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
				10	5	333.80	1	83.40			6	April – September/ Outfall 002 (more stringent $CBOD_5$ loading limit required than that which would correspond to the concentration limit)
				10	7	583.80	3	250.20			6	October – March/ Outfall 002
13199-001	0840	TX0055221	City of Tioga Grayson	1.0	7	58.38	2	16.68			6	
13314-001	1202	TX0101052	City of Fulshear Fort Bend	1.1	10	91.74	3	27.52			4	
14246-001	0823	TX0023272	City of Celina Collin	15	5	625.50	1.4	175.14			6	
14372-001	0823	TX0022403	City of Sanger Denton	1.86	10	155.12	2	31.02			4	Outfall 001
				1.86	7	108.59	2	31.02			6	Outfall 002
15635-001	1810	TX0138118	Plum Creek Utility Company, LLC Hays	0.75	7	43.79	2	12.51			4	
15804-001	1434	TX0139360	Integra Water Texas, LLC Bastrop	0.24	5	10.01	2	4.00			4	

State Permit Number	Segment Number	EPA ID Number	Permittee Name and County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
15813-001	1258	TX0139475	Preserve HW6, LLC Fort Bend	0.09	10	7.51	3	2.25			4	
15879-001	1009	TX0140252	290 Betka, LLC Harris	0.24	10	20.02	3	6.00			4	
15958-001	1428	TX0140953	Gateway Oasis V LLC Travis	0.3	5	12.51	2	5.00			6	
15993-001	1008	TX0141305	Quadvest, L.P. Montgomery	0.25	10	20.85	3	6.26			4	
15999-001	0816	TX0141348	Highland Lakes Midlothian I, LLC Ellis	2.76	5	115.09	1	23.02			6	
16016-001	1434	TX0141526	CTX Management Holdings, LLC Bastrop	1.5	5	62.55	2	25.02			4	
16022-001	1434	TX0141569	SWWC Utilities, Inc. Travis	0.8	5	33.36	2	13.34			4	
16023-001	1009	TX0141577	Harris County MUD No. 558 Harris	0.405	10	33.78	3	10.13			5	
16031-001	2422	TX0141631	Parkland Development LLC Chambers	0.1	5	4.17	2	1.67			4	
16043-001	0821	TX0141721	City of Anna Collin	16	5	667.20	1.4	186.82			6	

State Permit Number	Segment Number	EPA ID Number	Permittee Name and County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
16046-001	1105	TX0141771	Undine Texas Environmental, LLC Brazoria	0.25	10	20.85	3	6.26			4	
16052-001	1806	TX0141828	SJWTX, Inc Comal	0.26	5	10.84	2	4.34			4	
16055-001	0507	TX0141879	Double R Municipal District No. 2A of Hunt and Collin Counties Hunt	0.9					10	75.06	5	
16059-001	1434	TX0141895	RFJJ HWY 21 LLC Caldwell	0.9	5	37.53	2	15.01			4	
16064-001	0821	TX0141968	BR-Seven, LLC Collin	0.72	5	30.02	2	12.01			6	
16067-001	1010	TX0142000	Willis Waukegan Development LLC Montgomery	0.07	10	5.84	3	1.75			4	
16068-001	0823	TX0142018	City of Celina Collin	15	5	625.50	1.2	150.12			6	
16069-001	0803	TX0142026	Livingston Lagoon Ranch LLC Polk	0.015	10	1.25	3	0.38			6	
16070-001	0826	TX0142034	TCCI Land Development Inc. Denton	0.39	10	32.53	3	9.76			4	

State Permit Number	Segment Number	EPA ID Number	Permittee Name and County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
16073-001	2432	TX0142093	Alvin Mustang, LLC Brazoria	0.02	10	1.67	3	0.50			4	
16074-001	1250	TX0142085	City of Bertram Burnet	0.8	10	66.72	2	13.34			4	
16075-001	1015	TX0142107	MSEC Waste Water, Inc. Montgomery	0.6	5	25.02	1.1	5.50			6	
16077-001	1209	TX0142123	Smiling Mallard Development, Ltd. Brazos	0.1	10	8.34	3	2.50			4	
16081-001	1202	TX0142174	Sage Ranch TX, LLC Waller	0.125	10	10.43	3	3.13			4	
16082-001	1202	TX0142182	Tidwell Tract, Ltd. Fort Bend	0.8	10	66.72	2	13.34			4	
16084-001	1434	TX0142191	Esperanza Ranch MHC, LLC Caldwell	0.05	5	2.09	2	0.83			4	
16087-001	1003	TX014222	City of Cleveland Liberty	0.4	10	33.36	3	10.01			6	
16089-001	2432	TX0142239	Green Raindrops, Inc Brazoria	0.0099	10	0.83	3	0.25			4	
16091-001	0821	TX0142255	Venetian 141 Swisher, LLC Collin	0.2	10	16.68	3	5.00			4	

State Permit Number	Segment Number	EPA ID Number	Permittee Name and County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
16092-001	0821	TX0142263	Treasure Island Laguna Azure, LLC Grayson	1.4	7	81.73	2	23.35			5	
16095-001	1010	TX0142298	Meritage Homes of Texas LLC Montgomery	0.495	10	41.28	3	12.38			6	
16096-001	0823	TX0142301	66 Mustang Ranch WWTP, LLC Denton	0.25	5	10.43	2	4.17			4	
16098-001	1010	TX0142310	Quadvest, LP Montgomery	0.45	10	37.53	3	11.26			4	
16099-001	1010	TX0142328	3083 Frontage LLC Montgomery	0.015	10	1.25	3	0.38			6	
16100-001	1008	TX0142336	Quadvest, L.P. Harris	0.75	10	62.55	2	12.51			5	
16104-001	1206	TX0142379	Gilden Blair Blackburn Parker	0.02					20	3.34	2	
16106-001	1434	TX0142395	Creedmoor Municipal Utility District Travis	0.455	5	18.97	2	7.59			4	
16107-001	1810	TX0142409	Phau-Lockhart 450 LLC Caldwell	0.499	10	41.62	3	12.48			4	

State Permit Number	Segment Number	EPA ID Number	Permittee Name and County	Flow (MGD)	$CBOD_5$ (mg/L)	$CBOD_5$ (lbs/day)	NH_3-N (mg/L)	NH_3-N (lbs/day)	BOD_5 (mg/L)	BOD_5 (lbs/day)	DO (mg/L)	Months/ Comments
16112-001	1808	TX0142441	Stafford Development WWP, LLC Caldwell	0.9	5	37.53	2	15.01			4	

Planning Information Summary

The Water Quality Planning Division of TCEQ coordinated with TWDB and regional planning agencies to compile the wastewater facility information in this section. Domestic facility financing decisions under the State Revolving Fund (SRF) loan program must be consistent with the certified and approved WQMP.

The purpose of this section is to present data reflecting facility-planning needs, including previous water quality management plan needs requiring revision. Data are also presented to update other plan information for TWDB's SRF projects. Table 2 contains the updated service area population information. The table is organized in alphabetical order and includes the following 10 categories of information:

1. *Planning Area* – Area for which facility needs are proposed. The facility planning areas are subject to change during the facility planning process and any such changes will be documented in a later water quality management plan update. All planning areas listed are also designated management agencies (DMAs) unless otherwise noted in the "Comments" column.
2. *Service Area* – Area that receives the provided wastewater service.
3. *Needs* – A "T" indicates a need for either initial construction of a WWTF, additional treatment capacity, or the upgrading of a WWTF to meet existing or more stringent effluent requirements. A "C" indicates a need for improvements to, expansion of, rehabilitation of, or the initial construction of a wastewater collection system in the facility planning area. "T/C" indicates a need for both treatment and collection system facilities. More detailed facility planning conducted during a construction project may define additional needs and those needs will be reflected in a future update to the WQMP. A "F" indicates a need for flood mitigation.
4. *Needs Year* – The year in which the needs were identified for the planning area.
5. *Basin Name* – The river basin or designated planning entity for a designated planning area. The seven water quality management planning areas designated by the Governor are each administered by a Council of Governments (COG), a Development Council (DC), or a Planning Council (PC). Basin names are shown for areas outside one of these planning areas. The designated planning areas and their associated administering entities are:
    a. Corpus Christi – Coastal Bend COG (CBCOG)
    b. Killeen-Temple – Central Texas COG (CTCOG)
    c. Texarkana – Ark-Tex COG (ATCOG)
    d. Southeast Texas – South East Texas Regional Planning Council (SETRPC)
    e. Lower Rio Grande Valley – Lower Rio Grande Valley Development Council (LRGVDC)
    f. Dallas-Fort Worth – North Central Texas COG (NCTCOG)

g. Houston – Houston-Galveston Area Council (H-GAC)

6. *Segment* – The classified stream segment or tributary into which any recommended facility may discharge existing or projected wastewater. In the case of no-discharge facilities, this is the classified stream segment drainage area in which the facilities are located.
7. *County* – The county in which the facility planning area is located.
8. *Date* – The date the planning information was reviewed by TCEQ.
9. *Comments* – Additional explanation or other information concerning the facility planning area.
10. *Population* – The base year and projected populations for each facility planning area. Population projections presented are consistent with the latest available statewide population projections or represent the most current information obtained from facility planning analyses.

The facility information in this section is intended to be used in the preparation of facility plans and the subsequent design and construction of wastewater facilities. Design capacities of the treatment and collection systems will be based upon the population projections contained in this document, plus any additional needed capacity established for commercial/industrial flows and documented infiltration/inflow volumes (treatment or rehabilitation).

The probable needs shown under the "Needs" heading are preliminary findings; specific needs for an area must be as established in the completed and certified, detailed engineering studies conducted during facility planning under the SRF and other state loan programs.

Specific recommended effluent quality for any wastewater discharges resulting from any of the facilities in this document will be in accordance with the rule in the Texas WQS in effect at the time the permit is issued for a specific facility.

Table 2. Service Area Population Updates

Planning Agency	Service Area	Needs	Needs Year	Basin Name / COG	Segment	County	WQMP Date	Comments	Year	Population
City of Daingerfield	City boundary	T/C	2040	Cypress Creek Basin/ATCOG	0404	Morris	2/10/22	WWTP and collection system improvements	2021	2602
									2025	2628
									2030	2650
									2040	2702
City of Jacksonville	City boundary	T/C	2040	Neches	0611	Cherokee	4/5/22	WWTP and collection system improvements	2020	18083
									2030	19830
									2040	21543
									2050	23585
City of Marble Falls	City limits	T	2029	Colorado Basin	1405	Burnet	2/17/22	WWTP effluent management study and treatment design	2021	7037
									2030	15344
									2035	19016
									2040	22759
City of Moran	City boundary	T	2070	Brazos	1233	Shackelford	3/8/22	Replacement of the existing Imhoff tank with a new Imhoff tank and associated appurtenances	2020	178

Planning Agency	Service Area	Needs	Needs Year	Basin Name / COG	Segment	County	WQMP Date	Comments	Year	Population
									2025	178
									2030	179
									2040	180
City of Raymondville	City limits	T/C	2022	Bays and Estuaries/LRGVDC	2491	Willacy	4/7/22	Sanitary Sewer and Lift Station Rehabilitation	2020	12619
									2030	14224
									2040	15762
									2050	17401
City of Roma	City boundary	C	2050	Rio Grande	2302	Starr	3/8/22	WWTP and collection system improvements	2020	20613
									2025	21964
									2030	23314
									2040	25803
City of Shenandoah	City limits	T	2050	San Jacinto River Basin	1004	Montgomery	3/21/22	Existing WWTP updates	2020	2997
									2025	3451
									2030	3904
									2040	4281

Planning Agency	Service Area	Needs	Needs Year	Basin Name / COG	Segment	County	WQMP Date	Comments	Year	Population
Lumberton MUD	Project service	T/C	2049	Neches	77657	Hardin	4/11/22	WWTP and collection system improvements	2021	12973
									2025	13533
									2030	14315
									2040	15970
North Alamo WSC	Project service area	T/C	2038.5	Bays and Estuaries/LRGVDC	77657	Hidalgo	4/26/22	WWTP and collection system improvements and construction of a collection and conveyance system to transport wastewater from 9 target colonias to the WWTP.	2021	3966
									2025	5600
									2030	8150
									2040	10376

Designated Management Agencies

To be designated as a management agency for wastewater collection or treatment, an entity must demonstrate the legal, institutional, managerial and financial capability necessary to carry out the entity's responsibilities in accordance with Section 208(c) of the Clean Water Act (see below list of requirements). Before an entity can apply for an SRF loan, it must be recommended for designation as the management agency in the approved WQMP.

Designation as a management agency does not require the designated entity to provide wastewater services, but enables it to apply for grants and loans to provide those services. The facilities listed in Table 3 have submitted DMA resolutions to TCEQ. TCEQ submits this DMA information to EPA for approval as an update to the WQMP.

Section 208 (c) (2) Requirements for Management Agency

208(c)(2)(A): to carry out portions of an area-wide waste treatment plan.
208(c)(2)(B): to manage waste treatment works.
208(c)(2)(C): directly or by contract to design and construct new works.
208(c)(2)(D): to accept and utilize grants.
208(c)(2)(E): to raise revenues, including assessment of waste treatment charges.
208(c)(2)(F): to incur short and long term indebtedness.
208(c)(2)(G): to assure community pays proportionate cost.
208(c)(2)(H): to refuse to receive waste from non-compliant dischargers.
208(c)(2)(I): to accept for treatment industrial wastes.

Table 3. Designated Management Agencies

Planning Agency	Service Area	DMA Needs	DMA Date
City of Daingerfield	City limits	T/C	7/23/2021
City of Jacksonville	City boundary	T/C	3/16/2022
City of Marble Falls	City limits	T	12/15/2021
City of Moran	City boundary	T	7/19/2021
City of Raymondville	City limits	T/C	1/18/2022
City of Roma	City boundary	C	2/24/2021
City of Shenandoah	City limits	T	10/24/2021
Lumberton Municipal Utility District	Project service area	T/C	11/11/2021
North Alamo WSC	Project service area	T/C	11/16/2021

Total Maximum Daily Load Revisions

The TMDL Program works to improve water quality in impaired or threatened waters bodies in Texas. The program is authorized by and created to fulfill the requirements of Section 303(d) of the federal Clean Water Act.

The goal of a TMDL is to restore the full use of a water body that has limited quality in relation to one or more of its uses. The TMDL defines an environmental target, and based on that target, TCEQ and stakeholders develop an implementation plan with wasteload allocations for point source dischargers to mitigate human-caused sources of pollution within the watershed and restore full use of the water body.

TMDLs are developed based on intensive data collection and scientific analysis. After adoption by TCEQ, TMDLs are submitted to EPA for review and approval.

The attached appendixes may reflect proposed wasteload allocations for new dischargers and/or additions or revisions to TMDLs. Updates and addendums will be provided in the same units of measure used in the original TMDL document and will include the segment and assessment unit (AU) numbers of the affected segments. Also, note that for bacteria TMDLs, loads will typically be expressed as colony-forming units per day (cfu/day). On occasion, other expressions may be used due to different laboratory methods, such as counts or most probable number per day. For the purposes of the TMDL program, these terms are considered to be synonymous.

Appendix I. Updates to Five TMDLs for Indicator Bacteria in Brays Bayou Above Tidal and Tributaries

Segments 1007B, 1007C, 1007E, and 1007L

This appendix provides updates to TMDLs previously submitted through the state's WQMP for: Brays Bayou Above Tidal and Tributaries.

The report *Five Total Maximum Daily Loads for Indicator Bacteria in Brays Bayou Above Tidal and Tributaries For Segment Numbers 1007B, 1007C, 1007E, and 1007L* was adopted by TCEQ on 09/15/10 and approved by EPA on 09/27/10. Upon EPA approval, the TMDLs became part of the state's WQMP.

The Texas WQMP has since been updated four times prior to this update for this TMDL. The previous updates have revised the list of individual WLAs in the original TMDL document. Additionally, TCEQ submitted two addenda to the original TMDL in the April 2013 and January 2021 WQMP updates. These addenda added four new AUs to the original TMDL project.

The purpose of this update is to make the following change to the TMDL:

- update the WLA for one facility that has decreased its permitted discharge (presented in Table I-1)

The changes reflected in this update resulted in the shifting of allocations between the sum of the individual WLAs and the allowance for FG in two AUs. This was originally presented in Table 17 in the original TMDL document. The two affected AUs in this update are included here as Table I-2.

In Table 18 of the original TMDL, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for FG within each AU. These overall numbers did not change; Table 18 of the original TMDL remains the same.

Table I-1 - Changes to individual WLAs for the TMDL watersheds

Updates Table 15, pp. 35-36 in the original TMDL document.

The WLA is expressed in billion MPN/day *E. coli*.

State Permit Number	Outfall	EPA Permit Number	AU	Permittee Name	Flow (MGD)	WLA	TMDL Comments
12250-001	001	TX0084484	1007E_01	HARRIS COUNTY MUD 122	0.18	0.43	Decreased discharge

Table I-2 - TMDL summary calculations for two AUs in the TMDL watersheds

Updates Table 17, p. 41 in the original TMDL document.

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

AU	Segment Name	TMDL	WLA WWTF	WLA SW	LA	MOS	FG
1007B_01	Brays Bayou Above Tidal	2,390	359.4	1,839	0	120	71.6
1007E_01	Willow Waterhole Bayou Above Tidal	130	2.81	120	0	6.49	0.70

Appendix II. Updates to Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries

Segments 1013, 1013A, 1013C, 1014, 1014A, 1014B, 1014E, 1014H, 1014K, 1014L, 1014M, 1014N, 1014O, 1017, 1017A, 1017B, 1017D, and 1017E

This appendix provides updates to TMDLs previously submitted through the state's WQMP for: Buffalo and Whiteoak Bayous and Tributaries.

The report *Eighteen Total Maximum Daily Loads for Bacteria in Buffalo and Whiteoak Bayous and Tributaries For Segment Numbers 1013, 1013A, 1013C, 1014, 1014A, 1014B, 1014E, 1014H, 1014K, 1014L, 1014M, 1014N, 1014O, 1017, 1017A, 1017B, 1017D, and 1017E* was adopted by TCEQ on 04/08/09 and approved by EPA on 06/11/09. Upon EPA approval, the TMDLs became part of the state's WQMP.

The Texas WQMP has since been updated 30 times prior to this update for this TMDL. The previous updates have revised the list of individual WLAs in the original TMDL document. Additionally, TCEQ submitted addenda to the original TMDL in the April 2013, April 2015, and January 2021 WQMP updates. These addenda added three new AUs to the original TMDL project.

The purpose of this update is to make the following change to the TMDL (presented in Table II-1):

- update the WLA for one facility that has decreased its permitted discharge.

The changes reflected in this update resulted in the shifting of allocations between the sum of the individual WLAs and the allowance for future growth (FG) in one AU. This was originally presented in Table 53 in the original TMDL document. The affected AU in this update is included here as Table II-2.

In Table 54 of the original TMDL, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for FG within each AU. These overall numbers did not change; Table 54 of the original TMDL remains the same.

Table II-1 - Change to individual WLA for the TMDL watershed

Updates Table 45, pp. 99-103 in the original TMDL document.

The WLA is expressed in billion MPN/day *E. coli*.

State Permit Number	Outfall	EPA Permit Number	AU	Permittee Name	Flow (MGD)	WLA	TMDL Comments
15101-001	001	TX0134686	1014B_01	QUADVEST, L.P.	0.5	1.192	Decreased discharge

Table II-2 - TMDL summary calculations for one AU in the TMDL watershed

Updates Table 53, pp. 116-117 in the original TMDL document.

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

AU	Segment Name	TMDL	WLA WWTF	WLA SW	LA	MOS	Upstream Load	FG
1014B_01	Buffalo Bayou	626.91	103.83	482.44	38.60	0	0	2.04

Appendix III. Updates to Seven TMDLs 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

This appendix provides updates to TMDLs previously submitted through the state's WQMP for: Lake Houston, East Fork San Jacinto River, West Fork San Jacinto River, and Crystal Creek Watersheds.

The report *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 For Segments 1002, 1003, 1004, and 1004D* was adopted by TCEQ on 08/24/16 and approved by EPA on 10/07/16. Upon EPA approval, the TMDLs became part of the state's WQMP.

The Texas WQMP has since been updated 11 times prior to this update for this TMDL. The previous updates have revised the list of individual WLAs in the original TMDL document. Additionally, TCEQ submitted an addendum to the original TMDL in the October 2018 WQMP update. This addendum added one new AU to the original TMDL project.

The purpose of this update is to make the following changes to the TMDL (presented in Table III-1):

- add two new permits.

The changes reflected in this update resulted in the shifting of allocations between the sum of the individual WLAs and the allowance for FG in five AUs. This was originally presented in Table 17 in the original TMDL document. The five affected AUs in this update are included here as Table III-2.

For AUs 1003_01 and 1003_02, the existing future growth allocations were insufficient to cover the increased flow to the AUs for this update. However, ample loading is available in the $WLA_{StormWater}$ and LA terms. Loading was taken from each of those terms (in a way that maintains the proportions for them in the original TMDL) and allotted to future growth for both AUs. This results in no changes to the overall TMDL allocations.

In Table 18 of the original TMDL, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for FG within each AU. Because loading was moved from the $WLA_{StormWater}$ and LA terms to be used for future growth for AUs 1003_01 and 1003_02, these AUs are updated in Table III-3. These overall numbers for the other

AUs did not change, and again this results in no changes to the overall TMDL allocations.

Table III-1 - Changes to individual WLAs for the TMDL watersheds

Updates Table 13, pp. 54-55 in the original TMDL document.

The WLA is expressed in billion MPN/day *E. coli*.

State Permit Number	Outfall	EPA Permit Number	AU	Permittee Name	Flow (MGD)	WLA	TMDL Comments
16087-001	001	TX014222	1003_02	CITY OF CLEVELAND	0.4	0.9539	New permit
16075-001	001	TX0142107	1015A_01[a]	MSEC WASTE WATER, INC.	0.6	1.4309	New permit

[a] Mound Creek (1015A) is a tributary to Lake Creek, which discharges to West Fork San Jacinto River AU 1004_02.

Table III-2 - TMDL summary calculations for five AUs in the TMDL watersheds

Updates Table 17, p. 59 in the original TMDL document.

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

AU	Segment Name	TMDL	MOS	WLA WWTF	WLA SW	LA AU	LA TRIB	LA RES	LA TOTAL	FG
1002_06	Lake Houston	6,197	106.57	106.39	288.17	1,535.70	3,106.90	958.70	5,601.30	94.57
1003_01	East Fork San Jacinto River	866.4	43.32	11.91	1.75	809.14	0	0	809.14	0.28
1003_02	East Fork San Jacinto River	722.8	36.14	4.90	1.19	680.36	0	0	680.36	0.21
1004_01	West Fork San Jacinto River	2,779	88.77	103.14	196.81	1,294.21	44.86	958.70	2,297.77	92.51
1004_02	West Fork San Jacinto River	1,141	9.12	48.20	4.04	75.26	0	958.70	1,033.96	45.68

Table III-3 - TMDL final calculations

Updates Table 18, p. 60 in the original TMDL document.

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

AU	TMDL	WLA WWTF	WLA SW	LA TOTAL	MOS
1003_01	866.4	12.19	1.75	809.14	43.32
1003_02	722.8	5.11	1.19	680.36	36.14

In addition, Table III-4 below provides an update to Table 9 found in the October 2018 addendum to this TMDL project (*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*). One of the new permits discussed earlier in this update also affects an AU in this addendum.

Table III-5 below provides an update to Table 10 found in the October 2018 addendum to this TMDL project. The addendum added one AU that was not included in the original TMDL. This AU (1015A_01) was included as a contributing loading to 1002_06, 1004_01, and 1004_02 in the original TMDL. The permit for one new facility (16075-001/ TX0142107) affects the loadings of both 1015A_01 as well as the original TMDL AUs 1002_06, 1004_01, and 1004_02.

For AU 1015A_01, the existing FG allocation was insufficient to cover the increased flow to the AU for this update. However, ample loading is available in the $WLA_{StormWater}$ and LA terms. Loading was taken from each of those terms (in a way that maintains the proportions for them in the addendum) and allotted to FG for both AUs. This results in no changes to the overall TMDL allocations.

In Table 11 of the TMDL addendum, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for FG within the AU. Because loading was moved from the $WLA_{StormWater}$ and LA terms to be used for FG for AU 1015A_01, this AU is updated in Table III-6. Again this results in no changes to the overall TMDL allocation.

Table III-4 - Changes to individual WLAs for the TMDL addendum watershed

Updates Table 9, p. 19 in the TMDL addendum document.

The WLA is expressed in billion MPN/day *E. coli*.

State Permit Number	Outfall	EPA Permit Number	AU	Permittee Name	Flow (MGD)	WLA	TMDL Comments
16075-001	001	TX0142107	1015A_01	MSEC WASTE WATER, INC.	0.6	1.4309	New permit

Table III-5 - TMDL summary calculations for one AU in the TMDL addendum watershed

Updates Table 10, p. 20 in the TMDL addendum document.

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

AU	Segment Name	TMDL	MOS	WLA WWTF	WLA SW	LA	FG
1015A_01	Mound Creek	82.431	4.122	1.944	0.607	75.220	0.538

Table III-6 – Final TMDL calculations for one AU in the TMDL addendum watershed

Updates Table 11, p. 21 in the TMDL addendum document.

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

AU	Segment Name	TMDL	WLA WWTF	WLA SW	LA	MOS
1015A_01	Mound Creek	82.431	2.482	0.607	75.220	4.122

Appendix IV. Updates to Fifteen TMDLs for Indicator Bacteria in Watersheds Upstream of Lake Houston

Segments 1004E, 1008, 1008H, 1009, 1009C, 1009D, 1009E, 1010, and 1011

This appendix provides updates to TMDLs previously submitted through the state's WQMP for: Watersheds Upstream of Lake Houston.

The report *Fifteen Total Maximum Daily Loads for Indicator Bacteria in Watersheds Upstream of Lake Houston For Segment Numbers 1004E, 1008, 1008H, 1009, 1009C, 1009D, 1009E, 1010, and 1011* was adopted by TCEQ on 04/06/11 and approved by EPA on 06/29/11. Upon EPA approval, the TMDLs became part of the state's WQMP.

The Texas WQMP has since been updated 37 times prior to this update for this TMDL. The previous updates have revised the list of individual WLAs in the original TMDL document. Additionally, TCEQ submitted three addenda to the original TMDL in the October 2013, October 2019, and October 2020 WQMP updates. These addenda added nine new AUs to the original TMDL project.

The purpose of this update is to make the following changes to the TMDL (presented in Table IV-1):

- add seven new permits.
- update an existing permit with a name change and decreased discharge.

The changes reflected in this update resulted in the shifting of allocations between the sum of the individual WLAs and the allowance for FG in 10 AUs. This was originally presented in Table 18 in the original TMDL document. The 10 affected AUs in this update are included here as Table IV-2.

In Table 19 of the original TMDL, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for FG within each AU. Because loading was moved from the $WLA_{StormWater}$ and LA terms to be used for future growth for AU 1008_02, this AU is updated in Table IV-3. These overall numbers for the other AUs did not change, and again this results in no changes to the overall TMDL allocations.

Table IV-1 - Changes to individual WLAs for the TMDL watershed

Updates Table 16, pp. 49-56 in the original TMDL document.

The WLA is expressed in billion MPN/day *E. coli*.

State Permit Number	Outfall	EPA Permit Number	AU	Permittee Name	Flow (MGD)	WLA	TMDL Comments
15993-001	001	TX0141305	1008_02	QUADVEST, LP	0.25	0.596	New permit
16100-001	001	TX0142336	1008_02	QUADVEST, LP	0.75	1.789	New permit
15879-001	001	TX0140252	1009_01	290 BETKA, LLC	0.24	0.572	Name change and decreased discharge
16023-001	001	TX0141577	1009E_01	HARRIS COUNTY MUD #558	0.405	0.966	New permit
16067_001	001	TX0142000	1010_02	WILLIS WAUKEGAN DEVELOPMENT LLC	0.07	0.167	New permit
16095-001	001	TX0142298	1010_04	MERITAGE HOMES OF TEXAS LLC	0.495	1.180	New permit
16098-001	001	TX0142310	1010_04	QUADVEST, LP	0.45	1.073	New permit
16099-001	001	TX0142328	1010_04	3083 FRONTAGE, LLC	0.015	0.036	New permit

Table IV-2 - TMDL summary calculations for ten AUs in the TMDL watershed

Updates Table 18, p. 61 in the original TMDL document.

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

AU	Sampling Location	Segment Name	TMDL	WLA WWTF	WLA SW	LA	MOS	FG
1008_03	11314	Spring Creek	287	13.60	69.91	189.02	14.4	0.07
1008_03	11313	Spring Creek	1420	113.01	322	869	70.9	45.09
1008_04	11312	Spring Creek	1510	148.68	334	902	75.7	49.62
1009_01	11333	Cypress Creek	227	27.30	78.86	108.90	11.4	0.54
1009_02	11331	Cypress Creek	615	112.26	196	270	30.8	5.94
1009_03	11328	Cypress Creek	1340	196.01	415	574	67.0	87.99
1009_04	11324	Cypress Creek	1550	235.19	469	648	77.4	120.41
1009E_01	14159	Little Cypress Creek	91.1	20.10	16.14	48.42	4.56	1.88
1010_02	14241	Caney Creek	245	1.66	30	200.8	12.3	0.24
1010_04	11334	Caney Creek	493	23.69	57.4	383.8	24.7	3.41

Table IV-3 - TMDL final calculations

Updates Table 19, p. 62 in the original TMDL document.

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

AU	TMDL	WLA $_{WWTF}$	WLA $_{SW}$	LA $_{TOTAL}$	MOS
1008_02	287	13.67	69.91	189.02	14.4

In addition, Table IV-4 below provides an update to Table 9 found in the October 2019 addendum to this TMDL project (*Addendum Two to Fifteen Total Maximum Daily Loads for Indicator Bacteria in Watersheds Upstream of Lake Houston: Two Total Maximum Daily Loads for Indicator Bacteria in Brushy Creek and Spring Branch For AUs 1008J_01 and 1010C_01*). One of the permits discussed earlier in this update also affects one AU in this addendum.

Table IV-5 below provides updates to Table 10 found in the October 2019 addendum to this TMDL project. The addendum added two AUs that were not included in the original TMDL. The AU affected here (1010C_01) was included as an upstream loading to 1010_04 in the original TMDL. One of the permits (16098-001/ TX0142310) affects the loading of 1010C_01 as well as the original TMDL AU 1010_04.

In Table 11 of the October 2019 TMDL addendum, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for future growth within the single affected AU. Therefore, these overall numbers did not change, and Table 11 of the TMDL addendum remains the same.

Table IV-4 - Changes to individual WLAs in the Spring Branch watershed

Updates Table 9, p. 17 in the TMDL addendum document.

The WLA is expressed in billion cfu/day *E. coli*.

State Permit Number	Outfall	EPA Permit Number	AU	Permittee Name	Flow (MGD)	WLA	TMDL Comments
16098-001	001	TX0142310	1010C_01	QUADVEST, LP	0.45	1.073	New permit

Table IV-5 - TMDL summary calculations for one AU in the Spring Branch watershed

Updates Table 10, p. 19 in the TMDL addendum document.

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

Water Body	AU	TMDL	WLA $_{WWTF}$	WLA $_{SW}$	LA	FG	MOS
Spring Branch	1010C_01	134.408	2.433	4.682	120.517	0.056	6.72

Appendix V. Updates to Two Total Maximum Daily Loads for Indicator Bacteria in the Tidal Segments of the Mission and Aransas Rivers

Segments 2001 and 2003

This appendix provides updates to TMDLs previously submitted through the state's WQMP for: Mission and Aransas Rivers.

The report *Two Total Maximum Daily Loads for Indicator Bacteria in the Tidal Segments of the Mission and Aransas Rivers for Segments 2001 and 2003* was adopted by TCEQ on 05/25/16 and approved by EPA on 08/09/16. Upon EPA approval, the TMDLs became part of the state's WQMP.

The Texas WQMP has since been updated two times prior to this update for this TMDL. The previous updates have revised the list of individual WLAs in the original TMDL document. Additionally, TCEQ submitted an addendum to the original TMDL in the October 2017 WQMP update. This addendum added two new AUs to the original TMDL project.

The purpose of this update is to make the following change to the TMDL:

- update the WLA for one facility that has removed a permitted discharge (presented in Table V-1)

The changes reflected in this update resulted in the shifting of allocations between the sum of the individual WLAs and the allowance for FG in one AU. This was originally presented in Table 20 in the original TMDL document. The affected AU in this update is included here as Table V-2.

In Table 21 of the original TMDL, the WLAs for permitted facilities are the sum of the individual WLAs and the allowance for FG within each AU. These overall numbers did not change; Table 21 of the original TMDL remains the same.

Table V-1 - Changes to individual WLAs for the TMDL watershed

Updates Table 14, p. 35 in the original TMDL document.

The WLA is expressed in billion MPN/day Enterococci and *E. coli*.

State Permit Number	Outfall	EPA Permit Number	AU	Permittee Name	Flow (MGD)	Enterococci WLA	*E. coli* WLA	TMDL Comments
05283-000	101	TX0139629	2003_01	STEEL DYNAMICS SOUTHWEST, LLC	NA	NA	NA	Removed discharge

Table V-2 - TMDL summary calculations for one AU in the TMDL watershed

Updates Table 20, p. 42 in the original TMDL document.

All loads expressed as billion MPN/day Enterococci.

AU	Segment Name	TMDL	MOS	WLA WWTF	WLA SW	LA	FG
2003_01	Aransas River Tidal	150.321	7.516	9.366	0.05	132.197	1.192

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

Adding one TMDL for AU 1806A_01

One TMDL for Indicator Bacteria in Camp Meeting Creek

Introduction

TCEQ adopted *One TMDL for Bacteria in the Guadalupe River Above Canyon Lake* (TCEQ, 2007) on July 25, 2007. 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 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*[c] (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 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

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

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.

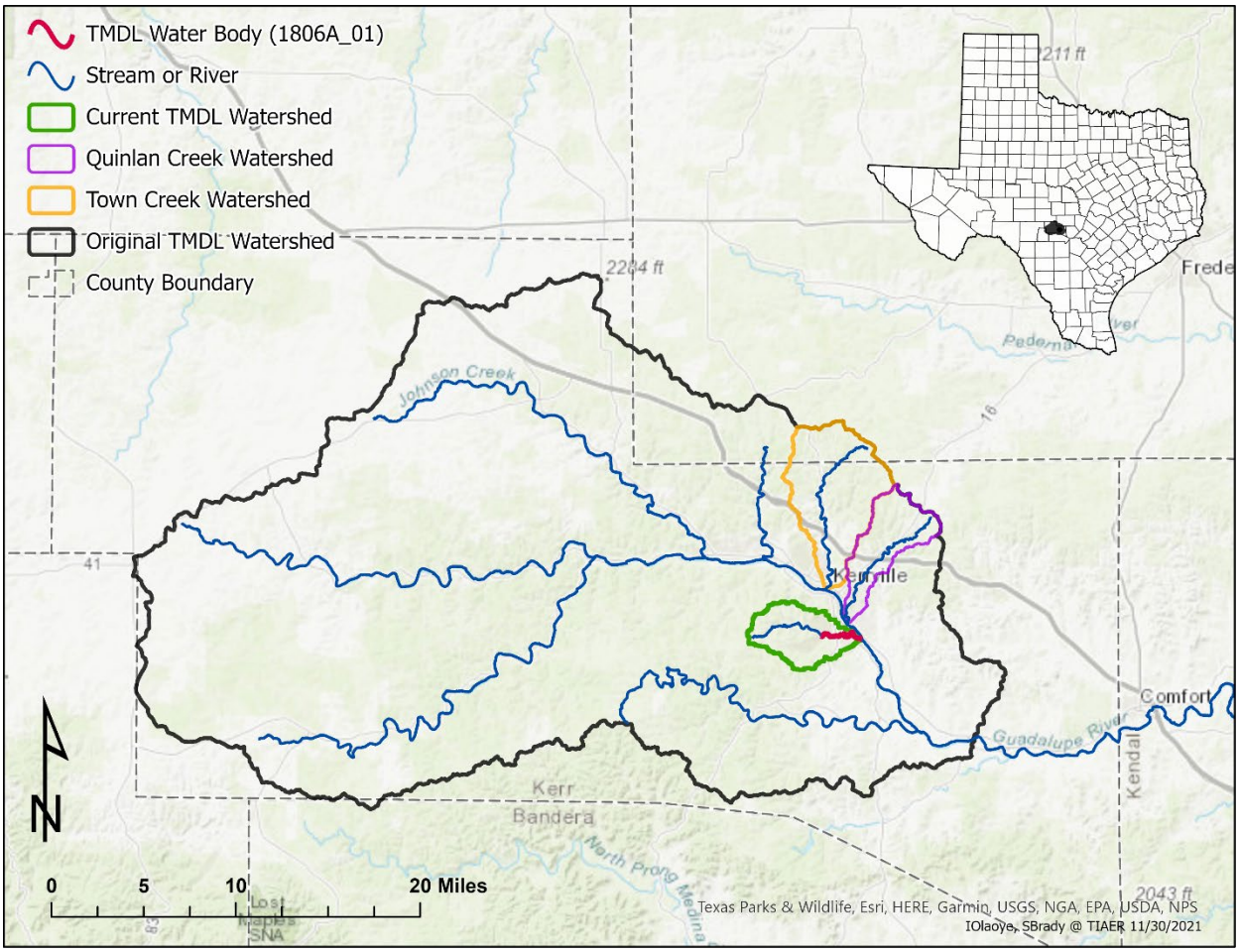

Figure VI-1. Map showing the previously approved TMDL watersheds and the Camp Meeting Creek AU 1806A_01 watershed added by this addendum

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

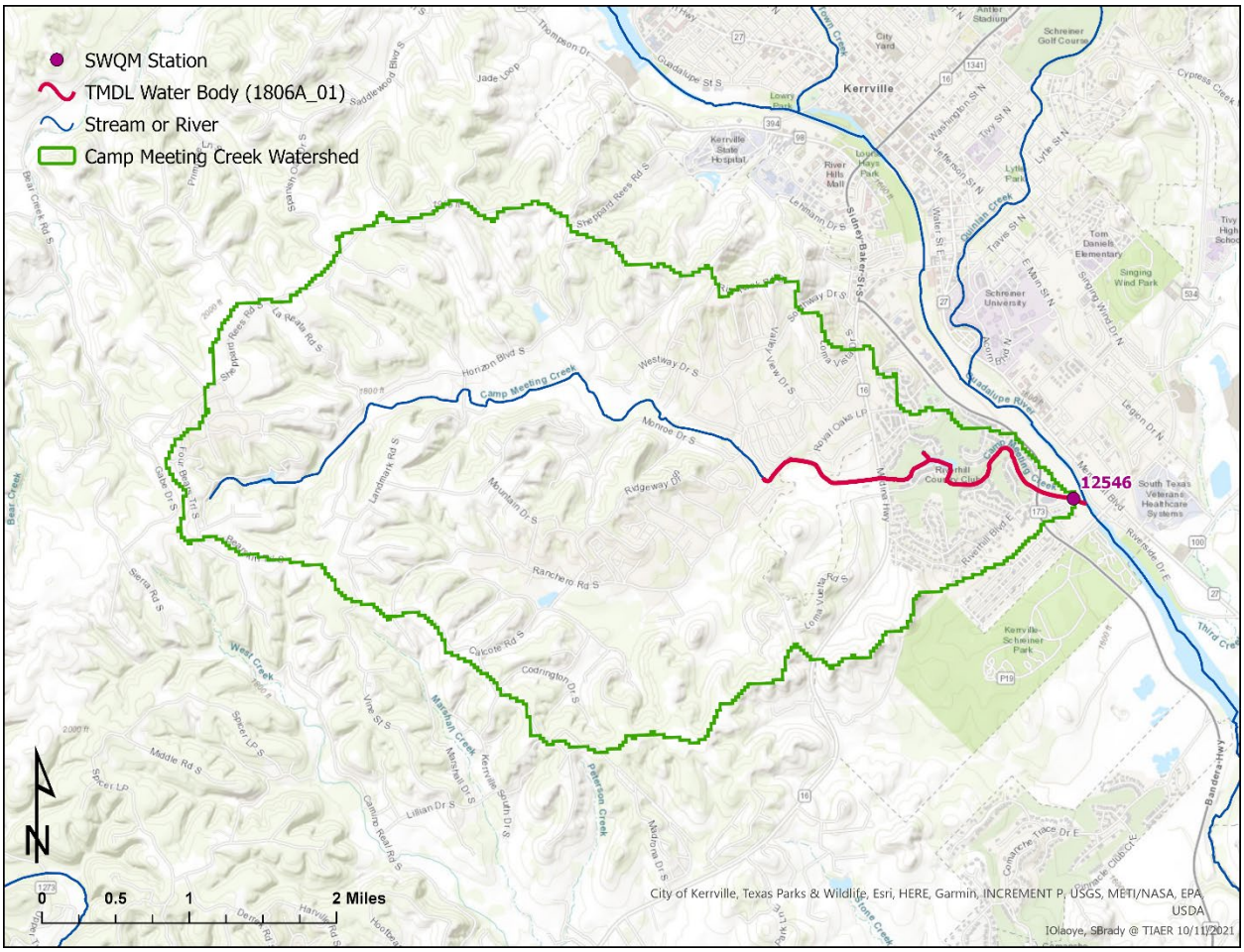

Figure VI-2. AU 1806A_01 watershed showing the TCEQ SWQM station

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.

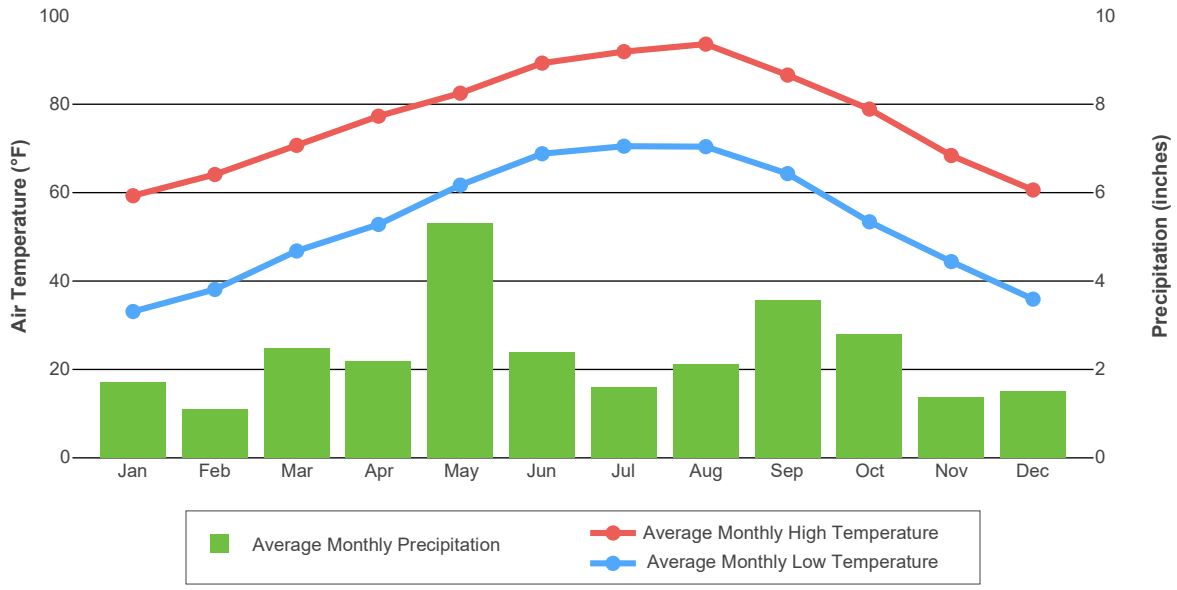

Figure VI-3. Average monthly air temperature and precipitation (2006–2020) at the Kerrville 3 NNE weather station

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 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%).

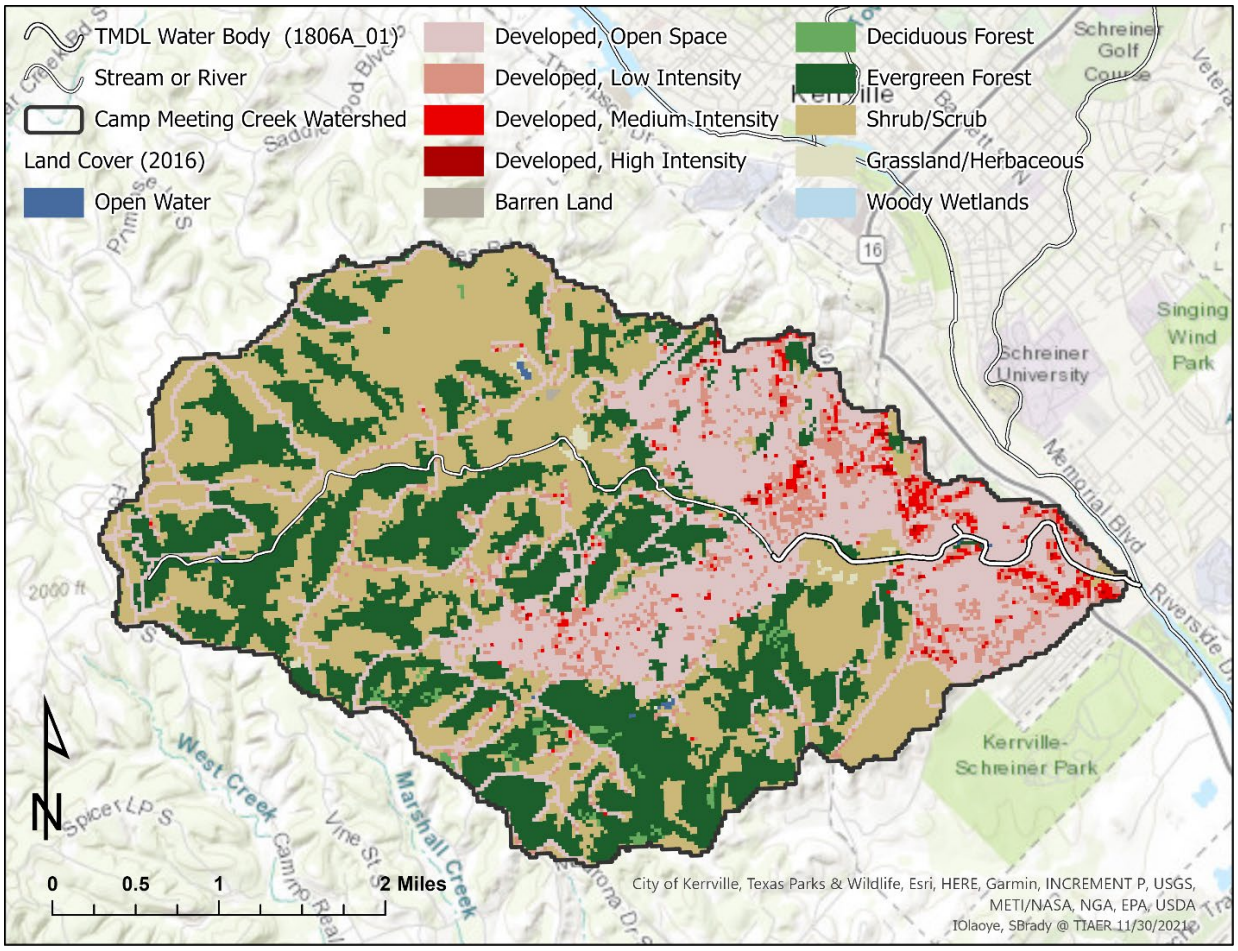

Figure VI-4. 2016 land cover

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 TPDES program. 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).

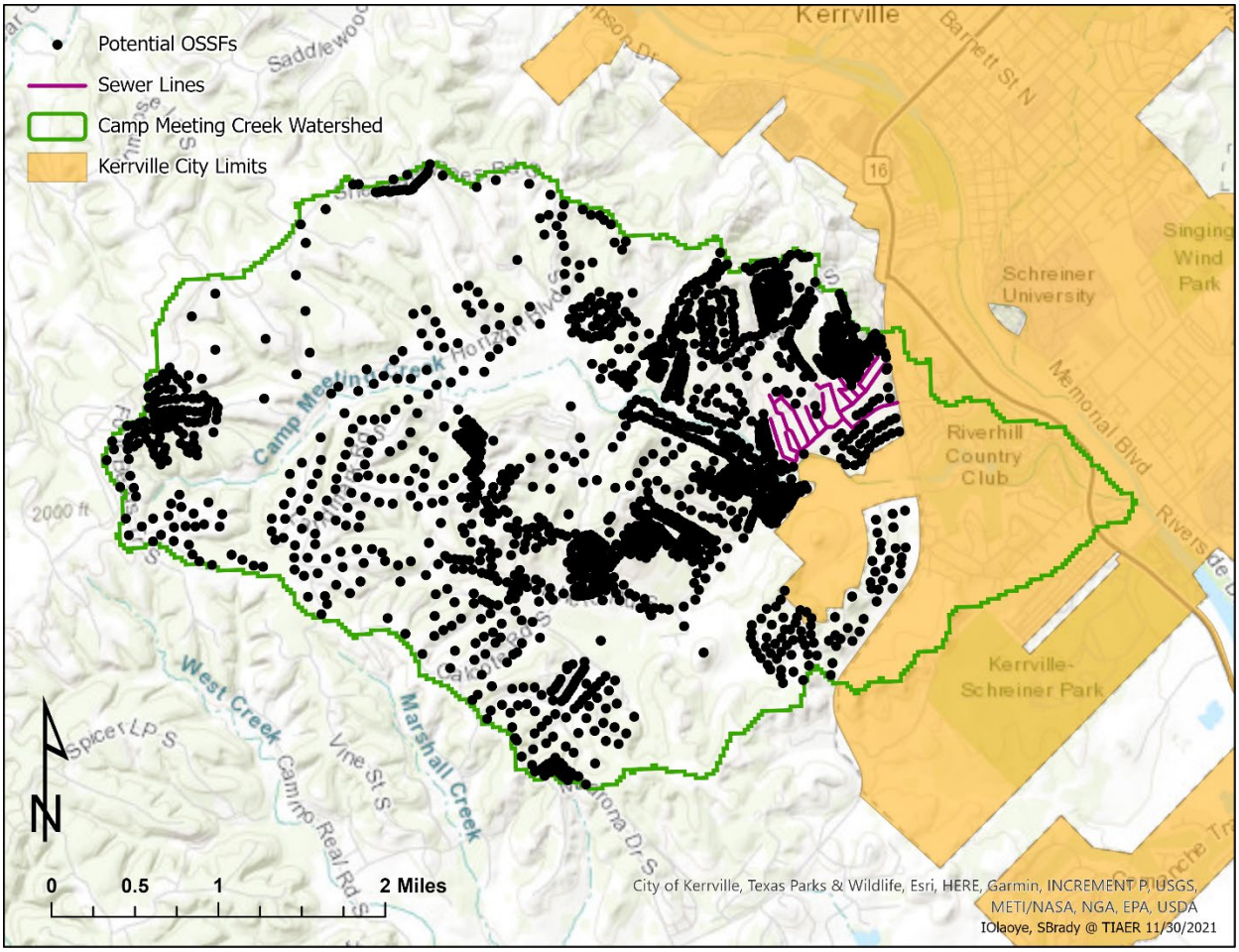

Figure VI-5. OSSFs located within the TMDL watershed

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.

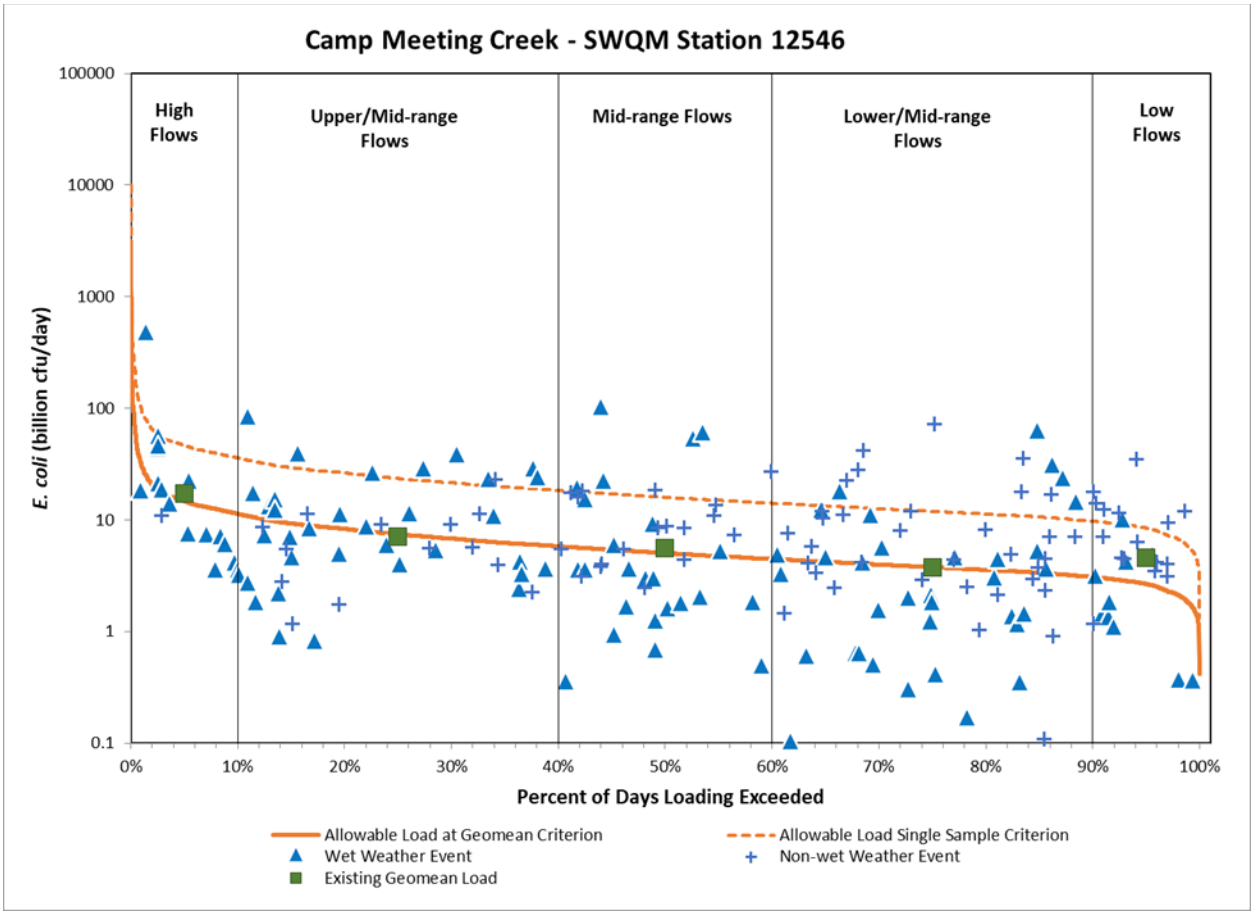

Figure VI-6. LDC at SWQM Station 12546

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 MGD. 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 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.[d] Notice of the comment period, along with the document, was also posted on the WQMP Updates webpage.[e] 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.

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.

[d] www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html

[e] www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html

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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

Appendix VII. Addendum Four to Fifteen TMDLs for Indicator Bacteria in Watersheds Upstream of Lake Houston

Adding one TMDL for AU 1010_03

One TMDL for Indicator Bacteria in Caney Creek

Introduction

TCEQ adopted *Fifteen TMDLs for Indicator Bacteria in Watersheds Upstream of Lake Houston* (TCEQ, 2011) on April 6, 2011. EPA approved the TMDLs on June 29, 2011. This document is the fourth addendum to the original TMDL report.

This fourth addendum includes information specific to one additional AU for Caney Creek (AU 1010_03; also referred to in this addendum as the TMDL watershed). This AU is located within the watershed of the approved original TMDLs for watersheds upstream of Lake Houston. 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 Caney Creek*[f] (Adams and Millican, 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 TMDLs.

Problem Definition

TCEQ first identified the bacteria impairment for Caney Creek AU 1010_03 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 subsequent 2020 Texas 303(d) List, the latest EPA-approved edition. Caney Creek (Segment 1010) contains four AUs; the impaired AU 1010_03 is addressed in this addendum, and AUs 1010_02 and 1010_04 were addressed in the original TMDL report. The subwatershed for just 1010_03 is located entirely within Montgomery County, while the entire TMDL watershed, including the drainage area of upstream AUs 1010_01 and 1010_02, is located in portions of Montgomery and Walker counties. Figure VII-1 shows the

[f] www.tceq.texas.gov/downloads/water-quality/tmdl/houston-galveston-recreational-42/42-as-463-caney-creek-tsd-addendum-4.pdf

watershed added in this addendum in relation to the entire watershed of the original TMDLs, and also includes the area covered by the other addenda.

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 VII-1 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) station on AU 1010_03, as reported in the 2020 Texas Integrated Report (TCEQ, 2020). 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 VII-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.

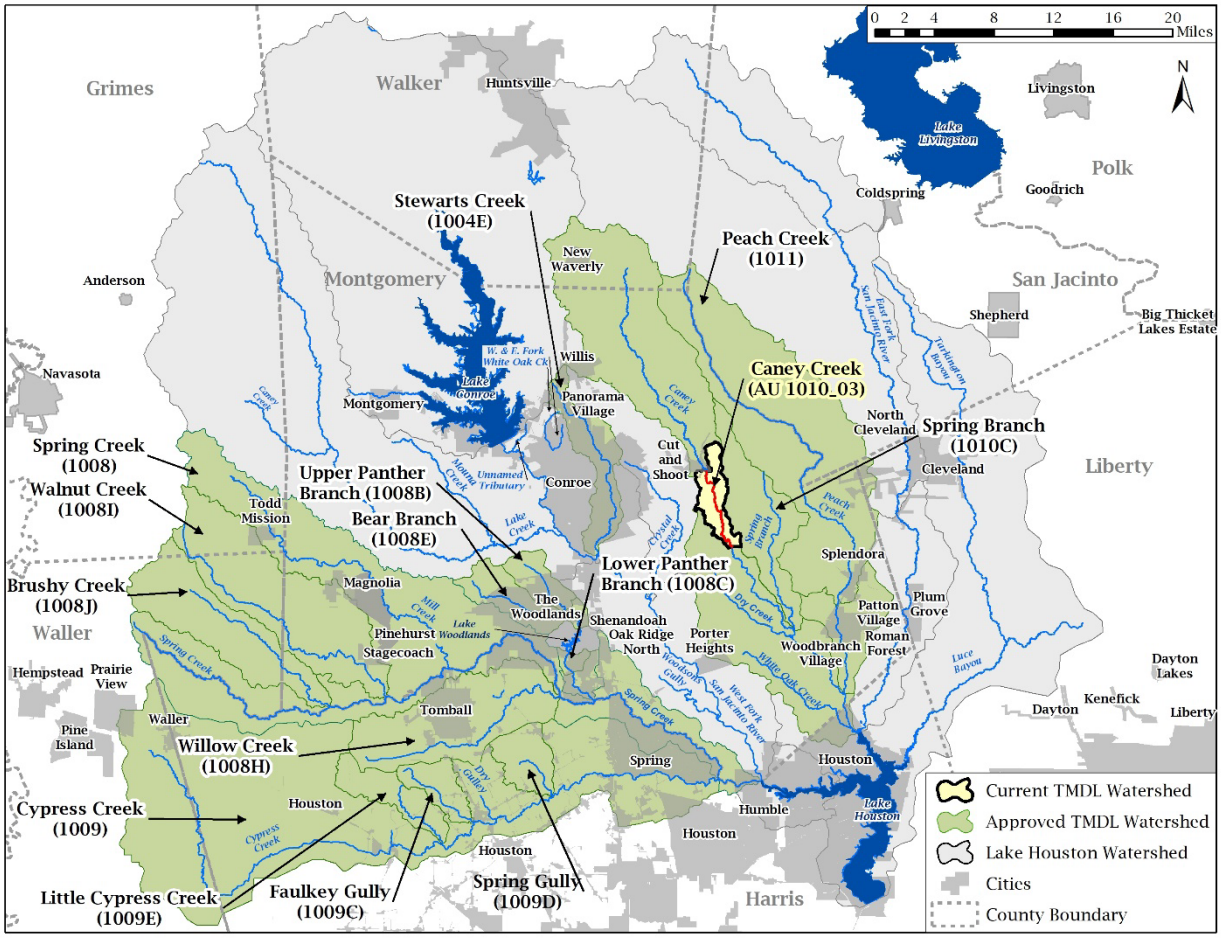

Figure VII-1. Map showing the previously approved TMDL watersheds and the Caney Creek AU 1010_03 subwatershed added by this addendum

Table VII-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)
1010_03	11335	*E. coli*	29	12/01/2011 – 11/30/2018	221

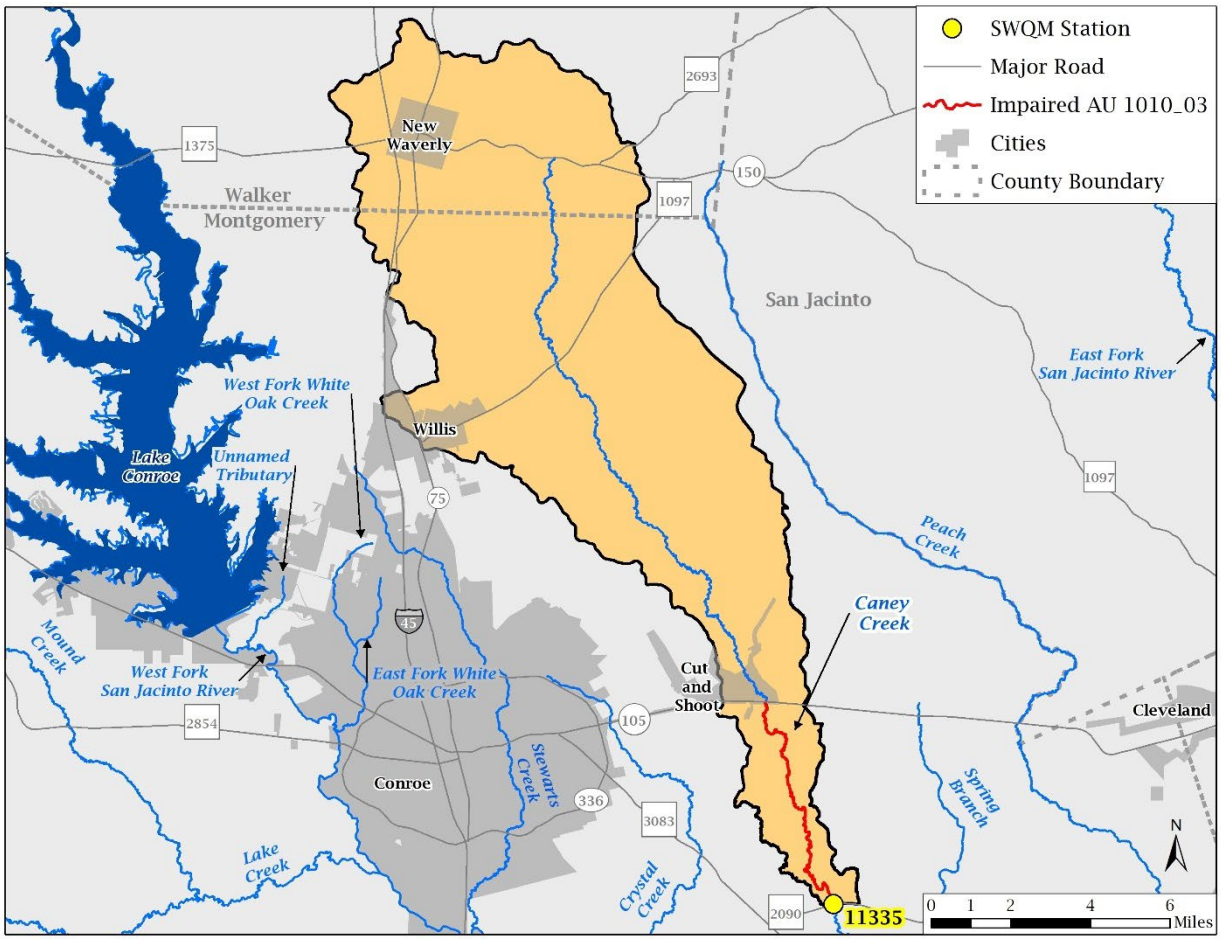

Figure VII-2. AU 1010_03 watershed showing the TCEQ SWQM station

Watershed Overview

Caney Creek (Segment 1010) is a tributary of the East Fork San Jacinto River (Segment 1003) and flows approximately 52 miles. AU 1010_03 is approximately eight miles long. While the subwatershed for just AU 1010_03 has an area of 10.1 square miles (6,448 acres), the entire AU 1010_03 watershed, including the drainage area of upstream AUs 1010_01 and 1010_02, drains an area of 104.7 square miles (67,002 acres). Using a watershed-based approach, the entire, 104.7 square mile watershed of Caney Creek AU 1010_03 will be considered in this report as the TMDL watershed for which the pollutant load allocations will be developed.

The 2020 Texas Integrated Report (TCEQ, 2020) provides the following segment and AU descriptions:

- 1010 (Caney Creek) – From the confluence with the East Fork San Jacinto River in Harris County to State Highway 150 in Walker County.
    - AU 1010_03 – From State Highway 105 to Farm-to-Market 2090.

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) National Climatic Data Center Database. The Conroe-North Houston Regional Airport weather station (USW00053902) located a few miles east of the watershed was used to retrieve the precipitation and temperature data (NOAA, 2021; Figure VII-3). Data from this 15-year period indicate that the average monthly high temperature typically reaches a maximum of 95.1 °F in August, and the average monthly low temperature reaches a minimum of 38.3 °F in January. Annual rainfall averages 46.6 inches. The wettest month is May (5.3 inches), while February (2.7 inches) is the driest month, with rainfall occurring throughout the year.

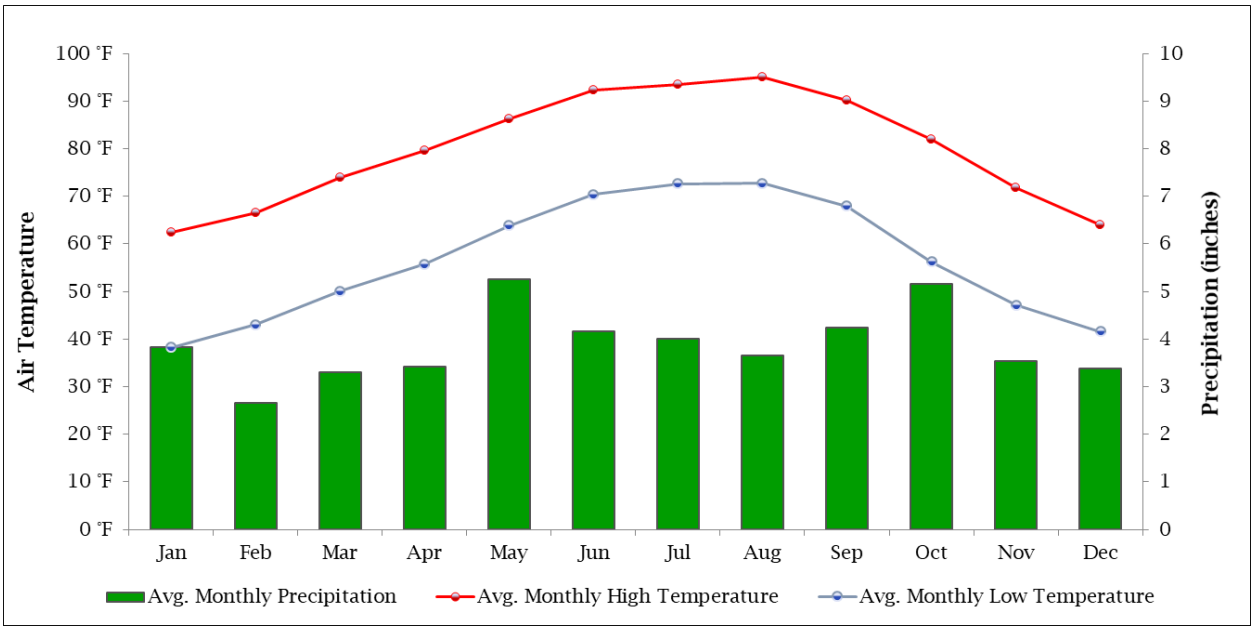

Figure VII-3. Average monthly temperature and precipitation (2006–2020) at the Conroe-North Houston Regional Airport weather station

Watershed Population and Population Projections

The TMDL watershed is located partially within Montgomery and Walker counties and includes portions of three municipal boundaries (Cut and Shoot, Willis, and New Waverly). According to the United States Census Bureau (USCB) 2010 Census (USCB, 2010), the TMDL watershed had an estimated population of 18,037 people in 2010.

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

Table VII-2. Estimated 2010 population and 2070 population projection for the TMDL watershed

Area	2010 Estimated Population	2070 Projected Population	Projected Population Increase	Percentage Change
Entire Caney Creek (AU 1010_03) Watershed	18,037	89,993	71,956	399%

The following steps detail the method used to estimate the 2010 and projected 2070 populations in the TMDL watershed.

8. Obtained 2010 USCB data at the block level.
9. Developed the 2010 watershed population using the USCB block level data for the portions of Montgomery and Walker counties within the watershed.
10. 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.
11. Obtained the TWDB Population Projections by Regional Water Planning Group for Region H. Projections for "County-Other" were used to determine population increases for the rural areas in Montgomery and Walker counties from 2010 to 2070 (TWDB, 2019a).
12. Located the relevant Water User Groups (WUGs) with areas within the watershed and determined the proportion of each WUG area within the watershed (TWDB, 2019b).
13. Calculated decadal percentage increases in population using the TWDB (2019b) decadal population projections for the portion of Cut and Shoot, New Waverly, and Willis WUGs between 2010 and. This projected increase was used to estimate population projections in these cities.
14. Summed the projected population increases obtained in steps 4 and 6 to the 2010 population of the watershed to obtain population projections for the watershed out to 2070.

Land Cover

The land cover data were obtained from United States Geological Survey (USGS) 2016 National Land Cover Database (NLCD) (USGS, 2019). The land cover for the TMDL watershed is shown in Figure VII-4. A summary of the land cover data is provided in Table VII-3 and indicates that the dominant land covers in the TMDL watershed are Pasture/Hay (28.2%) and Evergreen Forest (28.1%).

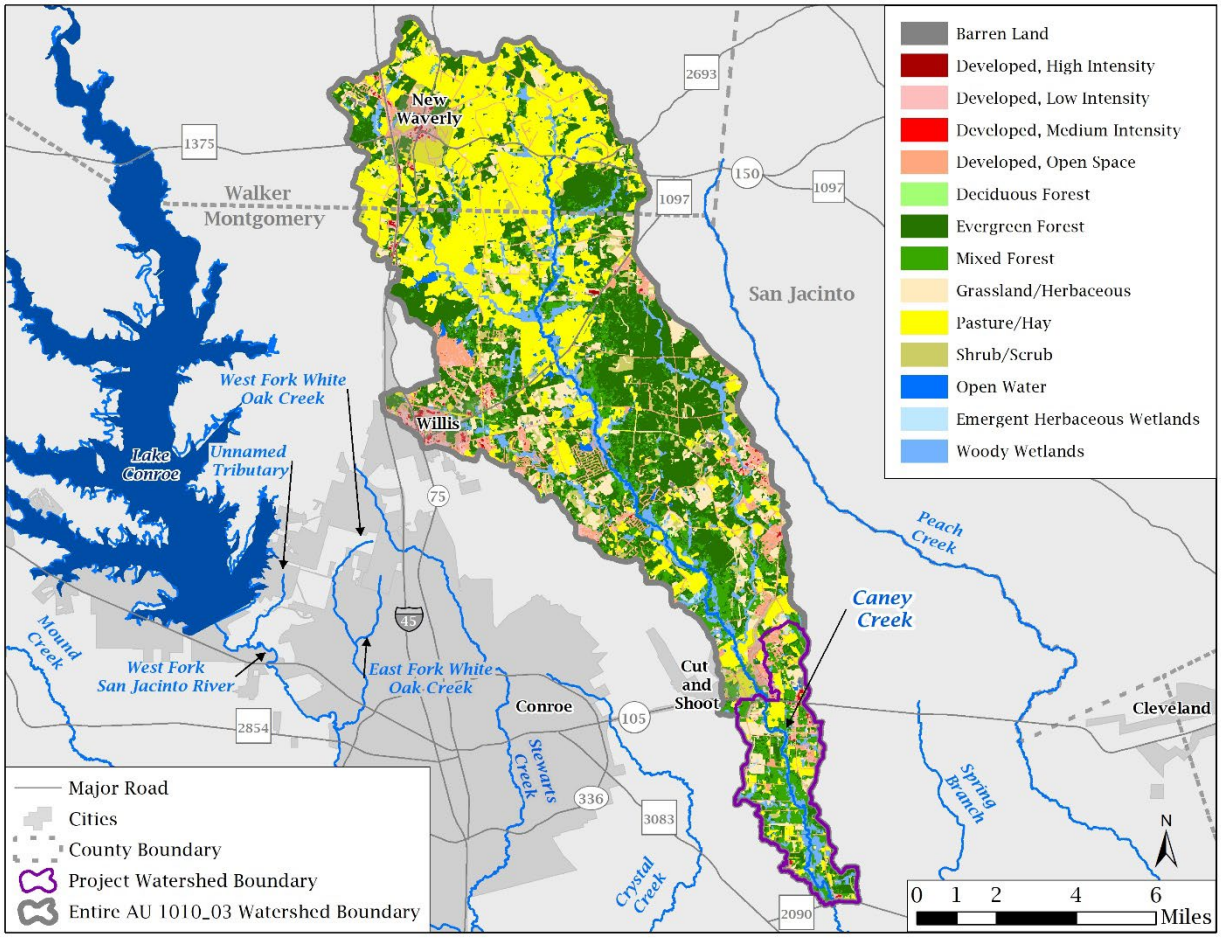

Figure VII-4. 2016 land cover

Table VII-3. Land cover summary

2016 NLCD Classification	Area (Acres)	Percentage of Total
Barren Land	132.8	0.2%
Developed, High Intensity	116.7	0.2%
Developed, Low Intensity	2,374.9	3.5%
Developed, Medium Intensity	427.9	0.6%
Developed, Open Space	4,846.1	7.2%
Deciduous Forest	66.8	0.1%
Evergreen Forest	18,813.4	28.1%
Mixed Forest	7,290.78	10.9%
Grassland/Herbaceous	5,452.4	8.1%
Pasture/Hay	18,888.5	28.2%

2016 NLCD Classification	Area (Acres)	Percentage of Total
Shrub/Scrub	2,855.1	4.3%
Open Water	422.1	0.6%
Emergent Herbaceous Wetlands	289.4	0.4%
Woody Wetlands	5,025.2	7.5%
Total	**67,002**	**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 TPDES program. 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 industries, regulated construction activities, and municipal separate storm sewer systems (MS4s).

Domestic and Industrial WWTFs

As of August 23, 2021, there were 10 WWTFs with TPDES permits within the TMDL watershed (Table VII-4 and Figure VII-5). All the facilities treat solely domestic wastewater.

Table VII-4.TPDES-permitted WWTFs discharging in the TMDL watershed

AU	TPDES Number	NPDES[a] Number	Permittee	Outfall Number	Bacteria (*E. coli*) Limits (cfu/100 mL)	Primary Discharge Type	Daily Average Flow – Permitted Discharge (MGD)
1010_03	WQ0012204001	TX0083216	Conroe Independent School District (ISD)	001	63	Treated domestic wastewater	0.02
1010_03	WQ0014285001	TX0124281	C & R Water Supply Inc.	001	63	Treated domestic wastewater	0.30
1010_03	WQ0015261001	TX0135453	Crystal Springs Water Co., Inc.	001	63	Treated domestic wastewater	0.325
1010_03	WQ0015689001	TX0138568	Crockett Martin Corp.	001	63	Treated domestic wastewater	0.025
1010_03	WQ0016005001	TX0141399	Crystal Springs Water Co., Inc.	001	63	Treated domestic wastewater	0.75
1010_02	WQ0011715001	TX0068659	Texas National Municipal Utility District (MUD)	001	63	Treated domestic wastewater	0.225
1010_02	WQ0012670001	TX0092517	Quadvest, L.P.	001	63	Treated domestic wastewater	0.175
1010_02	WQ0015984001	TX0141224	Texas Campgrounds Club, Inc.	001	63	Treated domestic wastewater	0.04
1010_01	WQ0011020001	TX0056685	City of New Waverly	001	63	Treated domestic wastewater	0.088
1010_01	WQ0011020002	TX0087831	City of New Waverly	001	63	Treated domestic wastewater	0.10

[a]NPDES: National Pollutant Discharge Elimination System

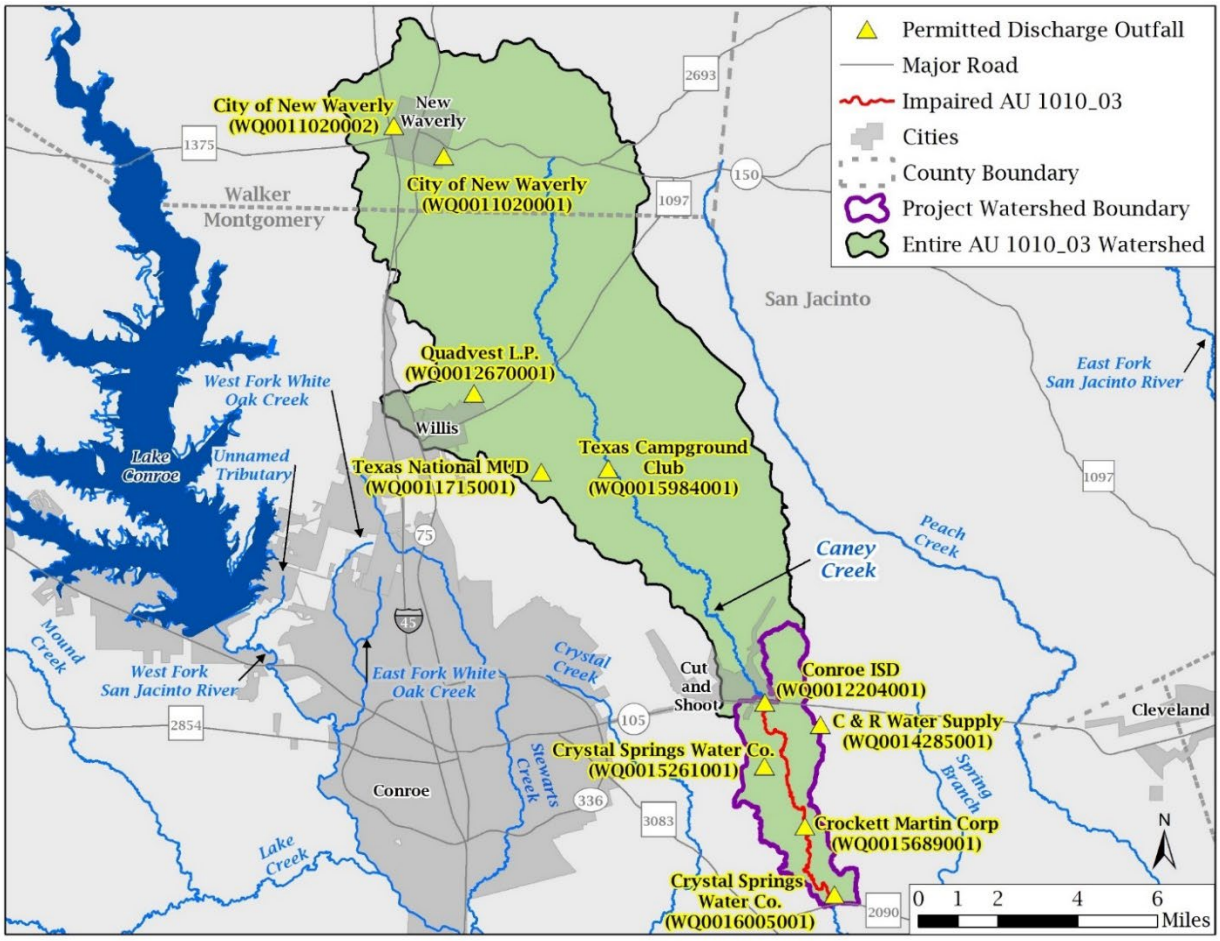

Figure VII-5. WWTFs in the TMDL watershed

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 2, 2021, found one concrete production facility covered by the general permit. The

same review revealed one pesticide permittee covered by the general permit. This facility and pesticide management area do not have bacteria reporting requirements or limits in their permits. Pesticide application in the pesticide management areas is assumed to contain inconsequential amounts of indicator bacteria; therefore, it was unnecessary to allocate bacteria loads to them. No other active wastewater general permit authorizations were found in the TMDL watershed.

Sanitary Sewer Overflows

A summary of sanitary sewer overflow (SSO) incidents that occurred during a four-year period from 2016 through 2019 in the TMDL watershed was obtained from the TCEQ Central Office in Austin. The summary data indicated 15 SSO incidents had been reported within the TMDL watershed. The SSOs with reported volumes had a total discharge of 36,327 gallons with a minimum of one gallon and a maximum of 24,000 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:

3. Stormwater subject to regulation, which is any stormwater originating from TPDES-regulated municipal MS4 entities, stormwater discharges associated with regulated industrial activities, and construction activities.
4. 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 September 14, 2021, found two active MSGP authorizations within the watershed and 17 CGP authorizations. There are currently two Phase II MS4 authorizations and one combined Phase I/Phase II permit within the TMDL watershed (Table VII-5). Figure VII-6 shows the urbanized area defined by USCB that accounts for MS4 coverage within the TMDL watershed.

Table VII-5. TPDES MS4 permit associated with the TMDL watershed

Entity	TPDES Permit	NPDES Permit	Authorization Type
Texas Department of Transportation	WQ0005011000	TXS002101	Combined Phase I/II
Montgomery County	General Permit (TXR040000)	TXR040348	Phase II
City of Willis	General Permit (TXR040000)	TXR040538	Phase II

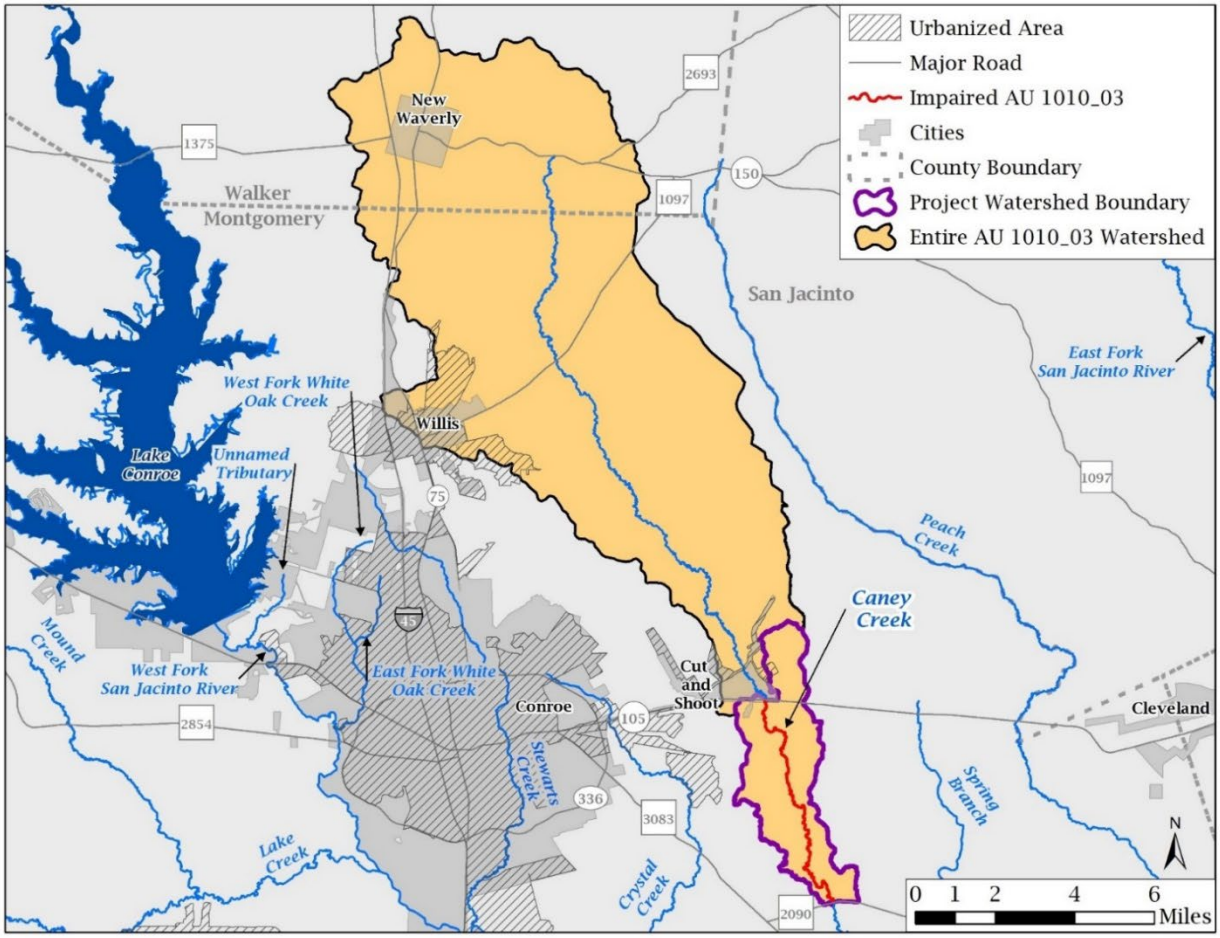

Figure VII-6. Regulated stormwater area based on urbanized area within the TMDL watershed

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 or small 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.

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 VII-6 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 NASS, 2019). The county-level estimated livestock populations for Montgomery and Walker counties were reviewed by Texas State Soil and Water Conservation Board staff and were distributed by dividing the suitable livestock land cover (Pasture/Hay, Grassland/Herbaceous, Shrub/Scrub, plus Deciduous, Evergreen and Mixed Forests) area of the watershed within each county by the total suitable livestock land cover area of each 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 VII-6. Estimated livestock populations

AU	Cattle and Calves	Hogs and Pigs	Poultry	Goats and Sheep	Horses
1010_03 (entire watershed)	3,352	152	3,758	422	437

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 VII-7 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 2010 Census data (USCB, 2010). The actual contribution and significance of bacteria loads from pets reaching the water bodies in the watershed is unknown.

Table VII-7. Estimated households and pet population

Estimated Households	Estimated Dog Population	Estimated Cat Population
6,214	3,815	2,840

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, a study by Timmons et al. (2012) estimated a range of feral hog densities within suitable habitat in Texas (8.9 to 16.4 hogs/square mile). The average hog density (12.65 hogs/square mile) was multiplied by the hog-habitat area (91.69 square miles) in the TMDL watershed. Habitat deemed suitable for hogs followed as closely as possible to the land cover selections of the study and include from the 2016 NLCD land cover: Deciduous Forest, Evergreen Forest, Mixed Forest, Emergent Herbaceous Wetlands, Woody Wetlands, Pasture/Hay, Shrub/Scrub, and Grassland/Herbaceous. Using this methodology, there are an estimated 1,160 feral hogs in the TMDL watershed.

For deer, the Texas Parks and Wildlife Department (TPWD) published data showing deer population-density estimates by Deer Management Unit (DMU) and Ecoregion in the state (TPWD, 2021). The TMDL watershed is located within portions of DMU 14 and the DMU Urban Houston for which there is no deer density data. Due to the lack of deer density data for DMU Urban Houston, density data from DMU 14 was used to estimate the deer population for the watershed. For the 2020 TPWD survey year, the estimated deer population density for DMU 14 was 25.03 deer/1,000 acres and applies to all habitat types within the DMU area. Applying this value to the entire area of the watershed returns an estimated 1,677 deer within the TMDL watershed.

Onsite Sewage Facilities

The estimated number of OSSFs in the TMDL watershed was determined using data supplied by H-GAC for Montgomery and Walker counties. These data indicate that there are 1,981 OSSFs located within the TMDL watershed (Figure VII-7). 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.

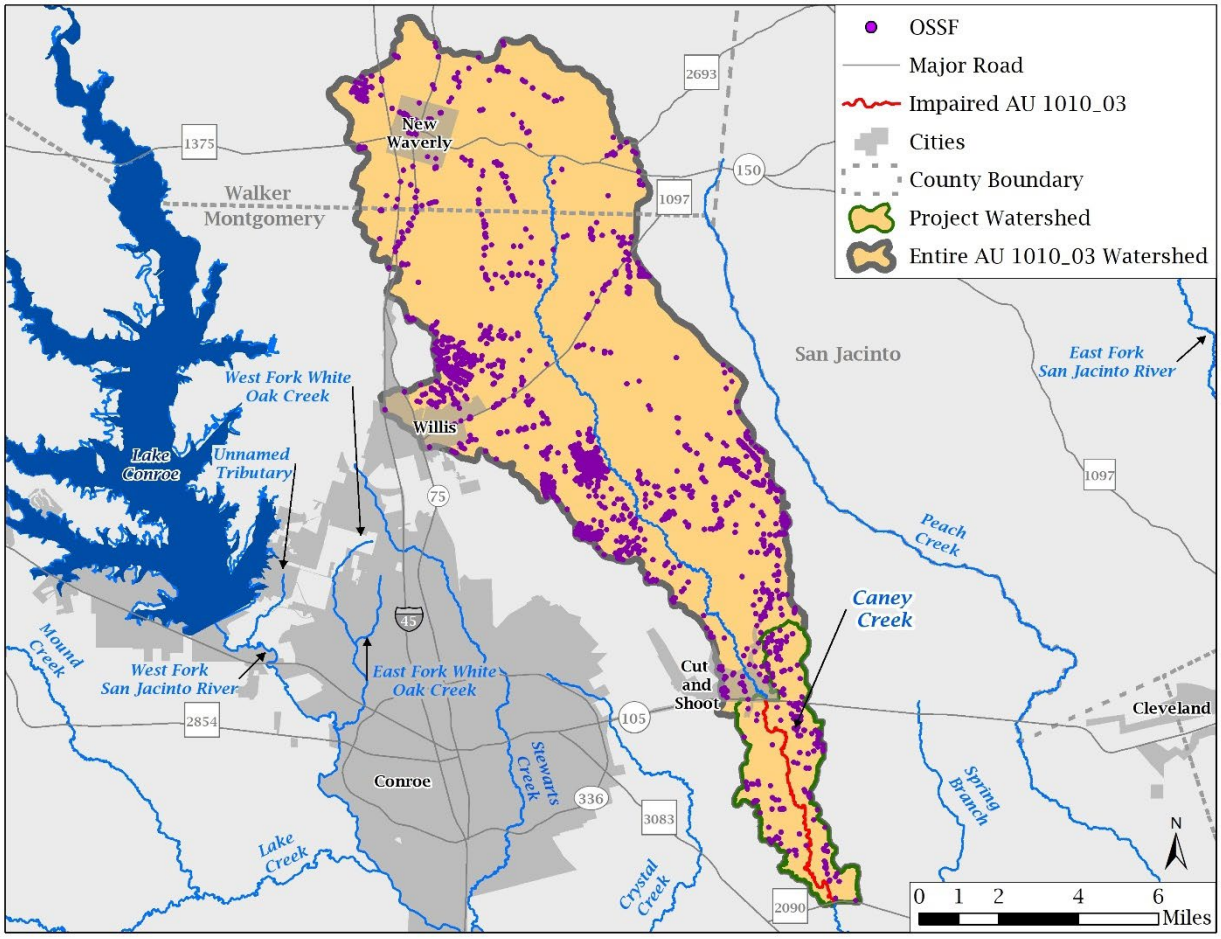

Figure VII-7. OSSFs located within the TMDL watershed

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 (Adams and Millican, 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 11335 in Figure VII-8 show exceedances of the geometric mean criterion have occurred under all three flow regimes, especially during Wet Conditions. There is some moderation of the elevated loadings under Moderate and Dry Conditions for the project watershed. The geometric means of the measured data for each flow regime generally support the observation of decreasing concentration with decreasing flow, and under Dry Conditions the data indicate the geometric mean is below the geometric mean criterion (126 cfu/100 mL). 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.

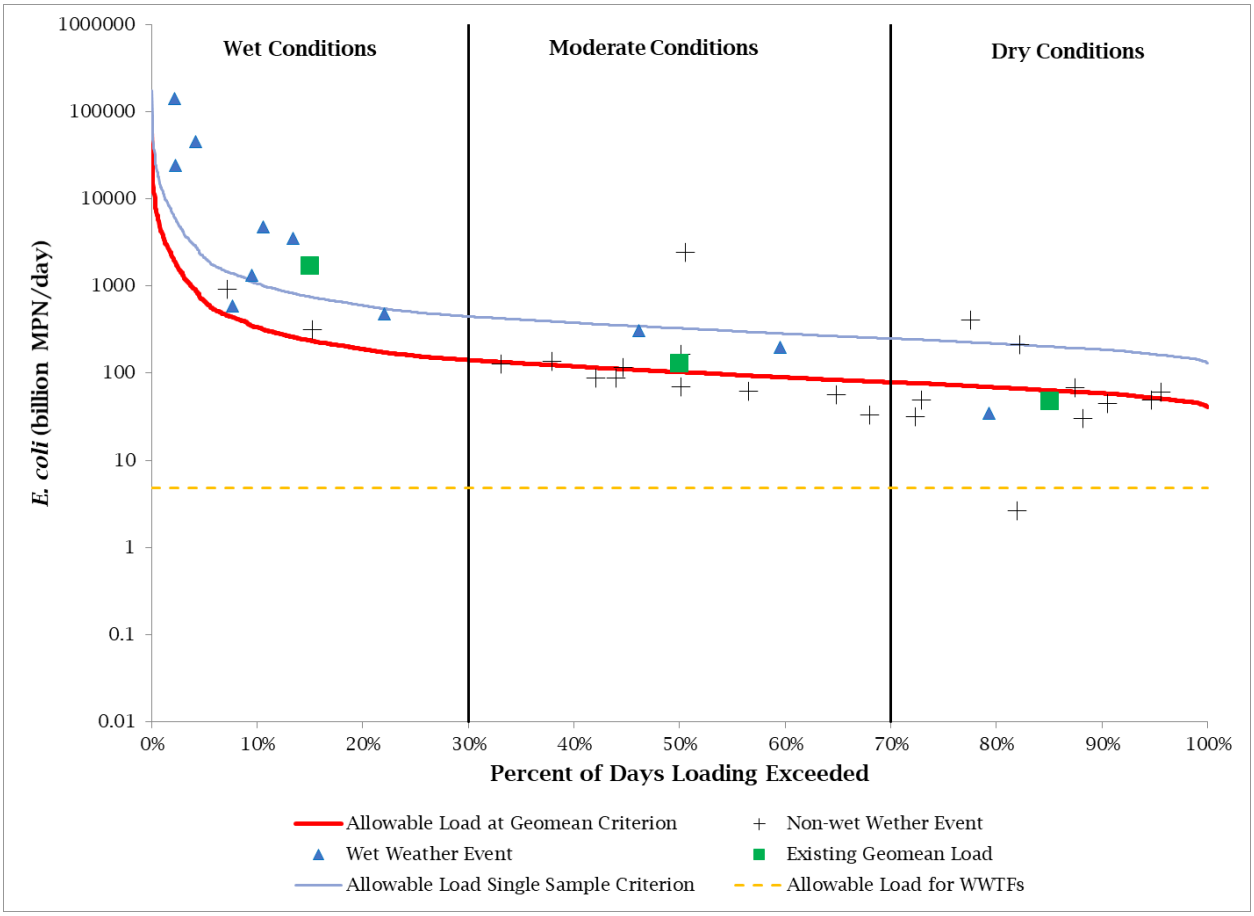

Figure VII-8. LDC at SWQM Station 11335

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 Caney Creek AU 1010_03 was derived using the median flow within the Wet Conditions flow regime (or 15% load duration exceedance) of the LDC developed for TCEQ SWQM Station 11335 (located at the watershed outlet). This station represents the location within Caney Creek AU 1010_03 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 one-half the instream geometric mean criterion. One-half of the water quality criterion (63 cfu/100 mL *E. coli*) is used as the WWTF target to provide instream and downstream load capacity and to be consistent with the original TMDL report. Table VII-8 presents the WLA for each WWTF and the resulting total allocation for the AU within the TMDL watershed.

Table VII-8. WLAs for TPDES-permitted facilities

AU	TPDES Number	Permittee	Bacteria Limit (cfu/100 mL *E. coli*)	Full Permitted Flow (MGD)	WLA_{WWTF} (billion cfu/day *E. coli*)
1010_03	WQ0012204001	Conroe ISD	63	0.02	0.048
1010_03	WQ0014285001	C & R Water Supply Inc.	63	0.30	0.715
1010_03	WQ0015261001	Crystal Springs Water Co., Inc.	63	0.325	0.775
1010_03	WQ0015689001	Crockett Martin Corp.	63	0.025	0.060
1010_03	WQ0016005001	Crystal Springs Water Co., Inc.	63	0.75	1.789
1010_02	WQ0011715001	Texas National MUD	63	0.225	0.537
1010_02	WQ0012670001	Quadvest, L.P.	63	0.175	0.417
1010_02	WQ0015984001	Texas Campgrounds Club, Inc.	63	0.04	0.095
1010_01	WQ0011020001	City of New Waverly	63	0.088	0.210
1010_01	WQ0011020002	City of New Waverly	63	0.10	0.238
			Total	**2.048**	**4.884**

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.

Acreages associated with MS4s (2,607 acres), MSGP authorizations (49 acres), CGP authorizations (1,608 acres), and concrete production facilities (55 acres) were calculated using geographic information system shapefiles as well as aerial imagery by measuring the estimated disturbed area at each facility location (or the "area disturbed" listed for CGP authorizations). The percentage of land under the jurisdiction of stormwater permits in the TMDL watershed is 6.45%.

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.

The FG component of the TMDL watershed was based on population projections and current permitted wastewater dischargers for the entire TMDL watershed. Recent population and projected population growth between 2010 and 2070 for the TMDL watershed are provided in Table VII-2. The projected population percentage increase within the watershed was multiplied by the corresponding WLA_{WWTF} to calculate future WLA_{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 VII-9 summarizes the TMDL calculations for the TMDL watershed. The TMDL was calculated based on the median flow in the 0-30 percentile range (15% exceedance, Wet Conditions flow regime) from the LDC developed for TCEQ SWQM Station 11335. Allocations are based on the current geometric mean criterion for *E. coli* of 126 cfu/100 mL for each component of the TMDL (with the exception of the WLA_{WWTF} and FG terms, which use one-half the criterion).

Table VII-9. TMDL allocation summary for AU 1010_03

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

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	FG
Caney Creek	1010_03	237.441	11.872	4.884	12.977	188.219	19.489

The final TMDL allocations (Table VII-10) needed to comply with federal requirements include the FG component within the WLA_{WWTF} (40 CFR Section 103.7).

Table VII-10. Final TMDL allocation for AU 1010_03

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

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA
Caney Creek	1010_03	237.441	11.872	24.373	12.977	188.219

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 (2010 through 2019) of routine monitoring data collected at one SWQM station (11335) in the warmer months (May-September) against those collected during cooler months (November-March). The months of April and October were considered transitional between warm and cool seasons and were excluded from the seasonal analysis. Differences in seasonal concentrations were then evaluated with a Wilcoxon Rank Sum test (also known as the "Mann-Whitney" test). The analysis of *E. coli* data indicated that there was no significant difference in indicator bacteria between the cool and warm weather seasons (α=0.05) for Caney Creek. 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 (Adams and Millican, 2021) was published on the TCEQ website on March 11, 2022. Project staff presented information about this addendum at the annual spring meeting of the the Bacteria Implementation Group (BIG) in Houston (held online) on May 25, 2021. The public had an opportunity to comment on this addendum during the public comment period (May 6 through June 7, 2022) for the 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.[g] Notice of the comment period, along with the document, was also posted on the WQMP Updates webpage.[h] TCEQ accepted public comments on the original TMDL report from November 19 through December 20, 2010. Two comments were submitted, and neither of them referred directly to the AU in this TMDL addendum.

Implementation and Reasonable Assurance

The AU covered by this addendum is within the existing bacteria TMDL watersheds upstream of Lake Houston. That TMDL watershed, including Caney Creek AU 1010_03, is within the area covered by the implementation plan (I-Plan) developed by the BIG for

[g] www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html

[h] www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html

bacteria TMDLs throughout the greater Houston area, which was approved by the commission on January 30, 2013. 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 VIII. Addendum Two to Eight TMDLs for Indicator Bacteria in Dickinson Bayou and Three Tidal Tributaries

Adding two TMDLs for AUs 1103F_01 and 1103G_01

Two TMDLs for Indicator Bacteria in Dickinson Bayou

Introduction

TCEQ adopted *Eight TMDLs for Indicator Bacteria in Dickinson Bayou and Three Tidal Tributaries* (TCEQ, 2012) on February 8, 2012. EPA approved the TMDLs on June 6, 2012. An addendum to the original TMDL was submitted to EPA through the July 2016 WQMP update (TCEQ, 2016). That addendum added three additional AU(s). This document is the second addendum to the original TMDL report.

This second addendum includes information specific to two additional AUs for Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 and Unnamed Tributary of Gum Bayou AU 1103G_01 (also referred to in this addendum as the TMDL watersheds). These AUS are located within the watershed of the approved original TMDLs for Dickinson Bayou. The concentrations of indicator bacteria in these additional AUs exceed the criterion used to evaluate support of the primary contact recreation 1 use.

This addendum details the development of the added TMDL allocations for these additional AUs, which were not specifically addressed in the original TMDL report. For background or other explanatory information, please refer to the *Technical Support Document for two Total Maximum Daily Loads for Indicator Bacteria in Unnamed Tributaries of Dickinson Bayou Tidal and Gum Bayou*[i] (Adams and Millican, 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 TMDLs.

Problem Definition

TCEQ first identified the bacteria impairments for Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 and Unnamed Tributary of Gum Bayou AU 1103G_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, 2018a) and then in the subsequent 2020 Texas 303(d) List, the latest EPA-approved edition. The impaired AUs are 1103F_01 and 1103G_01. The TMDL watersheds are located entirely within Galveston

[i] www.tceq.texas.gov/downloads/water-quality/tmdl/dickinson-bayou-recreational-80/80-as-464-unnamed-tribs-dickinson-bayou-tsd-2022-addendum-2.pdf

County. Figure VIII-1 shows the watersheds added in this addendum in relation to the entire watershed of the original TMDLs, and also includes the watersheds from the first addendum.

The Texas Surface Water Quality Standards (TCEQ, 2018b) 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 TMDLs developed in this addendum is the numeric criterion for indicator bacteria from the 2018 Texas Surface Water Quality Standards. Enterococci are the indicator bacteria for assessing primary contact recreation 1 use in saltwater.

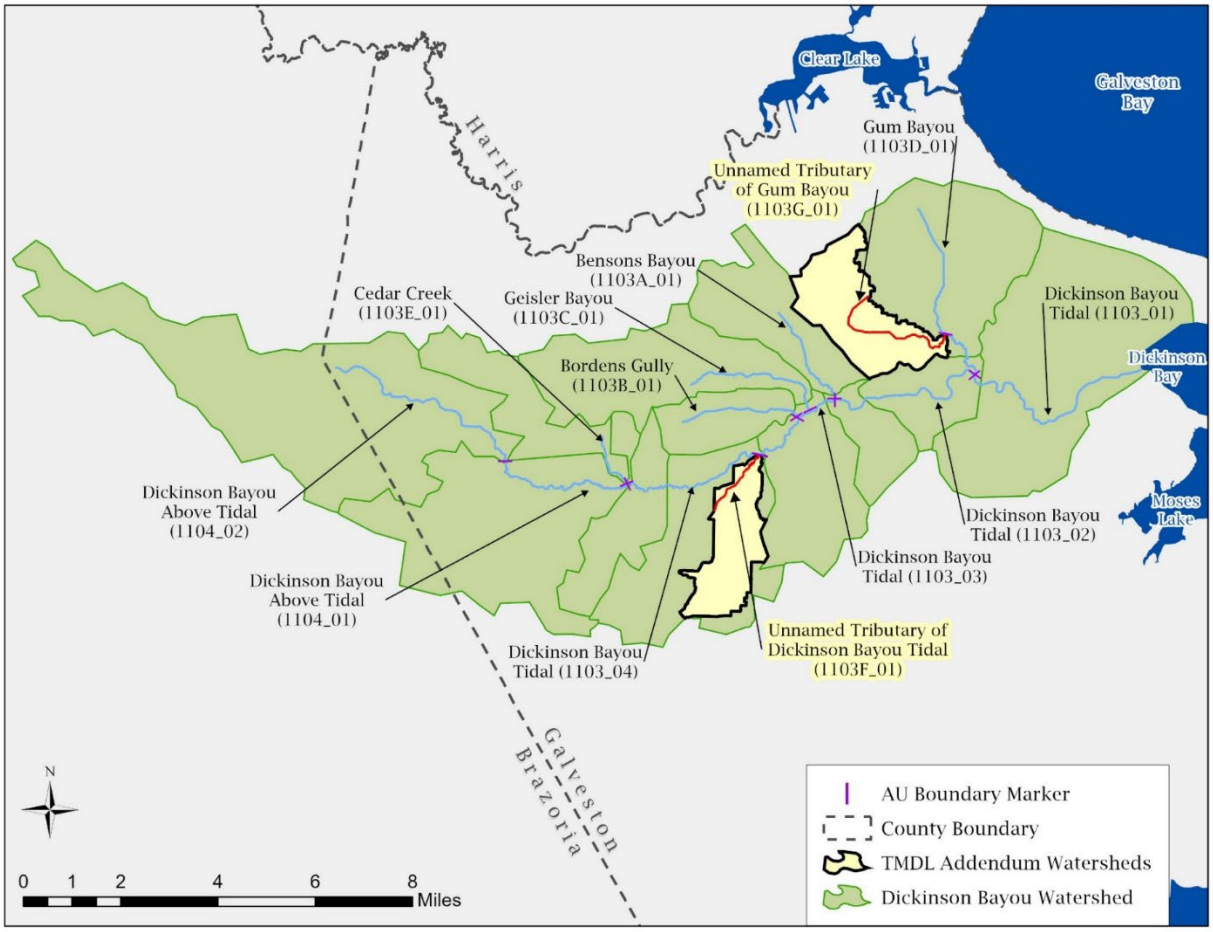

Figure VIII-1. Map showing the previously approved TMDL watersheds and the Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 and Unnamed Tributary of Gum Bayou AU 1103G_01 subwatersheds added by this addendum

Table VIII-1 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) stations on the water bodies, as reported in the 2020 Texas Integrated Report (TCEQ, 2020). The data from the assessment indicate nonsupport of the primary contact recreation 1 use for the AUs, because the geometric mean

concentration for Enterococci exceeds the saltwater geometric mean criterion of 35 colony forming units per 100 milliliters (cfu/100mL) of water. Figure VIII-2 shows the locations of the TCEQ SWQM stations that were used in evaluating water quality in the 2020 Texas Integrated Report for the water bodies added by this addendum.

Table VIII-1. 2020 Texas Integrated Report summary for the TMDL watersheds

AU	Station	Parameter	Number of Samples	Date Range	Enterococci Geometric Mean (cfu/100 mL)
1103F_01	20477	Enterococci	20	12/01/2011 – 11/30/2018	188
1103G_01	20728	Enterococci	28	12/01/2011 – 11/30/2018	522

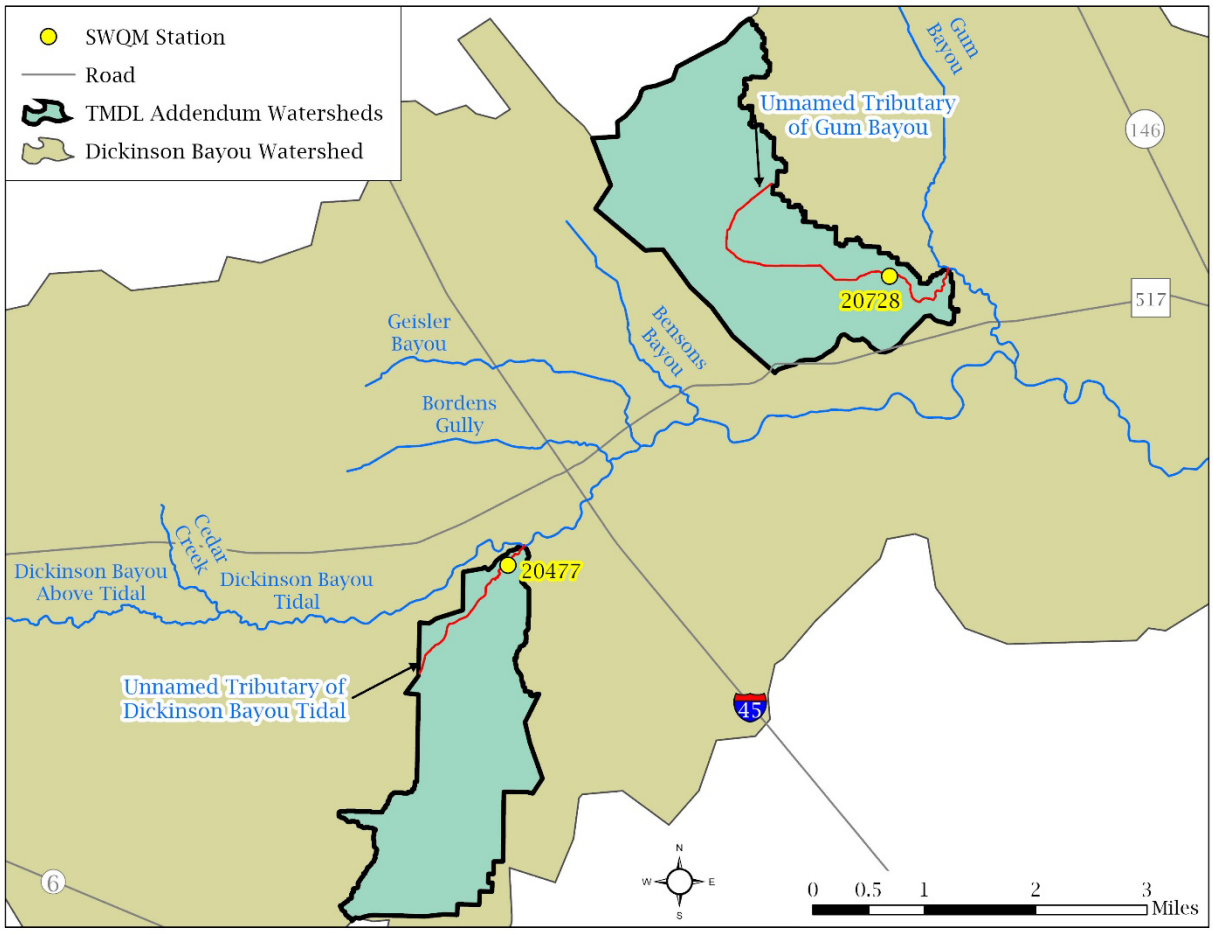

Figure VIII-2. AU 1103F_01 and AU 1103G_01 watersheds showing the TCEQ SWQM stations

Watershed Overview

The Unnamed Tributary of Dickinson Bayou Tidal (AU 1103F_01) is a tributary of Dickinson Bayou (Segment 1103). The Unnamed Tributary of Gum Bayou (AU 1103G_01) is a tributary to Gum Bayou (AU 1103D_01). AU 1103F_01 is approximately 1.71 miles long and drains an area of 3.14 square miles (2,011 acres). AU 1103G_01 is approximately 3.29 miles long and drains an area of 4.36 square miles (2,788 acres). Both TMDL watersheds are located entirely within Galveston County.

The 2020 Texas Integrated Report (TCEQ, 2020) provides the following description for AU 1103G_01. The description for AU 1103F_01 was revised during development of the TMDLs (TCEQ, 2021a) and the new description shown here will be included in future Integrated Reports:

- 1103F_01 (Unnamed Tributary of Dickinson Bayou Tidal) – From the Dickinson Bayou Tidal confluence to a point 2.75 kilometers (1.7 miles) upstream at Galveston County Drainage Ditch 9.
- 1103G_01 (Unnamed Tributary of Gum Bayou) – From the confluence with Gum Bayou to a point 0.39 miles south of Farm-to-Market 646/Farm-to-Market 1266 intersection between League City and Dickinson.

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) National Center for Environmental Information. The Houston National Weather Service Office weather station (USC00414333) located in League City was used to retrieve the precipitation and temperature data (NOAA, 2021, Figure VIII-3). Data from this 15-year period indicate that the average monthly high temperature typically reaches a maximum of 92.5 ˚F in August, and the average monthly low temperature reaches a minimum of 43 ˚F in January (Figure VIII-3). Annual rainfall averages 60.7 inches. The wettest month is September (7.9 inches) while February (2.6 inches) is the driest month, with rainfall occurring throughout the year.

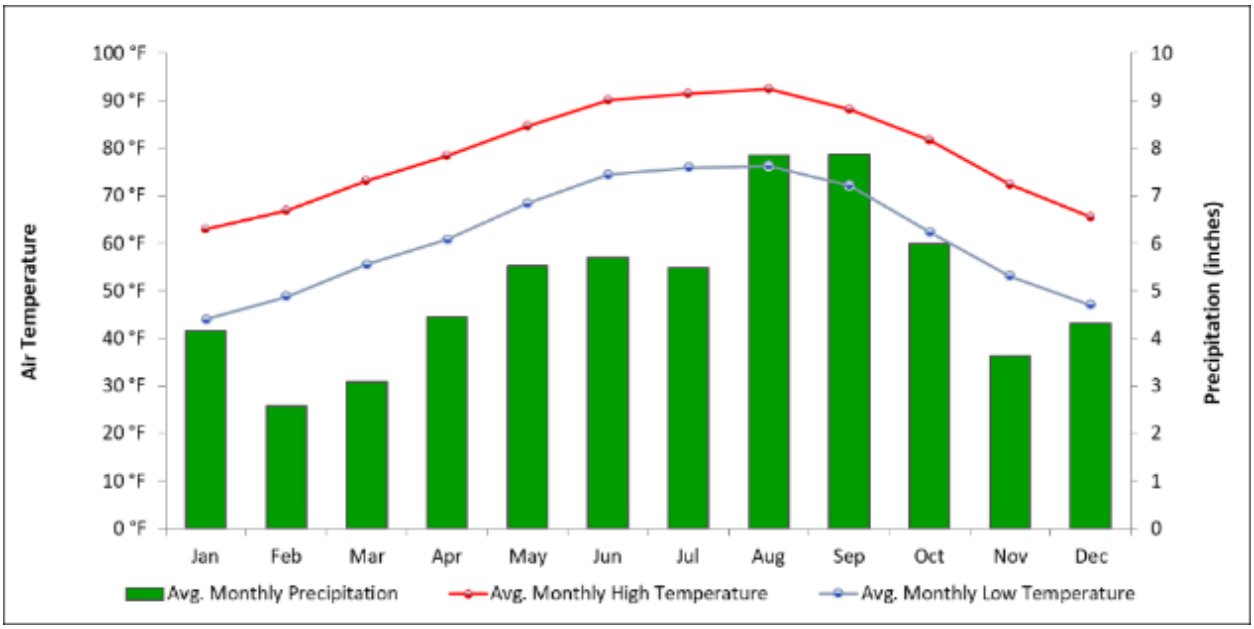

Figure VIII-3. Average monthly temperature and precipitation (2006–2020) at the National Weather Center Office in League City weather station

Watershed Population and Population Projections

The TMDL watersheds are located within Galveston County and include portions of three municipal boundaries (Dickinson, Santa Fe, and League City). According to the United States Census Bureau (USCB) 2010 Census (USCB, 2010), the AU 1103F_01 watershed had an estimated population of 1,608 people in 2010 and the AU 1103G_01 watershed had an estimated population of 10,166 people in 2010.

The population projections in Table VIII-2 are estimated from the H-GAC 2018 Regional Growth Forecast data (H-GAC, 2017). The regional growth forecasts include population projections for transportation analysis zones (TAZ), planning areas used by H-GAC to provide analyses at a local scale. H-GAC updates their regional growth forecast using inputs such as the latest available information on planned and announced developments, population and employment data, and feedback received from forecast users.

Table VIII-2. 2010 population and 2045 population projections for the TMDL watersheds

Area	2010 Estimated Population	2045 Projected Population	Projected Population Increase	Percentage Change
Unnamed Tributary of Dickinson Bayou Tidal (AU 1103F_01) Watershed	1,608	3,120	1,512	94.0%

Area	2010 Estimated Population	2045 Projected Population	Projected Population Increase	Percentage Change
Unnamed Tributary of Gum Bayou (AU 1103G_01) Watershed	10,166	17,266	7,100	69.8%

The following steps detail the method used to estimate the 2010 and projected 2045 populations in the TMDL watersheds.

1. Obtained 2010 USCB data at the block level.
2. Developed 2010 watershed populations using the block level data for the portion of the census blocks located within the watersheds.
3. For the census blocks that were partially located in the watershed, estimated population by multiplying the block population to the proportion of its area in the watersheds.
4. Obtained the 2018 H-GAC regional growth forecast data and associated TAZs to be used for population projections (H-GAC, 2017).
5. Joined population data for each TAZ with the TAZ polygons in a geographic information system and located the TAZs within the TMDL watersheds.
6. For the TAZs that were partially located in the watersheds, estimated population projections by multiplying the TAZ population to the proportion of its area in the watersheds.
7. Subtracted the 2010 watershed populations from the 2045 population projections to determine the projected population increases. Subsequently, divided the projected population increases by the 2010 watershed populations to determine the percentage population increases for the TMDL watersheds.

Land Cover

The land cover data were obtained from the United States Geological Survey (USGS) 2016 National Land Cover Database (NLCD; USGS, 2019). The land cover for the TMDL watersheds is shown in Figure VIII-4. A summary of the land cover data is provided in Table VIII-3. For the Unnamed Tributary of Dickinson Bayou Tidal (AU 1103F_01) watershed, the predominant land cover is Developed, Open Space comprising 45.41% of the total land cover, followed by Pasture/Hay (11.88%) and Developed, Low Intensity (10.77%). For the Unnamed Tributary of Gum Bayou (AU 1103G_01) watershed, the Developed categories (Low Intensity 30.53%, Open Space 26.76%, Medium Intensity 16.63%, and High Intensity 5.27%) are the dominant land covers comprising 79.19% of the total.

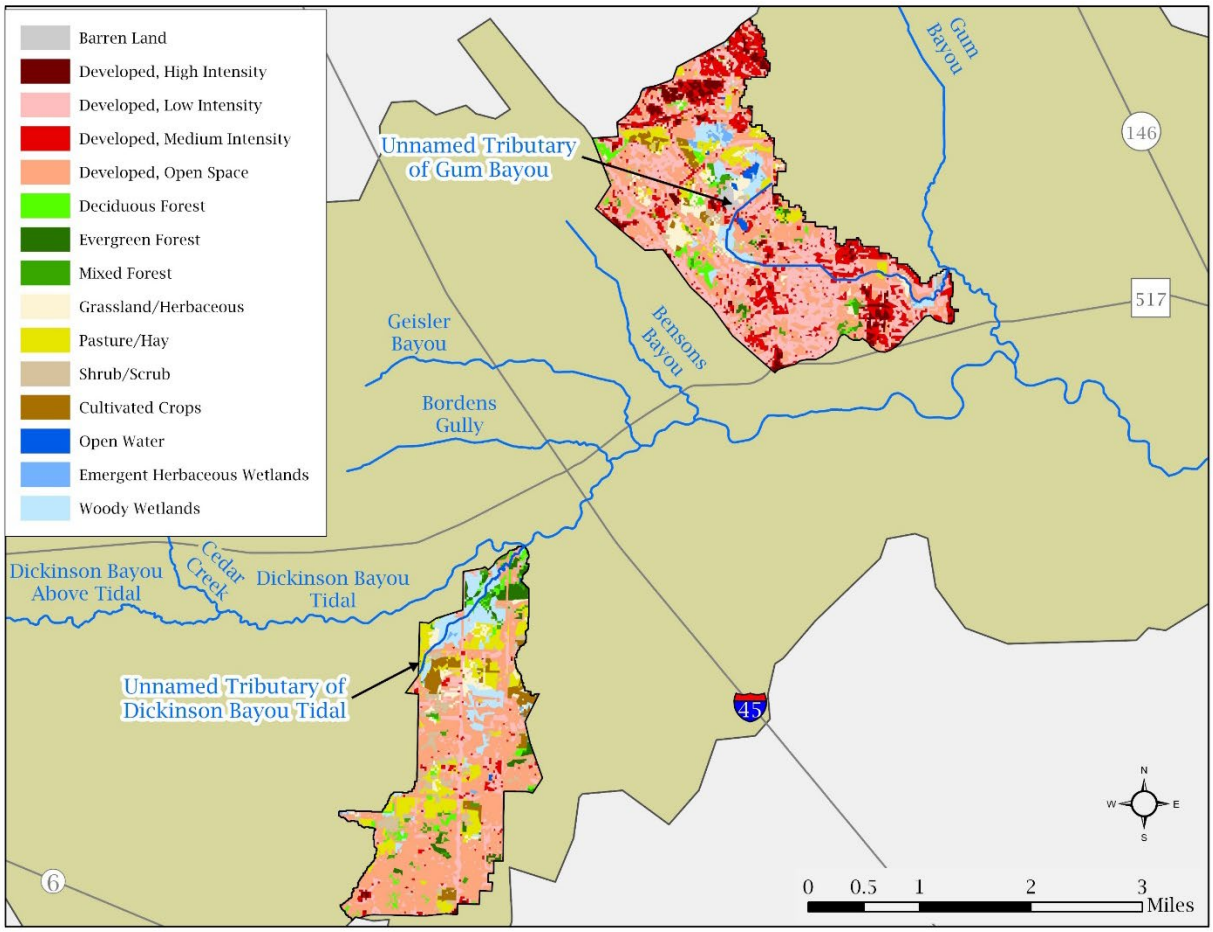

Figure VIII-4. 2016 land cover

Table VIII-3. Land cover summary

2016 NLCD Classification	1103F_01 Area (Acres)	1103F_01 Percentage of Total	1103G_01 Area (Acres)	1103G_01 Percentage of Total
Barren Land	0.45	0.02%	18.23	0.65%
Developed, High Intensity	6.47	0.32%	146.81	5.27%
Developed, Low Intensity	216.61	10.77%	850.94	30.53%
Developed, Medium Intensity	40.26	2.00%	463.65	16.63%
Developed, Open Space	913.25	45.41%	745.97	26.76%
Deciduous Forest	53.73	2.67%	57.05	2.05%
Evergreen Forest	61.31	3.05%	10.55	0.38%
Mixed Forest	41.06	2.04%	32.11	1.15%
Grassland/Herbaceous	65.11	3.24%	122.32	4.39%
Pasture/Hay	238.89	11.88%	122.45	4.39%

2016 NLCD Classification	1103F_01 Area (Acres)	1103F_01 Percentage of Total	1103G_01 Area (Acres)	1103G_01 Percentage of Total
Shrub/Scrub	103.79	5.16%	29.77	1.07%
Cultivated Crops	82.04	4.08%	41.78	1.50%
Open Water	1.88	0.09%	15.33	0.55%
Emergent Herbaceous Wetlands	6.35	0.32%	21.46	0.77%
Woody Wetlands	180.09	8.95%	109.17	3.92%
Total	**2,011.29**	**100%**	**2,787.59**	**100 %**

Endpoint Identification

The endpoint for the TMDLs is to maintain the concentration of Enterococci below the geometric mean criterion of 35 cfu/100 mL, which is protective of the primary contact recreation 1 use in saltwater.

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 TPDES program. 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 watersheds. 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 watersheds include stormwater discharges from industrial and regulated construction sites, and municipal separate storm sewer systems (MS4s).

Domestic and Industrial WWTFs

As of April 5, 2021, there were no WWTFs with TPDES permits within the TMDL watersheds.

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, 2021b) in the TMDL watersheds, as of April 5, 2021, found two pesticide permittees were covered by the general permit. The pesticide general permit does not have bacteria reporting requirements or limits. Pesticide application in the pesticide management areas is assumed to contain inconsequential amounts of indicator bacteria; therefore, it was unnecessary to allocate bacteria loads to them. No other active wastewater general permit authorizations were found in the TMDL watersheds.

Sanitary Sewer Overflows

A summary of sanitary sewer overflow (SSO) incidents that occurred during a five-year period from 2016 through 2020 in Galveston County was obtained from TCEQ Central Office in Austin. The summary data indicated no SSO incidents had been reported within the TMDL watersheds.

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 MS4 entities, stormwater discharges associated with regulated industrial facilities, 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, 2021b) in the TMDL watersheds, as of April 5, 2021, found one active MSGP authorization in the Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 watershed. The review also found one active MSGP authorization and one CGP authorization within the Unnamed Tributary of Gum Bayou AU 1103G_01 watershed. Loadings for the areas authorized under the MSGP and CGP were not specifically determined since these areas are already accounted for in the areas covered under MS4s. There are currently five Phase II MS4 authorizations and one combined Phase I/Phase II permit within the TMDL watersheds (Table VIII-4). Figure VIII-5 shows the urbanized area defined by the USCB that accounts for MS4 coverage within the TMDL watersheds.

Table VIII-4. TPDES MS4 permits associated with the TMDL watersheds

AUs	Entity	TPDES Permit	NPDES Permit	Authorization Type
1103F_01, 1103G_01	Texas Department of Transportation	WQ0005011000	TXS002101	Combined Phase I/II
1103F_01, 1103G_01	Galveston County	General Permit (TXR040000)	TXR040364	Phase II
1103F_01, 1103G_01	City of Dickinson	General Permit (TXR040000)	TXR040686	Phase II
1103F_01	City of Santa Fe	General Permit (TXR040000)	TXR040193	Phase II
1103F_01	Galveston County Drainage District 1	General Permit (TXR040000)	TXR040620	Phase II
1103G_01	City of League City	General Permit (TXR040000)	TXR040249	Phase II

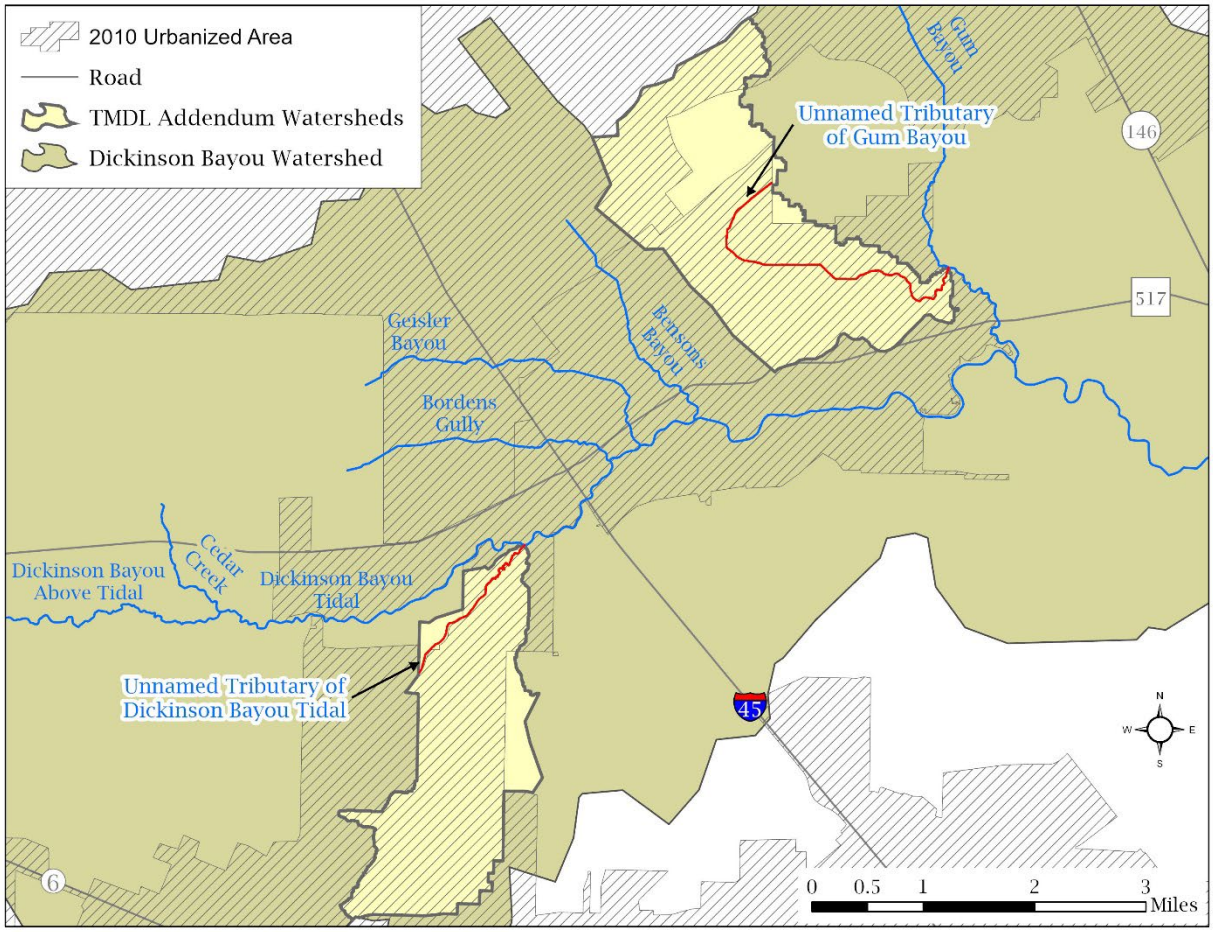

Figure VIII-5. Regulated stormwater area based on urbanized area within the TMDL watersheds

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.

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 watersheds.

Table VIII-5 provides estimated numbers of selected livestock in the TMDL watersheds based on the 2017 Census of Agriculture conducted by U.S. Department of Agriculture (USDA NASS, 2019). The county-level estimated livestock populations were reviewed by Texas State Soil and Water Conservation Board staff and were distributed by dividing the suitable livestock land cover (Hay/Pasture, Grassland/Herbaceous, and Shrub/Scrub) area of each TMDL watershed by the total suitable livestock land cover area within Galveston 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 VIII-5. Estimated livestock populations

AU	Cattle and Calves	Hogs and Pigs	Sheep and Lambs	Goats	Horses and Ponies	Mules, Burros, and Donkeys
1103F_01	106	7	3	6	11	4
1103G_01	71	4	2	4	7	2

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 VIII-6 summarizes the estimated number of dogs and cats within the TMDL watersheds. 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 watersheds was estimated using 2010 Census data (USCB, 2010). The actual contribution and significance of bacteria loads from pets reaching the water bodies is unknown.

Table VIII-6. Estimated households and pet population

AU	Estimated Households	Estimated Dog Population	Estimated Cat Population
1103F_01	607	373	277
1103G_01	3,597	2,209	1,644

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, a study by Timmons et al. (2012) estimated a range of feral hog densities within suitable habitat in Texas from 8.9 to 16.4 hogs per square mile. The average hog density (12.65 hogs/square mile) was multiplied by the hog-habitat area of 1.17 square miles in the Unnamed Tributary of Dickinson Bayou watershed and 0.79 square miles in the Unnamed Tributary of Gum Bayou watershed. Habitat deemed suitable for hogs includes the following classifications from the 2016 NLCD land cover: Deciduous Forest, Evergreen Forest, Mixed Forest, Emergent Herbaceous Wetlands, Woody Wetlands, Pasture/Hay, Shrub/Scrub, and Grassland/Herbaceous. Using this methodology, the estimated feral hog population is 15 in the Unnamed Tributary of Dickinson Bayou watershed and 10 in the Unnamed Tributary of Gum Bayou watershed.

For deer, the Texas Parks and Wildlife Department (TPWD) has published data showing deer population-density estimates by Deer Management Unit (DMU) and Ecoregion in the state (TPWD, 2021). The TMDL watersheds are located entirely within the DMU Urban Houston, for which there is no deer density data. However, because the TMDL watersheds are close to DMU 10, density data from this DMU was used to estimate deer populations for the TMDL watersheds. For the 2020 TPWD survey year, the estimated deer population density for DMU 10 was 21.52 deer per 1,000 acres and applies to all habitat types within the DMU. Applying this value to the entire area of the TMDL watersheds returns an estimated 43 deer within the Unnamed Tributary of Dickinson Bayou Tidal watershed and 60 deer in the Unnamed Tributary of Gum Bayou watershed. The Enterococci 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 TMDL watersheds was determined using data supplied by H-GAC (H-GAC, 2020) and the TCEQ Coastal On-Site Sewage Inventory Database (TCEQ, 2018c). Data from these sources indicate that there are 233 OSSFs located within the Unnamed Tributary of Dickinson Bayou Tidal watershed and 229 OSSFs within the Unnamed Tributary of Gum Bayou watershed (Figure VIII-6). 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).

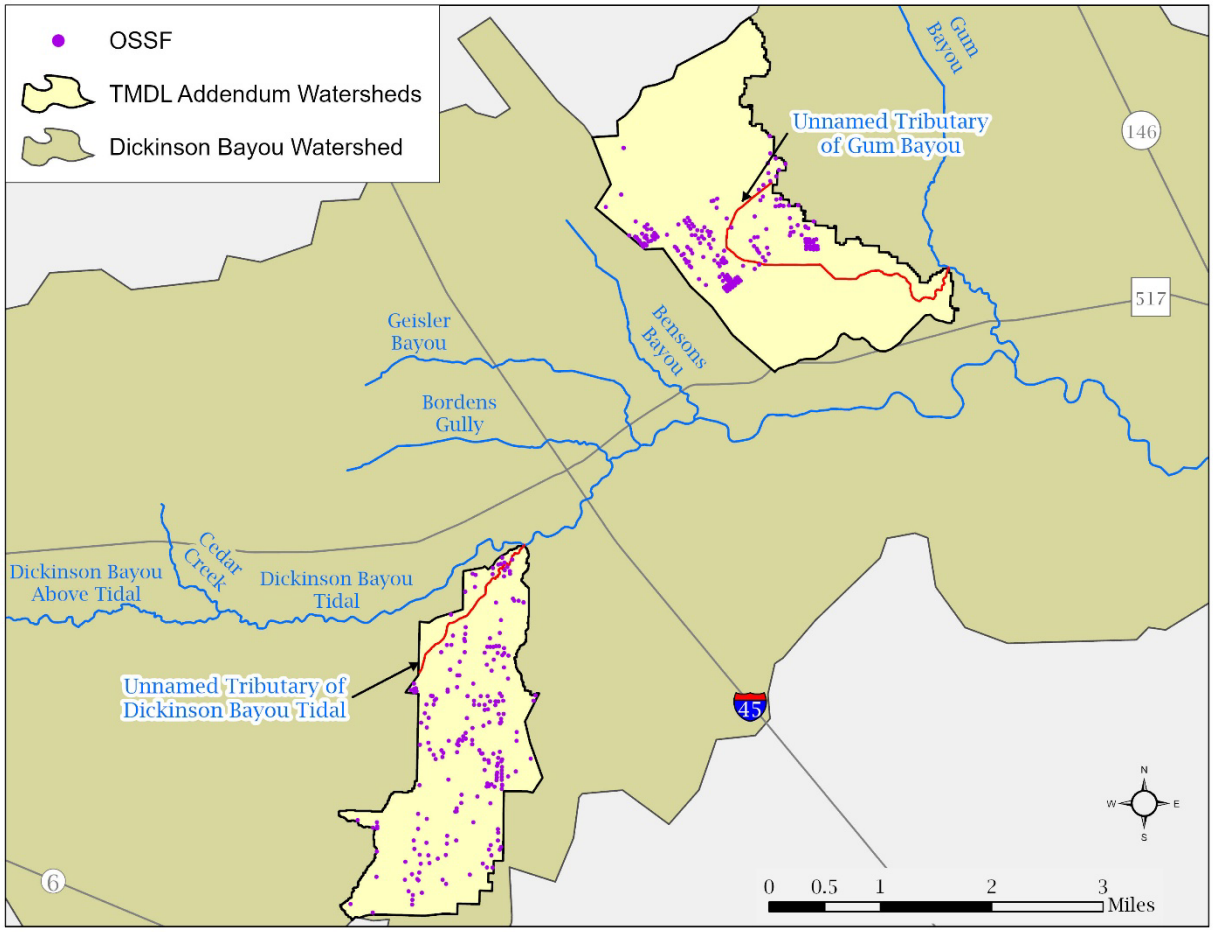

Figure VIII-6. OSSFs located within the TMDL watersheds

Linkage Analysis

An adaptation of the load duration curve (LDC) method was used to examine the relationship between instream water quality and the source of indicator bacteria loads. In watersheds where there are tidal exchanges along the Texas coast, the flow is adjusted to address tidal influences. The LDC developed through this approach is called a modified LDC (ODEQ, 2006). Modified LDCs are based on the assumption that combining freshwater with seawater increases the loading capacity in the tidal water body.

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 modified LDCs to define the TMDL pollutant load allocations. 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 (Adams and Millican, 2021) provides details about the linkage analysis along with the modified LDC method and its application.

The Enterococci data plotted on the modified LDC for the Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 SWQM Station 20477 in Figure VIII-7 show exceedances of the geometric mean criterion have commonly occurred regardless of streamflow conditions. Likewise, Enterococci data plotted on the modified LDC for the Unnamed Tributary of Gum Bayou AU 1103G_01 SWQM Station 20728 show exceedances of the geometric mean criterion have commonly occurred in all flow regimes (Figure VIII-8). The allowable load at the single sample criterion (130 cfu/100 mL) is included on the modified LDCs for comparison with individual Enterococci samples, although it is not used for assessment or allocation purposes.

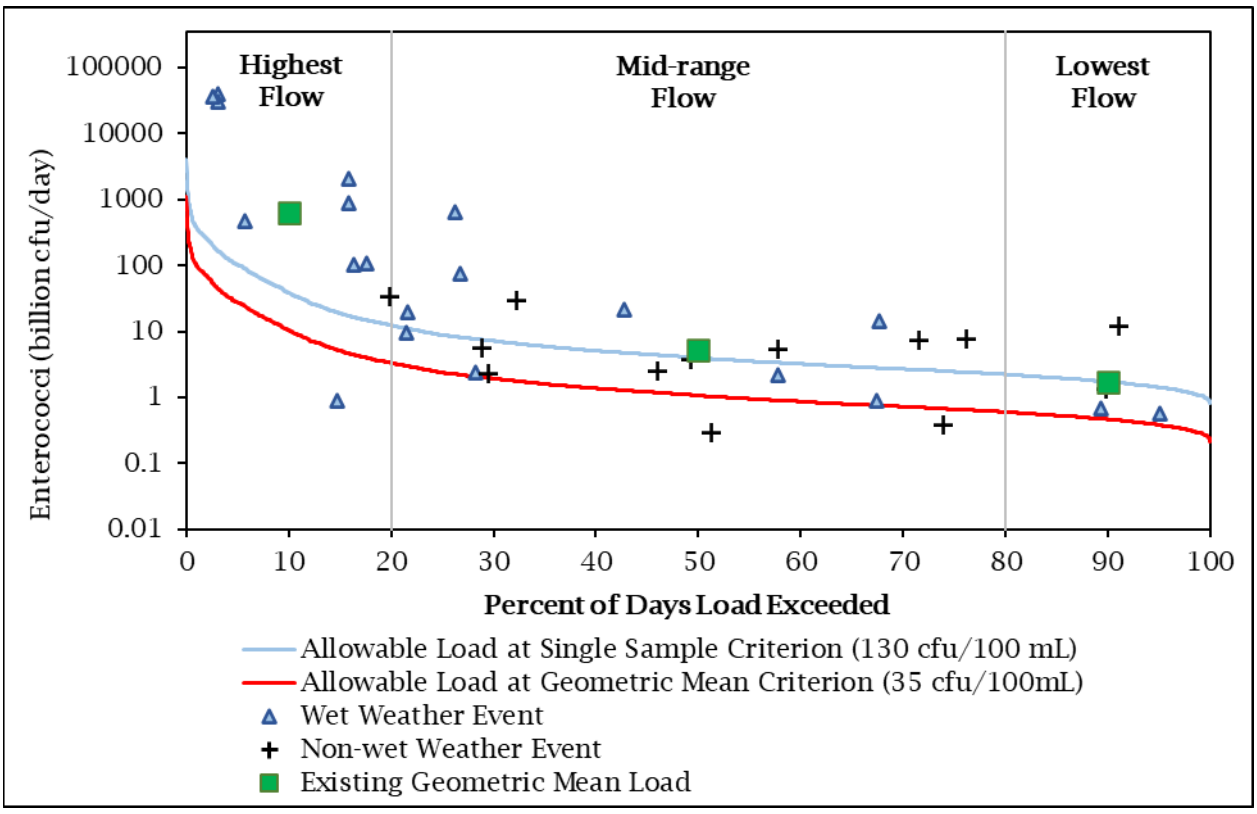

Figure VIII-7. Modified LDC for AU 1103F_01 at SWQM Station 20477

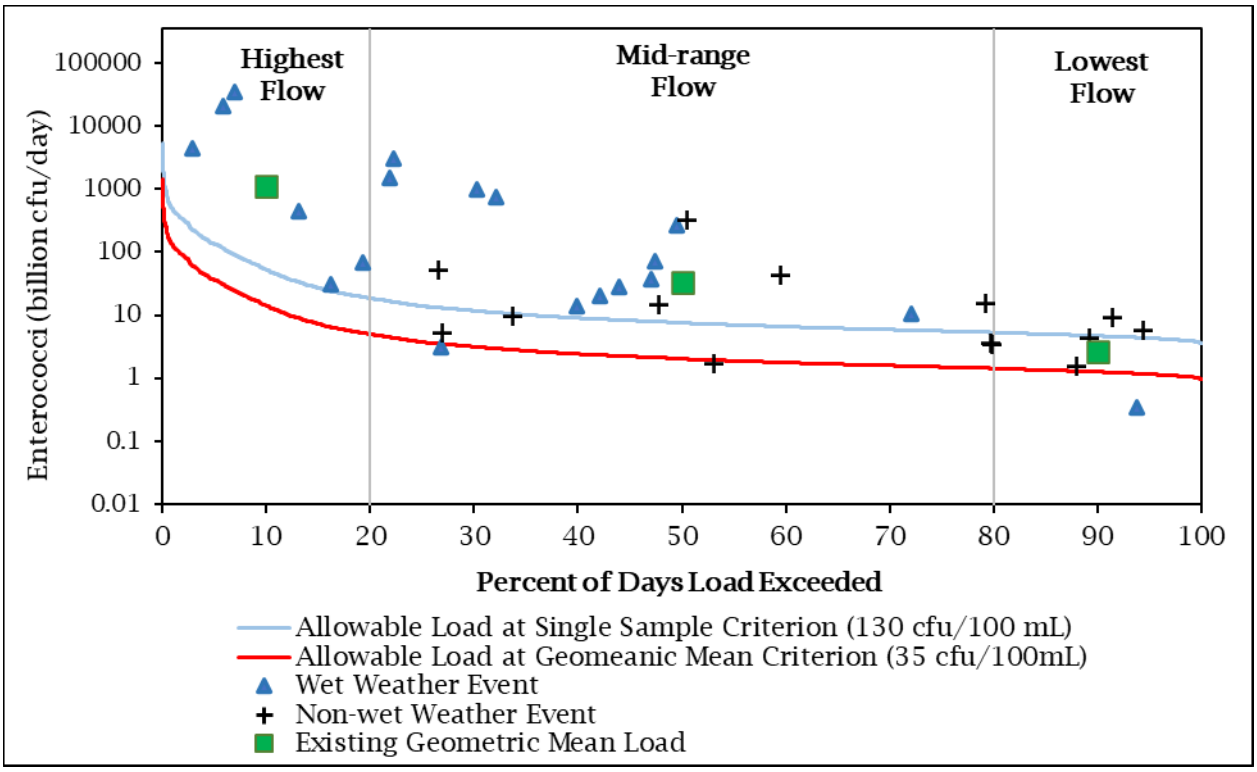

Figure VIII-8. Modified LDC for AU 1103G_01 at SWQM Station 20728

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 TMDLs in this report incorporate an explicit MOS of 5% of the total TMDL allocations.

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 TMDLs for AUs 1103F_01 and 1103G_01 were derived using the median flow in the 0-20 percentile range (or 10% load duration exceedance, "Highest Flow" regime) of the modified LDCs developed for TCEQ SWQM stations 20477 and 20728. These stations represent the locations within AUs 1103F_01 and 1103G_01 where an adequate number of Enterococci samples were collected.

Margin of Safety Calculation

The TMDLs in this report incorporate 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 one-half the instream geometric mean criterion. One-half of the water quality criterion (17.5 cfu/100 mL Enterococci) is used as the WWTF target to provide instream and downstream load capacity and to be consistent with the original TMDL report. Due to the absence of any permitted dischargers in the TMDL watersheds, 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 watersheds 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 area under an MS4 permit was calculated for the TMDL watersheds using geographic information system shapefiles. The acreage covered by an MS4 permit for the Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 watershed is 1,779 acres, 88.46% of the watershed, and the acreage for the Unnamed Tributary of Gum Bayou AU 1103G_01 watershed is 2,365 acres, 84.83% of the watershed.

Load Allocation

The load allocation (LA) component of the TMDLs 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.

The FG component of the TMDL watersheds was based on the population projections for the entire TMDL watersheds. 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 gpcd), and multiplying it by a potential population change, gives an FG flow. Based on the information in Table VIII-2, the projected population change within the AU 1103F_01 watershed for the time period 2010-2045 is 1,512 and the population change within the AU 1103G_01 watershed is 7,100. Multiplying the projected population growths by the higher daily wastewater flow capacity yields a value of 0.151 MGD for AU 1103F_01 and a value of 0.710 MGD for AU 1103G_01. These values would be considered the full permitted discharges of potential future WWTFs.

FG of existing or new point sources is not limited by these TMDLs 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 modified LDCs and tables in this TMDL report will guide determination of the assimilative capacity of the water bodies under changing conditions, including FG.

Summary of TMDL Calculations

Table VIII-7 summarizes the TMDL calculations for the TMDL watersheds. The TMDLs were calculated based on the median flow in the 0-20 percentile range (or 10% load duration exceedance, "Highest Flow" regime) from the modified LDCs developed for TCEQ SWQM stations 20477 and 20728. Allocations are based on the current geometric mean criterion for Enterococci of 35 cfu/100mL for each component of the TMDLs (with the exception of the WLA_{WWTF} and FG terms, which use one-half the criterion).

Table VIII-7. TMDL allocation summary for the TMDL AUs

All loads expressed as billion cfu/day Enterococci

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	FG
Unnamed Tributary of Dickinson Bayou Tidal	1103F_01	10.421	0.521	0	8.669	1.131	0.100
Unnamed Tributary of Gum Bayou	1103G_01	14.176	0.709	0	11.025	1.972	0.470

The final TMDL allocations (Table VIII-8) needed to comply with federal requirements include the FG component within the WLA_{WWTF} (40 CFR Section 103.7).

Table VIII-8. Final TMDL allocations for the TMDL AUs

All loads expressed as billion cfu/day Enterococci

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA
Unnamed Tributary of Dickinson Bayou Tidal	1103F_01	10.421	0.521	0.100	8.669	1.131
Unnamed Tributary of Gum Bayou	1103G_01	14.176	0.709	0.470	11.025	1.972

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 Enterococci concentrations obtained from 13 years (2008 through 2020) of routine monitoring data collected 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 Enterococci 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 Enterococci data indicated that there was a significant difference (α=0.05) in indicator bacteria between cool and warm weather seasons for the Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 (p=0.0026) with higher Enterococci concentrations during the cool season. For the Unnamed Tributary of Gum Bayou AU 1103G_01 (p=0.0716), there was no indication of significant difference of indicator bacteria between cool and warm weather seasons. Seasonal variation was also addressed by using all available flow and

Enterococci records (covering all seasons) from the period of record used in the modified 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 (Adams and Millican, 2021) was published on TCEQ's website on March 31, 2022. Project staff presented information about this addendum at the Galveston Bay Coalition of Watersheds stakeholder meeting (held online) on August 24, 2021. The public had an opportunity to comment on this addendum during the public comment period (May 6 through June 7, 2022) for the 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 News webpage.[j] Notice of the comment period, along with the document, was also posted on the WQMP Updates webpage.[k] TCEQ accepted public comments on the original TMDL report from September 16, 2011 through October 17, 2011. Of the four comments submitted, none of them referred directly to the AUs in this TMDL addendum.

Implementation and Reasonable Assurance

The water bodies covered by this addendum are within the existing bacteria TMDL watershed for Dickinson Bayou. The TMDL watersheds, including Unnamed Tributary of Dickinson Bayou Tidal AU 1103F_01 and Unnamed Tributary of Gum Bayou AU 1103G_01, are within the area covered by the implementation plan (I-Plan) developed by stakeholders for the TMDL watersheds, which was approved by the Commission on January 15, 2014. 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.

[j] www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html

[k] www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html

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Appendix IX. Addendum Two to Four TMDLs for Indicator Bacteria in the Cottonwood Creek, Fish Creek, Kirby Creek, and Crockett Branch Watersheds Upstream of Mountain Creek Lake

Adding one TMDL for AU 0841P_01

One TMDL for Indicator Bacteria in North Fork Cottonwood Creek

Introduction

TCEQ adopted *Four TMDLs for Indicator Bacteria in the Cottonwood Creek, Fish Creek, Kirby Creek, and Crockett Branch Watersheds Upstream of Mountain Creek Lake* (TCEQ, 2016) on November 2, 2016. EPA approved the TMDLs on December 7, 2016. This document is the second addendum to the original TMDL report.

This second addendum includes information specific to one additional AU for North Fork Cottonwood Creek (AU 0841P_01; also referred to in this addendum as the TMDL watershed). This AU is located within the watershed of the approved original TMDLs for watersheds upstream of Mountain Creek 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 for North Fork Cottonwood Creek*[1] (Millican and Adams, 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 TMDLs.

Problem Definition

TCEQ first identified the bacteria impairment for North Fork Cottonwood Creek in the *2020 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Texas Integrated Report; TCEQ, 2020), the latest EPA-approved edition of the Texas 303(d) List. North Fork Cottonwood Creek (0841P) contains only

[1] www.tceq.texas.gov/downloads/water-quality/tmdl/greater-trinity-recreational-66/66-as-223-north-fork-cottonwood-creek-technical-support-document.pdf

one AU, the impaired AU 0841P_01. The TMDL watershed is located in Tarrant and Dallas counties. Figure IX-1 shows the watershed added in this addendum in relation to the entire watershed of the original TMDLs, 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 IX-1 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) stations on AU 0841P_01, as reported in the 2020 Texas Integrated Report (TCEQ, 2020). 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 IX-2 shows the locations of the TCEQ SWQM stations that were used in evaluating water quality in the 2020 Texas Integrated Report for the AU added by this addendum, as well as an additional station with older data.

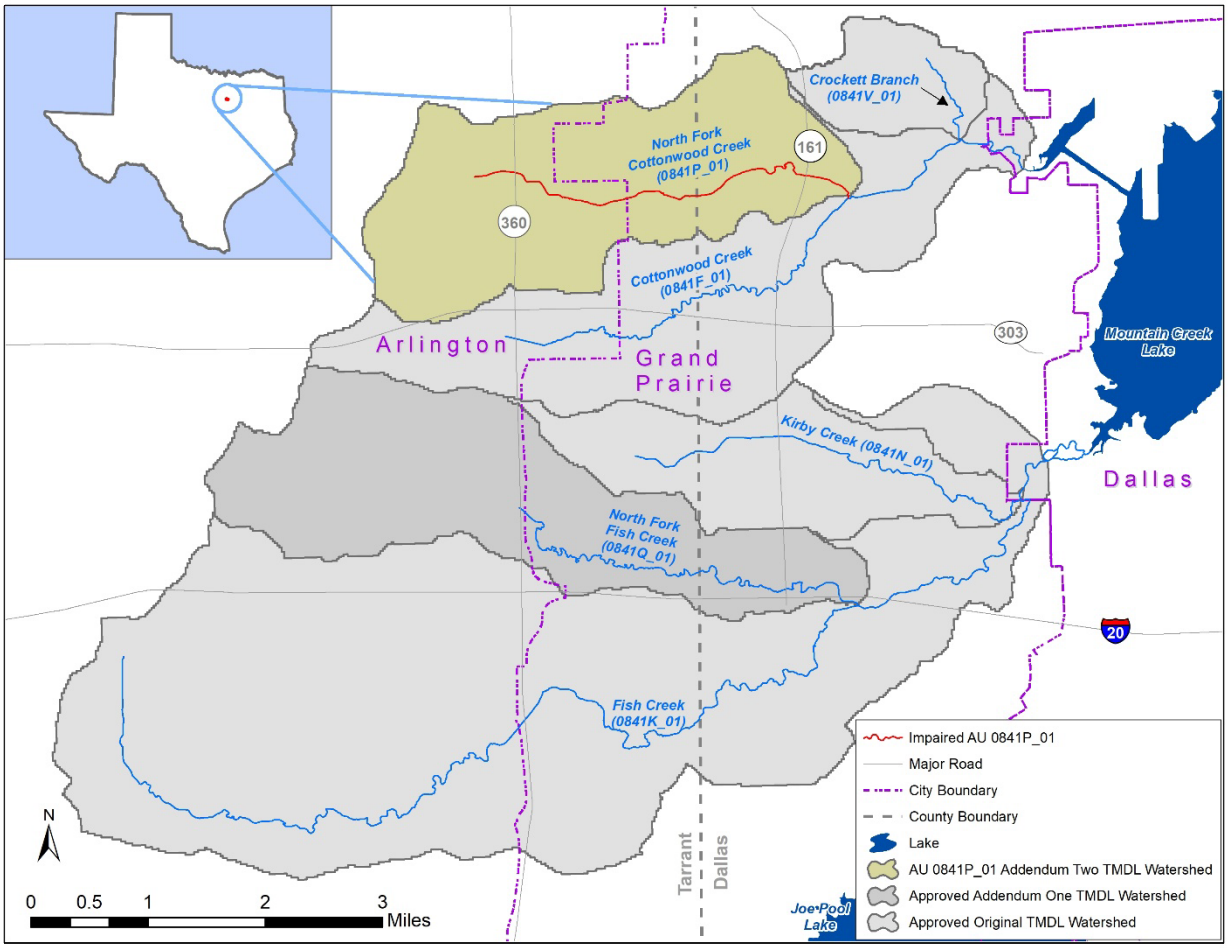

Figure IX-1. Map showing the previously approved TMDL watersheds and the North Fork Cottonwood Creek AU 0841P_01 watershed added by this addendum

Table IX-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)
0841P_01	10722, 20836	*E. coli*	49	12/01/2011 – 11/30/2018	258

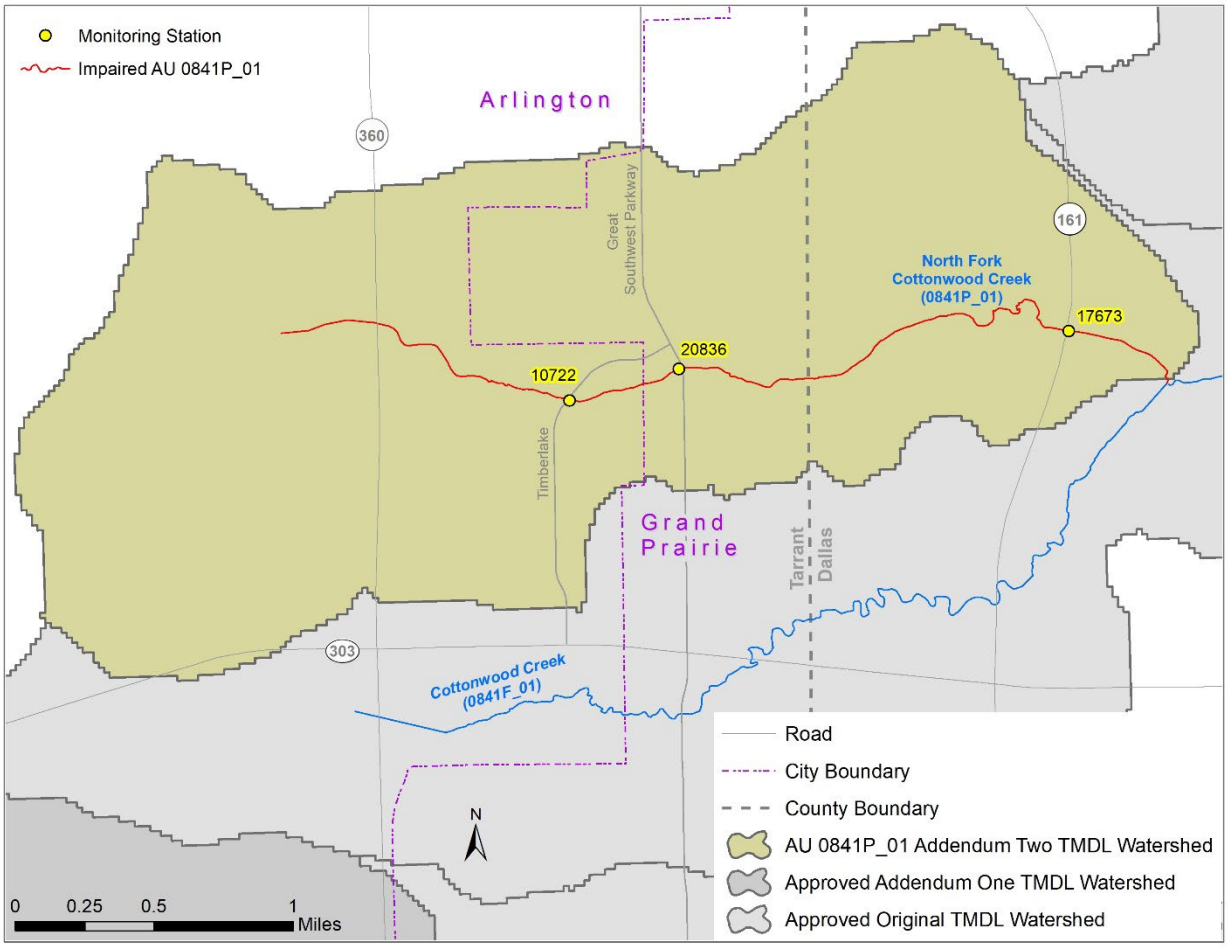

Figure IX-2. AU 0841P_01 watershed showing the TCEQ SWQM stations

Watershed Overview

North Fork Cottonwood Creek (0841P) is a tributary of Cottonwood Creek (0841F) and flows approximately 4.4 miles. The total drainage area for the TMDL watershed is 5.5 square miles.

The 2020 Texas Integrated Report (TCEQ, 2020) provides the following water body and AU description:

- 0841P (North Fork Cottonwood Creek; AU 0841P_01) – A 4.4 mile stretch of North Fork Cottonwood Creek running upstream from confluence with the South Fork Cottonwood Creek in Grand Prairie, Dallas County, to approximately 0.3 miles upstream of Carter Street in Arlington, Tarrant County.

Watershed Climate

Weather data were obtained for the 21-year period from January 1999 through December 2019 from the National Oceanic and Atmospheric Administration (NOAA)

National Climatic Data Center Database. The Arlington Municipal Airport weather station (USW00053907) located in the western portion of the nearby Fish Creek (0841K) watershed was used to retrieve the precipitation and temperature data (NOAA, 2021; Figure IX-3). Data from this 21-year period indicate that the average monthly high temperature typically reaches a maximum of 96.8 °F in August, and the average monthly low temperature reaches a minimum of 35.6 °F in January. Annual rainfall averages 34.3 inches. The wettest month is May (4.4 inches), while August (1.6 inches) is the driest month, with rainfall occurring throughout the year.

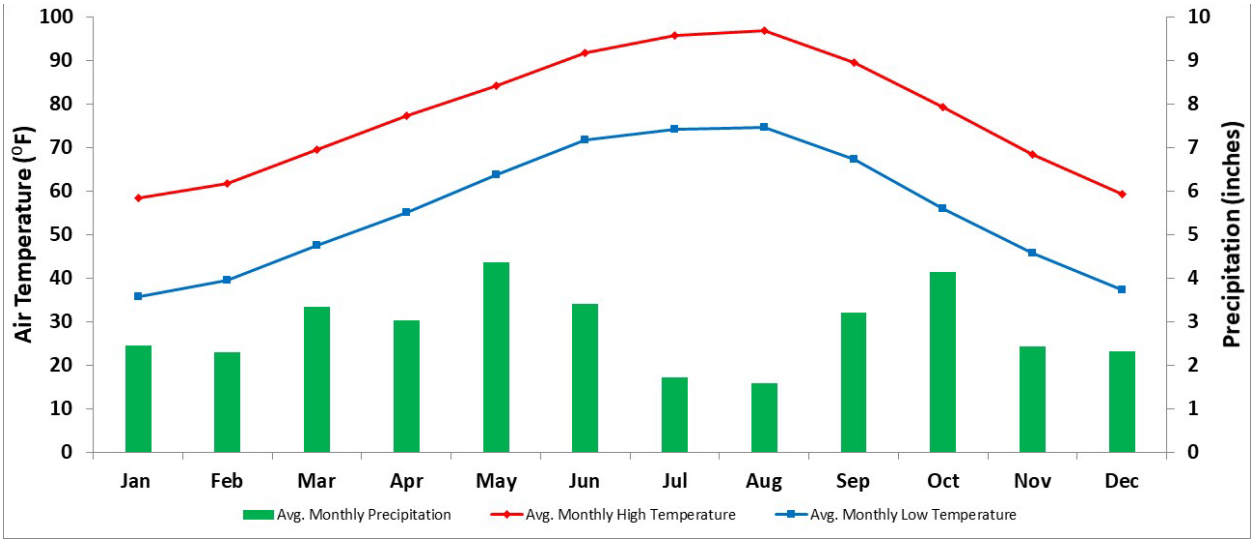

Figure IX-3. Average monthly temperature and precipitation (1999–2019) at the Arlington Municipal Airport weather station

Watershed Population and Population Projections

The TMDL watershed is primarily located within the municipal boundaries of Arlington and Grand Prairie. According to the United States Census Bureau (USCB) 2010 Census (USCB, 2010), the TMDL watershed had an estimated population of 32,252 people in 2010.

The population projection in Table IX-2 was estimated using data developed by NCTCOG by using traffic survey zone allocations (NCTCOG, 2017a). Traffic survey zones are planning areas used by NCTCOG to provide for more analysis at a local scale. NCTCOG modeled the 2045 projected populations using inputs such as number of households, household populations, land cover changes, and future land use plans.

Table IX-2. Estimated 2010 population and 2045 population projection for the TMDL watershed

Area	2010 Estimated Population	2045 Projected Population	Projected Population Increase	Percentage Change
North Fork Cottonwood Creek (AU 0841P_01) Watershed	32,252	44,643	12,391	38.4%

The following steps detail the method used to estimate the 2010 and projected 2045 populations in the TMDL watershed.

15. Obtained 2010 U.S. Census data at the block level.
16. Developed 2010 watershed populations using the block level data for the portion of the census blocks located within the watershed.
17. Obtained population projections for the year 2045 from the NCTCOG traffic survey zone allocations.
18. Developed population projections using traffic survey zone data for the portion of the traffic survey zones located within the watershed.
19. Subtracted the 2010 watershed population from the 2045 population projection to determine the projected population increase. Subsequently, divided the projected population increase by the 2010 watershed population to determine the percentage population increase for the North Fork Cottonwood Creek watershed.

Land Cover

The land cover data were obtained from NCTCOG and represent land cover estimates for 2015 (NCTCOG, 2017b). The land cover for the TMDL watershed is shown in Figure IX-4. A summary of the land cover data is provided in Table IX-3 and indicates that the dominant land cover in the TMDL watershed is Residential (34.76%).

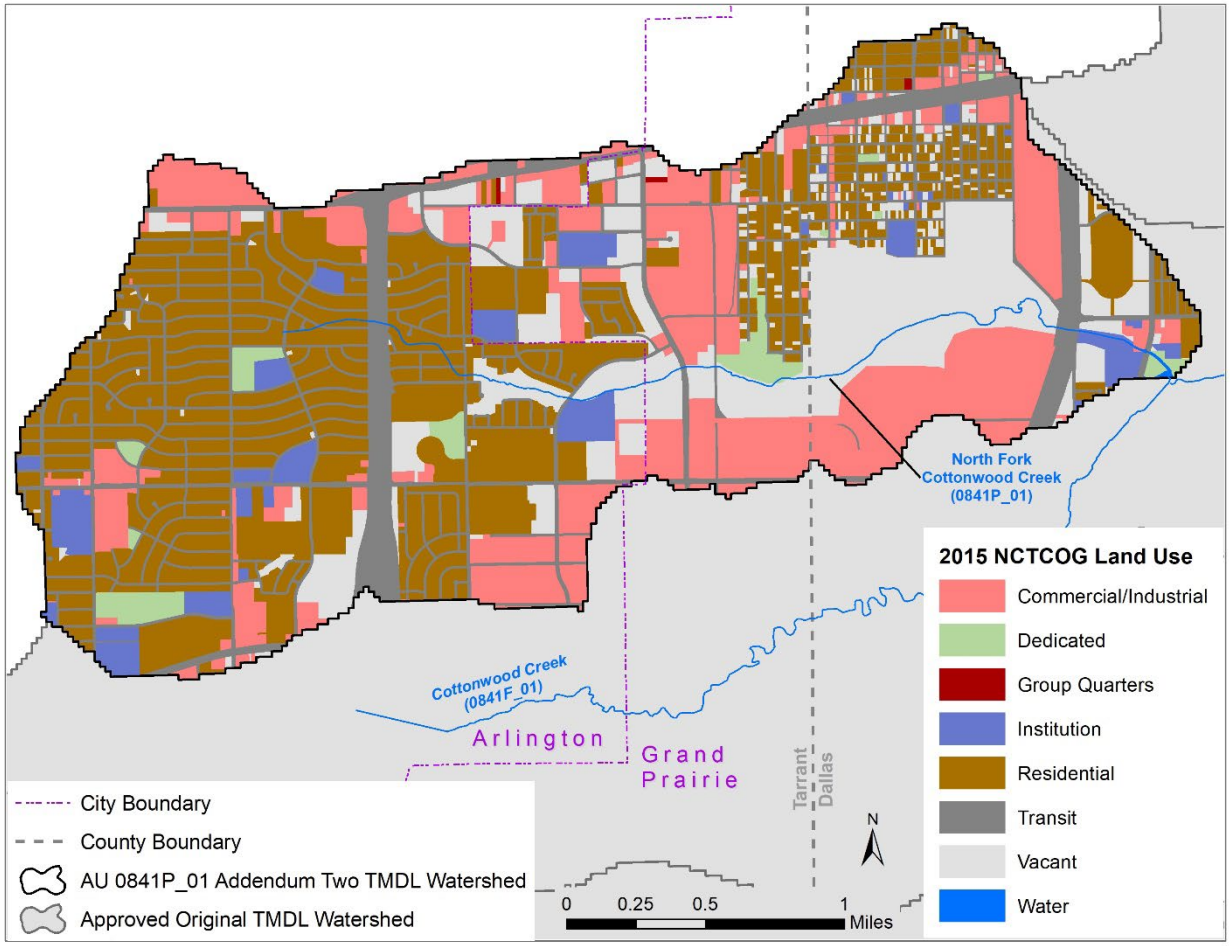

Figure IX-4. 2015 land cover

Table IX-3. Land cover summary

2015 NCTCOG Classification	Area (Acres)	Percentage of Total
Commercial/Industrial	776.9	21.91%
Group Quarters	2.7	0.08%
Residential	1,232.6	34.76%
Institution	163.7	4.62%
Transit	657.9	18.56%
Dedicated	76.4	2.15%
Vacant	633.4	17.86%
Water	2.0	0.06%
Total	**3,545.6**	**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 TPDES program. 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 industries, regulated construction activities, and municipal separate storm sewer systems (MS4s).

Domestic and Industrial WWTFs

No permitted WWTFs exist in the TMDL study area. Domestic wastewater is collected by and transported to the Trinity River Authority (TRA) Central Regional Wastewater System, which is outside the study area (Figure IX-5).

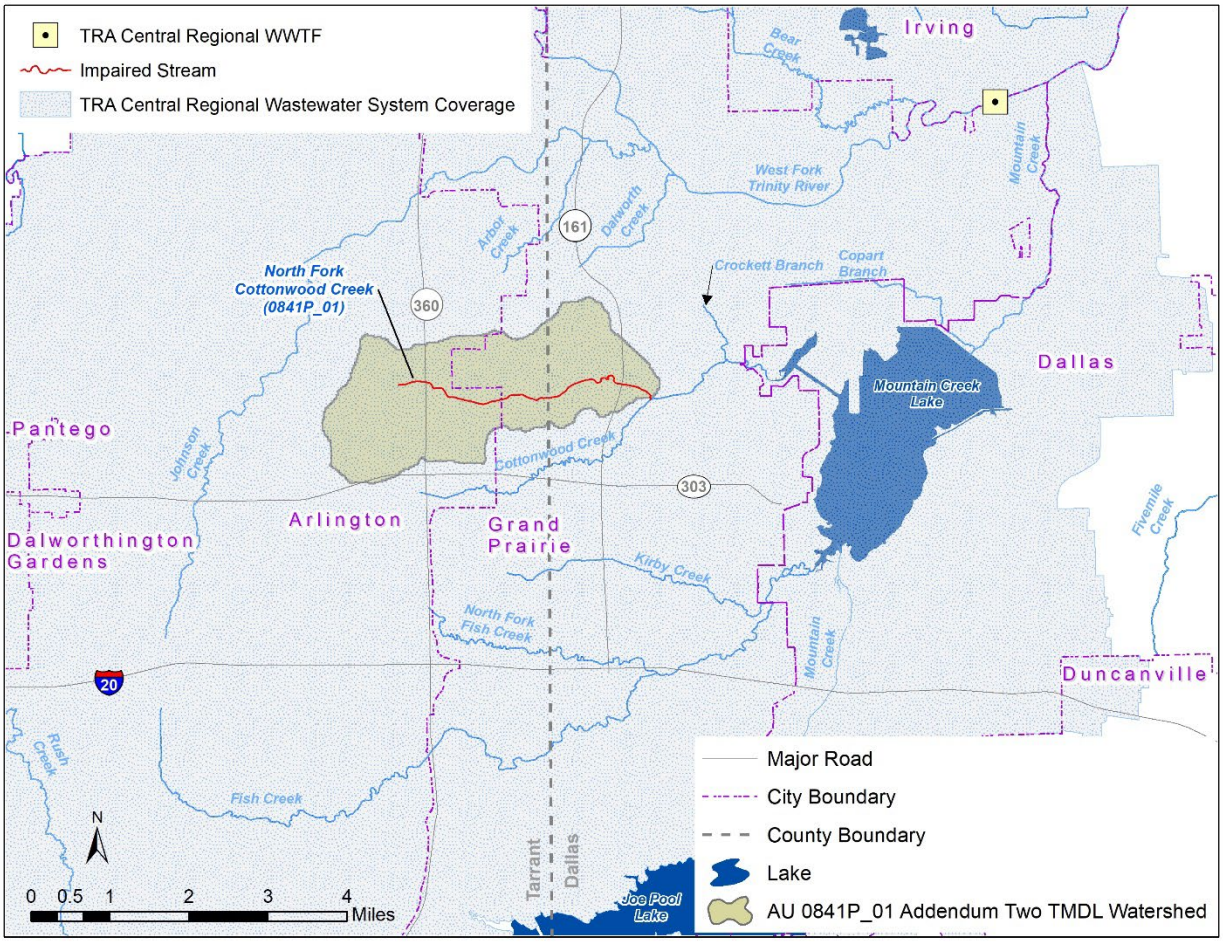

Figure IX-5. Coverage area of the TRA Central Regional Wastewater System within the TMDL study area

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 February 25, 2021, revealed two pesticide permittees covered by the general permit. These pesticide management areas do not have bacteria reporting requirements or limits in their permits. Pesticide application in the pesticide management areas is assumed to contain inconsequential amounts of indicator bacteria; therefore, it was unnecessary to allocate bacteria loads to them. No other active wastewater general permit authorizations were found in the TMDL watershed.

Sanitary Sewer Overflows

A summary of sanitary sewer overflow (SSO) incidents that occurred during a 10-year period from 2010 through 2019 in the TMDL watershed was obtained from NCTCOG. The SSO data was originally collected by TCEQ Region 4 and was refined by NCTCOG by assigning latitude and longitude coordinates to each SSO event. The summary data indicated 37 SSO incidents had been reported within the TMDL watershed. The SSOs had a total discharge of 17,074 gallons with a minimum of seven gallons and a maximum of 5,560 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:

5. Stormwater subject to regulation, which is any stormwater originating from TPDES-regulated MS4 entities, stormwater discharges associated with regulated industrial activities, and construction activities.
6. 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 March 30, 2021, found one active MSGP authorization within the watershed and several CGP authorizations. The areas of these were not quantified since MS4s accounted for 100% of the watershed. There are currently one Phase I MS4 permit, one Phase II MS4 authorization, and one combined Phase I/Phase II permit

within the TMDL watershed (Table IX-4). Figure IX-6 shows the urbanized area defined by USCB that accounts for MS4 coverage within the North Fork Cottonwood Creek watershed.

Table IX-4. TPDES MS4 permits associated with the TMDL watershed

Entity	TPDES Permit	NPDES Permit	Authorization Type
City of Arlington	WQ0004635000	TXS000301	Phase I
Texas Department of Transportation	WQ0005011000	TXS002101	Combined Phase I/II
City of Grand Prairie	General Permit (TXR040000)	TXR040065	Phase II

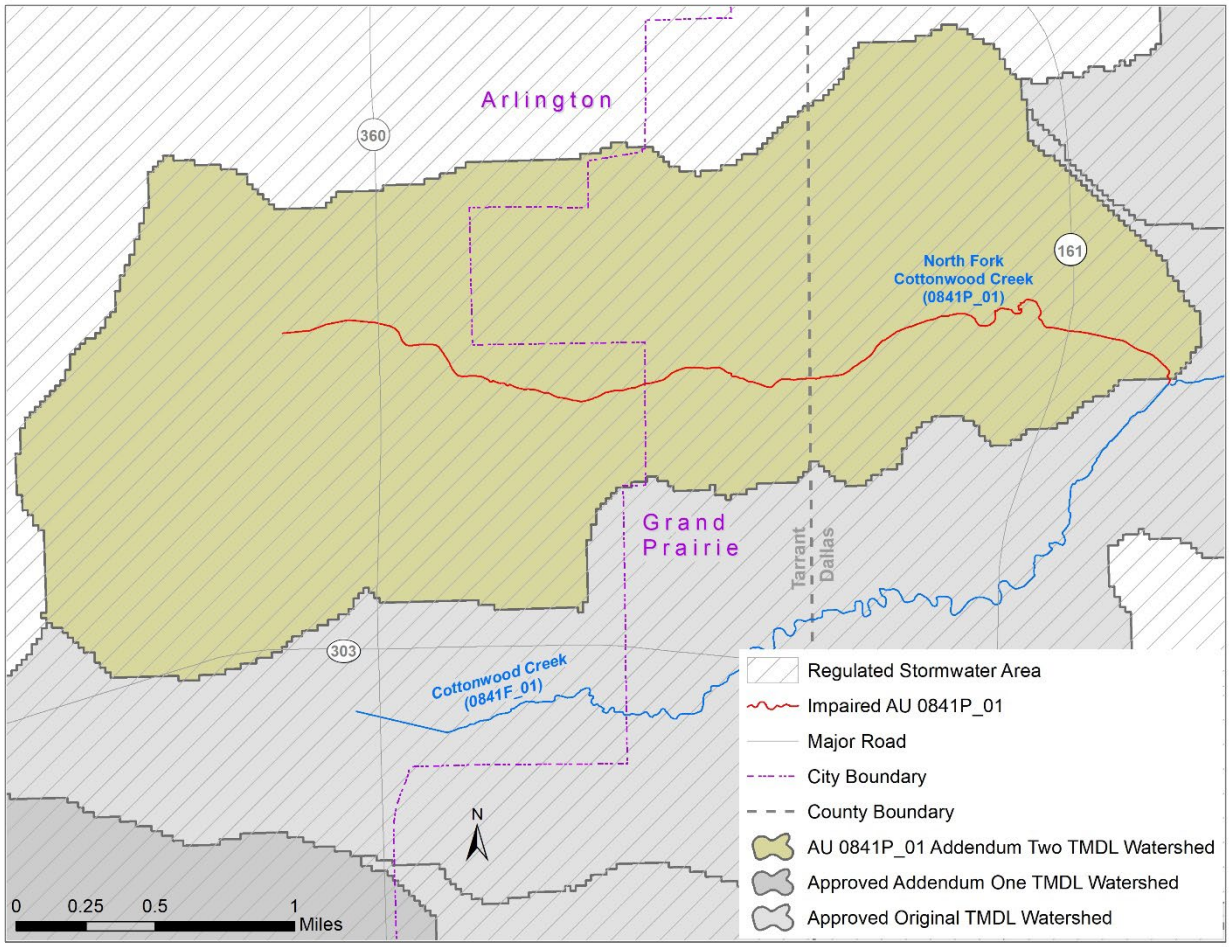

Figure IX-6. Regulated stormwater area based on urbanized area within the TMDL watershed

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 or small 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.

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. Agricultural activities were not a source in this highly urbanized watershed.

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 IX-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 2010 Census data (USCB, 2010). The actual contribution and significance of bacteria loads from pets reaching the water bodies in the watershed is unknown.

Table IX-5. Estimated households and pet population

Estimated Households	Estimated Dog Population	Estimated Cat Population
10,056	6,175	4,596

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.

The *E. coli* contribution from feral hogs and wildlife in the TMDL watershed cannot be determined based on existing information. However, due to the urbanized nature of the watershed it is assumed that the contribution is minimal.

Onsite Sewage Facilities

Failing OSSFs were not considered a major source of bacteria loading in the North Fork Cottonwood Creek watershed, because the entire watershed area is served by the TRA wastewater collection and treatment system. A review of OSSF information received from NCTCOG indicates that there are no known OSSFs in 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 (Millican and Adams, 2021) provides details about the linkage analysis along with the LDC method and its application.

LDCs for the three SWQM stations were developed for informational purposes, while the LDC for the watershed outlet was constructed for developing the TMDL allocation for North Fork Cottonwood Creek. Based on the LDCs developed for the three SWQM station locations with historical *E. coli* data added to the graph, the following broad linkage statements can be made. For this TMDL watershed, the historical *E. coli* data show that elevated bacteria loadings occur under all three flow regimes. The geometric means of the measured data exceed the geomean criterion under all three flow regimes for SWQM Stations 10722 and 20836 (Figures IX-7 and IX-8). Geometric means measured at SWQM Station 17673 (Figure IX-9) indicate a slight moderation of the elevated loadings under Mid-Range and Low Flow conditions; however, this may not represent current conditions since data has not been collected at this station in over 10 years. The allowable load at the single sample criterion (399 cfu/100 mL) is included on the LDCs for comparison with individual *E. coli* samples, although it is not used for assessment or allocation purposes. The LDC for the watershed outlet (Figure IX-10) has no bacteria data plotted on it, as no sampling took place at that location.

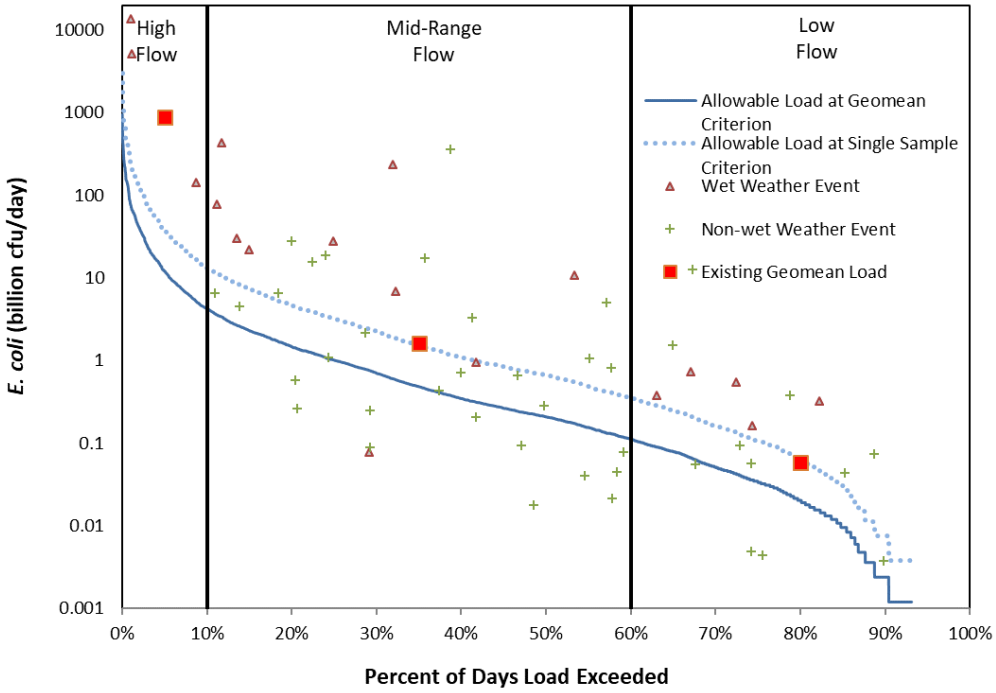

Figure IX-7. LDC at SWQM Station 10722

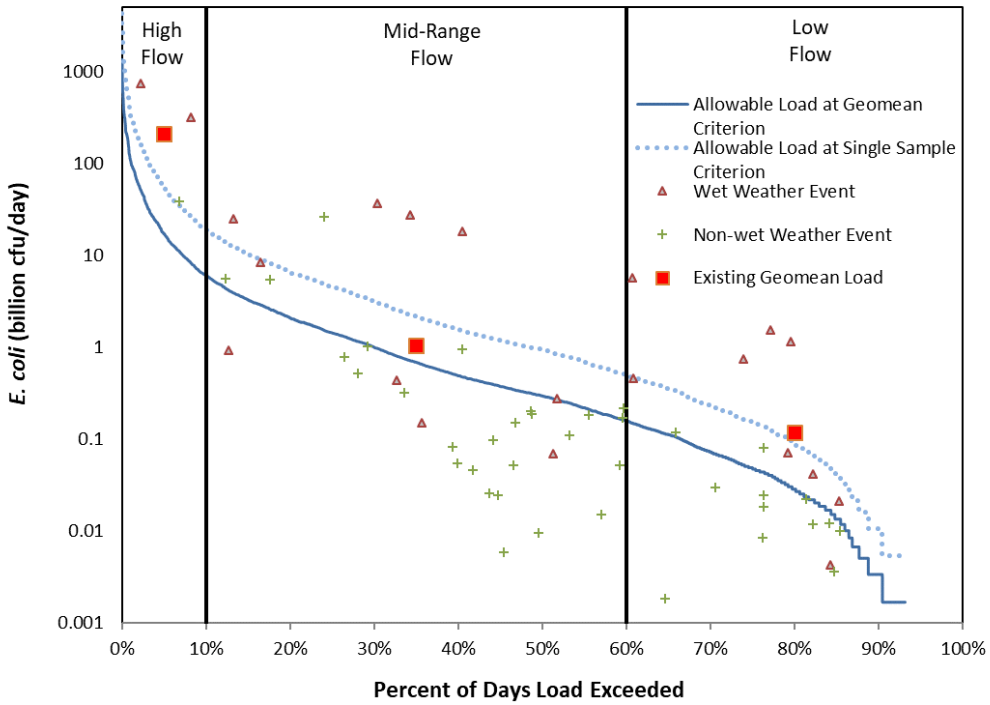

Figure IX-8. LDC at SWQM Station 20836

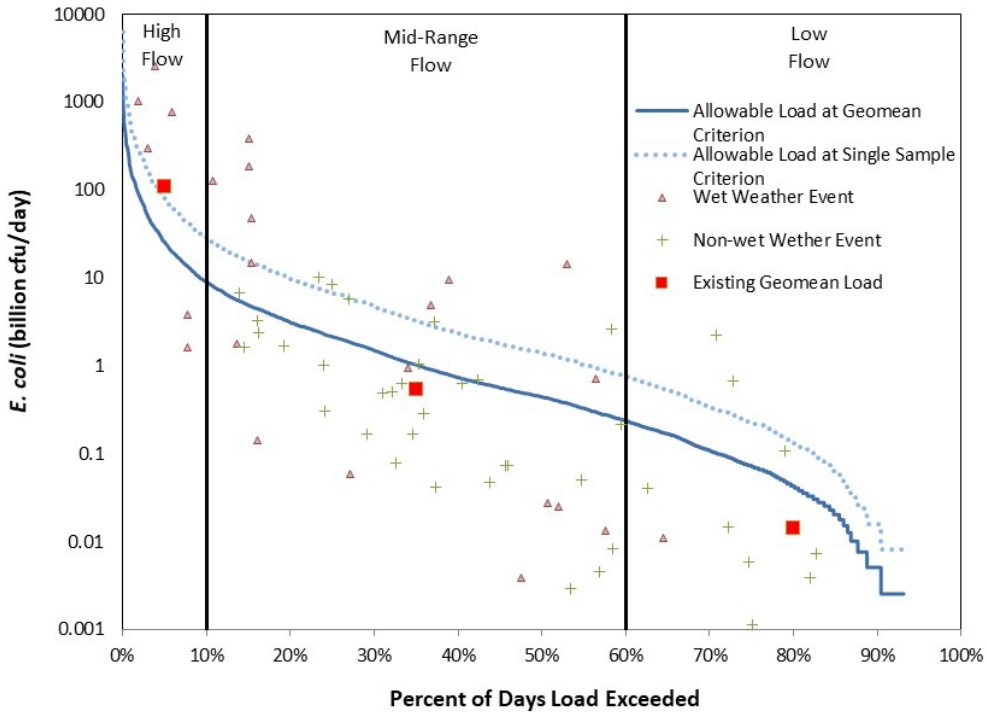

Figure IX-9. LDC at SWQM Station 17673

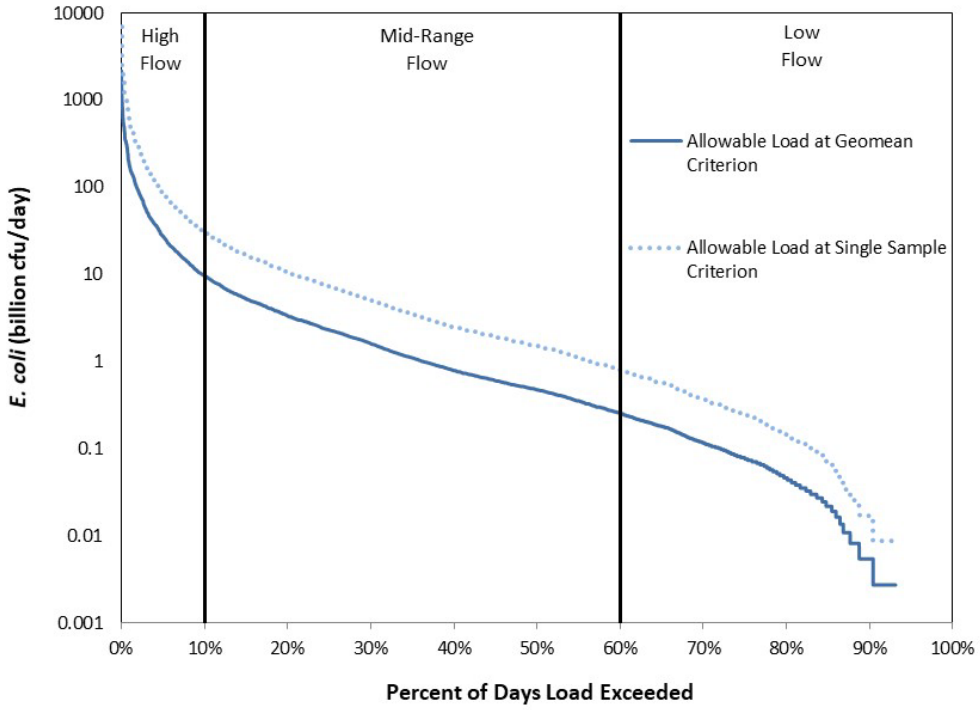

Figure IX-10. LDC for the outlet of North Fork Cottonwood Creek

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 North Fork Cottonwood Creek AU 0841P_01 was derived using the median flow within the High Flow regime (or 5% load duration exceedance) of the LDC developed for the watershed outlet. The watershed outlet was used because the most downstream station within North Fork Cottonwood Creek AU 0841P_01 has not had *E. coli* monitoring since 2008.

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 one-half the instream geometric

mean criterion. One-half of the water quality criterion (63 cfu/100 mL *E. coli*) is used as the WWTF target to provide instream and downstream load capacity and to be consistent with the original TMDL report. Due to the absence of any permitted dischargers in the North Fork Cottonwood 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 North Fork Cottonwood Creek watershed is covered 100% by MS4 permits. However, even in highly urbanized areas such as the North Fork Cottonwood Creek watershed, there remain some areas of potential direct deposition of bacteria loadings from unregulated sources such as wildlife. To account for these unregulated areas, the stream length based on the TCEQ definition of AU 0841P_01 and average channel width as calculated based on aerial imagery was used to compute an area of unregulated stormwater contribution. The percentage of land under the jurisdiction of stormwater permits in the TMDL watershed is 98.9%.

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.

Due to the absence of any existing WWTFs and the fact that it is highly unlikely that any new WWTFs will be established within the North Fork Cottonwood Creek watershed (TRA, 2021), the FG component is zero.

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 IX-6 summarizes the TMDL calculations for the TMDL watershed. The TMDL was calculated based on the median flow in the 0-10 percentile range (5% exceedance, High Flow regime) from the LDC developed for the outlet of the North Fork Cottonwood Creek watershed. Allocations are based on the current geometric mean criterion for *E. coli* of 126 cfu/100 mL for each component of the TMDL (with the exception of the WLA_{WWTF} and FG terms, which would be based on one-half the criterion if they applied).

Table IX-6. TMDL allocation summary for AU 0841P_01

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

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	FG
North Fork Cottonwood Creek	0841P_01	27.492	1.375	0	25.830	0.287	0

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

Table IX-7. Final TMDL allocation for AU 0841P_01

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

Water Body	AU	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA
North Fork Cottonwood Creek	0841P_01	27.492	1.375	0	25.830	0.287

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 19 years (2001 through 2019) of routine monitoring data collected at three SWQM stations (10722, 20836, and 17673) in the warmer months (May-September) against those collected during cooler months (November-March). The months of April and October were considered transitional between warm and cool seasons and were excluded from the seasonal analysis. Differences in seasonal concentrations were then evaluated with a Wilcoxon Rank Sum test (also known as the "Mann-Whitney" test). The analysis of *E. coli* data indicated that there was no significant difference in indicator bacteria between the cool and warm weather seasons (α=0.05) for North Fork Cottonwood Creek. 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 (Millican and Adams, 2021) was published on the TCEQ website on December 7, 2021. Project staff presented information about this addendum at the annual meeting of the Greater Trinity River Bacteria TMDL Implementation Plan Coordination Committee hosted by NCTCOG (held online) on July 1, 2021. The public had an opportunity to comment on this addendum during the public comment period (May 6 through June 7, 2022) for the 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.[m] Notice of the comment period, along with the document, was also posted on the WQMP Updates webpage.[n] TCEQ accepted public comments on the original TMDL report from May 27 through June 27, 2016. No comments were submitted.

Implementation and Reasonable Assurance

The AU covered by this addendum is within the existing bacteria TMDL watershed for Cottonwood Creek, Fish Creek, Kirby Creek, and Crockett Branch. That TMDL watershed, including North Fork Cottonwood Creek AU 0841P_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 December 11, 2013. 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.

[m] www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html

[n] www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html

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