

Technical Support Document for One Total Maximum Daily Load for Indicator Bacteria in Dry Branch Creek

Assessment Unit: 0841I_01



Dry Branch Creek at Sampling Station 17173

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Abbreviations

| | |
|---------------------|--|
| AU | assessment unit |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| cfu | colony forming units |
| CGP | Construction General Permit |
| DAR | drainage area ratio |
| DFW | Dallas/Fort Worth |
| DSLPL | days since last precipitation |
| <i>E. coli</i> | <i>Escherichia coli</i> |
| EPA | (United States) Environmental Protection Agency |
| FDA _{SWP} | fractional drainage area stormwater permit |
| FDC | flow duration curve |
| FG | future growth |
| I&I | inflow and infiltration |
| LA | load allocation |
| LDC | load duration curve |
| MGD | million gallons per day |
| MCM | minimum control measure |
| mL | milliliter |
| MOS | margin of safety |
| MS4 | municipal separate storm sewer system |
| MSGP | Multi-Sector General Permit |
| NCTCOG | North Central Texas Council of Governments |
| NOAA | National Oceanic and Atmospheric Administration |
| OSSF | on-site sewage facility |
| SSO | sanitary sewer overflow |
| SWMP | stormwater management program |
| SWQM | surface water quality monitoring |
| TCEQ | Texas Commission on Environmental Quality |
| TMDL | total maximum daily load |
| TPDES | Texas Pollutant Discharge Elimination System |
| TRA | Trinity River Authority |
| USCB | United States Census Bureau |
| USGS | United States Geological Survey |
| WLA | wasteload allocation |
| WLA _{SW} | wasteload allocation stormwater |
| WLA _{WWTF} | wasteload allocation wastewater treatment facilities |
| WWTF | wastewater treatment facility |

Section 1. Introduction

1.1. Background

Section 303(d) of the federal Clean Water Act requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. States must develop a total maximum daily load (TMDL) for each pollutant that contributes to the impairment of a water body included on a state's 303(d) list of impaired waters. The Texas Commission on Environmental Quality (TCEQ) is responsible for ensuring that TMDLs are developed for impaired surface waters in Texas.

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

The TMDL Program is a major component of Texas' overall process for managing the quality of its surface waters. The program addresses impaired or threatened streams, reservoirs, lakes, bays, and estuaries (water bodies) in, or bordering on, the state of Texas. The program's primary objective is to restore and maintain water quality uses—such as drinking water supply, recreation, support of aquatic life, or fishing—of impaired or threatened water bodies.

TCEQ first identified the bacteria impairment within assessment unit (AU) 0841I_01 of Dry Branch Creek in the U.S. Environmental Protection Agency (EPA)-approved *2020 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)* (Texas Integrated Report, TCEQ, 2020). The impairment was identified again in the subsequent 2022 Texas Integrated Report (TCEQ, 2022a), the latest EPA-approved edition.

This document will consider one bacteria impairment in one AU of Dry Branch Creek. The impaired water body and identifying AU number are:

- Dry Branch Creek 0841I_01

1.2. Water Quality Standards

To protect public health, aquatic life, and development of industries and economies throughout Texas, TCEQ established the Texas Surface Water Quality Standards (TCEQ, 2018a). The Standards describe the limits for indicators that are monitored to assess the quality of available water for specific uses. TCEQ monitors and assesses water bodies based on these Standards and publishes the Texas Integrated Report list biennially.

The Standards are rules that do all the following:

- Designate the uses, or purposes, for which the state's water bodies should be suitable.
- Establish numerical and narrative goals for water quality throughout the state.
- Provide a basis on which TCEQ regulatory programs can establish reasonable methods to implement and attain the state's goals for water quality.

Standards are established to protect uses assigned to water bodies. The primary uses assigned to water bodies are:

- aquatic life use
- contact recreation
- domestic water supply
- general use

Fecal indicator bacteria are used to assess the risk of illness during contact recreation (e.g., swimming) from ingestion of water. Fecal indicator bacteria are bacteria that are present in the intestinal tracts of humans and other warm-blooded animals. The presence of these bacteria in water indicates that associated pathogens from fecal waste may be reaching water bodies because of such sources as inadequately treated sewage, improperly managed animal waste from livestock, pets, aquatic birds, wildlife, and failing septic systems (TCEQ, 2018b). The fecal indicator bacteria used for freshwater in Texas is *Escherichia coli* (*E. coli*), a species of fecal coliform bacteria.

On February 7, 2018, TCEQ adopted revisions to the *Texas Surface Water Quality Standards* (TCEQ, 2018a) and on May 19, 2020, EPA approved the categorical levels of recreational use and their associated criteria. Recreational use consists of several categories:

- **Primary contact recreation 1** – Activities that are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, handfishing, and the following whitewater activities: kayaking, canoeing, and rafting). It has a geometric mean criterion for *E. coli* of 126 colony forming units (cfu) per 100 milliliters (mL) and an additional single sample criterion of 399 cfu per 100 mL.
- **Primary contact recreation 2** – Water recreation activities, such as wading by children, swimming, water skiing, diving, tubing, surfing, handfishing, and whitewater kayaking, canoeing, and rafting, that involve a significant risk of ingestion of water but that occur less frequently than for primary contact recreation 1 due to physical characteristics of the water body or limited public access. The geometric mean criterion for *E. coli* is 206 cfu per 100 mL.
- **Secondary contact recreation 1** – Activities that commonly occur but have limited body contact incidental to shoreline activity (e.g., fishing, canoeing,

kayaking, rafting, and motor boating). These activities are presumed to pose a less significant risk of water ingestion than primary contact recreation 1 or 2 but more than secondary contact recreation 2. The geometric mean criterion for *E. coli* is 630 cfu per 100 mL.

- **Secondary contact recreation 2** – Activities with limited body contact incidental to shoreline activity (e.g., fishing, canoeing, kayaking, rafting, and motor boating) that are presumed to pose a less significant risk of water ingestion than secondary contact recreation 1. These activities occur less frequently than secondary contact recreation 1 due to physical characteristics of the water body or limited public access. The geometric mean criterion for *E. coli* is 1,030 cfu per 100 mL.
- **Noncontact recreation** – Activities that do not involve a significant risk of water ingestion, such as those with limited body contact incidental to shoreline activity, including birding, hiking, and biking. Noncontact recreation use may also be assigned where primary and secondary contact recreation activities should not occur because of unsafe conditions, such as ship and barge traffic. The geometric mean criterion for *E. coli* is 2,060 cfu per 100 mL.

Dry Branch Creek is a freshwater stream and has a primary contact recreation 1 use. The associated criterion for *E. coli* is a geometric mean of 126 cfu per 100 mL.

1.3. Report Purpose and Organization

The Dry Branch Creek TMDL project was initiated through a contract between TCEQ and Texas Institute for Applied Environmental Research. The tasks of this project were to (1) develop, have approved, and adhere to a quality assurance project plan; (2) develop a technical support document for the impaired watershed; and (3) assist TCEQ with public participation. The purpose of this report is to provide technical documentation and supporting information for developing the bacteria TMDL for the impaired AU. This report contains:

- Information on historical data.
- Watershed properties and characteristics.
- Summary of historical bacteria data that confirm the Texas 303(d) listings of impairment due to concentrations of *E. coli*.
- Development of a load duration curve (LDC).
- Application of the LDC approach for the developing the pollutant load allocation.

Whenever it was feasible, the data development and computations for developing the LDC and pollutant load allocation were performed in a manner to remain consistent with the previously completed *Thirteen Total Maximum Daily Loads for Indicator Bacteria in the Lower West Fork Trinity River Watershed* (TCEQ, 2013).

Section 2. Historical Data Review and Watershed Properties

2.1. Description of Study Area

The Dry Branch Creek watershed is highly urbanized and located within Dallas County. Dry Branch Creek (0841I) is a tributary of Bear Creek (0841B). The watershed drains an area of 3.4 square miles (2,171 acres).

Dry Branch Creek is approximately 1.5 miles long and has only one AU (0841I_01). It is an unclassified, perennial stream that flows into Bear Creek (0841B), which eventually flows into the Lower West Fork Trinity River (0841).

The 2022 Texas Integrated Report (TCEQ, 2022a) supplies the following water body and AU description for Dry Branch Creek:

- 0841I (Dry Branch Creek; AU 0841I_01) - A 1.5 mile stretch of Dry Branch Creek running upstream from confluence with the Lower West Fork Trinity River to Rock Island Road in Irving, Dallas County.

The AU description for 0841I_01 that is contained in the 2022 Texas Integrated Report along with previous reports is not accurate. Dry Branch Creek (0841I_01) is actually a tributary of Bear Creek (0841B) not Lower West Fork Trinity River. TCEQ will revise the AU description for 0841I_01 in future editions of the Texas Integrated Report to describe the terminus of AU 0841I_01 at the confluence with Bear Creek (TCEQ, 2022b).

Using a watershed-based approach, the entire watershed of Dry Branch Creek will be considered in this report. The watersheds of the original TMDLs (TCEQ, 2013), and this study of Dry Branch Creek are shown in Figure 1.

2.2. Review of Routine Monitoring Data

2.2.1. Analysis of Bacteria Data

Surface water quality monitoring has been done within the Dry Branch Creek watershed at TCEQ surface water quality monitoring (SWQM) Station 17173 (Figure 2). *E. coli* data collected at TCEQ SWQM Station 17173 over the seven-year period of December 1, 2013, through November 30, 2020, were used in assessing attainment of the primary contact recreation 1 use as reported in the 2022 Texas Integrated Report (TCEQ, 2022a) and are summarized in Table 1. The 2022 assessment data for the TMDL watershed indicate non-support of the primary contact recreation 1 use because geometric mean concentrations exceed the *E. coli* geometric mean criterion of 126 cfu/100 mL.

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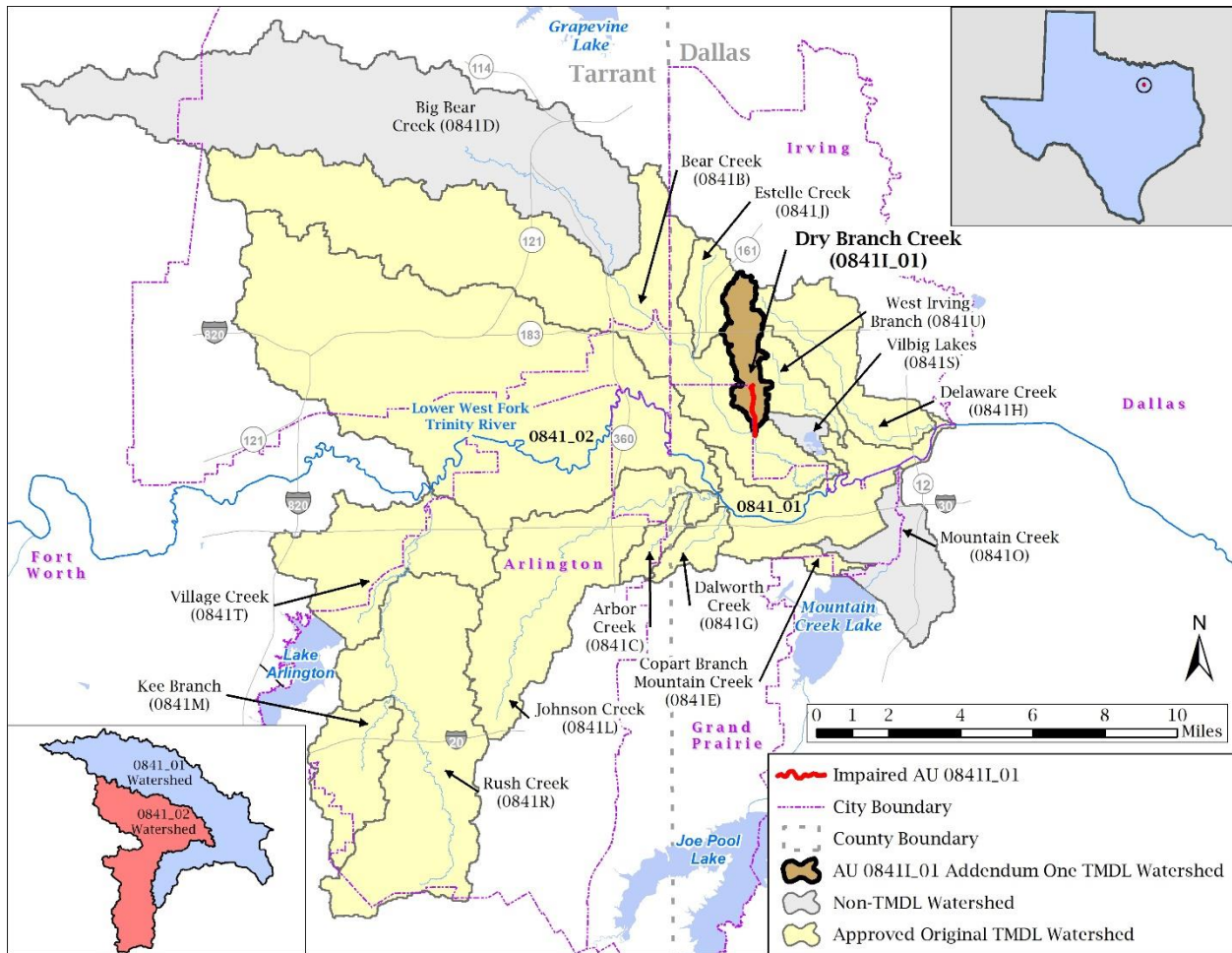


Figure 1. Map showing the previously approved TMDL watersheds and the Dry Branch Creek watershed added by this addendum

Table 1. 2022 Texas Integrated Report summary

| Integrated Report Year | Water Body Name | AU | Parameter | SWQM Station | No. of Samples | Data Date Range | Geometric Mean (cfu/100 mL) |
|------------------------|------------------|----------|----------------|--------------|----------------|-----------------|-----------------------------|
| 2022 | Dry Branch Creek | 0841L_01 | <i>E. coli</i> | 17173 | 37 | 2013-2020 | 416 |

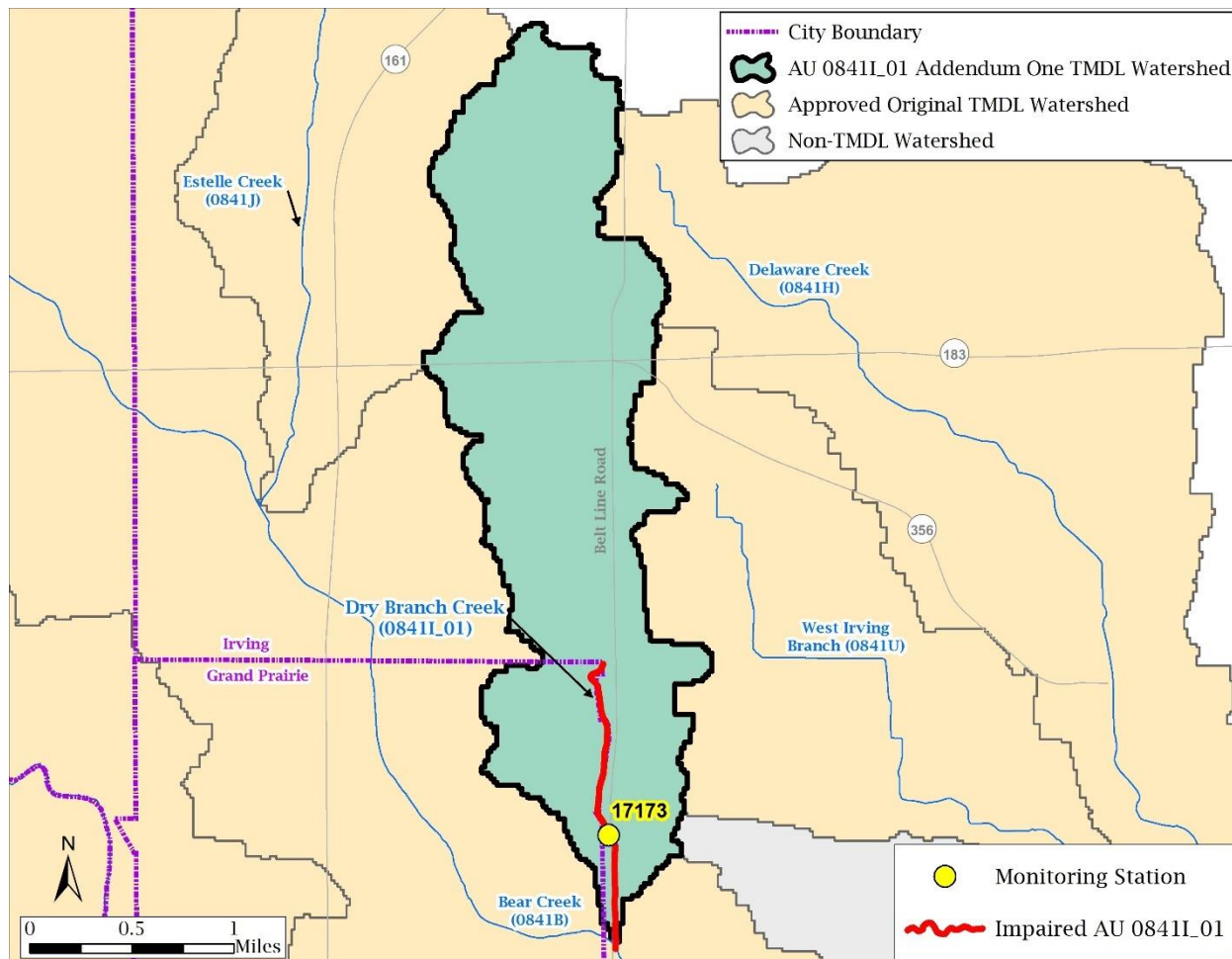


Figure 2. Active TCEQ SWQM station

2.3. Climate and Hydrology

The Dry Branch Creek watershed is near the center of the Dallas/Fort Worth (DFW) metroplex, which has a humid subtropical climate according to the National Oceanic and Atmospheric Administration (NOAA; NOAA, 2009). Typically, the DFW area has mild winters with the first frost occurring in late November and the last frost in mid-March; however, brief periods of extreme cold do occur. Summers in the DFW area are hot and temperatures frequently exceeding 100°F are typically combined with fair skies and westerly winds. Annual precipitation predominately occurs in the form of thunderstorms that are typically brief in nature and are recurrent in the spring.

For the Dallas Fort Worth International Airport weather station located in the northwestern portion of the Dry Branch Creek (0841I) watershed, the average high temperatures typically peak in August (96.8 °F) with highs above 100 °F occurring June through August (Figure 3; NOAA, 2022). During winter, the average low temperature generally bottoms out at 36.6 °F in January (NOAA, 2022).

Weather data obtained from the National Climatic Data Center for the Dallas Fort Worth International Airport station spanning a period from 2002 through 2021 indicate the wettest month is typically May (4.9 inches) while July (1.9 inches) is normally the driest month, with rainfall occurring throughout the year (Figure 3; NOAA, 2022). Average annual rainfall for the twenty-year period was 36.2 inches.

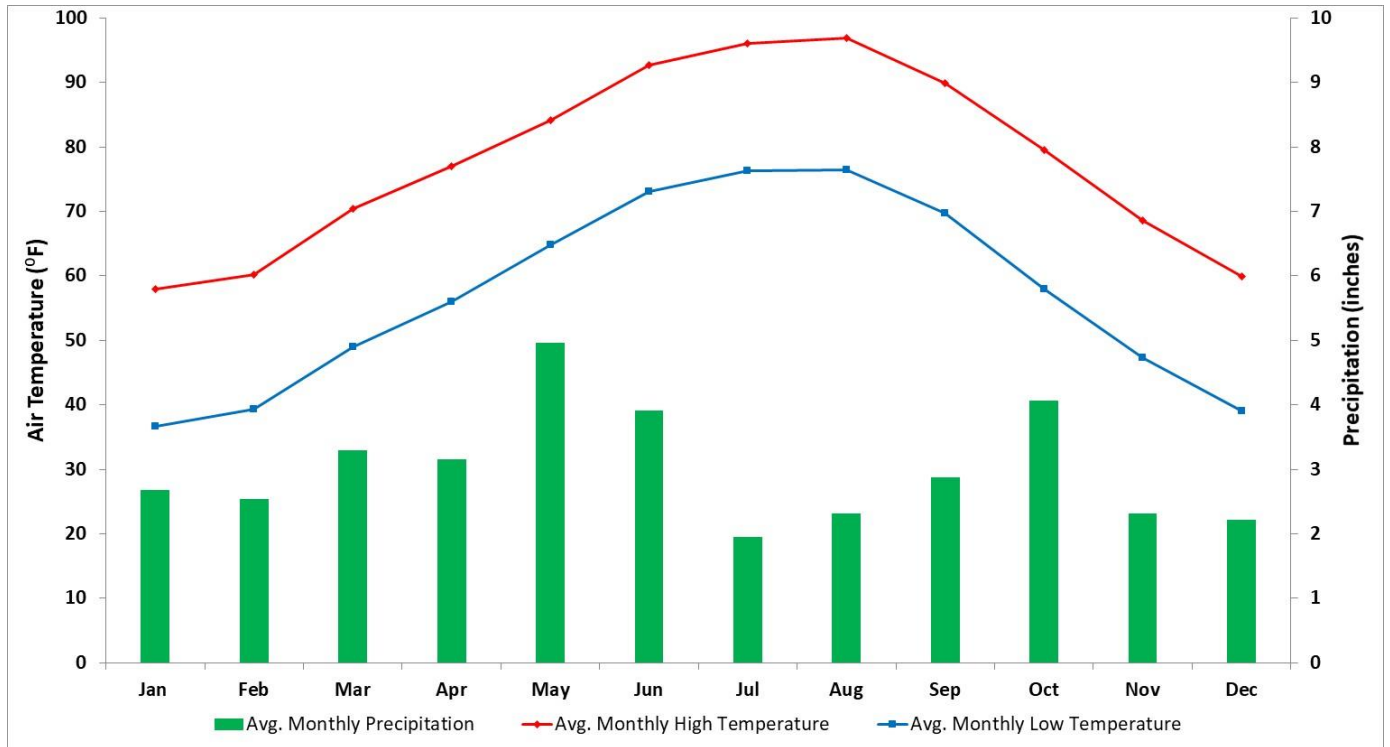


Figure 3. Average monthly temperature and precipitation (2002–2021) at the Dallas Fort Worth International Airport

2.4. Population and Population Projections

As shown in Figure 1, the Dry Branch Creek watershed is geographically located within the municipal boundaries of Irving and Grand Prairie. According to the 2020 United States Census Bureau (USCB) data (USCB, 2021), the Dry Branch Creek watershed has an estimated population of 20,410.

Population projections for the year 2045 were developed by the North Central Texas Council of Governments (NCTCOG) by using traffic survey zone allocations. 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. The projected population increase was then estimated based on the increase from the 2020 population to the projected 2045 population. This predicts that the population within the watershed will increase by 8.5%. (Table 2; USCB, 2021 and NCTCOG, 2017a). You can find additional information on this process in Appendix A.

Table 2. 2020 – 2045 population projection

| Water Body Name | AU | 2020 U.S Census Population | 2045 Population Projection | Projected Population Increase (2020–2045) | Percentage Change |
|------------------|----------|----------------------------|----------------------------|---|-------------------|
| Dry Branch Creek | 0841L_01 | 20,410 | 22,150 | 1,740 | 8.5% |

2.5. Land Cover

The land cover data for the Dry Branch Creek watershed were obtained from NCTCOG (NCTCOG, 2017b) and represent land cover estimates for 2015. The land cover is represented by the following categories and definitions:

- **Commercial/Industrial:** land occupied by office, retail, industrial (manufacturing, warehouses, salvage yards, quarries, mines), utilities (sewage/water treatment plants, power infrastructure), stadiums, communication (radio, television, cable, and phone infrastructure), construction sites, and parking.
- **Group Quarters:** land occupied by nursing homes, dormitories, jails, military personnel quarters, and hotels/motels.
- **Residential:** land occupied by single family, multi-family, and mobile home residences.
- **Institution:** land occupied by churches, schools, museums, hospitals, medical clinics, libraries, government facilities, and military bases.
- **Transit:** land occupied by roads, rail lines, rail stations, bus lines and bus facilities.
- **Dedicated:** land occupied by public and private parks, golf courses, tennis courts, pools, campgrounds, amusement parks, and cemeteries.
- **Vacant:** land that is undeveloped with the potential to be developed or reserved for recreational use.
- **Water:** covered by lakes, rivers, and ponds.

The 2015 land cover data from NCTCOG is provided in Figure 4. A summary of the land cover data is provided in Table 3 and shows that residential is the dominant land cover comprising approximately 42.37% of the total land cover.

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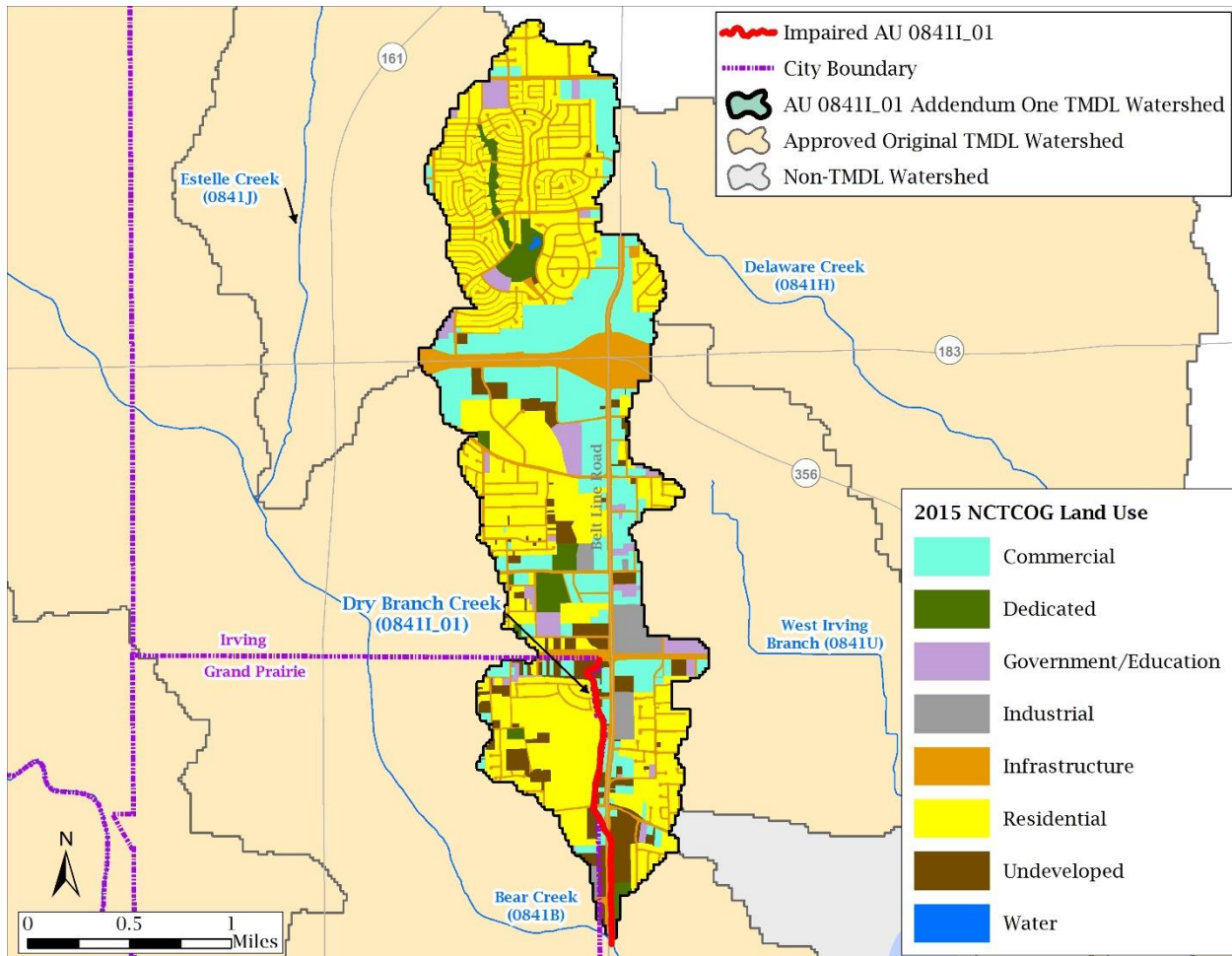


Figure 4. Land cover map showing classifications

Table 3. Land cover classification by area and percentage

| Classification | Area (acres) | Percentage of Total |
|-----------------------|----------------|---------------------|
| Residential | 919.6 | 42.37% |
| Commercial/Industrial | 493.6 | 22.74% |
| Transit | 433.5 | 19.97% |
| Group Quarters | 5.8 | 0.27% |
| Institution | 82.6 | 3.81% |
| Dedicated | 77.4 | 3.57% |
| Vacant | 156.7 | 7.21% |
| Water | 1.4 | 0.06% |
| Total | 2,170.6 | 100% |

2.6. Potential Sources of Fecal Indicator Bacteria

Pollutants may come from several sources, both regulated and unregulated. Regulated pollutants, referred to as “point sources,” come from a single definable point, such as a pipe, and are controlled by permit under the Texas Pollutant Discharge Elimination System (TPDES) program. Wastewater treatment facilities (WWTFs) and stormwater discharges from industrial sites, regulated 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 permits.

Except for WWTFs, which receive individual wasteload allocations (WLAs) (see the “WLA” section), the regulated and unregulated sources in this section are presented to give a general account of the various 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.

2.6.1. Regulated Sources

Regulated sources are controlled by permit under the TPDES program. The regulated sources in the TMDL watershed include stormwater discharges from industrial sites, regulated construction activities, and municipal separate storm sewer systems (MS4s).

2.6.1.1. Domestic and Industrial Wastewater Treatment Facilities

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

2.6.1.2. TCEQ/TPDES General Wastewater Permits

Certain types of activities must 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)

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Discharges related to the following general permit authorizations are not expected to affect the bacteria loading in the TMDL watershed and were excluded from this investigation:

- TXG640000 - conventional water treatment plants
- TXG670000 - hydrostatic test water discharges
- TXG830000 - water contaminated by petroleum fuel or petroleum substances
- TXG870000 - pesticides (application only)
- WQG100000 - wastewater evaporation

A review of active general permits (TCEQ, 2022c) in the Dry Branch Creek watershed as of June 7, 2022, found no active general wastewater permit authorizations of the types described above.

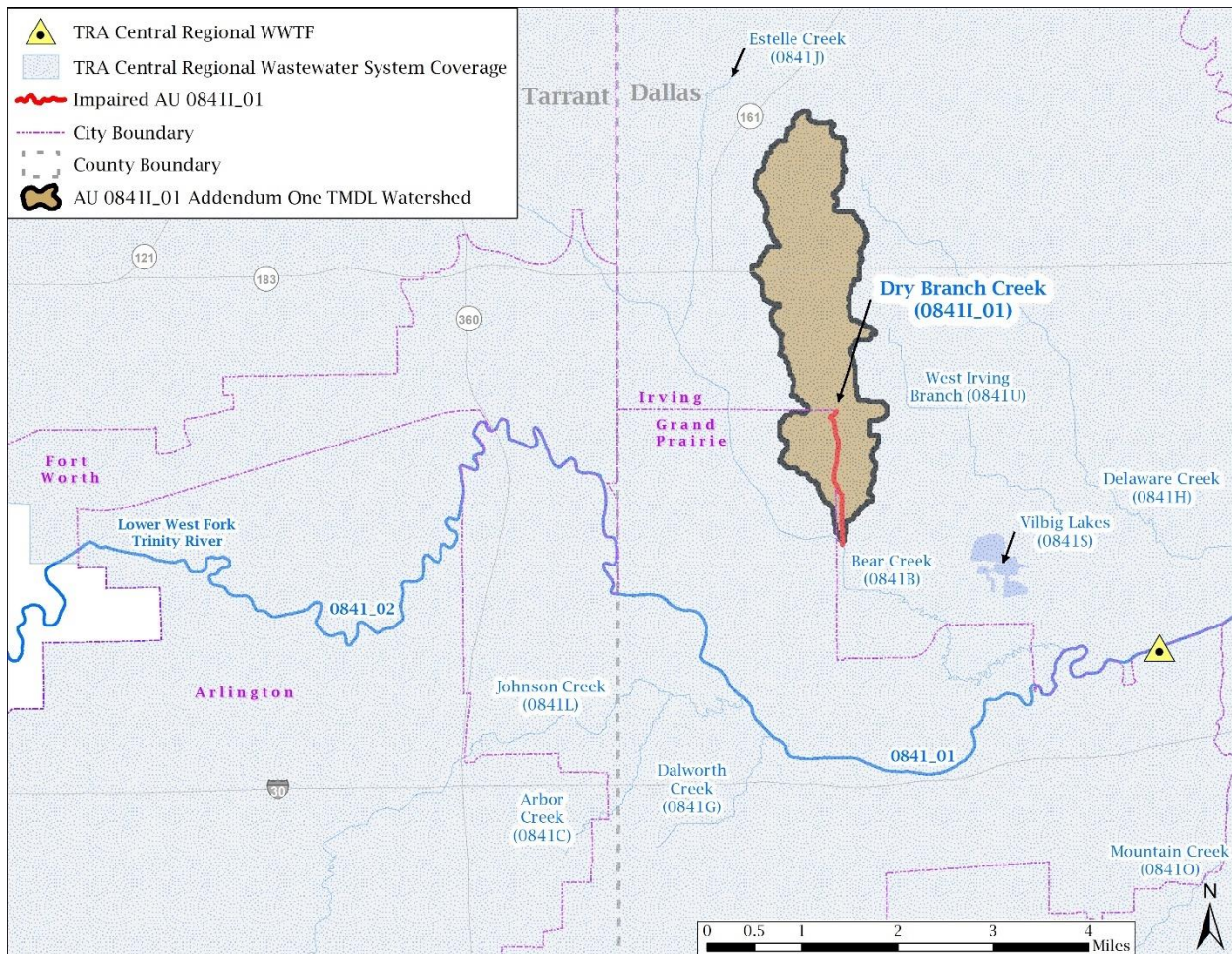


Figure 5. Coverage area of the TRA Central Regional Wastewater System within the TMDL study area

2.6.1.3. 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 activities, and construction activities.
2. Stormwater runoff not subject to regulation.

TPDES MS4 Phase I and II rules require municipalities and certain other entities in urbanized areas to obtain permit coverage for their stormwater systems. A regulated MS4 is a publicly owned system of conveyances and includes ditches, curbs, gutters, and storm sewers that do not connect to a wastewater collection system or treatment facility. Phase I permits are individual permits for large and medium-sized communities with populations of 100,000 or more based on the 1990 United States Census, while the Phase II General Permit regulates other MS4s within a USCB defined urbanized area.

The purpose of an MS4 permit is to reduce discharges of pollutants in stormwater to the “maximum extent practicable” by developing and implementing a stormwater management program (SWMP). The SWMP describes the stormwater control practices that the regulated entity will implement, consistent with permit requirements, to minimize the discharge of pollutants. MS4 permits require that the SWMPs specify the best management practices to meet several minimum control measures (MCMs) that, when implemented in concert, are expected to result in significant reductions of pollutants discharged into receiving water bodies. Phase II MS4 measures include all of the following:

- Public education, outreach, and involvement.
- Illicit discharge detection and elimination.
- Construction site stormwater runoff control.
- Post-construction stormwater management in new development and redevelopment.
- Pollution prevention and good housekeeping for municipal operations.
- Industrial stormwater sources.

Phase I MS4 individual permits have their own set of MCMs that are similar to the Phase II MCMs, but Phase I permits have additional requirements to perform water quality monitoring and implement a floatables program. The Phase I MCMs include all of these activities:

- MS4 maintenance activities.
- Post-construction stormwater control measures.

- Detection and elimination of illicit discharges.
- Pollution prevention and good housekeeping for municipal operations.
- Limiting pollutants in industrial and high-risk stormwater runoff.
- Limiting pollutants in stormwater runoff from construction sites.
- Public education, outreach, involvement, and participation.
- Monitoring, evaluating, and reporting.

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

- TXR040000 - Phase II MS4 General Permit for MS4s located in urbanized areas (discussed above)
- 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

There is currently one Phase I MS4 and one combined Phase I/II permit authorization within the urbanized area of the Dry Branch Creek watershed (Table 4 and Figure 6).

A review of active stormwater general permit coverage as of June 7, 2022 (TCEQ, 2022c), found one Phase II MS4 authorization, two CGP authorizations, and no MSGP authorizations located within the Dry Branch Creek watershed. The areas covered by CGP authorizations are not discussed further, since MS4 permits cover 100% of the watershed area.

Table 4. TPDES MS4 permits

| Regulated Entity | Authorization Type | TPDES Permit No./ EPA ID | Location |
|------------------------------------|-----------------------------|--|---|
| City of Irving | Phase I MS4 | WQ0004691000/ TXS001301 | Areas, except for any agricultural lands, located within the corporate boundaries of the City of Irving in Dallas County. |
| Texas Department of Transportation | Combined Phase I and II MS4 | WQ0005011000/ TXS002101 | TXDOT rights-of way located within Phase I MS4s and Phase II UAs |
| City of Grand Prairie | Phase II MS4 | General Permit (TXR040000)/ TXR040065 | Area within the City of Grand Prairie limits that is located within the Dallas-Fort Worth-Arlington urbanized area |

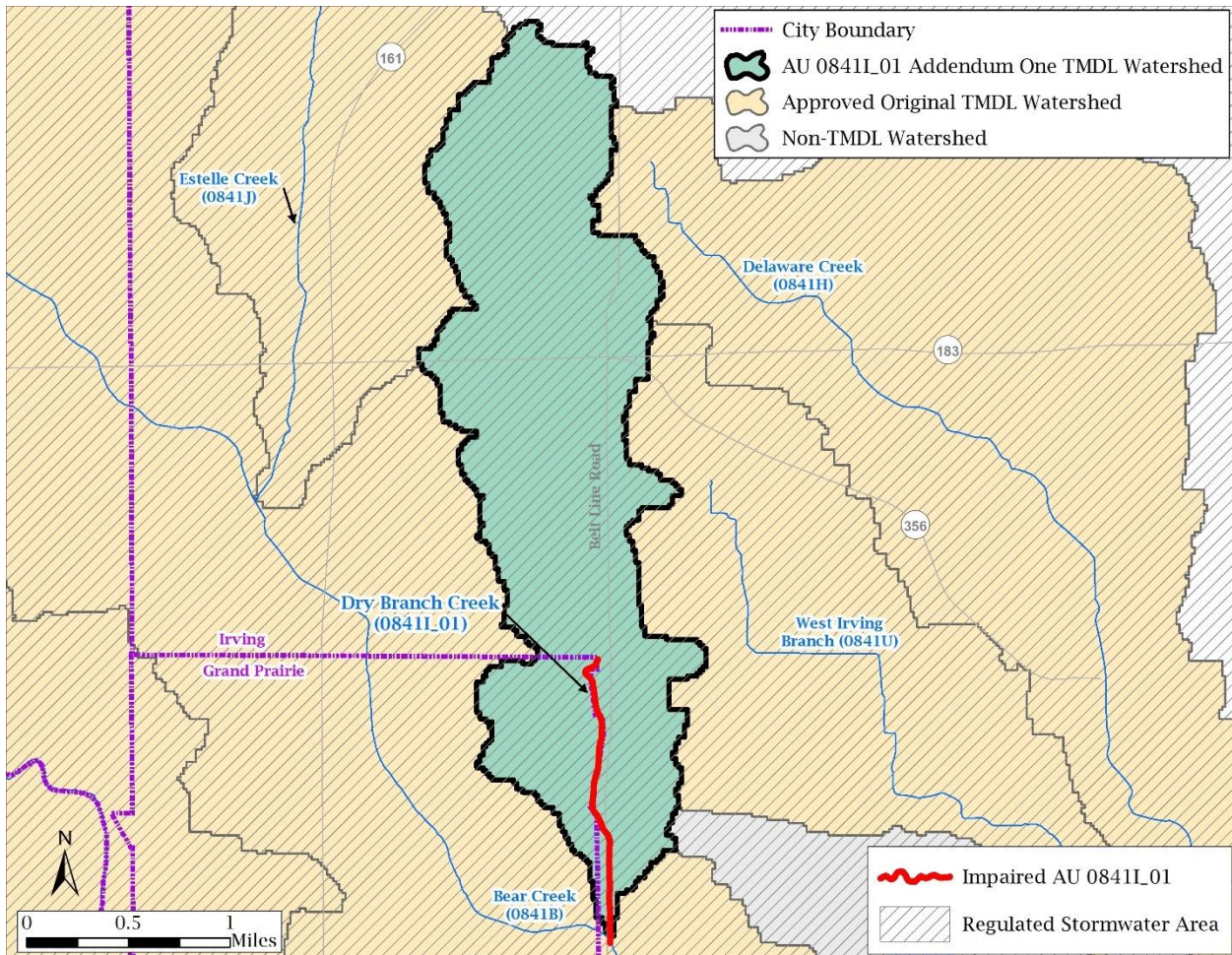


Figure 6. Regulated stormwater area based on Phase I and Phase II MS4 permits as defined by the urbanized area

2.6.1.4. Sanitary Sewer Overflows

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

Information about reported SSO incidents in the Dry Branch Creek watershed was acquired through NCTCOG for incidents that occurred from 2016 to 2021. The SSO data were originally collected by TCEQ Region 4 and were refined by NCTCOG by assigning latitude and longitude coordinates to each SSO event. Table 5 summarizes the SSO data. Figure 7 shows the locations of reported incidents.

Table 5. Summary of SSO incidents from 2016–2021 (in gallons)

| No. of Incidents | Total Volume | Minimum Volume | Maximum Volume |
|------------------|--------------|----------------|----------------|
| 19 | 101,187 | 1 | 100,000 |

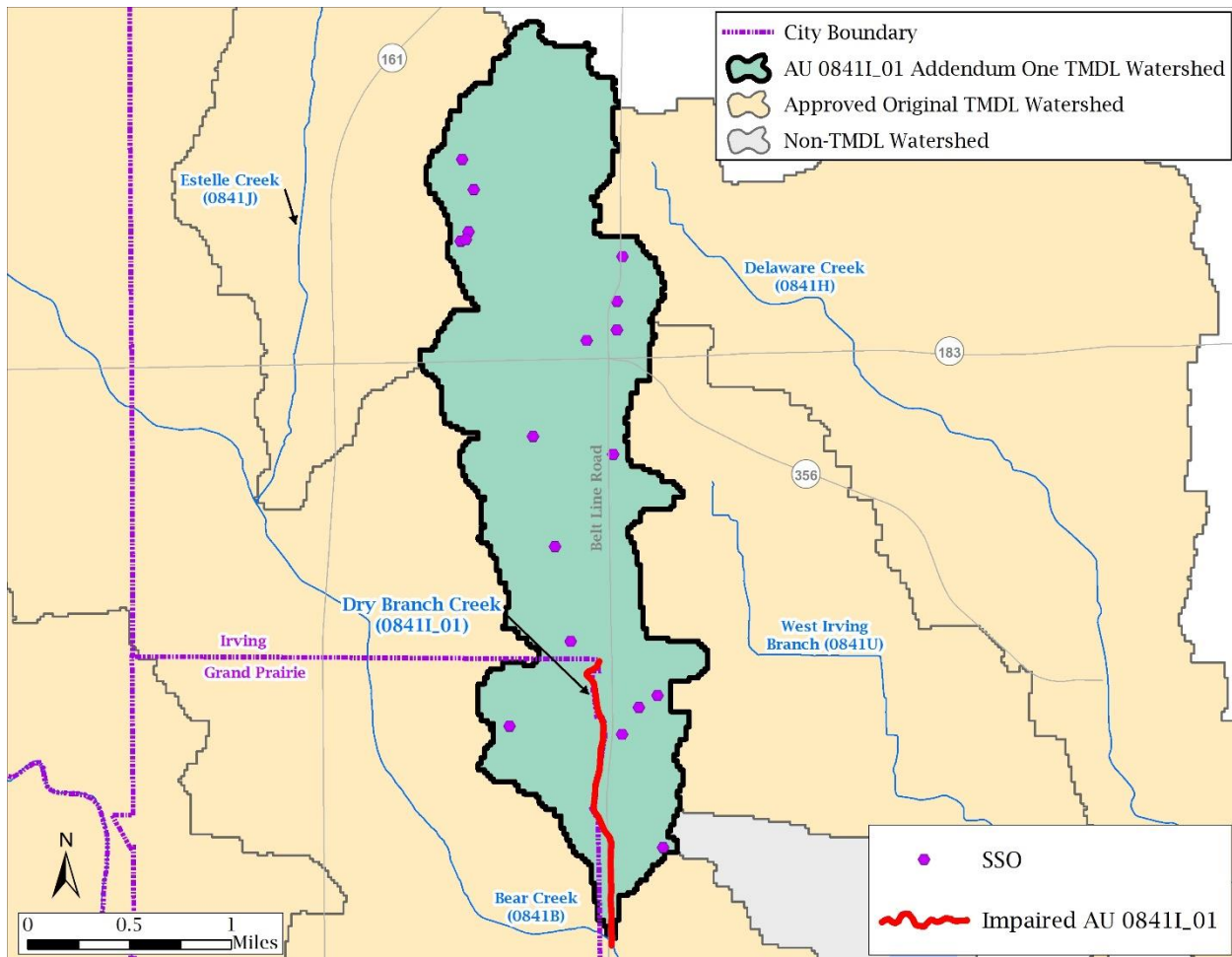


Figure 7. SSOs from 2016–2021

2.6.1.5. Dry Weather Discharges/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. Examples of illicit discharges in the *Illicit Discharge Detection and Elimination Manual: A Handbook for Municipalities* (NEIWPC, 2003) include:

Direct illicit discharges:

- Sanitary wastewater piping that is directly connected from a home to the storm sewer.
- Materials that have been dumped illegally into a storm drain catch basin.
- A shop floor drain that is connected to the storm sewer.
- A cross-connection between the sanitary sewer and storm sewer systems.

Indirect illicit discharges:

- An old and damaged sanitary sewer line that is leaking fluids into a cracked storm sewer line.
- A failing septic system that is leaking into a cracked storm sewer line or causing surface discharge into the storm sewer.

2.6.2. Unregulated Sources

Unregulated sources of bacteria are generally nonpoint. Nonpoint source loading enters the impaired water body through distributed, nonspecific locations, which may include urban runoff not covered by a permit. Potential sources, detailed below, include wildlife, feral hogs, and domestic pets.

2.6.2.1. 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 and feral hogs. Wildlife and feral hogs are attracted naturally to riparian corridors of water bodies. With direct access to the stream channel, the direct deposition of wildlife and feral hog waste can be a concentrated source of bacteria loading to a water body. Wildlife and feral hogs also leave feces on land, where they may be washed into nearby water bodies by rainfall runoff.

The *E. coli* contribution from feral hogs and wildlife in the Dry Branch Creek watershed cannot be determined based on existing information; however, due to its urbanized nature, it is assumed that the contribution would be minimal.

2.6.2.2. Unregulated Agricultural Activities and Domesticated Animals

Due to the highly urbanized nature of the TMDL study area, livestock are not a major source of bacteria loading.

Fecal matter from dogs and cats is transported to water bodies by runoff in both urban and rural areas and can be a potential source of bacteria loading. Table 6 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 according to data from the American Veterinary Medical Association 2017-

2018 U.S. Pet Statistics (AVMA, 2018). Due to the absence of the 2020 Census household data, the number of households in the TMDL watershed were estimated using 2010 Census household and population data (USCB, 2010) to obtain the ratio of people to households. This ratio was applied to the 2020 Dry Branch Creek population data (USCB, 2021) to estimate the number of households in the Dry Branch Creek watershed. The actual contribution and significance of bacteria loads from pets reaching the water body is unknown.

Table 6. Estimated households and pet populations

| Watershed | Estimated Households | Estimated Dog Population | Estimated Cat Population |
|------------------|----------------------|--------------------------|--------------------------|
| Dry Branch Creek | 6,722 | 4,127 | 3,072 |

2.6.2.3. On-Site Sewage Facilities

Private residential on-site sewage facilities (OSSFs), commonly referred to as septic systems, are not a major source of bacteria loading in the Dry Branch Creek watershed, because the entire watershed area is served by a wastewater collection and treatment system. A review of OSSF information received from NCTCOG indicates that no OSSFs are known to exist in the TMDL study area.

2.6.2.4. Bacteria Survival and Die-off

Bacteria are living organisms that survive and die. Certain enteric bacteria can survive and replicate in organic materials if the right conditions prevail (such as warm temperature). Fecal organisms from improperly treated effluent can survive and replicate during their transport in pipe networks, and they can survive and replicate in organic rich materials such as improperly treated compost and sewage sludge (or biosolids). While the die-off of indicator bacteria has been demonstrated in natural water systems due to the presence of sunlight and predators, the potential for their re-growth is less well understood. Both replication and die-off are instream processes and are not considered in the bacteria source loading estimates in the TMDL watershed.

Section 3. Bacteria Tool Development

This section describes the rationale for selecting the bacteria tool used for TMDL development and details the procedures and results of LDC development.

3.1. Tool Selection

For consistency between this TMDL and the previously completed TMDLs located within the West Fork Trinity River watershed, the pollutant load allocation activities for Dry Branch Creek used the LDC method. The LDC method has been previously used on TCEQ-adopted and EPA-approved *Thirteen Total Maximum Daily Loads for Indicator Bacteria in the Lower West Fork Trinity River Watershed* (TCEQ, 2013).

The LDC method allows for estimation of existing and allowable loads by using 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. This information can be used to identify broad categories of sources (point and nonpoint) that may be contributing to the impairment.

The LDC method has found relatively broad acceptance among the regulatory community, primarily due to the simplicity of the approach and ease of application. The regulatory community recognizes the frequent information limitations, often associated with bacteria TMDLs that constrain the use of more powerful mechanistic models. Further, the bacteria task force appointed by TCEQ and the Texas State Soil and Water Conservation Board supports application of this method within their three-tiered approach to TMDL development (Jones et al., 2009). The LDC method provides a means to estimate the difference in bacteria loads and relevant criterion and can give indications of broad sources of the bacteria.

3.2. Data Resources

Successful application of the LDC method requires two basic types of data: continuous daily streamflow data and historical bacteria data for the relevant indicator bacteria, which in this case is *E. coli*.

Hydrologic data in the form of daily streamflow records were unavailable for the Dry Branch Creek watershed; however, streamflow records were available for the nearby Walnut Creek watershed. Streamflow records for Walnut Creek are collected and made readily available by the United States Geological Survey (USGS; USGS, 2022), which operates the streamflow gauge (Table 7, Figure 8). USGS streamflow gauge 08049700 is located along the mainstem of Walnut Creek and serves as the primary source for streamflow records used in this document.

The drainage area ratio (DAR) approach was applied to the streamflow records for Walnut Creek as explained in more detail in Section 3.3.3.

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Table 7. Basic information on Walnut Creek USGS streamflow gauge

| Gauge No. | Site Description | Drainage Area (acres) | Daily Streamflow Record (beginning & end date) |
|-----------|------------------------------------|-----------------------|--|
| 08049700 | Walnut Creek near Mansfield, Texas | 40,179 | Oct. 1960 - present |

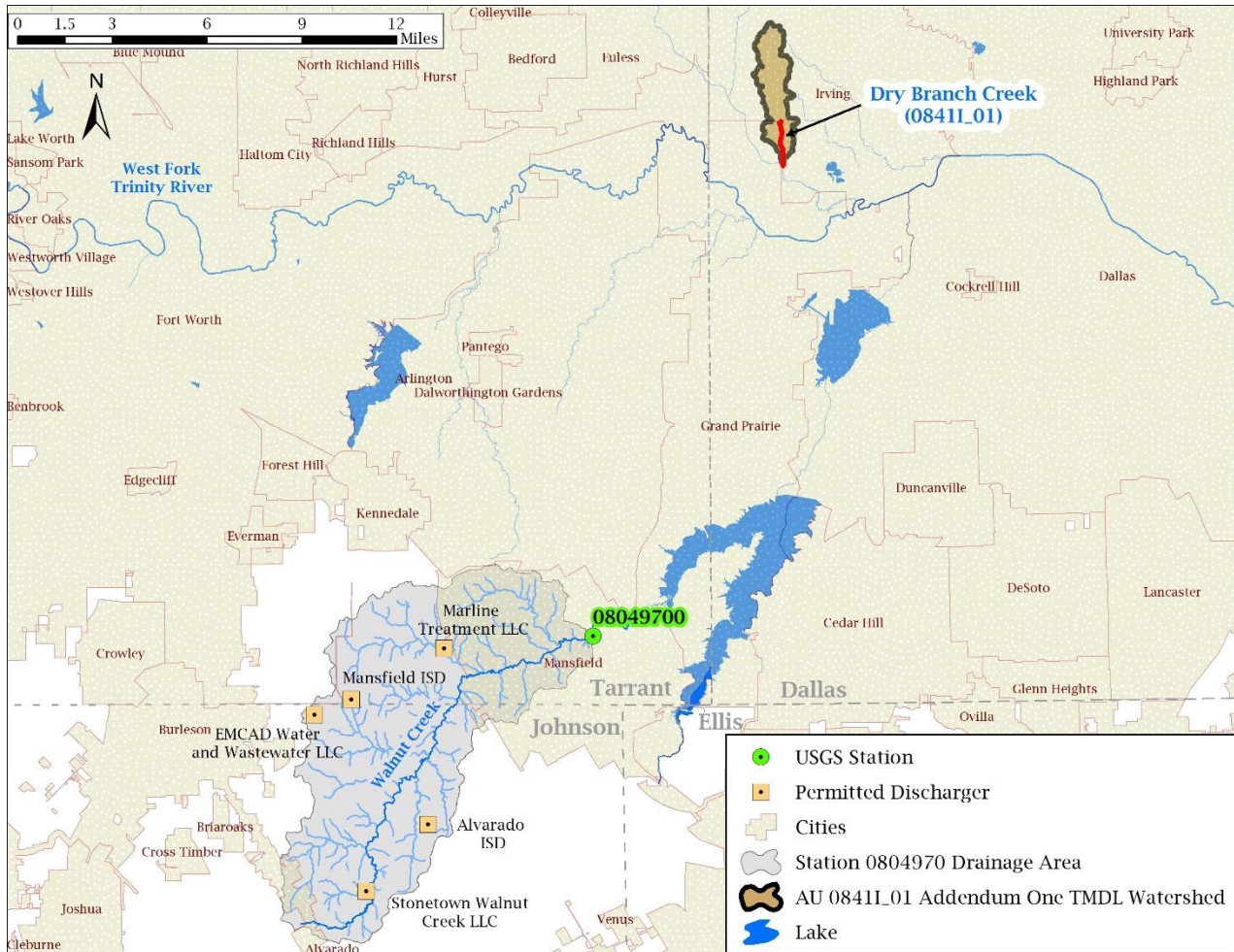


Figure 8. TMDL study area, Walnut Creek watershed, and USGS Station 08049700 location near Mansfield, Texas

Ambient *E. coli* data were retrieved from the TCEQ Surface Water Quality Monitoring Information System on June 7, 2022, for TCEQ SWQM Station 17173 located on Dry Branch Creek (Table 8 and Figure 2).

Table 8. Summary of historical data set of *E. coli* concentrations

| TCEQ SWQM Station | Station Location | No. of <i>E. coli</i> Samples | Data Date Range |
|-------------------|--|-------------------------------|-----------------------|
| 17173 | Dry Branch Creek upstream of Beltline Road, Irving, TX | 74 | Dec. 2001 - Jul. 2021 |

3.3. Method for Developing Flow Duration and Load Duration Curves

To develop the flow duration curve (FDC) and LDC, the previously discussed data resources were used in the following series of sequential steps.

- Step 1: Determine the hydrologic period of record to be used in developing the FDC.
- Step 2: Determine the stream location for which FDC and LDC development is desired.
- Step 3: Develop daily streamflow record at desired location.
- Step 4: Develop FDC at the desired stream location, segmented into discrete flow regimes.
- Step 5: Develop allowable bacteria LDC at the same stream location based on the relevant criteria and the data from the FDC.
- Step 6: Superimpose historical bacteria data on the allowable bacteria LDC.

You can find more information explaining the LDC method in Cleland (2003) and EPA (2007).

3.3.1. Step 1: Determine Hydrologic Period

A 60-year daily hydrologic (streamflow) record was available for USGS streamflow gauge 08049700 located on nearby Walnut Creek (Table 7, Figure 8). Optimally, the period of record to develop FDCs should include as much data as possible to capture extremes of high and low streamflow and hydrologic variability from high to low precipitation years, but the flow during the period of record selected should also be representative of recent conditions experienced within the watershed and when the *E. coli* data were collected. Therefore, a 25-year record of daily streamflow from January 1997 through December 2021 was selected to develop the FDC at the sampling station location. This period also includes the collection dates of all available *E. coli* data at the time this work effort was undertaken. A 25-year period is of sufficient duration to contain a reasonable variation from dry months and years to wet months and years and at the same time is short enough in duration to contain a hydrology that is responding to recent and current conditions in the watershed. A 25-year hydrologic period was also used in the previously completed TMDL *Thirteen Total Maximum Daily Loads for Indicator Bacteria in the Lower West fork Trinity River Watershed* (TCEQ, 2013), which maintains consistency of the Dry Branch Creek TMDL with the previous TMDLs. At the time of this report USGS streamflow gauge 08049700 is still active.

3.3.2. Step 2: Determine Desired Stream Location

When using the LDC method, the best location for developing the pollutant load allocation is a currently monitored SWQM station near the outlet of the watershed. TCEQ SWQM Station 17173 is the only such location within the TMDL watershed where an adequate number of *E. coli* data have been collected. The 74 *E. coli* sampling results for TCEQ SWQM Station 17173 collected over a period from December 2001 to July

2021 were determined to be adequate to develop pollutant load allocations and exceed the minimum of 24 samples suggested in Jones et al. (2009). The LDC developed at the location of TCEQ SWQM Station 17173 was the basis for developing the pollutant load allocations for Dry Branch Creek.

3.3.3. Step 3: Develop Daily Streamflow Records at Desired Location

Once the hydrologic period of record and stream locations were determined, the next step was to develop the 25-year daily streamflow records from extant USGS records.

The method to develop the necessary streamflow record for the FDC/LDC location involved a DAR approach. The DAR approach involves multiplying a USGS gauging station daily streamflow value by a factor to estimate the flow at a desired SWQM station location. The factor is determined by dividing the drainage area upstream of the desired SWQM station by the drainage area upstream of the USGS gauge (Table 9).

Because an assumption of the DAR approach is similarity of hydrologic response based on commonality of landscape features such as geology, soils, and land cover, point source derived flows from within the USGS gauge watershed should first be removed from the flow record prior to application of the ratio. There are five active WWTF discharges upstream of the USGS gauge on Walnut Creek (Figure 8); however, each of these discharges is small (largest permitted discharge of 0.04 million gallons per day [MGD]) and all are greater than 10 stream miles from the gauge location. The combination of the small size of the discharges, their distance from the gauge and the fact that the USGS gauge location for the 25-year period of record experienced zero streamflow 8% of the time and flow less than 0.05 cubic feet per second (cfs) 15% of the time lead to the assumption that the existing discharges are not significantly impacting the gauged streamflow record. Therefore, no adjustments for WWTF discharges were made to the Walnut Creek USGS gauge record prior to application of the DARs.

In addition to the WWTF discharges, surface water diversions associated with water rights permits have the potential of impacting stream hydrology and application of the DAR approach. A spatial query of water rights features (diversions, withdrawals, return flows) showed that the TMDL watershed did not contain any active water rights authorizations; however, there was one active water-right authorization located in the Walnut Creek watershed. A review of the Texas Water Rights Viewer (TCEQ, 2022d) indicates that only one user, located above the USGS gauge 08049700, reported diversions from 2013 through 2020.

The average monthly diversions for each month from 2013 through 2020 were calculated and the monthly diversions were then added to the USGS gauged daily flows for the entire 25-year period of record. After adding the average monthly water rights diversions to the USGS gauged daily flows, each daily flow was multiplied by the DAR (Table 9).

Table 9. DARs based on the drainage area of the Walnut Creek USGS gauge

| Gauge/Station | Drainage Area (acres) | DAR |
|-------------------------|-----------------------|--------|
| USGS Gauge 08049700 | 40,179 | 1.0 |
| TCEQ SWQM Station 17173 | 2,052 | 0.0511 |

3.3.4. Steps 4–6: Flow Duration and Load Duration Curves

FDCs and LDCs are graphs that visualize the percentage of time during which a value of flow or load is equaled or exceeded. To develop an FDC for a location, all the following steps were taken in the order shown.

- Order the daily streamflow data for the location from highest to lowest and assign a rank to each data point (one for the highest flow, two for the second highest flow, and so on).
- Compute the percentage of days each flow was exceeded by dividing each rank by the total number of data points plus one.
- Plot the corresponding flow data against exceedance percentages.

Further, when developing an LDC:

- Multiply the streamflow in cfs by the appropriate water quality criterion for *E. coli* (geometric mean of 126 cfu/100 mL or 1.26 cfu/mL) and by a conversion factor (2.44658×10^9), which gives a loading unit of cfu/day.
- Plot the exceedance percentages, which are identical to the value for the streamflow data points, against the geometric mean criterion for *E. coli*.

The resulting curve represents the maximum allowable daily loadings for the geometric mean criterion. The next step was to plot the sampled *E. coli* data on the developed LDC using the following steps:

- Compute the daily loads for each sample by multiplying the measured *E. coli* concentrations on a particular day by the corresponding streamflow on that day and the conversion factor (2.44658×10^9).
- Plot on the LDC for each SWQM station the load for each measurement at the exceedance percentage for its corresponding streamflow.

The plots of the LDC with the measured loads (*E. coli* concentrations times daily streamflow) display the frequency and magnitude at which measured loads exceed the maximum allowable loadings for the geometric mean criterion. Measured loads that are above a maximum allowable loading curve indicate an exceedance of the water quality criterion, while those below a curve show compliance.

3.4. Flow Duration Curve

The FDC was developed for TCEQ SWQM Station 17173 within Dry Branch Creek (Figure 9). For this report, the FDC was developed by applying the DAR method using the Walnut Creek USGS gauge 25-year period of record described in the preceding sections. Flow exceedances less than 10% typically represent streamflow influenced by storm runoff, while higher flow exceedances represent receding hydrographs after a runoff event and base flow conditions.

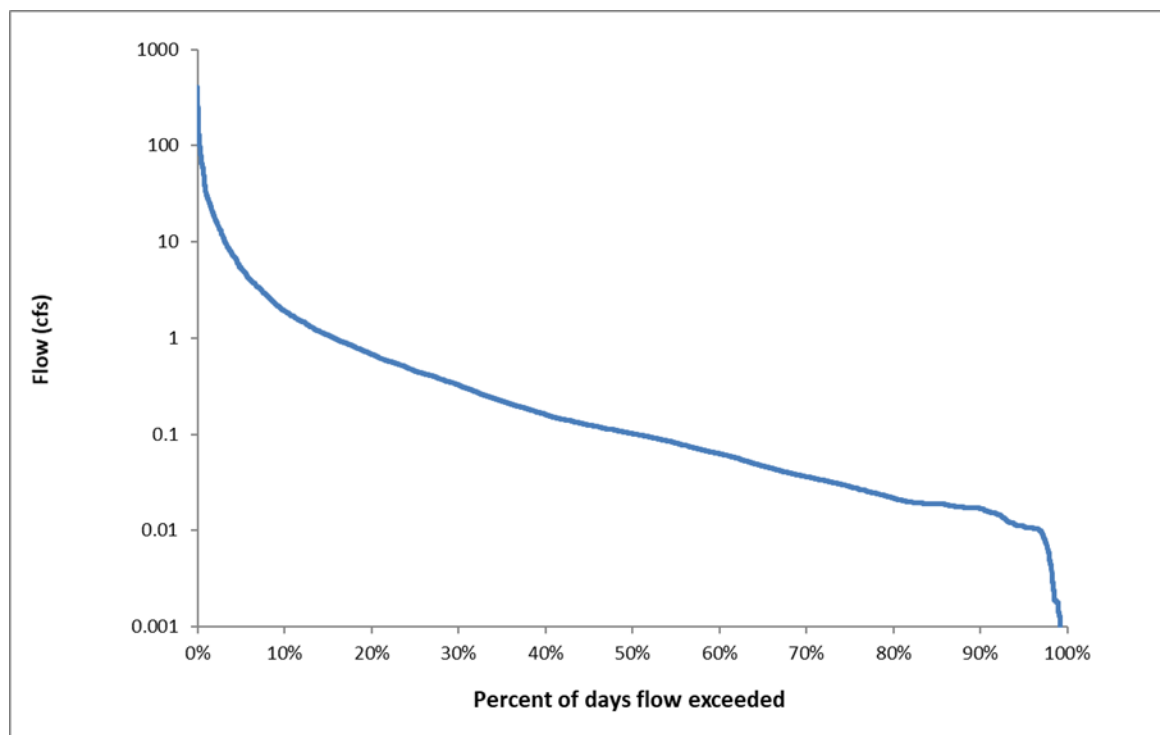


Figure 9. FDC for TCEQ SWQM Station 17173

3.5. Load Duration Curve

An LDC was developed for TCEQ SWQM Station 17173 within the Dry Branch Creek watershed (Figure 10). A useful refinement of the LDC approach is to divide the curve into flow-regime regions to analyze exceedance patterns in smaller portions of the duration curve. This approach can aid in determining streamflow conditions under which exceedances are occurring.

For TCEQ SWQM Station 17173, streamflow distribution was divided into three flow regimes: very high, high, and low flow (Table 10), which maintains consistency with the previously completed TMDLs (TCEQ, 2013). Very high flows correspond to large storm-induced runoff events. High flows typically represent periods of medium base flows but can also represent small runoff events and periods of flow recession following large storm events. Conditions within the low flow regime represent relatively low flow conditions, resulting from extended periods of little or no rainfall.

Table 10. Flow regime classifications

| Flow Regime Classification | Flow Exceedance Percentile |
|----------------------------|----------------------------|
| Very High Flow | 0 - 10% |
| High Flow | 10 - 50% |
| Low Flow | 50 - 100% |

The LDC developed for TCEQ SWQM Station 17173 showing these three flow regimes is provided in Figure 10. The LDC for the location of TCEQ SWQM Station 17173 was constructed for developing the TMDL allocation for Dry Branch Creek (0841I_01). Geometric mean loadings for the data points within each flow regime have also been distinguished on the figure to aid interpretation. The LDC for the SWQM station provides a means of identifying the streamflow conditions under which exceedances in *E. coli* concentrations have occurred. The LDC depicts the allowable loading under the geometric mean criterion (126 cfu/100 mL) and shows that existing loadings often exceed the criterion. In addition, the LDC also presents the allowable loading under the single sample criterion (399 cfu/100 mL).

On the graph, the measured *E. coli* data are associated with a “wet weather event” or a “non-wet weather event.” A sample was determined to be influenced by a wet weather event based on the reported “days since last precipitation” (DSLPP), as noted on field data sheets associated with each sampling event. DSLPP (TCEQ water quality parameter code 72053) is a field parameter that may be noted during a sampling event to inform of the general climatic and hydrologic conditions. A sample taken with a DSLPP \leq 2 days was defined as a wet weather event. Note that a wet weather event can be indicated even under low flow conditions as a result of only a small runoff event during a period of very low base flow in the stream.

The *E. coli* event data plotted on the LDC for TCEQ SWQM Station 17173 in Figure 10 show exceedances of the geometric mean criterion have commonly occurred within the very high and high flow regime conditions. This pattern of frequent exceedances during very high and high flow regimes of the geometric mean criterion is also evident in the plotted existing geometric mean load that are displayed within the LDC for each flow regime.

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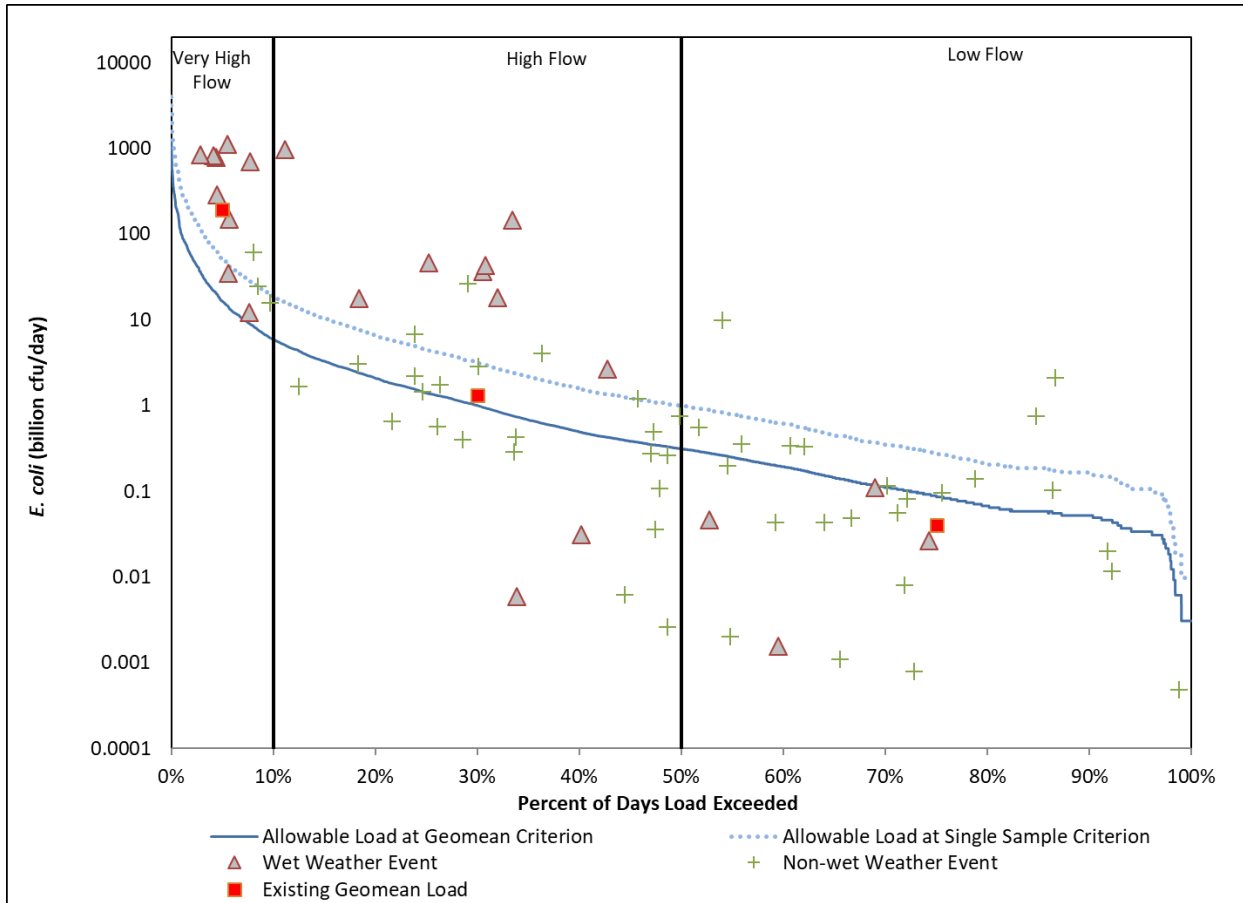


Figure 10. LDC for TCEQ SWQM Station 17173

Section 4. TMDL Allocation Analysis

4.1. Endpoint Identification

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

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.

4.2. Seasonal Variation

Seasonal variations occur when there is a cyclic pattern in streamflow and, more importantly, in water quality constituents. TMDLs must account for seasonal variation in watershed conditions and pollutant loading, as required by federal regulations [Title 40, Code of Federal Regulations Chapter 1, Part 130, Section 130.7(c)(1) (or 40 CFR 130.7(c)(1))].

Analysis of the seasonal differences in indicator bacteria concentrations were assessed by comparing available *E. coli* concentrations obtained from routine monitoring at TCEQ SWQM Station 17173. Differences in *E. coli* concentrations were evaluated by performing a Wilcoxon Rank Sum test. *E. coli* concentrations during warmer months (May - September) were compared against those during the cooler months (November - March). April and October are considered transitional periods between warm and cool seasons and therefore were excluded from the analysis. This analysis of *E. coli* data indicated that there was a significant difference ($\alpha=0.05$) in indicator bacteria between cool and warm weather seasons for Dry Branch Creek ($p=0.04$) with the warm season having higher *E. coli* concentrations.

4.3. Linkage Analysis

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

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

Bacteria load contributions from regulated and unregulated stormwater sources are greatest during runoff events. Rainfall runoff, depending upon the severity of the storm, can carry bacteria from the land surface into the receiving stream. Generally, this loading follows a pattern of higher concentrations in the water body as the first flush of storm runoff enters the receiving stream. Over time, the concentrations decline as runoff washes fecal bacteria from the land surface and the volume of runoff decreases following the rain event.

An LDC 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 direct relationship between pollutant load sources (regulated and unregulated) and instream loads. Further, this one-to-one relationship was inherently assumed when using the LDC to define the TMDL pollutant load allocation (Section 4.7). That allocation was based on the flows associated with the watershed areas under stormwater regulation, and the remaining portion was assigned to the unregulated stormwater.

4.4. Load Duration Curve Analysis

LDC analyses were used to examine the relationship between instream water quality and the broad sources of indicator bacteria loads, and they are the basis of the TMDL allocations. The strength of this TMDL is the use of the LDC method to determine the TMDL allocations. An LDC is a simple statistical method that provides a basic description of the water quality problem. This tool is easily developed and explained to stakeholders and uses available water quality and flow data. The LDC method does not require any assumptions about loading rates, stream hydrology, land use conditions, and other conditions in the watershed. The EPA supports the use of this approach to characterize pollutant sources. In addition, many other states are using this method to develop TMDLs.

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

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

Based on the LDC developed for TCEQ SWQM Station 17173 with historical *E. coli* data added to the graph (Figure 10) and Section 2.6 (Potential Sources of Fecal Indicator Bacteria), the following broad linkage statements can be made. For this TMDL watershed, historical *E. coli* data show that elevated bacteria loadings occur under all

three flow regimes with exceedances occurring more frequently within the very high and high flow regimes. The geometric means of measured data within each flow regime indicate moderation of the elevated loadings with decreases in streamflow conditions.

4.5. Margin of Safety

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

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

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

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

4.6. Load Reduction Analysis

While the TMDL for Dry Branch Creek was developed using an LDC and associated load allocations, additional insight may, in certain situations, be gained through a load reduction analysis. A single percentage load reduction required to meet the allowable loading for each of the three flow regimes was determined using the historical *E. coli* data obtained from the SWQM station within AU 0841I_01.

For each flow regime the percentage reduction required to achieve the geometric mean criterion was determined by calculating the difference in the existing (or measured) geometric mean concentration and the 126 cfu/100 mL criterion and dividing that difference by the existing geometric mean concentration (Table 11).

Table 11. Percent reduction calculations for TCEQ SWQM Station 17173

| Flow Regime | TCEQ SWQM Station | Number of Samples | Geometric Mean (cfu/100 mL) | Percentage Reduction Required |
|------------------------|-------------------|-------------------|-----------------------------|-------------------------------|
| Very High Flow (0-10%) | 17173 | 12 | 1,468 | 91.4% |
| High Flow (10-50%) | 17173 | 34 | 165 | 23.6% |
| Low Flow (50-100%) | 17173 | 28 | 59 | 0% |

4.7. Pollutant Load Allocation

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

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{FG} + \text{MOS} \quad (\text{Equation 1})$$

Where:

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

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

FG = loadings associated with future growth from potential regulated facilities

MOS = margin of safety load

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

4.7.1. Assessment Unit-Level TMDL Calculations

The bacteria TMDL for AU 0841I_01 was developed as a pollutant load allocation based on information from the LDC for TCEQ SWQM Station 17173 (Figure 10). As discussed in more detail in Section 3, the bacteria LDC was developed by multiplying each flow value along the FDC by the *E. coli* criterion (126 cfu/100 mL) and by the conversion factor used to represent maximum loading in cfu/day. Effectively, the “Allowable Load” displayed in the LDC at 5% exceedance (the median value of the very high flow regime) is the TMDL:

$$\text{TMDL (cfu/day)} = \text{Criterion} * \text{Flow (cfs)} * \text{Conversion Factor} \quad (\text{Equation 2})$$

Where:

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

Conversion Factor (to billion cfu/day) = (28,316.846 mL/cubic feet (ft³) * 86,400 seconds/day (s/d) ÷ 1,000,000,000

The allowable loading of *E. coli* that the impaired water body can receive daily was determined using Equation 2 based on the median value within the very high flow regime of the FDC (or 5% flow exceedance value) for the TCEQ SWQM station (Table 12).

Table 12. Summary of allowable loading calculation

| Water Body Name | AU | 5% Exceedance Flow (cfs) | 5% Exceedance Load (cfu/Day) | TMDL (Billion cfu/Day) |
|------------------|----------|--------------------------|------------------------------|------------------------|
| Dry Branch Creek | 0841I_01 | 5.367 | 1.655E+10 | 16.545 |

4.7.2. Margin of Safety Allocation

The MOS is applied only to the allowable loading for a watershed. Therefore, the MOS is expressed mathematically as the following:

$$\text{MOS} = 0.05 * \text{TMDL} \quad (\text{Equation 3})$$

Using the TMDL value for AU 0841I_01 provided in Table 12, the MOS may be readily computed by proper substitution in Equation 3 (Table 13).

Table 13. MOS calculation

Load units expressed as billion cfu/day *E. coli*

| Water Body Name | AU | TMDL ^a | MOS |
|------------------|----------|-------------------|-------|
| Dry Branch Creek | 0841I_01 | 16.545 | 0.827 |

^a TMDL from Table 12.

4.7.3. Waste Load Allocations

The WLA consists of two parts — the wasteload allocated to TPDES-regulated WWTFs (WLA_{WWTF}) and the wasteload allocated to regulated stormwater dischargers (WLA_{SW}).

$$\text{WLA} = \text{WLA}_{\text{WWTF}} + \text{WLA}_{\text{SW}} \quad (\text{Equation 4})$$

4.7.3.1. Wastewater

TPDES-permitted WWTFs are allocated a daily wasteload calculated as their full permitted discharge flow rate multiplied by one-half the instream geometric criterion. One-half of the water quality criterion (63 cfu/100mL) is used as the WWTF target to provide instream and downstream load capacity, and to be consistent with previously developed TMDLs. Thus, WLA_{WWTF} is expressed in the following equation:

$$\text{WLA}_{\text{WWTF}} = \text{Target} * \text{Flow} * \text{Conversion Factor} \quad (\text{Equation 5})$$

Where:

Target= 63 cfu/100 mL

Flow = full permitted flow in MGD

Conversion Factor (to billion cfu/day) = 3,785,411,800 mL/million gallons ÷
1,000,000,000

Due to the absence of any permitted dischargers in the Dry Branch Creek watershed, the WLA_{WWTf} is zero.

4.7.3.2. Regulated Stormwater

Stormwater discharges from MS4, industrial, and construction areas are considered regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges. A simplified approach for estimating the WLA for these areas was used in the development of this TMDL due to the limited amount of data available, the complexities associated with simulating rainfall runoff, and the variability of stormwater loading.

The percentage of the land area that is under the jurisdiction of stormwater permits in the TMDL watershed was used to estimate the amount of the overall runoff load that should be allocated as the permitted stormwater contribution in the WLA_{SW} component of the TMDL. The LA component of the TMDL corresponds to direct nonpoint runoff and is the difference between the total load from stormwater runoff and the portion allocated to WLA_{SW} .

WLA_{SW} is the sum of loads from regulated stormwater sources and is calculated as follows:

$$WLA_{SW} = (TMDL - WLA_{WWTf} - FG - MOS) * FDA_{SWP} \quad \text{(Equation 6)}$$

Where:

TMDL = total maximum daily load

WLA_{WWTf} = sum of all WWTF loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety load

FDA_{SWP} = fractional proportion of drainage area under jurisdiction of stormwater permits

The fractional proportion of the drainage area under the jurisdiction of stormwater permits (FDA_{SWP}) must be determined to estimate the amount of overall runoff load that should be allocated to WLA_{SW} . The term FDA_{SWP} was calculated based on the combined area under regulated stormwater permits. As described in Section 2.6.1.3, the Dry Branch Creek watershed is covered completely by MS4 Phase I and II permits. However, even in highly urbanized areas such as this one, there remain small areas of potential direct deposition of bacteria loadings from unregulated sources such as wildlife. To account for these small unregulated areas, the stream length of Dry Branch Creek (from the confluence with Bear Creek upstream to Rock Island Road in Irving, Dallas County) and average channel width as calculated based on recent aerial imagery was used to compute an area of unregulated stormwater contribution (Table 14).

Table 14. Basis of unregulated stormwater area and computation of FDA_{SWP} term

| Water Body Name | AU | Total Area (acres) | Stream Length (feet) | Estimated Average Channel Width (feet) | Estimated Stream Area (acres) | Fraction Unregulated Area | FDA _{SWP} |
|------------------|---------|--------------------|----------------------|--|-------------------------------|---------------------------|--------------------|
| Dry Branch Creek | 0841L01 | 2,171 | 7,920 | 18 | 3.3 | 0.002 | 0.998 |

The daily allowable loading of *E. coli* assigned to WLA_{SW} was determined based on the combined area under regulated stormwater permits. To calculate the WLA_{SW} (Equation 6), the FG term must be known. As noted previously in section 2.6.1.1, the Dry Branch Creek watershed is entirely within the collection system area of the TRA Central Regional WWTF. There are no WWTFs within the Dry Branch Creek watershed and there are no plans to build a new one within the watershed (TRA, 2022). Consequently, the FG term is zero. Table 15 provides the information needed to compute WLA_{SW}.

Table 15. Regulated stormwater WLA calculation

Load units expressed as billion cfu/day *E. coli*

| Water Body Name | AU | TMDL ^a | MOS ^b | WLA _{WWTF} ^c | FG ^d | FDA _{SWP} ^e | WLA _{SW} ^f |
|------------------|---------|-------------------|------------------|----------------------------------|-----------------|---------------------------------|--------------------------------|
| Dry Branch Creek | 0841L01 | 16.545 | 0.827 | 0 | 0 | 0.998 | 15.694 |

^a TMDL from Table 12

^b MOS from Table 13

^c WLA_{WWTF} = 0 due to an absence of any WWTFs in the TMDL watershed

^d FG = 0 since the establishment of WWTFs within the TMDL watershed is highly unlikely

^e FDA_{SWP} from Table 14

^f WLA_{SW} = (TMDL - WLA_{WWTF} - FG - MOS) * FDA_{SWP} (Equation 6)

4.7.4. Future Growth

The FG component of the TMDL equation addresses the requirement to account for future loadings that may occur due to 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.

FG would typically be calculated as follows:

$$FG = \text{Target} * (\%POP_{2020-2045} * WWTF_{FP}) * \text{Conversion Factor} \quad (\text{Equation 7})$$

Where:

Target = 63 cfu/100 mL

POP₂₀₂₀₋₂₀₄₅ = estimated percentage increase in population between 2020 and 2045

$WWTF_{FP}$ = full permitted WWTF discharge (MGD)

Conversion Factor = 3,785,411,800 mL/million gallons) ÷ 1,000,000,000

As stated earlier, 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 Dry Branch Creek watershed (TRA, 2022), the FG component is zero.

4.7.5. Load Allocations

Within the Dry Branch Creek watershed, a small area not regulated by stormwater permits was assigned, as detailed in Table 14. The LA is the load from unregulated sources, and is calculated as:

$$LA = TMDL - WLA_{WWTF} - WLA_{SW} - FG - MOS \quad \text{(Equation 8)}$$

Where:

TMDL = total maximum daily load

WLA_{WWTF} = sum of all WWTF loads

WLA_{SW} = sum of all regulated stormwater loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety load

The calculation results are shown in Table 16.

Table 16. LA calculation

Load units expressed as billion cfu/day *E. coli*

| Water Body Name | AU | TMDL ^a | MOS ^b | WLA_{WWTF} ^c | WLA_{SW} ^d | FG ^e | LA ^f |
|------------------|----------|-------------------|------------------|---------------------------|-------------------------|-----------------|-----------------|
| Dry Branch Creek | 0841L_01 | 16.545 | 0.827 | 0 | 15.694 | 0 | 0.024 |

^a TMDL from Table 12

^b MOS from Table 13

^c WLA_{WWTF} = 0 due to an absence of any WWTFs in the TMDL watershed

^d WLA_{SW} from Table 15

^e FG = 0 since the establishment of WWTFs within the TMDL watershed is highly unlikely

^f LA = TMDL - WLA_{WWTF} - WLA_{SW} - FG - MOS (Equation 8)

4.8. Summary of TMDL Calculations

Table 17 summarizes the TMDL calculation for the Dry Branch Creek watershed. The TMDL was calculated based on the median flow in the 0-10 percentile range (5% exceedance, very high flow regime) for flow exceedance from the LDC developed for TCEQ SWQM Station 17173. Allocations are based on the current geometric mean criterion for *E. coli* of 126 cfu/100 mL for each component of the TMDL (except for the

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WLA_{WWTF} and FG terms, which have used one-half the criterion). You can see the TMDL allocation summary for the Dry Branch Creek TMDL watershed in Table 17.

Table 17. TMDL allocation summary

Load units expressed as billion cfu/day *E. coli*

| AU | TMDL ^a | MOS ^b | WLA _{WWTF} ^c | WLA _{SW} ^d | LA ^e | FG ^f |
|---------|-------------------|------------------|----------------------------------|--------------------------------|-----------------|-----------------|
| 0841L01 | 16.545 | 0.827 | 0 | 15.694 | 0.024 | 0 |

^a TMDL = from Table 12

^b MOS = from Table 13

^c WLA_{WWTF} = 0 due to an absence of any WWTFs in the TMDL watershed

^d WLA_{SW} = from Table 15

^e LA = from Table 16

^f FG = 0 since the establishment of WWTFs within the TMDL watershed is highly unlikely

The final TMDL allocations (Table 18) needed to comply with the requirements of 40 CFR 130.7 include the FG component within the WLA_{WWTF}.

Table 18. Final TMDL allocation

Load units expressed as billion cfu/day *E. coli*

| AU | TMDL | MOS | WLA _{WWTF} | WLA _{SW} | LA |
|---------|--------|-------|---------------------|-------------------|-------|
| 0841L01 | 16.545 | 0.827 | 0 | 15.694 | 0.024 |

Section 5. References

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Appendix A. Estimation of the 2020 Census population and 2045 population projection for the Dry Branch Creek AU 0841I_01 Watershed

The following steps detail the method used to estimate the 2020 and projected 2045 populations in the Dry Branch Creek watershed.

- 1) Obtained 2020 USCB data at the block level.
- 2) Developed the 2020 watershed population using the block level data for the portion of the census blocks located within the watershed.
- 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 watershed.
- 4) Obtained population projections for the year 2045 from NCTCOG traffic survey zone allocations.
- 5) Developed population projections using traffic survey zone data for the portion of the traffic survey zones located within the watershed.
- 6) Subtracted the 2020 watershed population from the 2045 population projection to determine the projected population increase. Subsequently, the projected population increase was divided by the 2020 watershed population to determine the percent population increase for the Dry Branch Creek watershed.