Clear Creek and Tributaries: Bacteria in Waters Used for Contact Recreation

- Nine TMDLs Adopted September 10, 2008
  Approved by EPA March 6, 2009
- Four TMDLs Added by Addendum October 2012
  Approved by EPA March 12, 2013
- **Two TMDLs Added by Addendum October 2018**
  Approved by EPA February 22, 2019 (scroll to view or print this addendum)

Prepared by the:
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Addendum Two to Nine Total Maximum Daily Loads for Bacteria in Clear Creek and Tributaries

One Total Maximum Daily Load for Indicator Bacteria in Mary's Creek Bypass

For Segment 1102F

Assessment Unit 1102F_01

Introduction

The Texas Commission on Environmental Quality (TCEQ) adopted *Nine Total Maximum Daily Loads for Bacteria in Clear Creek and Tributaries: Segments 1101, 1101B, 1101D, 1102, 1102A, 1102B, 1102C, 1102D, and 1102E (TCEQ, 2008)* on September 10, 2008. The total maximum daily loads (TMDLs) were approved by the United States Environmental Protection Agency on March 6, 2009. This document represents an addendum to the original TMDL document.

This addendum includes information specific to one additional assessment unit (AU) of one segment located within the watershed of the approved TMDL project for bacteria in Clear Creek. Concentrations of indicator bacteria in this AU exceed the criteria used to evaluate attainment of the water quality standard for contact recreation. This addendum presents the new information associated with the additional AU. For background or other explanatory information, please refer to the *Technical Support Document: Bacteria Total Maximum Daily Load for the Mary's Creek Bypass Watershed: Segment 1102F_01* (University of Houston, 2016). Refer to the original, approved TMDL document for details related to the overall Clear Creek watershed as well as the methods and assumptions used in developing the original TMDLs.

The addendum watershed was addressed in the original TMDL. This addendum provides the details related to developing the TMDL allocation for this additional AU, which was not specifically addressed in the original TMDL document.

Problem Definition

The TCEQ first identified the bacteria impairment within the Mary's Creek Bypass segment included within this addendum in the 2014 edition of the *Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303 (d)* (2014 Integrated Report; TCEQ, 2015). Table 1 provides a summary for the 2014 Integrated Report (the most recent approved version). The impaired AU is Mary's Creek Bypass (1102F_01), as shown in Figure 1. The

Mary's Creek Bypass segment has only one AU. The project watershed is located within Brazoria and Galveston counties. Figure 1 also shows the Mary's Creek Bypass watershed in relation to the entire watershed of the original TMDLs.

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

Table 1. Synopsis of the 2014 Integrated Report for Mary's Creek Bypass.

Integrated Report Year	Segment	AU	Parameter	Contact Recreation Use	Year First Impaired	Category
2014	1102F	1102F_01	*E. coli*	Nonsupport	2014	5a

Table 2 summarizes the ambient water quality data for the TCEQ surface water quality monitoring (SWQM) stations on Mary's Creek Bypass, as reported in the 2014 Integrated Report. The data from the assessment indicate nonsupport of the primary contact recreation use for Mary's Creek Bypass, because the geometric mean concentration of *E. coli* exceeds the geometric mean criterion of 126 most probable number (MPN)/100 milliliters (mL) of water. Recent environmental monitoring within the Mary's Creek Bypass watershed has occurred at TCEQ monitoring stations 17917 (Mary's Creek Bypass at Dixie Farm) and 18639 (Mary's Creek Bypass at FM 518) (Figure 2).

Description of the Study Area

Mary's Creek Bypass is located in the southern portion of the greater Houston area within the Clear Creek watershed. The Clear Creek watershed encompasses approximately 180 square miles of land located just southeast of the City of Houston, Texas. The Clear Creek watershed is part of the San Jacinto-Brazos Coastal Basin. Clear Creek flows into Clear Lake (Segment 2425) that, in turn, feeds into Upper Galveston Bay (Segment 2421). Mary's Creek Bypass is a flood control diversion of the main channel of Mary's Creek (Segment 1102B). Mary's Creek Bypass is 2.37 miles long and has a drainage area of 1309.6 acres.

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

- Mary's Creek Bypass (AU 1102F_01): From the Mary's Creek confluence NE of FM 518 to a point 0.96 km (0.60 mi) upstream to the Mary's Creek confluence (northwest of County Road 126).

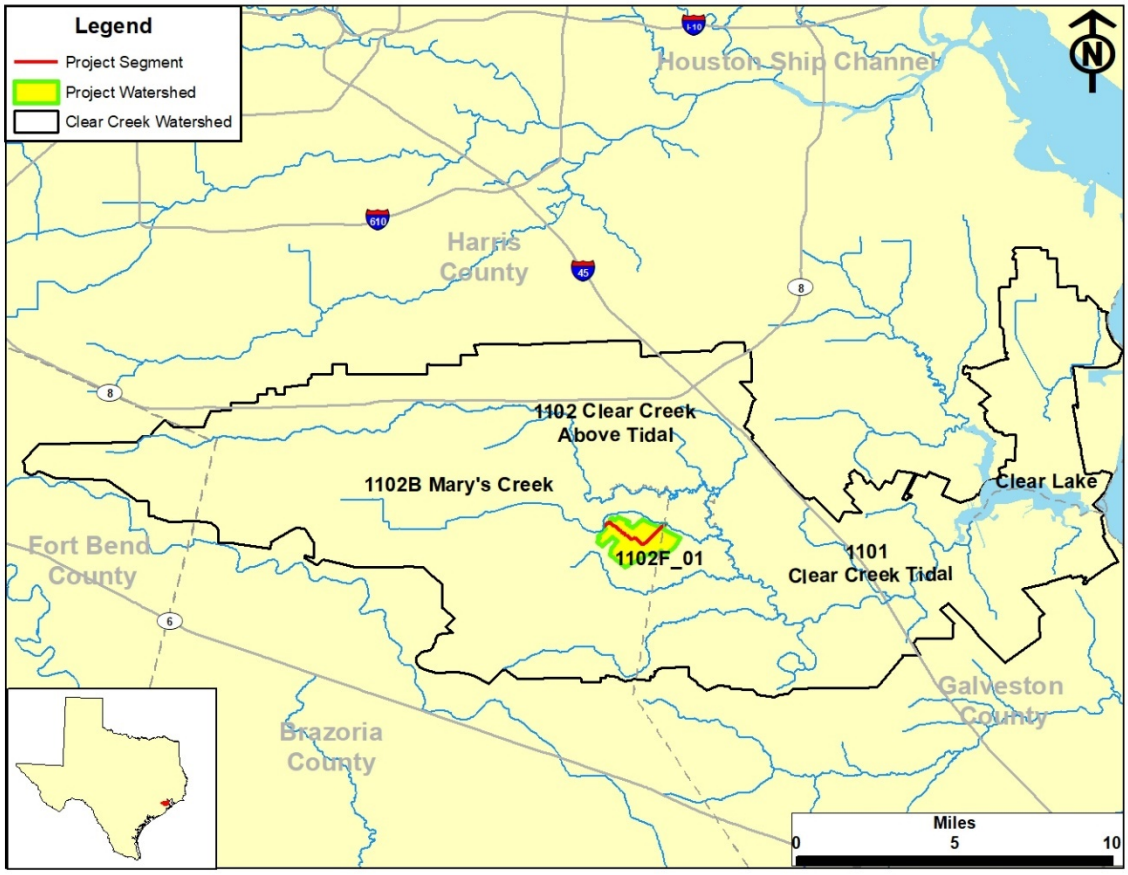

Figure 1. Location map for Mary's Creek Bypass in the Clear Creek watershed.

Table 2. 2014 Integrated Report summary for the Mary's Creek Bypass watershed.

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

Integrated Report Year	AU	Parameter	Stations	Number of Samples	Data Range	*E. coli* Geometric Mean (MPN/100 mL)
2014	1102F_01	*E. coli*	17917, 18639	20	2005–2012	159.39

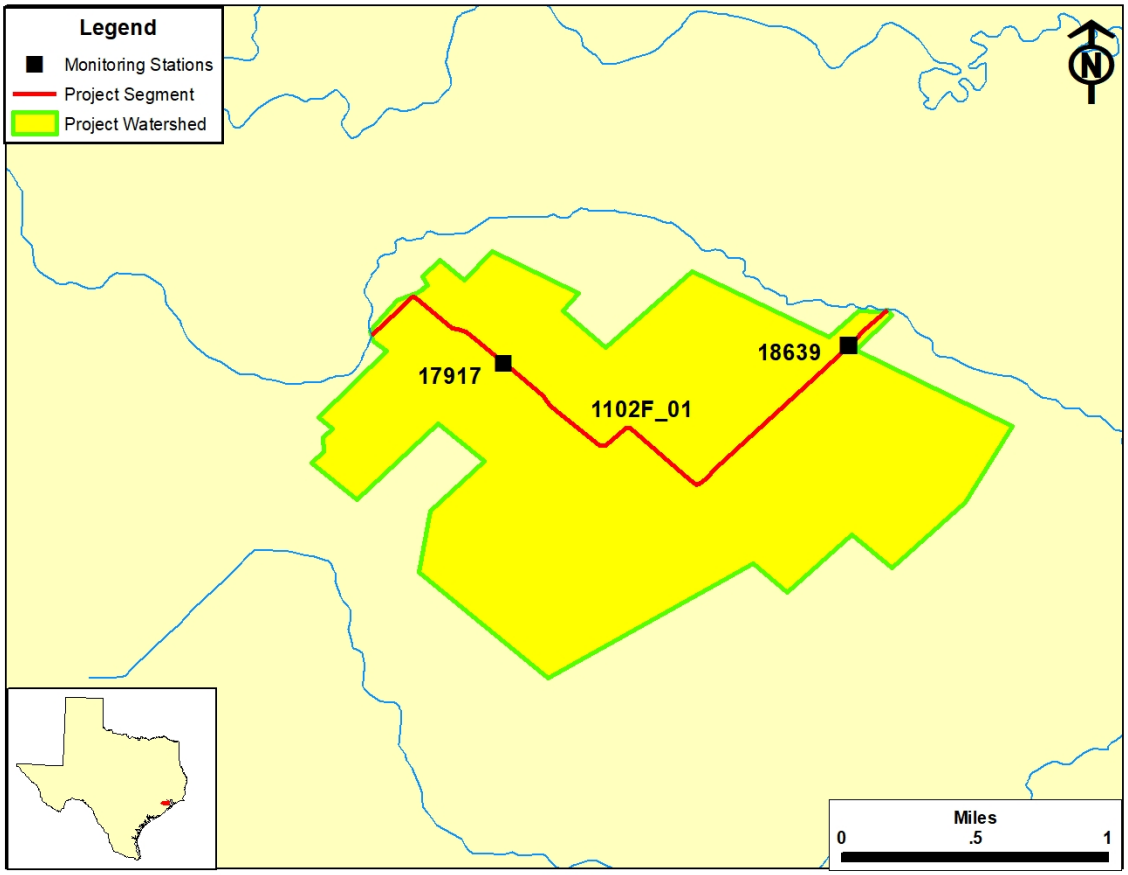

Figure 2. Mary's Creek Bypass watershed showing TCEQ monitoring stations used to assess primary contact recreation.

Watershed Climate

The climate of the region is subtropical humid, with very hot and humid summers and mild winters (USACE, 1985). July is the hottest month with an average high of 34.2 degrees Celsius (93.4 degrees Fahrenheit), while January is the coldest month with an average low of 7.3 degrees Celsius (45 degrees Fahrenheit). Table 3 provides climate (temperature) normals (NOAA, 2010).

Summer rainfall is dominated by sub-tropical convection, winter rainfall by frontal storms, and fall and spring months by combinations of these two (Burian, 2005), with an annual precipitation total of approximately 51 inches. Average annual rainfall from 2005 to 2015, based on the Harris County Office of Homeland Security and Emergency Management (HCOEM), is summarized in Table 4.

Monthly rainfall totals are fairly consistent throughout the year, with slightly more rainfall falling in July and October (approximately six and a half inches), compared to the remainder of the year (generally three to five inches). High-intensity rainfall often causes localized street flooding and occasional out-of-bank conditions. The study watershed is located near the Gulf Coast, and is

potentially subject to hurricanes between June 1 and November 30 every year, although the chance of tropical weather declines dramatically in October.

Table 3. NOAA climate normals, 1981-2010.

Month	Daily Max (°C)	Daily Min (°C)	Daily Mean (°C)	Classification
January	17.4	7.3	12.4	Cool
February	19.5	9.2	14.3	Cool
March	23.1	12.7	17.9	Cool
April	26.3	15.9	21.1	n/a
May	29.9	20.1	25	Warm
June	32.8	23.1	27.9	Warm
July	34.2	24.1	29.2	Warm
August	34.1	24.1	29.1	Warm
September	31.8	22	26.9	Warm
October	27.8	16.8	22.3	n/a
November	22.5	11.9	17.2	Cool
December	18.6	8.2	13.4	Cool

Table 4. Monthly rainfall averages in the Mary's Creek Bypass watershed.

Month	Average Monthly Rainfall (inches)
January	3.8
February	2.5
March	3.4
April	3.3
May	5.1
June	4.0
July	6.5
August	4.2
September	4.6
October	6.4
November	3.2
December	4.1
Average Annual Rainfall (inches)	51.1

Land Use

Table 5 summarizes the areas and the corresponding percentages of the land use categories within the Mary's Creek Bypass watershed. The land cover data were retrieved from the National Oceanic and Atmospheric Administration (NOAA, 2011) land cover database obtained from the Houston-Galveston Area Council (H-GAC) and are displayed in Figure 3. The total acreage of each land cover/land use type in Table 5 corresponds to the watershed delineation in Figure 3. The predominant land use/land cover category in this watershed is developed land (90.9 percent as the sum of all developed classes).

Table 5. Land use/land cover within the Mary's Creek Bypass watershed.

Aggregated Land Cover Category	Area (Acres)	Percent (%)
Open Water	4.0	0.31%
Developed, Open Space	384.8	29.38%
Developed, Low Intensity	395.7	30.21%
Developed, Medium Intensity	378.5	28.90%
Developed, High Intensity	31.4	2.40%
Barren Land	0.2	0.02%
Deciduous Forest	28.3	2.16%
Evergreen Forest	15.8	1.21%
Mixed Forest	4.0	0.31%
Shrub/Scrub	1.8	0.14%
Herbaceous	57.5	4.39%
Hay/Pasture	4.7	0.36%
Woody Wetlands	2.9	0.22%
Total	1,309.6	100%

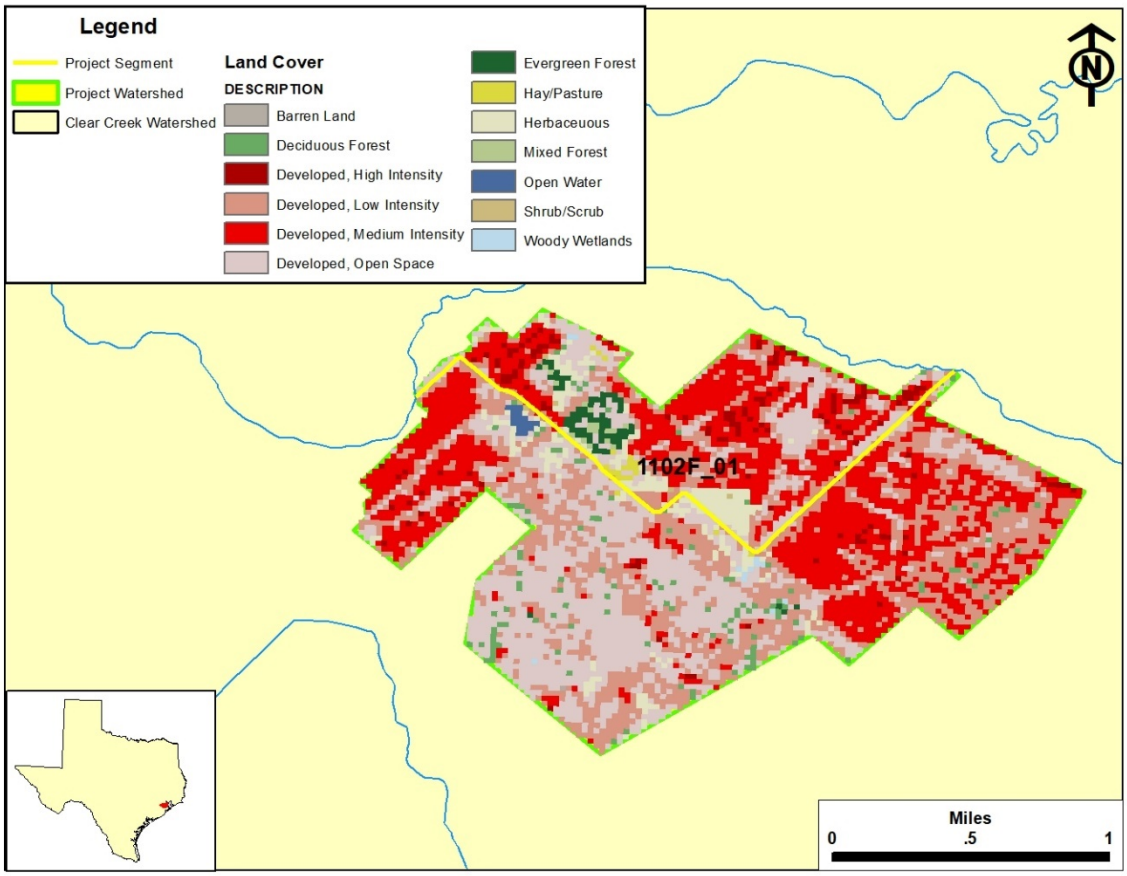

Figure 3. Land use/land cover map for Mary's Creek Bypass.

Watershed Population and Population Projections

The watershed has two incorporated cities within its boundaries—Friendswood and Pearland. From 2010 to 2030, these cities are anticipated to grow by 23% and 37% respectively according to the Texas Water Development Board (TWDB). Census 2010 block populations were used to estimate the population within the Mary's Creek Bypass watershed including unincorporated areas. According to the 2010 Census data, the Mary's Creek Bypass watershed has an estimated population of 2,960 (U.S. Census Bureau, 2010). Table 6 provides a summary of the 2010 population and 2030 population projection.

Table 6. 2010 Population and 2030 population projections for the Mary's Creek Bypass watershed.

Location	2010 U. S. Census	2030 Population Projection	Projected Population Increase (2010-2030)	Percent Change
Mary's Creek Bypass Watershed	2,960	3,993	1,033	34.9%

Endpoint Identification

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

Source Analysis

Regulated Sources

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

Domestic and Industrial Wastewater Treatment Facilities

There are no permitted wastewater treatment facility (WWTF) outfalls in the Mary's Creek Bypass watershed. The City of Pearland and the Gulf Coast Waste Disposal Authority provide wastewater service to the Mary's Creek Bypass watershed but do not discharge to Mary's Creek Bypass itself. The City of Pearland facility also provides wastewater service to the area within Brazoria County Municipal Utility District (MUD) #18, which is located within the watershed.

Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) are unauthorized discharges that must be addressed by the responsible party. TCEQ Region 12-Houston provided a database for SSO data in the Mary's Creek Bypass watershed (Laird, 2016). The

locations and magnitudes of all the reported SSOs from 2001 to 2016 within the Mary's Creek Bypass watershed are summarized in Table 7 and displayed in Figure 4.

Table 7. Mary's Creek Bypass watershed SSO summary, 2001 through 2016.

Facility Name	NPDES Permit No.	Facility ID	Number of Occurrences	Date	Amount (Gallons)
City of Pearland	TX0032743	10134-010	1	12/13/2001	22,000
Gulf Coast Waste Disposal Authority	TX0069728	11571-001	1	4/17/2008	300

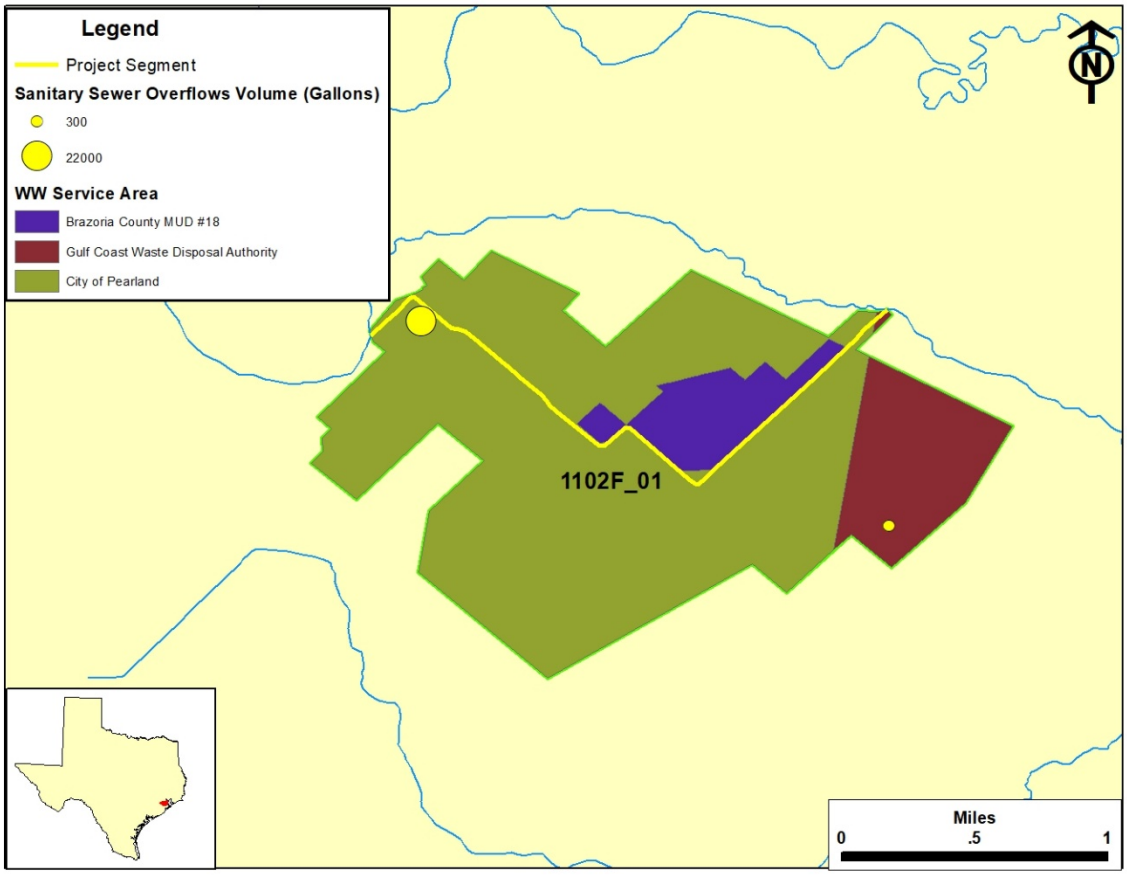

Figure 4. SSO locations and WWTF service areas.

TPDES-Regulated Stormwater

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

Three of these permits (MS4, MSGP, and construction) pertain solely to stormwater discharges. The other two (concrete production facilities and petroleum bulk stations and terminals) also authorize the discharge of process wastewater. The geographic region of the Mary's Creek Bypass watershed covered by MS4 permits is that portion of the Mary's Creek Bypass watershed defined by the 2010 Census as being an urbanized area (Figure 5). The watershed is almost completely covered under the 2010 Census urbanized area. Therefore, the urbanized area will be used as a surrogate for the area for all regulated stormwater in the watershed. Table 8 shows a summary of MS4 permit area coverage present in the Mary's Creek Bypass watershed.

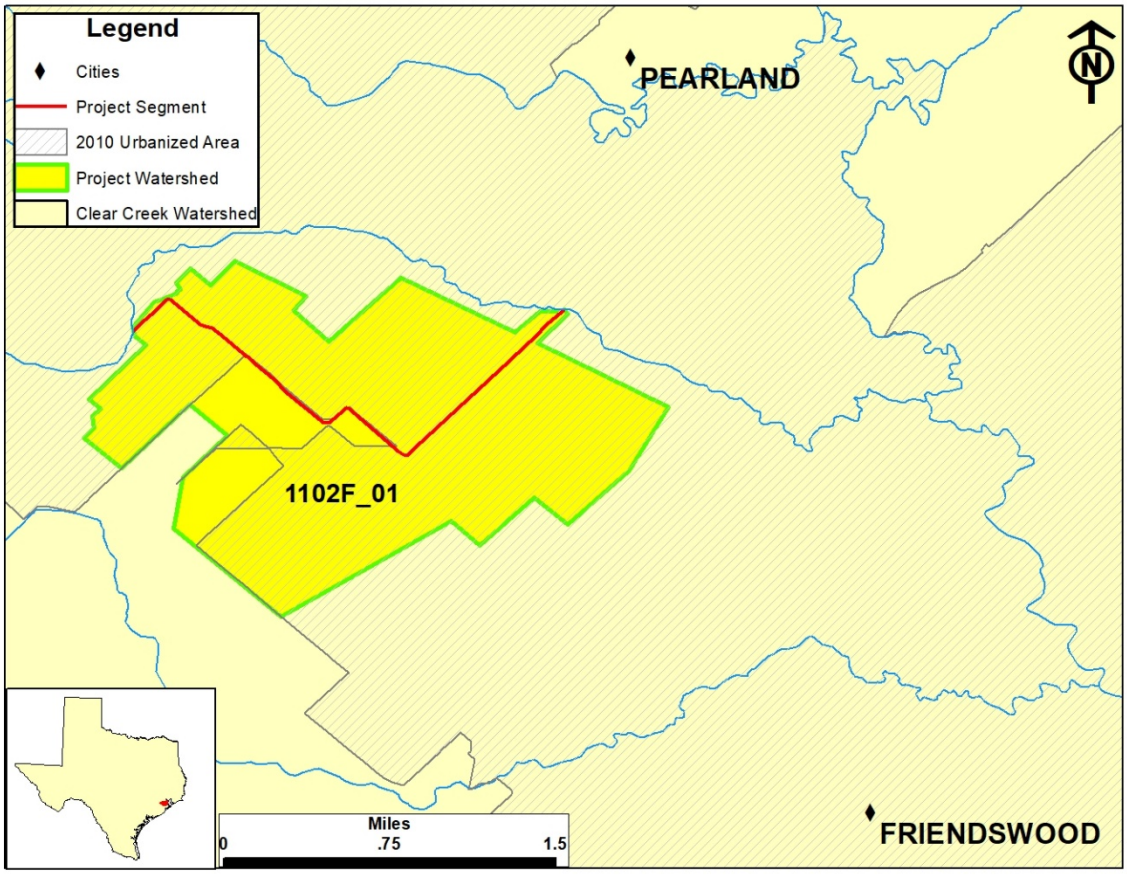

Figure 5. 2010 urbanized area.

Table 8. Percentage of Permitted Stormwater in the Mary's Creek Bypass watershed.

Regulated Entity Names and Stormwater Permit Numbers	Total Watershed Area (Acres)	Area under MS4 Permit (Acres)	Percent of Watershed Under MS4 Jurisdiction
Brazoria Drainage District 4 (TXR040144), City of Pearland MS4 (TXR040208), City of Friendswood (TXR040233), and Galveston County Consolidated Drainage District (TXR040067)	1309.6	1149.1	87.7%

Unregulated Sources

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

Wildlife and Unmanaged Animal Contributions

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

As is typical of coastal watersheds, a significant population of avian species frequent the Mary's Creek Bypass watershed and its riparian corridors. However, currently there are insufficient data available to estimate populations and spatial distribution of wildlife and avian species within the watershed. Consequently, it is difficult to assess the magnitude of indicator bacteria contributions from wildlife species as a general category.

Domesticated Animals

Livestock, if present, are not considered to be a significant source of bacteria, because most of the watershed is urbanized.

Table 9 summarizes the estimated number of dogs and cats within the Mary's Creek Bypass watershed. Pet population estimates were calculated as the estimated number of dogs (0.584) and cats (0.638) per household according to data from the American Veterinary Medical Association (AVMA) 2012 U.S Pet Statistics (AVMA, 2015). The actual contribution and significance of indicator bacteria loads from pets reaching the water bodies of the Mary's Creek Bypass watershed is unknown.

Table 9. Estimated households and pet populations for the Mary's Creek Bypass watershed.

Estimated Number of Households	Estimated Dog Population	Estimated Cat Population
1,117	652	713

On-site Sewage Facilities

Estimates of the number of OSSFs in the Mary's Creek Bypass watershed were determined using data supplied by H-GAC for Brazoria and Galveston counties. The H-GAC data indicate that there are 82 OSSFs located within the Mary's Creek Bypass watershed (Figure 6).

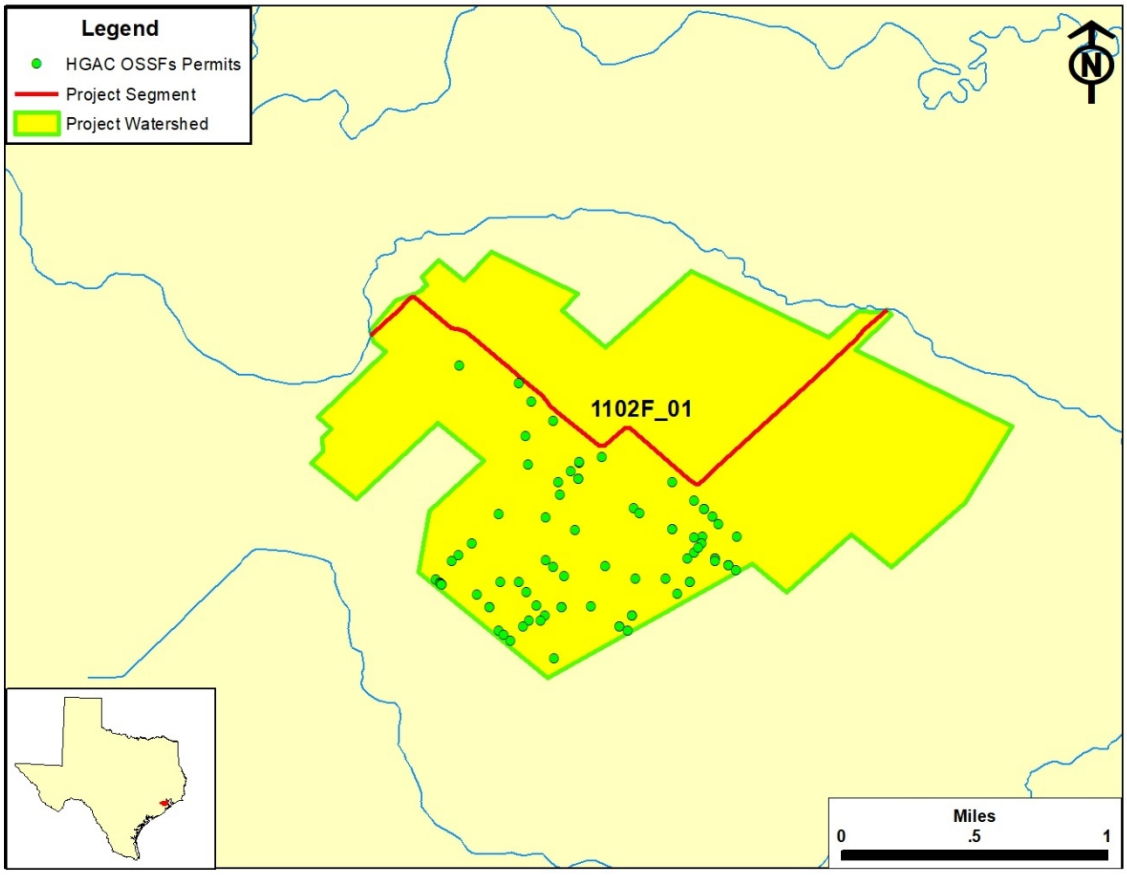

Figure 6. OSSF locations within the Mary's Creek Bypass watershed.

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 and the landscape as regulated and non-regulated sources. Further, this one-to-one relationship was also inherently assumed when using LDCs to define the TMDL pollutant load allocation. The LDC method allows for estimation of existing and TMDL loads by utilizing the cumulative frequency distribution of streamflow and measured pollutant concentration data (Cleland, 2003). In addition to estimating stream loads, this method allows for the determination of the hydrologic conditions under which impairments are typically occurring, can give indications of the broad origins of the bacteria (i.e., point source and stormwater), and provides a means to allocate allowable loadings. The technical support document (University of Houston, 2016) provides details about the linkage analysis and the LDC method and its application.

Margin of Safety

The margin of safety (MOS) is designed to account for any uncertainty that may arise in specifying water quality control strategies for the complex environmental processes that affect water quality. Quantification of this uncertainty, to the extent possible, is the basis for assigning an MOS. The TMDLs covered by this report incorporate an explicit MOS of 5 percent of the total TMDL allocation.

Pollutant Load Allocation

The TMDL component for the impaired AU covered in this report was derived using the median flow within the Highest Flows regime (or 10 percent flow) of the LDC developed for the sampling stations located within the AU watershed.

The LDC for Mary's Creek Bypass segment 1102F_01 (Figure 7) is based on *E. coli* bacteria measurements at SWQM stations 17917 and 18639. The LDC indicates that *E. coli* levels exceed the instantaneous water quality criterion during high flow conditions. This analysis also indicates that the *E. coli* observations in the highest flow range may be wet weather influenced.

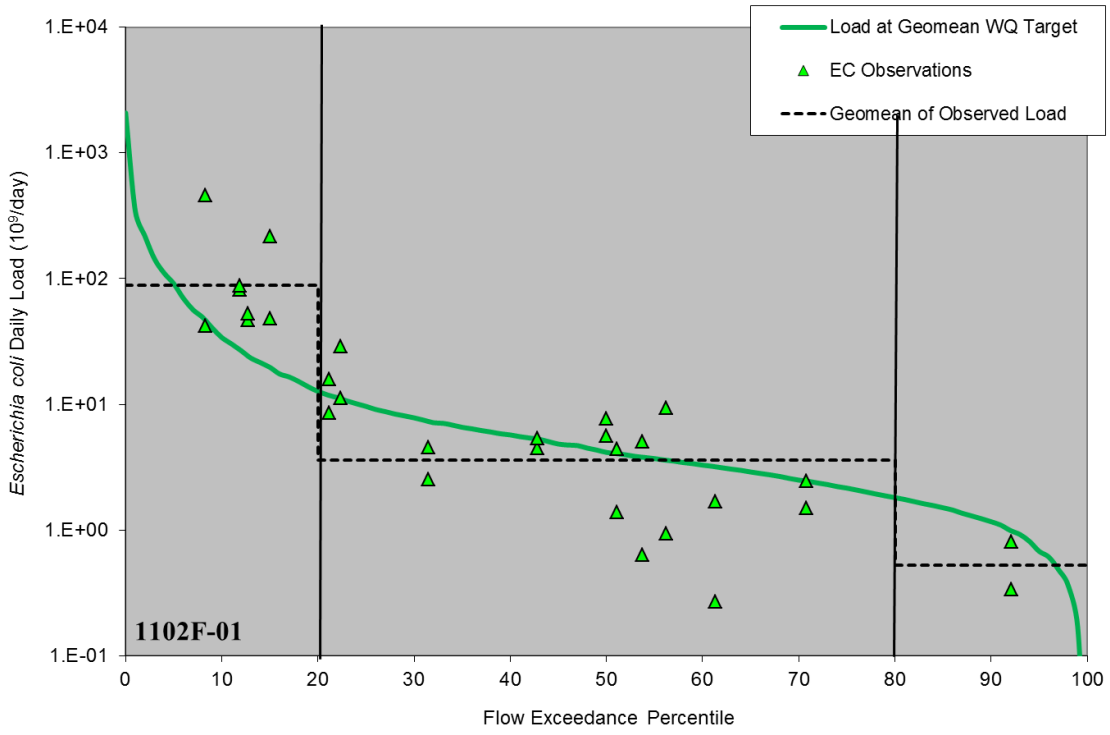

Figure 7. LDC for Mary's Creek Bypass AU 1102F_01

Wasteload Allocation

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

Wastewater Treatment Facilities

There are no TPDES-permitted WWTFs which discharge in the watershed.

Regulated Stormwater

Stormwater discharges from MS4, industrial, and construction sites are also considered regulated point sources. Therefore, the WLA calculations must also include an allocation for regulated stormwater discharges (WLA_{SW}). The percentage of the land area included in the Mary's Creek Bypass watershed that is under the jurisdiction of stormwater permits (defined as the area designated as urbanized area in the 2010 US Census) is used to estimate the amount of the overall runoff load that should be allocated as the permitted stormwater contribution in the WLA_{SW} component of the TMDL. The percentage of land under the jurisdiction of stormwater permits in the Mary's Creek Bypass watershed is 87.7 percent.

Load Allocation

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

Future Growth

The FG component of the TMDL equation addresses the requirement of TMDLs to account for future loadings that might occur as a result of population growth, changes in community infrastructure, and development. The assimilative capacity of streams increases as the amount of flow increases. Increases in flow allow for additional indicator bacteria loads if the concentrations are at or below the contact recreation standard.

Because, the drainage area of Mary's Creek Bypass is entirely serviced by WWTFs whose outfall locations lie outside the watershed boundaries, no estimated future flow increase is necessary. If a new WWTF discharge is located within the project watershed in the future, it will be addressed through a routine Water Quality Management Plan (WQMP) update.

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

TMDL Calculations

Table 10 summarizes the TMDL calculation for Mary's Creek Bypass AU 1102F_01. The TMDL was calculated based on the median flow in the 0-20

percentile range (10 percent exceedance, Highest Flows flow regime) for flow exceedance from the LDC developed for SWQM stations 17917 and 18639. Allocations are based on the current geometric mean criterion for *E. coli* of 126 MPN/100 mL for each component of the TMDL. This is the final TMDL allocation needed to comply with the requirements of 40 Code of Federal Regulations (CFR) Section 103.7. An additional table with a future growth allocation is not included in this document. See the FG section for more information.

In the event that the criterion changes due to a change in the designated recreational use, Appendix A provides guidance for recalculating the allocations in Table 10.

Table 10. TMDL allocation summary for Mary's Creek Bypass AU 1102F_01.

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

AU	TMDL	WLA_{WWTF}	WLA_{SW}	LA	MOS
1102F_01	35.82	0.00	29.86	4.17	1.79

Seasonal Variation

Federal regulations in 40 CFR Section 130.7(c)(1) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. Seasonality was examined for this TMDL by using more than five years of water quality data and by using the longest period of United States Geological Survey flow records when estimating flows to develop flow exceedance percentiles. Though there was insufficient data in the Mary's Creek Bypass watershed to assess seasonal impacts, previous analysis in the Clear Creek watershed published in 2012 concluded that there was no difference in *E. coli* concentration between the warmer and colder months (TCEQ, 2012).

Public Participation

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

The technical support document for this TMDL addition (University of Houston, 2016) was posted on the TMDL project page at: <www.tceq.texas.gov/assets/public/waterquality/tmdl/68ccbact/68-ccbacteria-addendum2-tsd2016-08.pdf> on May 25, 2018. A presentation on this addendum was given at the annual spring meeting of the Bacteria Implementation Group (BIG) in Houston on June 5, 2018. The public will have an opportunity to comment on this addendum during a 30-day WQMP update public comment period (November 9 through December 11, 2018). This is an ongoing process, so notice of the public comment period for this addendum will

be sent to the stakeholders and posted on the TCEQ's TMDL Program online news page at <www.tceq.texas.gov/waterquality/tmdl/tmdlnews.html>, and the document will be posted at <www.tceq.texas.gov/permitting/wqmp/WQmanagement_updates.html>. TCEQ accepted public comments on the original TMDL during the period June 6 through July 5, 2008. Twenty-five comments were submitted, and none of them referred directly to the AU in this TMDL addendum.

Implementation and Reasonable Assurance

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

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Appendix A.

Equations for Calculating TMDL Allocations for Contact Recreation Standard Changes

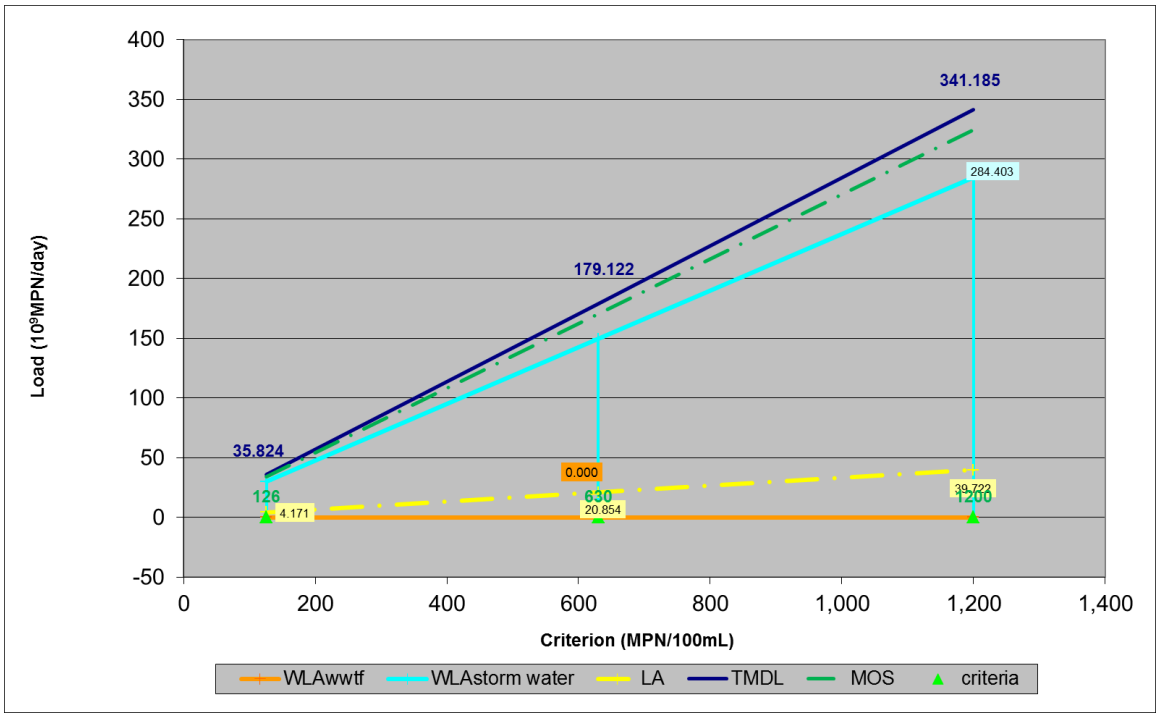

Figure A-1. Allocation loads for *E. coli* for the Mary's Creek Bypass watershed (1102F_01) as a function of water quality criteria.

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

TMDL = 0.28432 * Std
MOS = 0.01421 * Std
LA = 0.03310 * Std
WLA_{WWTF} = 0.0
WLA_{sw} = 0.23700 * Std

Where:

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

Table A-1. TMDL allocations for the Mary's Creek Bypass watershed for potential changed contact recreation standards.

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

Std (MPN/100mL)	TMDL	WLA_{WWTF}	WLA_{SW}	LA	MOS
126	35.824	0.000	29.862	4.171	1.791
630	179.122	0.000	149.312	20.854	8.956
1200	341.184	0.000	284.403	39.722	17.059