Mission and Aransas Rivers Watershed Protection Plan

A document developed by the stakeholders of the Mission and Aransas rivers watersheds to restore and protect water quality in Mission River Tidal (segment 2001), Aransas River Tidal (segment 2003), Mission River Above Tidal (segment 2002), Aransas River Above Tidal (segment 2004), and Poesta Creek (segment 2004B).

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Cover photo: Tributary entering into Saint Charles Bay, near Copano Bay.
Photo courtesy of Texas Water Resources Institute.

Acknowledgments

This document presents the strategy developed by the stakeholders of the Mission and Aransas rivers watersheds to restore and protect water quality in the Mission and Aransas rivers and the waterbodies that flow into them. Local stakeholders dedicated considerable time and effort to discussing the watershed and influences on water quality and developing management measures to address water quality concerns. The ultimate success of the Mission and Aransas Rivers Watershed Protection Plan depends on the current and continued engagement of local stakeholders with technical and financial support from regional, state, and federal agencies.

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- Coastal Bend Bays and Estuaries Program
- Texas State Soil and Water Conservation Board
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List of Abbreviations

Acronym	Meaning
ac	Acre
ACEP	Agricultural Conservation Easement Program
AU	Assessment Unit
AVMA	American Veterinary Medical Association
BMP	Best Management Practice
BOD	Biological Oxygen Demand
CCN	Certificate of Convenience and Necessity
cfu	Colony Forming Unit
CIAP	Coastal Impact Assistance Program
CIG	Conservation Innovation Grants
CMP	Coastal Management Program
CRP	Clean Rivers Program
CSP	Conservation Stewardship Program
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
CZM	Coastal Zone Management Program
CZMA	Coastal Zone Management Act
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
ECHO	Environmental Compliance and History Online
EDAP	Economically Distressed Areas Program
EQIP	Environmental Quality Incentives Program
EE	Environmental Education (Grants)
EPA	U.S. Environmental Protection Agency
FBMB	Farm Business Management and Benchmarking
FDC	Flow Duration Curve
gal	Gallons
GIS	Geographic Information Systems
ha	Hectare
HSG	Hydrologic Soil Group
I&I	Inflow and Infiltration
ICIS	Integrated Compliance Information System
LA	Load Allocation
LDC	Load Duration Curve
LOADEST	Load Estimator
mL	Milliliter
MGD	Millions of Gallons Per Day
MM	Management Measure
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
MUD	Municipal Utility District
NIFA	National Institute of Food and Agriculture
NIWQP	National Integrated Water Quality Program
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRA	Nueces River Authority
NRCS	Natural Resources Conservation Service
ODEQ	Oregon Department of Environmental Quality
OSSF	On-Site Sewage Facilities
ppt	Parts Per Thousand
RCPP	Regional Conservation Partnership Program
RUAA	Recreational Use Attainability Analysis
SARE	Sustainable Agriculture Research and Education
SCR 1	Secondary Contact Recreation 1
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SSO	Sanitary Sewer Overflow
SWCD	Soil and Water Conservation District
SWQM	Surface Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TEEX	Texas A&M Engineering Extension Service
TGLO	Texas General Land Office
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TRWA	Texas Rural Water Association
TSS	Total Suspended Solids
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
TWS	Texas Wildlife Services
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plan
WSC	Water Supply Corporation
WWTF	Wastewater Treatment Facility

Executive Summary

A watershed is an area of land that drains to a common body of water. Within a watershed, water follows natural hydrologic boundaries and is influenced by the landscape it flows across and through. Both natural and human influenced processes that occur within a watershed alter the quantity and quality of water within the system.

This document presents a plan to restore and protect water quality in the Mission and Aransas rivers watersheds. By approaching water quality issues at the watershed level rather than political boundaries, this plan holistically identifies potential pollutant sources and solutions. This approach also incorporates the values, visions, and knowledge of individuals with a direct stake in water quality conditions.

Problem Statement

Water quality monitoring indicates that sections of the Mission and Aransas rivers and Poesta Creek do not meet water quality standards for recreation because of elevated levels of *Escherichia coli (E. coli)* and Enterococci. The tidal segments of the Mission and Aransas rivers were first identified as impaired in the *2004 Texas Integrated Report and 303(d) List,* while Aransas River Above Tidal and Poesta Creek segments were first identified as impaired in the *2014 Texas Integrated Report and 303(d) List.*

With the water quality impairments comes a need to plan and implement actions that restore water quality and ensure safe and healthy water for stakeholders. To meet this need, an assessment and planning project was undertaken to develop the Mission and Aransas Rivers Watershed Protection Plan (WPP).

Action Taken

The stakeholder process began in spring 2006 with a series of stakeholder meetings to discuss water quality. An extensive review of the watershed's land and water resources was carried out, enabling stakeholders to make decisions based on up-to-date information on watershed characteristics and land uses. Potential sources of bacteria pollution were identified and quantified based on data from the best available data sources and were then integrated into simplistic pollutant load assessment tools. The results of these tools provided information to determine the types and sources of bacteria in the watershed with the highest potential to impact water quality in addition to the sources that could be readily addressed.

Watershed Protection Plan Overview

This document is a culmination of a stakeholder process to identify sources of pollution and the methods to reduce pollutant loads in the Mission and Aransas rivers. By comprehensively considering the multitude of potential pollutant sources in the watershed, this plan describes management strategies that, when implemented, will reduce pollutant loadings in the most cost-effective manners available at the time of planning. Despite the extensive amounts of information gathered during the development of this WPP, a better understanding of the watershed and the effectiveness of management measures will undoubtedly develop. As such, this plan is a living document that will evolve as needed through the adaptive management process.

Pollutant Reductions

According to the Texas Commission on Environmental Quality (TCEQ) *2014 Texas Integrated Report and 303(d) List,* two segments of the Aransas River, one segment of the Mission River, and one segment of Poesta Creek did not meet primary contact recreation water quality standards. These segments include four impaired assessment units (AUs): 2001_01, 2003_01, 2004_0,2 and 2004B_02. Analysis of water quality and flow data collected in all water bodies indicate bacteria load reductions of 97.6% (Mission River Tidal), 98.6% (Aransas River Tidal), 93.6% (Aransas River Above Tidal), and 90.4% (Poesta Creek) across all flow conditions are required to meet current water quality standards.

Recommended Actions

No single source of bacteria in the watershed is the primary cause of the water quality impairment. A variety of sources, including livestock, wildlife, humans, and stormwater, contribute *E. coli* and Enterococci bacteria to the river and its tributaries. Stakeholders identified nine management measures that would reduce and most feasibly manage instream bacteria levels.

Livestock

Livestock contributions to bacteria loads can be managed through a variety of grazing management practices. Identification, planning, and implementation of operation-specific goals and practices to reduce water quality impacts will be achieved through Texas State Soil and Water Conservation Board (TSSWCB) Water Quality Management Plans (WQMPs) or U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Conservation Plans. Cost share programs are available to producers to assist in the implementation and maintenance of these practices. This WPP also includes a schedule for the delivery of education programs and workshops for producers to demonstrate and show how particular operations can reduce impacts on water quality.

Tax Exemption

Currently, small acreage landowners apply for agricultural property tax exemptions and must stock their land to meet the tax requirement, which can sometimes exceed the carrying capacity of the land. The WPP recommends exploring alternatives for property tax exemptions that would encourage the adoption of practices that mitigate the effects of overstocking on small acreage properties receiving agricultural property tax exemptions. This WPP also includes a schedule for the delivery of education programs geared towards elected officials to ensure responsible parties understand the need for improved water quality.

Feral Hogs

Feral hogs not only contribute to crop and property damages, but their behavior also contributes to water quality and riparian habitat degradation. Although many property owners already work hard to remove feral hogs from their property, this WPP recommends continued efforts to remove feral hogs from the watershed. The delivery of feral hog management workshops will provide property owners with the knowledge and tools to maximize efforts at controlling and reducing feral hog populations.

Illicit Dumping

Illicit and illegal dumping was a concern raised by stakeholders. Given the illegal nature of these activities, the potential contributions to water quality are unknown. At the very least, it is a public nuisance and creates undesirable conditions in area water bodies (including increased bacteria). This WPP recommends education focusing on proper disposal for local officials and residents, signage at water bodies, enforcement, and other community-based efforts.

On-site Sewage Facilities

Although most on-site sewage facilities (OSSFs), sometimes called septic systems, operate properly, failing OSSFs can result in untreated household sewage reaching the soil surface and running off into nearby water bodies. Ensuring that these systems function properly and are consistently maintained is crucial for water quality and minimizing potential human health impacts. The Mission and Aransas Rivers WPP recommends all failing systems be repaired or replaced as needed. Furthermore, the plan recommends delivery of education programs and workshops that can equip homeowners with the knowledge of how to properly maintain their OSSFs.

Urban Stormwater

Stormwater from urban and impervious surface runoff is likely a small contributor to bacteria loads in this largely rural watershed. However, opportunities exist to address stormwater loads in the watershed in addition to increasing awareness in areas of denser populations. This plan recommends implementing structural best management practices (BMPs), such as modification of stormwater retention and detention and conveyance systems to reduce bacteria in waterways. Nonstructural BMPs include municipal pet waste programs and education and outreach for local officials and residents to reduce pollutant loadings from stormwater.

Sanitary Sewer Overflows and Unauthorized Discharges

Sanitary sewer overflows (SSOs) and unauthorized discharges occur when excess water enters the sewage collection system, resulting in an overload of system capacity. Overloaded systems will discharge untreated or insufficiently treated waste. Although infrequent, these discharges can contribute to bacteria loading, particularly during intense rain events. Inflow and infiltration (I&I) refers to stormwater that enters the sewage collection systems through faulty sewer pipes, connections, cleanouts, and manholes. I&I is a major contributor to SSO and unauthorized discharges. The plan recommends that city and utility districts conduct routine sewer pipe inspections, undertake visual inspections of existing manholes, and engage in other surveillance activities. Education will also be provided to residents on how they can prevent wastewater infrastructure from failing.

Wastewater Treatment Facilities

Discharge from wastewater treatment facilities (WWTFs) can be a major contributor of bacteria in a subwatershed if the WWTFs are not meeting their discharge standards. In order to help mitigate bacteria loads in the rivers, four facilities in the watersheds have agreed to limit the concentrations of bacteria in their discharges by half the level currently specified in their limits (i.e., 63 most probable number [MPN] *E. coli* and 17.5 *Enterococcus*). This WPP also recommends education for city personnel and elected officials about the economic benefits of voluntarily reducing bacteria concentrations and for WWTF operators about the capabilities of their WWTF systems, so they can maximize treatment potential.

Watershed Monitoring

The Mission and Aransas rivers watersheds are currently being monitored on a quarterly basis, which is the minimum needed to assess the health of the rivers. Expanding existing water quality monitoring in the watersheds will help better define where the problem areas are in the watersheds regarding water quality. It will also more accurately identify causes of the water quality problems, help determine long-term trends in water quality, and assess the effectiveness of the BMP implementation. This plan also recommends educating stakeholders on the ongoing monitoring and creating a website for them to track the monitoring results.

Goals

The primary goal of the Mission and Aransas Rivers WPP is to restore water quality in Mission River and Aransas River and their tributaries to water quality standards set by the state of Texas through the long-term conservation and stewardship of the watershed's resources.

To achieve this goal, the plan establishes a 5-year implementation schedule with interim milestones and water quality targets to track progress. This plan will also help meet conditions for the state's Coastal Nonpoint Source Pollution Control Program as set forth in Section 6217 of the Coastal Zone Management Act (CZMA). Because portions of the watershed fall within the Coastal Zone Boundary, the plan will also work to reduce runoff pollutant concentrations and volumes from entering tidal portions of the river and coastal zone.

Ultimately, this plan sets forth an approach to improve stewardship of the watershed resources that allows stakeholders to continue relying on the watershed as part of their livelihood while also restoring the quality of its water resources.

Chapter 1
Watershed Management

Introduction

A watershed is the land area surrounding a water body that drains to a common waterway such as a stream, river, or lake. All of the land surfaces that contribute runoff to a water body are considered part of the watershed. Watersheds can vary greatly in size. Some watersheds can be very small and drain only a few square miles. Conversely, larger watersheds can encompass many smaller watersheds and drain large portions of states or regions of the country.

The Mission and Aransas rivers watersheds include over 1,869 combined square miles of land that drains into Copano Bay. The Mission and Aransas rivers watersheds are part of the larger Copano Bay watershed system.

Watersheds and Water Quality

Natural processes and human activities can influence water quality and quantity within a watershed. For example, rain falling on the land area within a watershed might generate runoff that then flows across agricultural fields, lawns, roadways, industrial sites, grasslands, or forests.

Point source pollution is categorized as being discharged from a defined point or location, such as a pipe or a drain, and can be traced back to a single point of origin. This type of pollution is typically discharged directly into a water body and subsequently contributes to the water body's flow. Point sources of pollution that are permitted to discharge their effluent within specific pollutant limits must hold a Texas Pollutant Discharge Elimination System (TPDES) permit.

Pollution that comes from a source that does not have a single point of origin is defined as nonpoint source pollution. This type of pollution is generally composed of pollutants that are picked up and carried by runoff in stormwater during rain events. Runoff that travels across land can pick up natural and anthropogenic pollutants. The concentrations and types of pollutants that are found in a water body will be indicators of both the water quality and suitable uses for the water, such as irrigation, drinking, or recreational contact.

To effectively identify and address water quality issues in a watershed, this watershed protection plan (WPP) addresses potential contaminants from both point and nonpoint sources.

The Watershed Approach

The watershed approach is widely accepted by state and federal water resource management agencies to facilitate water quality management. The U.S. Environmental Protection Agency (EPA) describes the watershed approach as "a flexible framework for managing water resource quality and quantity within a specified drainage area or watershed" (EPA 2008). The watershed approach requires engaging stakeholders to make management decisions that are backed by sound science (EPA 2008). One critical aspect of the watershed approach is that it focuses on hydrologic boundaries rather than political boundaries to address potential water quality impacts to all potential stakeholders.

A stakeholder is anyone who lives, works, or has interest within the watershed or may be affected by efforts to address water quality issues. Stakeholders may include individuals, groups, organizations, or agencies. The continuous involvement of stakeholders throughout the watershed approach is critical for effectively selecting, designing, and implementing management measures that address water quality throughout the watershed.

Watershed Protection Plan

WPPs are locally driven mechanisms for voluntarily addressing complex water quality problems that cross political boundaries. A WPP serves as a framework to better leverage and coordinate resources of local, state, and federal agencies, in addition to nongovernmental organizations.

The Mission and Aransas Rivers WPP follows EPA's nine key elements, which are designed to provide guidance for the development of an effective WPP (EPA 2008), and which are needed to secure future federal funding through the 319(h) Nonpoint Source Grant. WPPs will vary in methodology, content, and strategy based on local priorities and needs; however, common fundamental elements are included in successful plans and include (see Appendix A – WPP Checklist):

1. Identification of causes and sources of impairment
2. Expected load reductions from management strategies
3. Proposed management measures
4. Technical and financial assistance needed to implement management measures
5. Information, education, and public participation needed to support implementation
6. Schedule for implementing management measures
7. Milestones for progress of WPP implementation
8. Criteria for determining successes of WPP implementation
9. Water quality monitoring

Adaptive Management

Adaptive management consists of developing a natural resource management strategy to facilitate decision-making based on an ongoing science-based process. Such an approach includes results of continual testing, monitoring, evaluating applied strategies, and revising management approaches to incorporate new information, science, and societal needs (USDA et al. 2000).

As management measures recommended in a WPP are put into action, water quality and other measures of success will be monitored and adjustments to the implementation strategy will be made as needed. The utilization of an adaptive management process will help to focus effort, implement strategies, and maximize impact on pollutant loadings throughout the watershed over time.

Education and Outreach

The development and implementation of a WPP depends on effective education, outreach, and engagement efforts to inform stakeholders, landowners, and residents of the activities and practices associated with the WPP. Education and outreach events provide the platform for the delivery of new and/or improved information to stakeholders through the WPP implementation process. Education and outreach efforts are integrated into many of the management measures that are detailed in this WPP.

Chapter 2
Watershed Characterization

Introduction

This chapter describes the current conditions of the Mission and Aransas rivers watersheds. A comprehensive characterization of the watersheds' current land uses and land cover, soil types, climate, and potential pollutant sources are required to reliably assess pollutant loads and potential management measures to address bacteria sources. Development of the information within this chapter relied heavily on state and federal data resources as well as local stakeholder knowledge.

Description of the Watershed and Waterbodies

The Mission and Aransas rivers, located adjacent to each other along the Texas Gulf Coast, are both comprised of two segments: the upstream segment of each river, designated as "above tidal," and the downstream segment designated as simply "tidal." The above tidal portions of both the Mission and Aransas rivers are perennial freshwater streams, while the tidal portions are influenced by seawater from Mission and Copano bays. There are also two segments in the Aransas River watershed that flow directly into the above tidal segment, Poesta Creek and Aransas Creek. In the Mission River watershed there are three additional segments: Medio Creek, Blanco Creek, and Sarco Creek. Medio and Blanco creeks flow directly into the above tidal segment while Sarco Creek flows directly into Blanco Creek. This study incorporates a watershed approach where the drainage area of each river is considered (Figure 1).

Mission River Above Tidal begins at the confluence of the Blanco and Medio creeks in Refugio County and is approximately 11 miles in length. Mission River Tidal begins downstream of US 77 in Refugio County and flows approximately 16 miles into Mission Bay. At its mouth, the Mission River drains an area of approximately 1,029 square miles in Bee (36% of the watershed), Refugio (31%), Goliad (30%), and Karnes (3%) counties.

The headwaters of Poesta Creek begin in Bee County, northwest of Beeville, and flow 28.7 miles southeast to Aransas Creek, forming Aransas River Above Tidal, which is approximately 35 miles in length. Aransas River Tidal begins

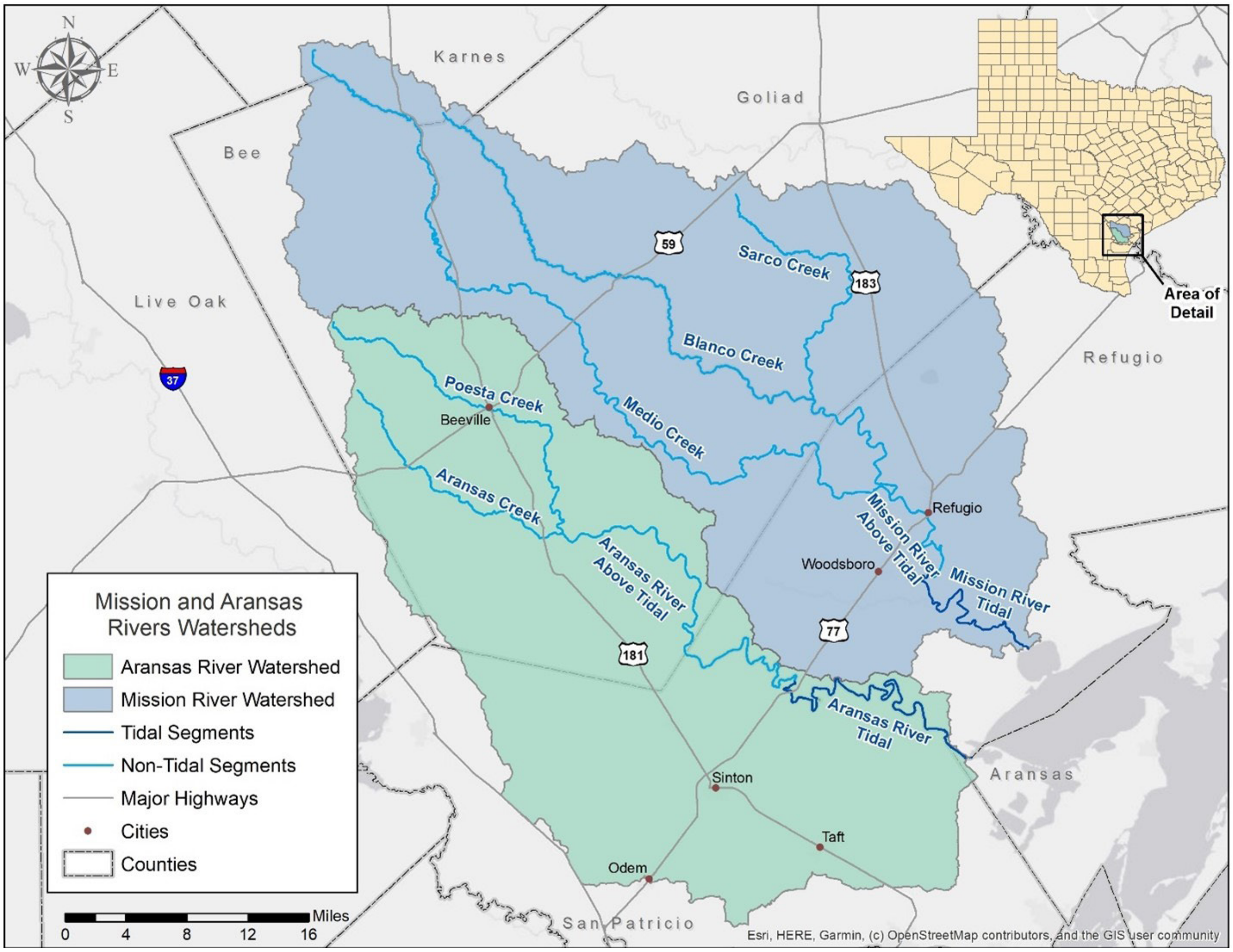


Figure 1. Mission and Aransas rivers watersheds.

upstream of US 77 on the Refugio/San Patricio county line and flows approximately 28 miles into Copano Bay. At its mouth, the Aransas River drains an area of approximately 843 square miles in Bee (48% of the watershed), San Patricio (47%), Refugio (4%), Live Oak (0.6%), and Aransas (0.2%) counties.

This Mission and Aransas rivers watershed includes the following waterbodies:

- Mission River Tidal; 2001
- Mission River Above Tidal; 2002
- Medio Creek; 2002A
- Sarco Creek; 2002B
- Blanco Creek; 2002C
- Aransas River Tidal; 2003
- Aransas River Above Tidal; 2004
- Poesta Creek; 2004B
- Aransas Creek; 2004A

Although this plan includes two adjacent watersheds, the decision was made to include both watersheds in the same plan and in the same stakeholder meetings. A number of ranches and properties span both watersheds, and many stakeholders had shared interests in both waterbodies. As documented through the rest of this chapter, both watersheds are similar in land use, soils, and climate, as well as in water quality and potential fecal indicator bacteria sources (Chapter 3). Earlier projects in the watersheds included development of total maximum daily loads, implementation plans, and special studies, which provided much needed data and existing stakeholder involvement to leverage in plan development. By including both watersheds in the same plan and stakeholder process, stakeholder fatigue was minimized over the multi-year process and existing efforts were efficiently built-on.

Soils and Topography

The soils and topography of a watershed are important components of watershed hydrology. Slope and elevation define where water will flow, while elevation and soil properties influence how much and how fast water will infiltrate into, flow over, or move through the soil into a water body. Soil properties may also limit the types of development and activities that can occur in certain areas.

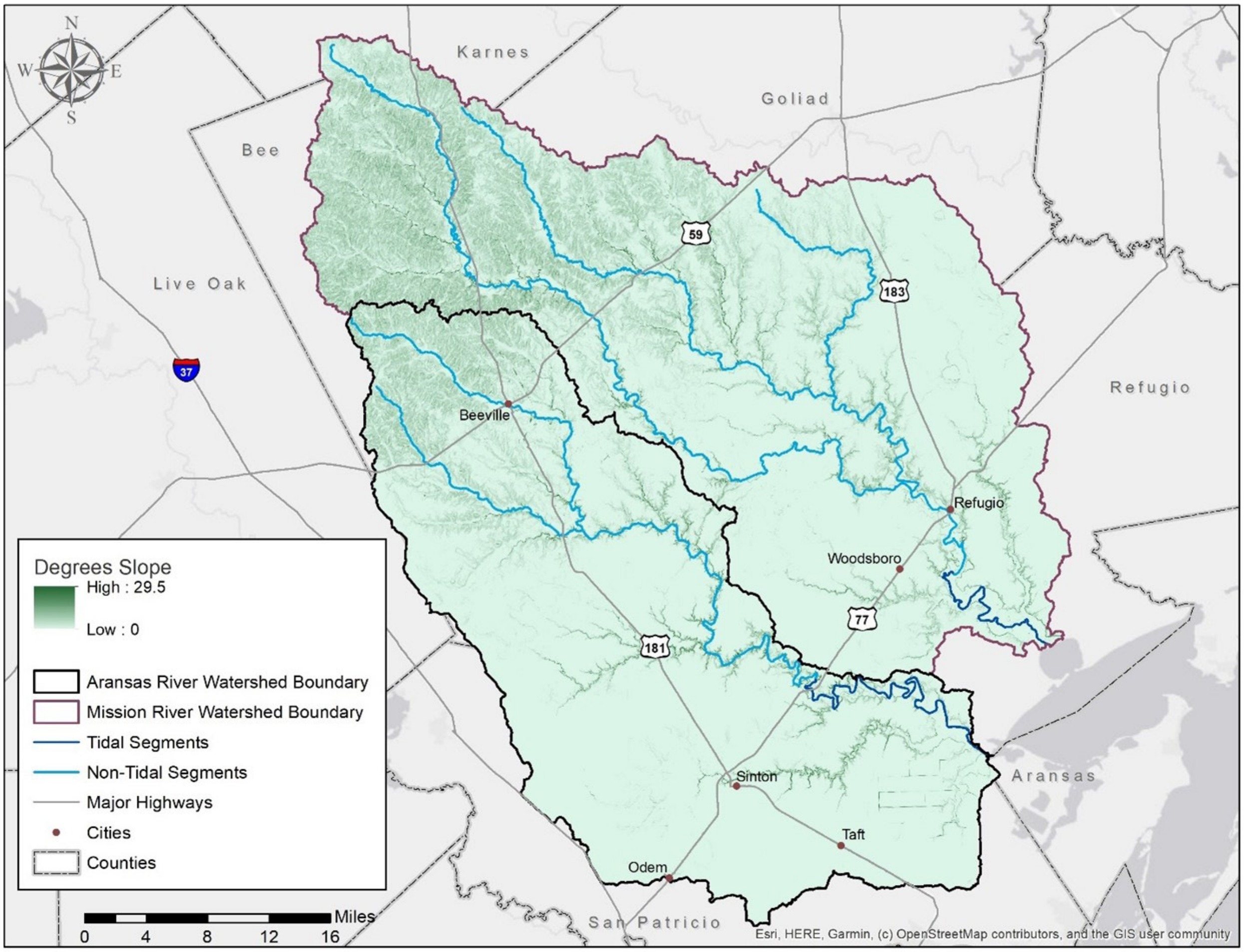


Figure 2. Watershed elevation.

The Mission and Aransas rivers watersheds can be characterized as predominantly flat coastal plain watersheds. The majority of these watersheds have moderate drainage. The watersheds have a peak elevation of about 541 feet with the lowest elevation point being approximately 1.5 feet below sea level. There is an average slope of 1° across the watersheds, with more intense slopes restricted to areas such as cut banks near the river system (Figure 2).

Soil data was obtained from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database (USDA 2017). The USDA NRCS SSURGO data assigns different soils to one of seven possible runoff potential classifications or hydrologic soil groups (HSGs). These classifications are based on the estimated rate of water infiltration when soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The four main groups are A, B, C, and D, with three dual classes (A/D, B/D, C/D). Group A soils have a high infiltration rate when wet (and therefore low runoff potential). Group A soils are deep and well-drained (typical of well-drained sands or gravelly sands). Conversely, Group D soils have very slow infiltration rates with high runoff potential when wet. Group D soils are typically soils with high clay content, soils with high water tables, or shallow soils on top of clay or impervious material. Group B and C soils are defined as having moderate and slow infiltration rates, respectively. The majority of soils in the Mission and Aransas rivers watersheds have an HSG of D (35.87% of the Aransas River watershed and 34.63% of the Mission River watershed) or B (38.72% of the Aransas River watershed and 30.99% of the Mission River watershed; Figure 3). The remaining six groups are the least dominant HSGs in the watershed (Table 2 ; USDA 2017).

The USDA NRCS provides suitability ratings for septic tank absorption fields based on soil properties, depth to bedrock or groundwater, hydraulic conductivity, and other properties that may affect on-site sewage facility (OSSF) installation, maintenance and effluent absorption. A "not limited" suitability rating indicates soils with features favorable to OSSF use. "Somewhat limited" indicates soils that are moderately favorable, with limitations that can be overcome by design, planning, and installation. "Very limited" indicates soils that are very unfavorable for OSSF use, with the expectation of poor performance and high amounts of maintenance. The majority of the soils in the watershed are rated "very limited"

Table 1. Descriptions of the hydrologic soil groups in the Mission and Aransas rivers watersheds.

Hydrologic soil group	Aransas River watershed acres	Aransas River watershed percent of total	Mission River watershed acres	Mission River watershed percent of total
A	65,510	12.14%	55,320	8.39%
A/D	968	0.17%	937	0.14%
B	209,029	38.72%	203,612	30.99%
B/D	835	0.15%	2,167	0.32%
C	67,965	12.59%	161,575	24.52%
C/D	1,682	0.32%	4,130	0.62%
D	193,533	35.87%	228,243	34.63%
Null	192	0.036%	2,597	0.39%
Total	539,714	100%	658,581	100%

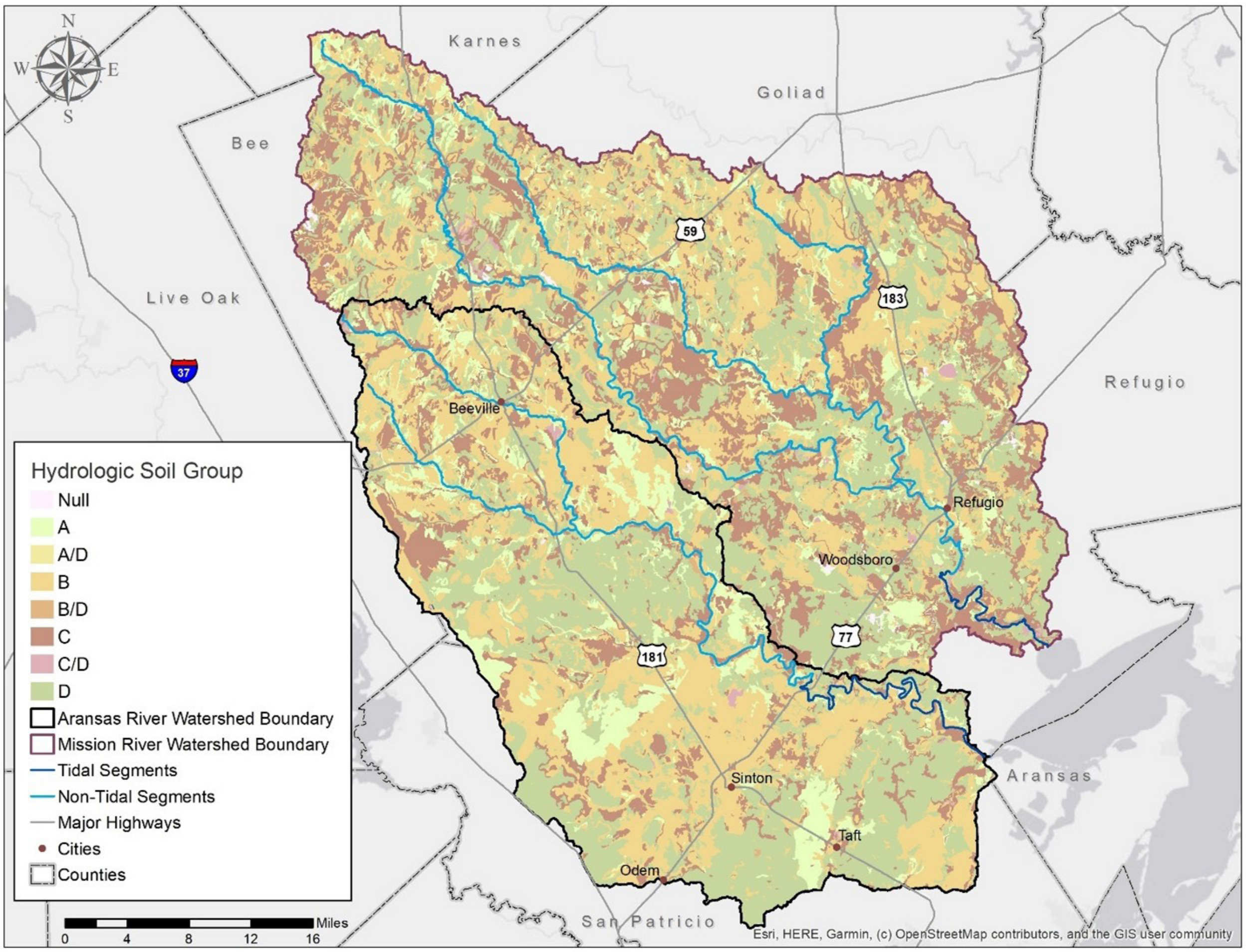


Figure 3. Hydrologic soil groups.

for OSSF use, with small areas rated "somewhat limited" (Figure 4; USDA 2017).

Ecoregions

Ecoregions are land areas with ecosystems that contain similar quality and quantity of natural resources (Griffith et al. 2007). Ecoregions have been delineated into four separate levels; level I is the most unrefined classification while level IV is the most refined. Both the Mission and Aransas rivers watersheds are located in two ecoregions (level III ecoregions), including the East Central Texas Plains Ecoregion, in Bee, Goliad, and Karnes counties, and the Western Gulf Coastal Plain

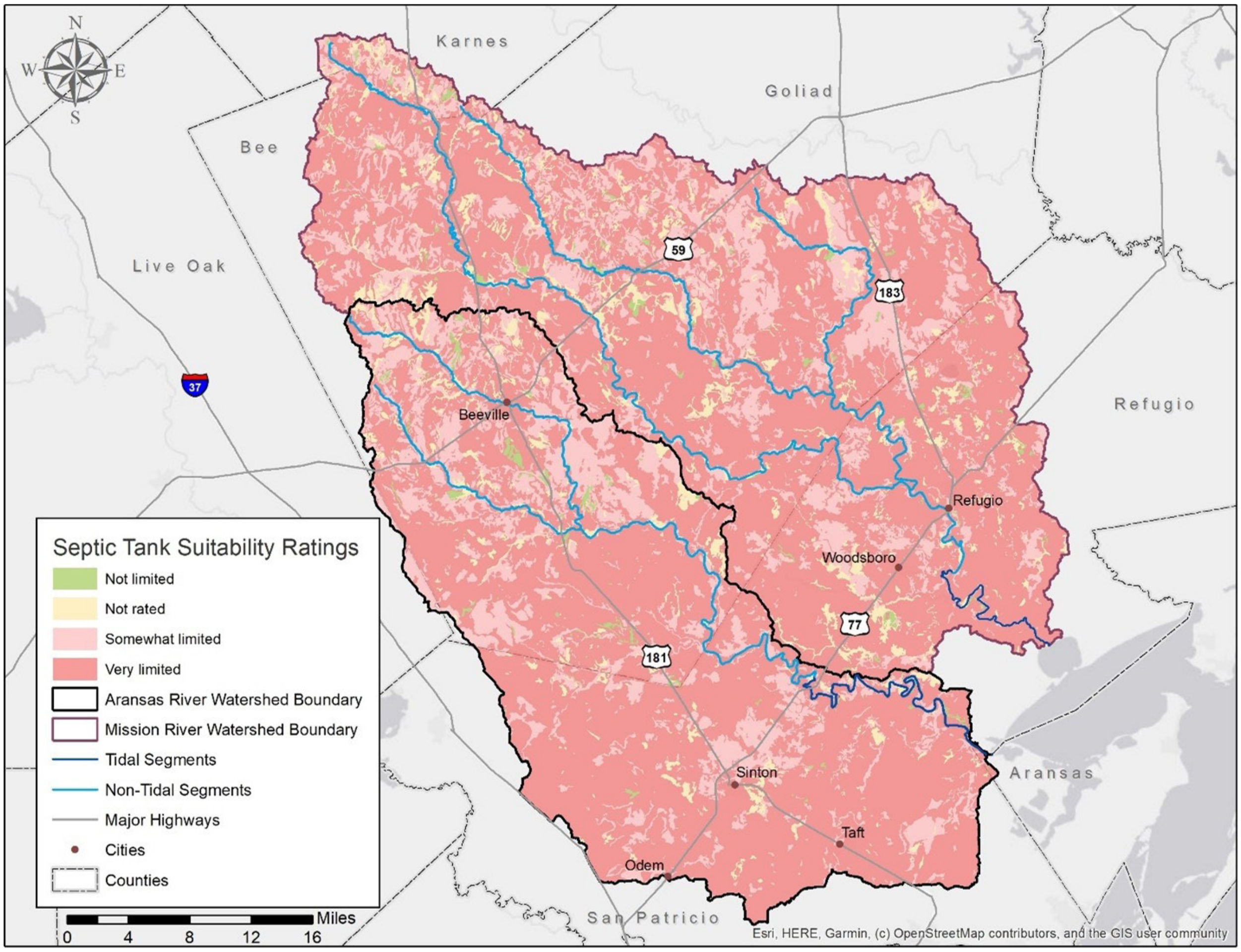


Figure 4. On-site sewage facility adsorption field ratings.

Ecoregion, in Bee, Goliad, Refugio, and San Patricio counties. The dominant soil types are fine-textured clay and acidic, sandy, or clay loams, respectively. The watersheds are further subdivided into three level IV ecoregions identified as the Southern Post Oak Savanna, Southern Subhumid Gulf Coastal Prairies, and the Mid-Coast Barrier Islands and Coastal Marshes.

The Southern Post Oak Savanna has more woods and forest than the adjacent prairie ecoregions. The land cover is a mix of woods, improved pasture, and rangeland. Almost all the Southern Subhumid Gulf Coastal Prairies have been converted to cropland, pasture, or urban and industrial land uses. This ecoregion used to be dominated by grasses such as little bluestem, yellow Indiangrass, and tall dropseed. The Mid-Coast Barrier Islands and Coastal Marshes are mainly dominated by seacoast bluestem, sea-oats, and common reed in the low to moderately saline Copano Bay region.

Land Use and Land Cover

Watershed land cover data was obtained from the 2011 National Land Cover Database (NLCD; Dewitz and U.S. Geological Survey 2021) and shown in Figure 5. As displayed in Table 2, the watershed area encompassing segments 2001, 2002, 2002A, 2002B, and 2002C (Mission River watershed) is 658,581 acres (ac). Dominant land uses in the Mission River watershed include scrub/grassland (47.3%) and pasture (31.5%). The watershed area encompassing segments 2003, 2004, 2004A, and 2004B (Aransas River watershed) is 539,714 ac and is dominated by cultivated crops (44.7%) and scrub/grassland (24.3%). Both watersheds are mostly rural, with only about 5% of the combined area classified as developed. Definitions of land use/land cover categories can be found in Appendix B.

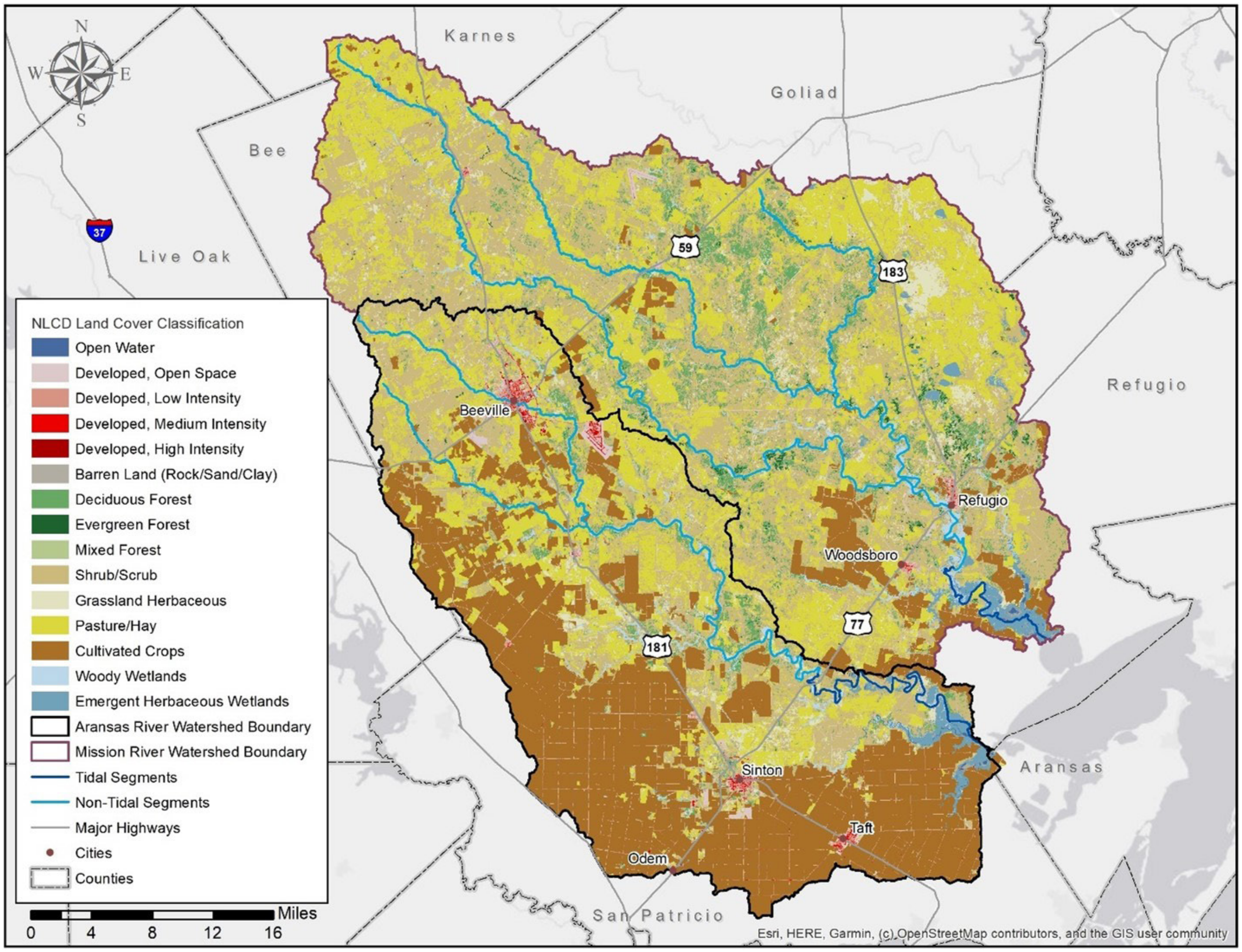


Figure 5. Land cover map.

Climate

The watersheds of the Mission and Aransas rivers are in the approximate boundary area between climate regions (Larkin and Bomar 1983). The region's subtropical climate is caused by the "predominant onshore flow of tropical maritime air from the Gulf of Mexico," while the increasing moisture content (from west to east) reflects variations in "intermittent seasonal intrusions of continental air" (Larkin and Bomar 1983). For the period from 1981 to 2010, average annual precipitation in the Mission River watershed was 33.2 inches, slightly higher than the average annual total precipitation for the Aransas River watershed of 32.3 inches (Figure 6; PRISM 2012). In Beeville, the location of the meteorological station most representative of the Aransas River watershed, the wettest month is normally September (3.8 inches), and the driest month is normally February (1.6 inches), although some rainfall typically occurs year-round (Figure 7; NOAA 2012).

In Beeville, average high temperatures generally reach their peak of 95°F in August, but highs above 100°F have occurred from April through September. Fair skies generally accompany the highest temperatures of summer when nightly average lows drop to about 72°F. During winter, the average low temperature is 43°F in January, although below freezing temperatures have occurred from September through April. The frost-free period in Beeville generally lasts for about 287 days, with the average last frost occurring February 23 and the first frost occurring on December 7 (Welsh 2007).

Demographics

According to the 2010 U.S. Census (USCB 2012), the population throughout the Mission River watershed is generally rural and dispersed outside of the cities of Refugio (population 2,890) and Woodsboro (1,512). The total population of the Mission River watershed was approximately 8,882, indicating a population den-

Table 2. Land use/land cover within the Mission and Aransas rivers watersheds (Dewitz and U.S. Geological Survey 2021).

2006 NLCD[a]	Mission Tidal (2001_01)		Mission Above Tidal (2002_01)		Mission River grand total	
Classification	**Acres**	**Percent of total**	**Acres**	**Percent of total**	**Acres**	**Percent of grand total**
Open water	632	0.3%	211	0.0%	843	0.1%
Developed	7,476	3.7%	18,207	4.0%	25,683	3.9%
Barren land	560	0.3%	1,152	0.3%	1,713	0.3%
Forest	10,143	5.0%	38,424	8.4%	48,567	7.4%
Scrub/grassland	81,994	40.5%	229,593	50.3%	311,586	47.3%
Pasture	62,182	30.7%	145,204	31.8%	207,386	31.5%
Cultivated crops	26,955	13.3%	11,532	2.5%	38,487	5.8%
Wetlands	12,593	6.2%	11,723	2.6%	24,316	3.7%
Total	202,535 acres		456,046 acres		658,581 acres	
2006 NLCD	**Aransas Tidal (2003_01)**		**Aransas Above Tidal (2004_01)**		**Aransas River grand total**	
Classification	**Acres**	**Percent of total**	**Acres**	**Percent of total**	**Acres**	**Percent of grand total**
Open water	1,195	0.5%	27	0.0%	1,222	0.3%
Developed	13,024	5.7%	19,605	6.3%	32,629	6.0%
Barren land	398	0.2%	265	0.1%	663	0.1%
Forest	2,486	1.1%	11,974	3.9%	14,460	2.7%
Scrub/grassland	33,808	14.7%	97,542	31.5%	131,350	24.3%
Pasture	17,105	7.5%	83,805	27.0%	100,910	18.7%
Cultivated crops	152,145	66.3%	89,111	28.7%	241,256	44.7%
Wetlands	9,406	4.1%	7,818	2.5%	17,224	3.2%
Total	229,567 acres		310,147 acres		539,714 acres	

[a] National Land Cover Database (NLCD)

Table 3. Population projections in the Mission and Aransas rivers watersheds.

City	Watershed	2010 U.S. Census	2020 population projection	2030 population projection	2040 population projection	2050 population projection	Percent increase (2010–2050)
Refugio	Mission	2,890	3,009	3,104	3,126	3,179	10.0%
Woodsboro	Mission	1,512	1,575	1,624	1,636	1,663	10.0%
Beeville	Aransas	12,863	13,516	14,082	14,327	14,351	11.6%
Odem	Aransas	2,389	2,535	2,659	2,730	2,782	16.5%
Sinton	Aransas	5,665	6,011	6,305	6,473	6,596	16.4%
Taft	Aransas	3,048	3,235	3,392	3,483	3,549	16.4%
Total		28,367	29,881	31,166	31,775	32,120	13.2%

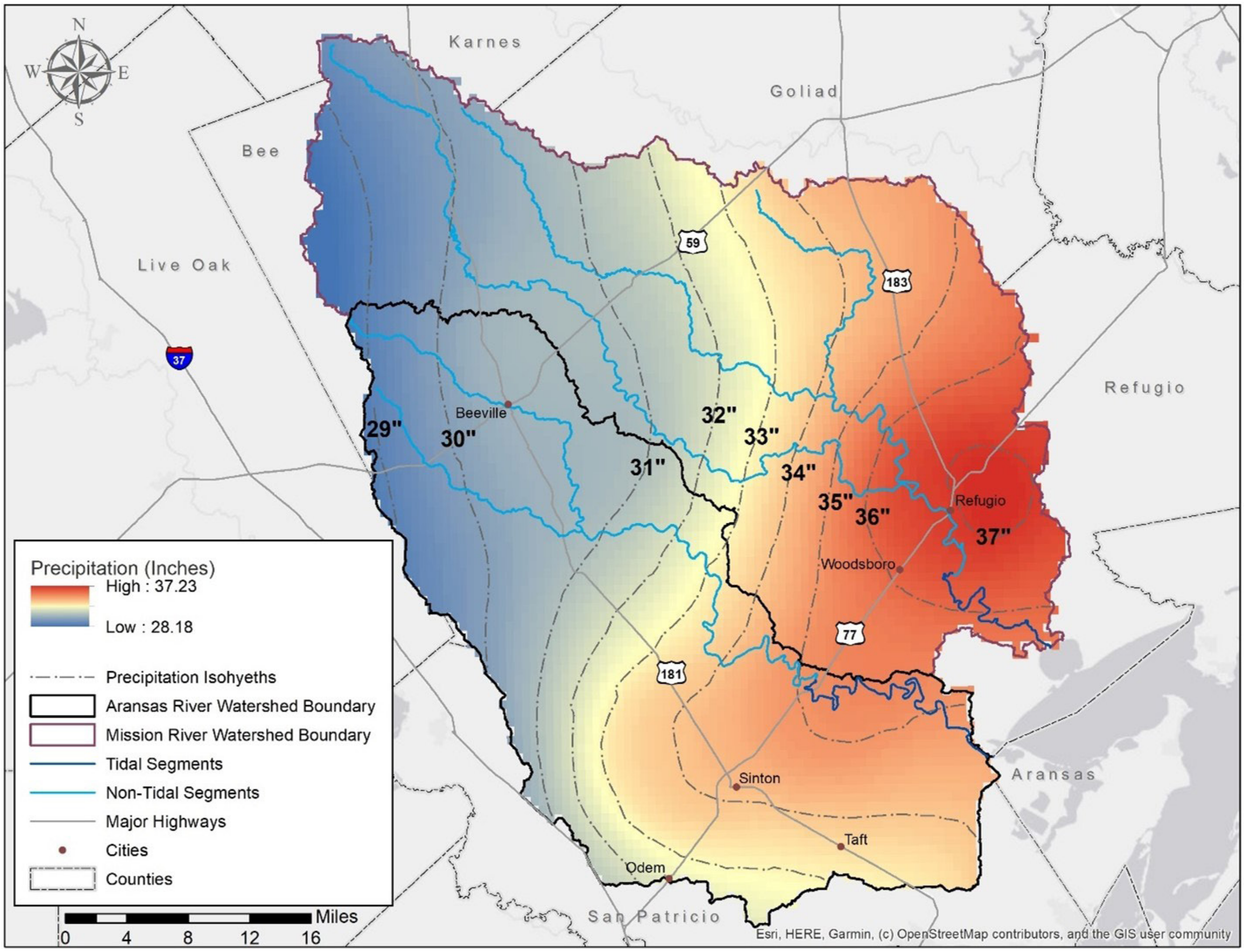


Figure 6. 30-year normal precipitation values.

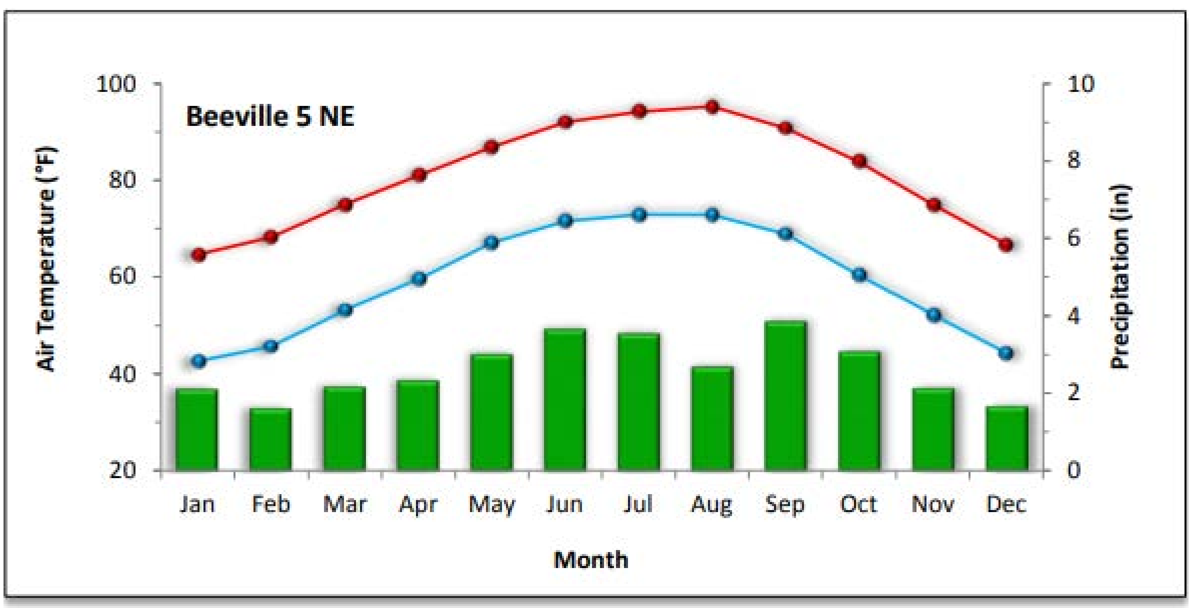


Figure 7. Average minimum and maximum air temperature and total precipitation by month over December 1972–November 2012 for the Beeville area (NOAA 2012).

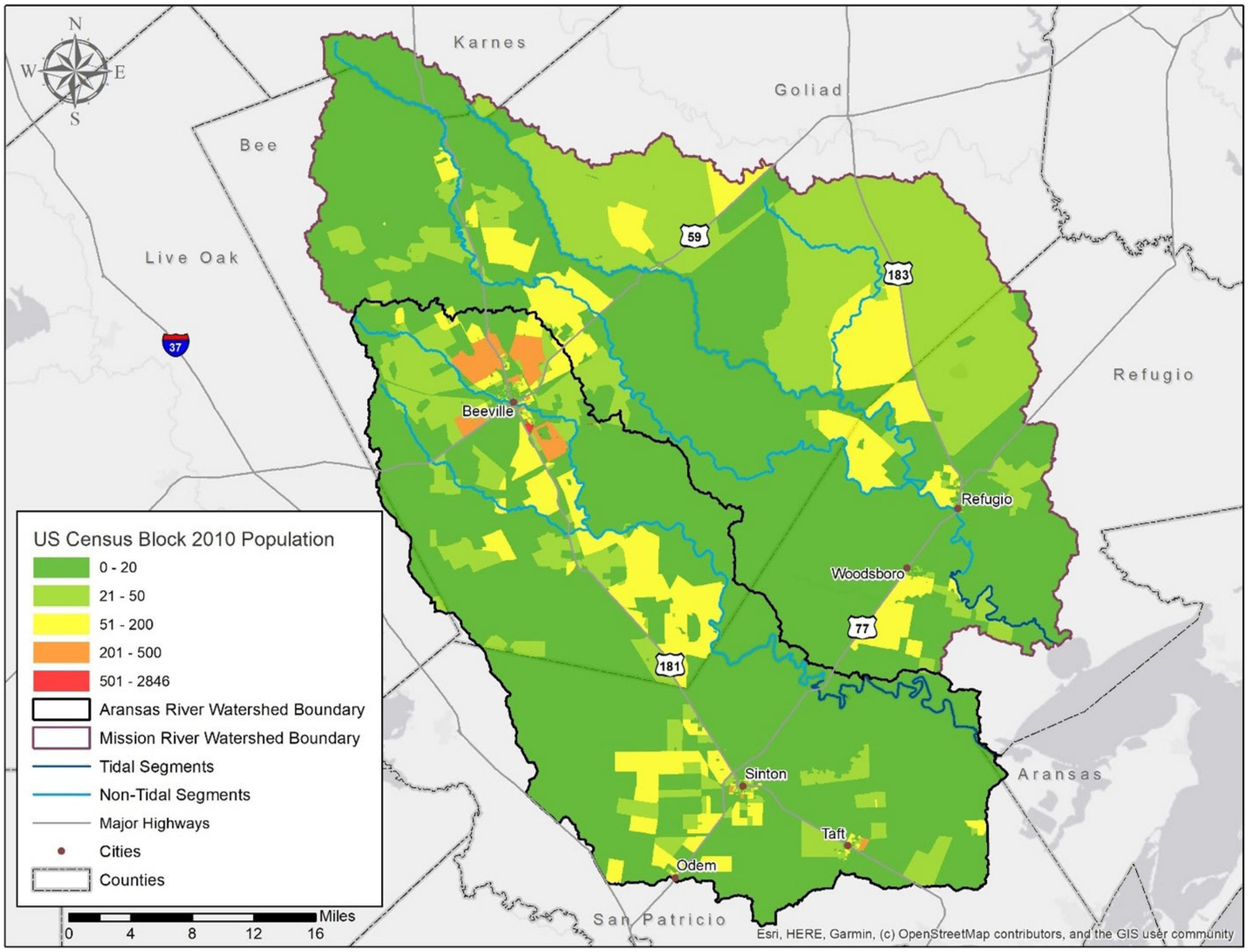


Figure 8. 2010 Population by Census Block.

sity of about nine people per square mile. The largest municipalities within the more populous Aransas River watershed are the cities of Beeville (population 12,863), Sinton (5,665), Taft (3,048), and Odem (2,389). The total population of the Aransas River watershed was approximately 45,689, indicating a population density of about 54 people per square mile, more than six times that of the Mission River watershed (Figure 8).

Population projections developed by the Texas Demographic Center and the Texas Water Development Board (TWDB; TWDB 2013) indicate that the populations of the seven counties that are included within the Mission and Aransas rivers watersheds (Aransas, Bee, Goliad, Karnes, Live Oak, Refugio, and San Patricio) are expected to increase by an average of 14.5% between 2010 and 2050. For the cities within the watershed, including Beeville, Odem, Refugio, Sinton, Taft, and Woodsboro, the populations are projected to increase by an average of 13.5% between 2010 and 2050 (Table 3). The cities of Odem, Sinton, and Taft, all located within the Aransas River Tidal watershed, are expected to have the most significant growth.

Chapter 3
Water Quality

Introduction

Under the federal Clean Water Act (CWA) section 303(d) and 305(b), the state of Texas is required to identify water bodies that are unable to meet water quality standards for their designated uses. The Texas Commission on Environmental Quality (TCEQ) assigns unique segment identifiers to each water body. Locations within a segment are broken up into hydrologically distinct assessment units (AUs). The AUs are evaluated every 2 years to determine if they meet designated water quality standards, and those that are not meeting requirements are listed on the Texas Integrated Report and 303(d) List in the Texas Integrated Report (TCEQ 2019): https://www.tceq.texas.gov/waterquality/assessment/14twqi/14txir.

TCEQ defines the designated uses for all water bodies, which in turn establishes the water quality criteria to which a water body must adhere. Currently, all water bodies in the Mission and Aransas rivers watersheds must meet primary contact recreation uses and support aquatic life use. The water quality for recreation use is evaluated by measuring concentrations of fecal indicator bacteria in 100 milliliters (mL) of water. Aquatic life use is a measure of a water body's ability to support a healthy aquatic ecosystem. Aquatic life use is evaluated based on the dissolved oxygen (DO) concentration, toxic substance concentrations, ambient water and sediment toxicity, and indices of habitat, benthic macroinvertebrates, and fish communities. General use water quality requirements also include measures of temperature, pH, chloride, sulfate, and total dissolved solids. Currently, water bodies are also screened for levels of concern for nutrients and chlorophyll-a.

According to the *2014 Texas Integrated Report and 303(d) List,* there are five AUs impaired due to elevated levels of bacteria: AU 2001_01 in Mission River Tidal, AU 2003_01 in Aransas River Tidal, AU 2004_02 in

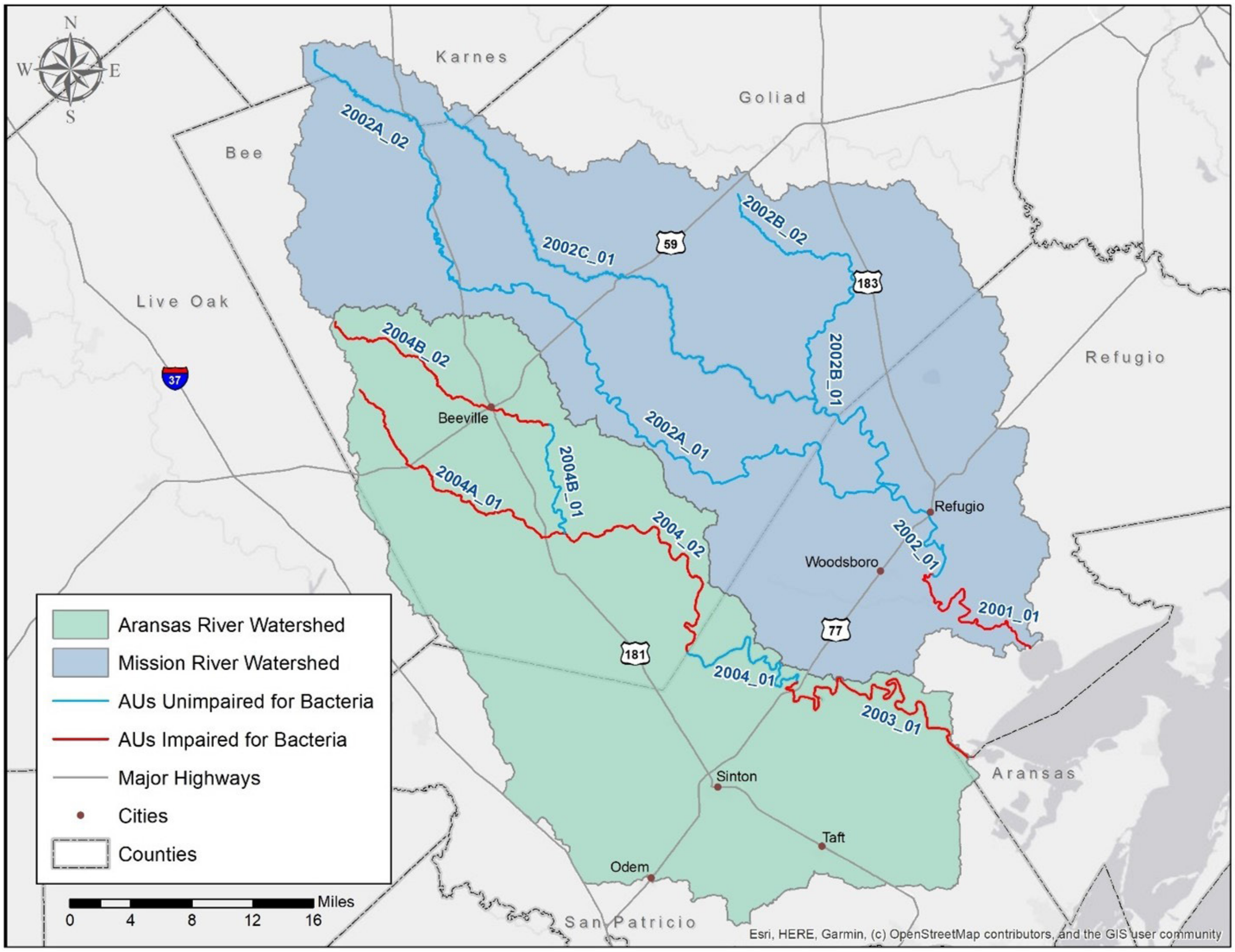


Figure 9. Texas Commission on Environmental Quality assessment units (AUs) and watershed impairments.

Aransas River Above Tidal, AU 2004A_01 in Aransas Creek, and AU 2004B_02 in Poesta Creek (Figure 9). There are also concerns for depressed DO in Aransas Creek and Poesta Creek as well as concerns for elevated nitrate and total phosphorus in Aransas River Above Tidal.

Although Aransas Creek (AU 2004A_01) is listed as impaired on the *2014 Texas Integrated Report and 303(d) List,* a recreational use attainability analysis (RUAA) was conducted in the summer of 2012 to determine if the presumed use should be changed to secondary contact recreation 1 (SCR 1). The study concluded that Aransas Creek should be changed to SCR 1 due to lack of any type of recreation observed during the study and naturally low water levels. The Aransas Creek RUAA for SCR 1 was approved by EPA on November 1, 2018. Therefore, no water quality data will be discussed in this chapter regarding Aransas Creek (AU 2004A_01).

Water quality is monitored at designated sampling sites throughout the watershed. The TCEQ Surface Water Quality Monitoring (SWQM) Program coordinates the collection of water quality samples at specified water quality monitoring sites through the watershed and the state (Figure 10). Through the TCEQ Clean Rivers Program (CRP), the Nueces River Authority (NRA) conducts quarterly monitoring of field parameters (clarity, temperature, DO, specific conductance, pH, salinity, and flow), conventional parameters (total suspended solids, sulfate, chloride, ammonia, total hardness, nitrate-nitrogen, total phosphorous, alkalinity, total organic carbon, turbidity, and chlorophyll-*a*), and bacteria. Sampling sites and frequency are detailed in Table 4.

Table 4. Sites currently monitored by Nueces River Authority.

Station			Annual samples collected			
ID	Assessment Unit	Description	Conventional	Field	Flow	Bacteria
12943	2001_01	Mission River Tidal @ FM 2678	4	4		4
12944	2002_01	Mission River @ US 77	4	4	4	4
12947	2003_01	Aransas River Tidal @ FM 629	4	4		4
12948	2003_01	Aransas River Tidal @ US 77 Bridge	4	4		4
12952	2004_02	Aransas River @ CR E of Skidmore	4	4	4	4
12937	2004B_01	Poesta Creek @ SH 202	4	4	4	4

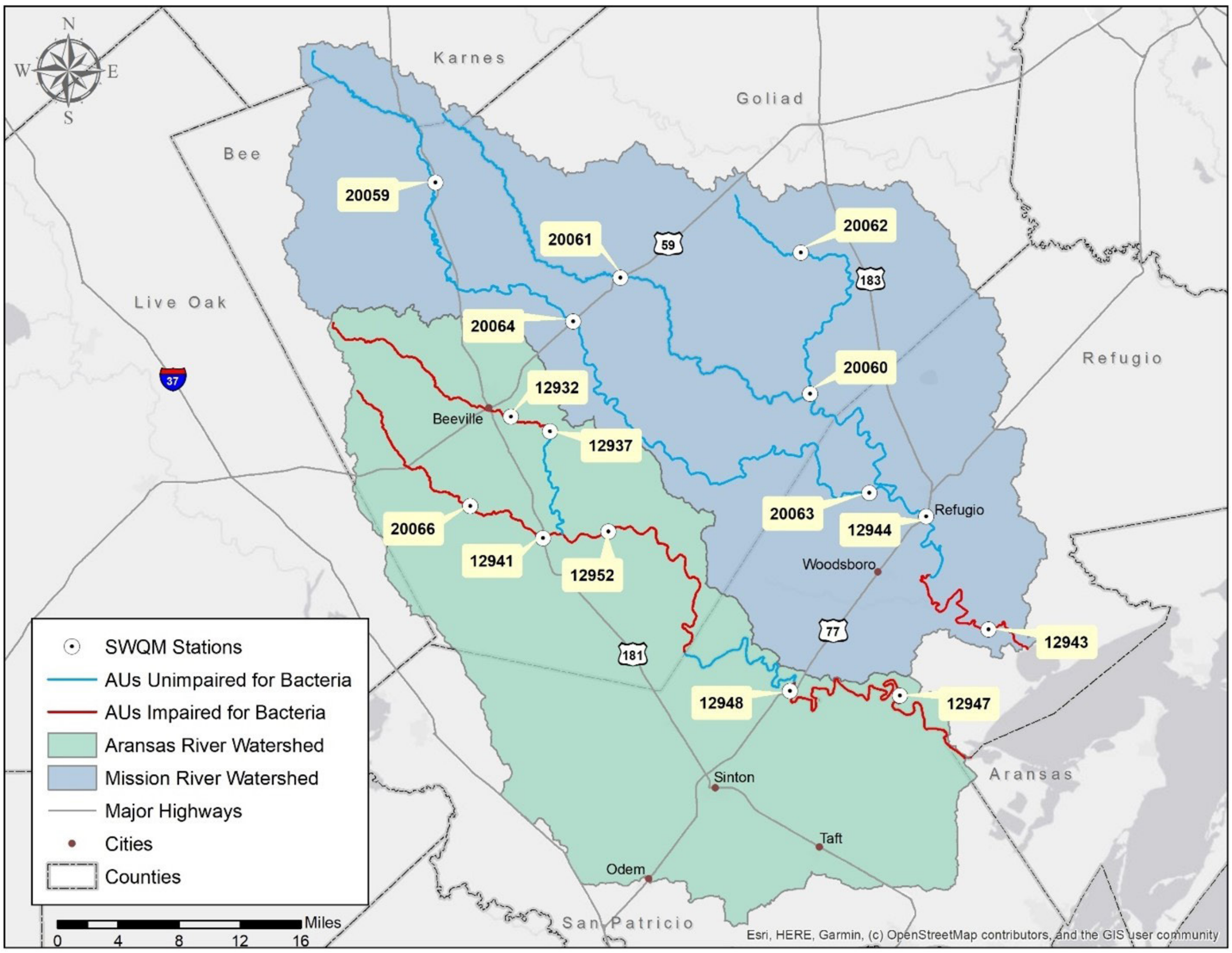


Figure 10. Surface water quality monitoring (SWQM) stations.

Table 5. *2014 Texas Integrated Report* assessment results for bacteria in the Mission and Aransas rivers watersheds (TCEQ 2019).

Assessment Unit	Description	Current standard	Geomean	Supporting/not supporting
2001_01	Mission River Tidal	35 MPN[a]/100 mL[b] *Enterococcus*	71.06	Not supporting
2002_01	Mission River Above Tidal	126 MPN/100 mL *E. coli*	118.59	Fully supporting
2003_01	Aransas River Tidal	35 MPN/100 mL *Enterococcus*	64.29	Not supporting
2004_02	Aransas River Above Tidal	126 MPN/100 mL *E. coli*	166.41	Not supporting
2004B_02	Poesta Creek	126 MPN/100 mL *E. coli*	310.76	Not supporting

[a] Most Probable Number (MPN)
[b] milliliter (mL)

Table 6. Special study *E. coli* results for Medio, Sarco, and Blanco creeks.

Segment	Description	Current standard	Geomean
2002A	Medio Creek	126 MPN[a]/100 mL[b] *E. coli*	76.58
2002B	Sarco Creek	126 MPN/100 mL *E. coli*	73.85
2002C	Blanco Creek	126 MPN/100 mL *E. coli*	53.52

[a] Most Probable Number (MPN)
[b] milliliter (mL)

Bacteria

As mentioned above, concentrations of fecal indicator bacteria are evaluated to assess the risk of illness during contact recreation. In freshwater environments, concentrations of *E. coli* bacteria are measured to evaluate the presence of fecal contamination in water bodies from warm-blooded animals and other sources. In marine-influenced environments, *Enterococcus* are measured due to better survival rates in saltwater environments. The presence of these fecal indicator bacteria may indicate that associated pathogens from the intestinal tracts of warm-blooded animals could be reaching water bodies and can cause illness in people that recreate in them. Indicator bacteria can originate from numerous sources, including wildlife, domestic livestock, pets, malfunctioning OSSFs, urban and agricultural runoff, SSOs, and direct discharges from wastewater treatment facilities (WWTFs).

Under the primary contact recreation standards, the geometric mean criterion for bacteria is 126 most probable number (MPN) of *E. coli* per 100 mL in freshwater and 35 MPN of *Enterococcus* per 100 mL in saltwater. Currently, all water bodies in the Mission and Aransas rivers watersheds are evaluated under this standard. As previously mentioned, four AUs (2001_01 [Mission River Tidal], 2003_1 [Aransas River Tidal], 2004_02 [Aransas River Above Tidal], and 2004B_02 [Poesta Creek]) are listed as impaired due to elevated indicator bacteria according to the *2014 Texas Integrated Report* (Table 5; TCEQ 2019). This listing is based on the geometric mean value from at least 20 bacteria samples collected at stations in each AU between November 2005 and December 2012.

Currently, *E. coli* concentrations are measured at four stations throughout the watersheds: one station in the Aransas River Above Tidal (AU 2004_02), one station in the unimpaired Mission River Above Tidal (AU 2002_01), one station in Aransas Creek (AU 2004A_01), and one station in Poesta Creek (AU 2004B_02). *Enterococcus* concentrations are also being measured at two stations in the watersheds: one in the Mission River Tidal AU (2001_01) and one in the Aransas River Tidal (AU 2003_01). Historical *Enterococcus* measurements for each tidal segment are shown in Figure 11, and historical *E. coli* measurements for each non-tidal segment are shown in Figure 12. The reductions needed to meet water quality standards are further discussed in Chapter 4.

Though not included in the *2014 Texas Integrated Report*, a special water quality study was conducted on Medio, Sarco, and Blanco creeks between October 2007 and January 2011. During this study, *E. coli* data was collected at three stations on Medio Creek (AUs 2002A_01-02), two stations on Sarco Creek (AUs 2002B_01-02), and one station on Blanco Creek (AU 2002C_01). *E. coli* geomeans derived from the study for each creek segment can be found in Table 6.

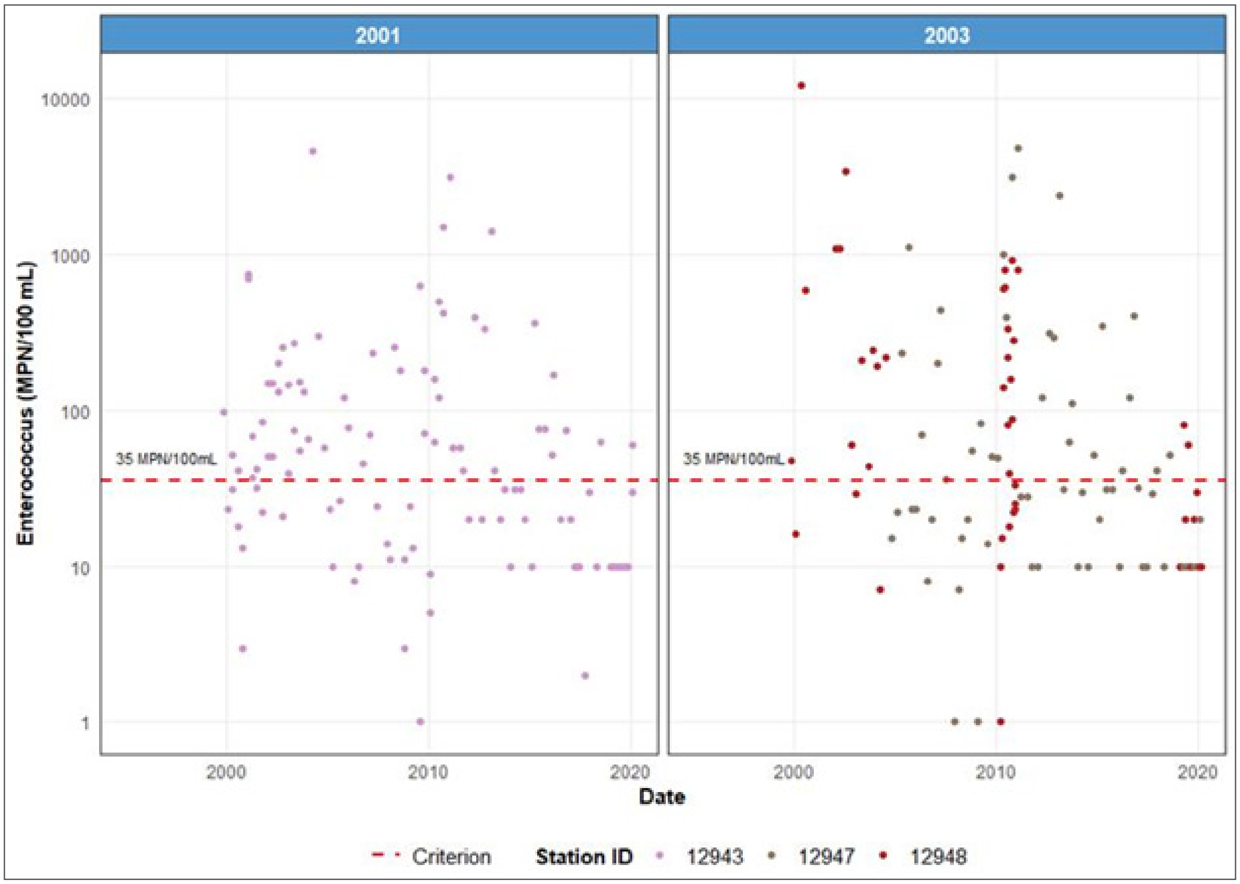


Figure 11. Historical *Enterococcus* concentrations at tidal segments 2001 and 2003.

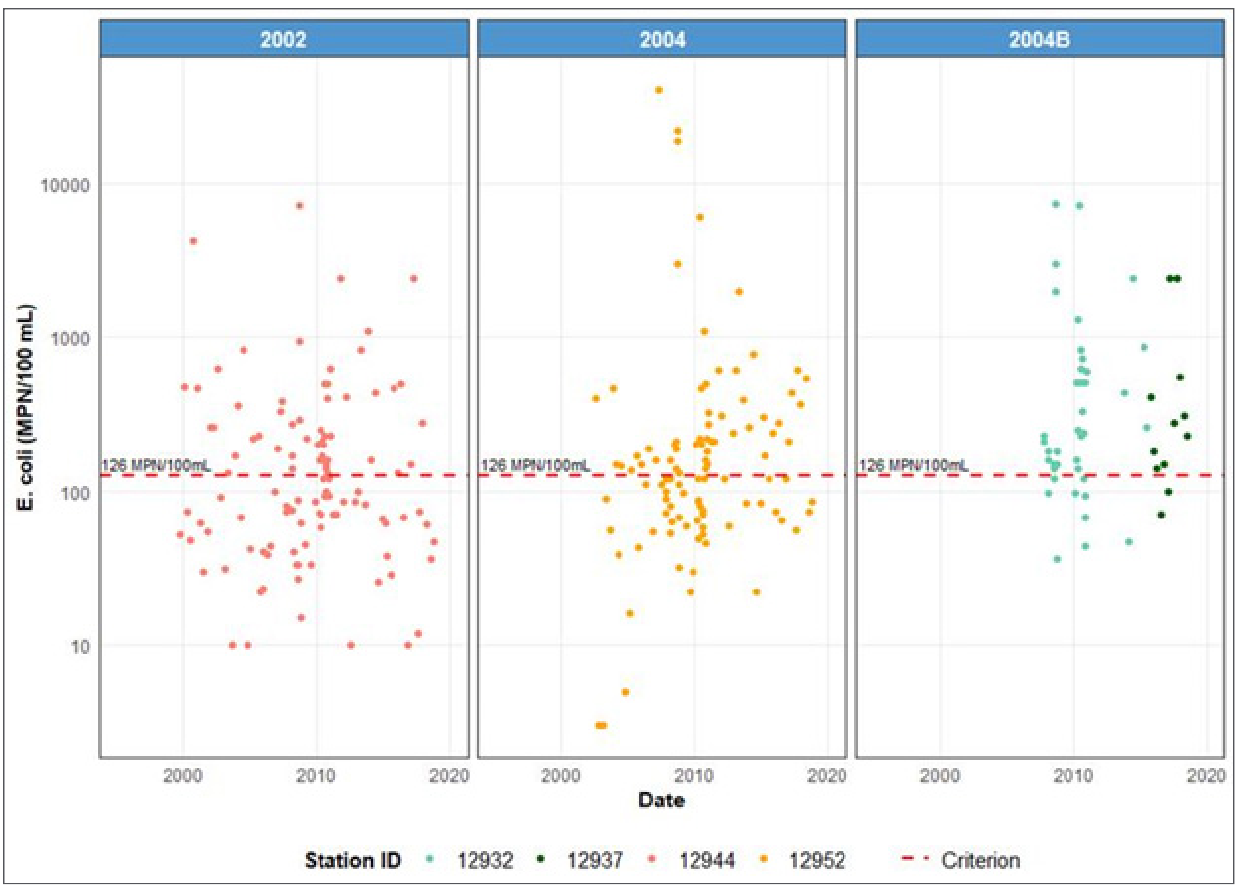


Figure 12. Historical *E. coli* concentrations at non-tidal segments 2002, 2004, and 2004B.

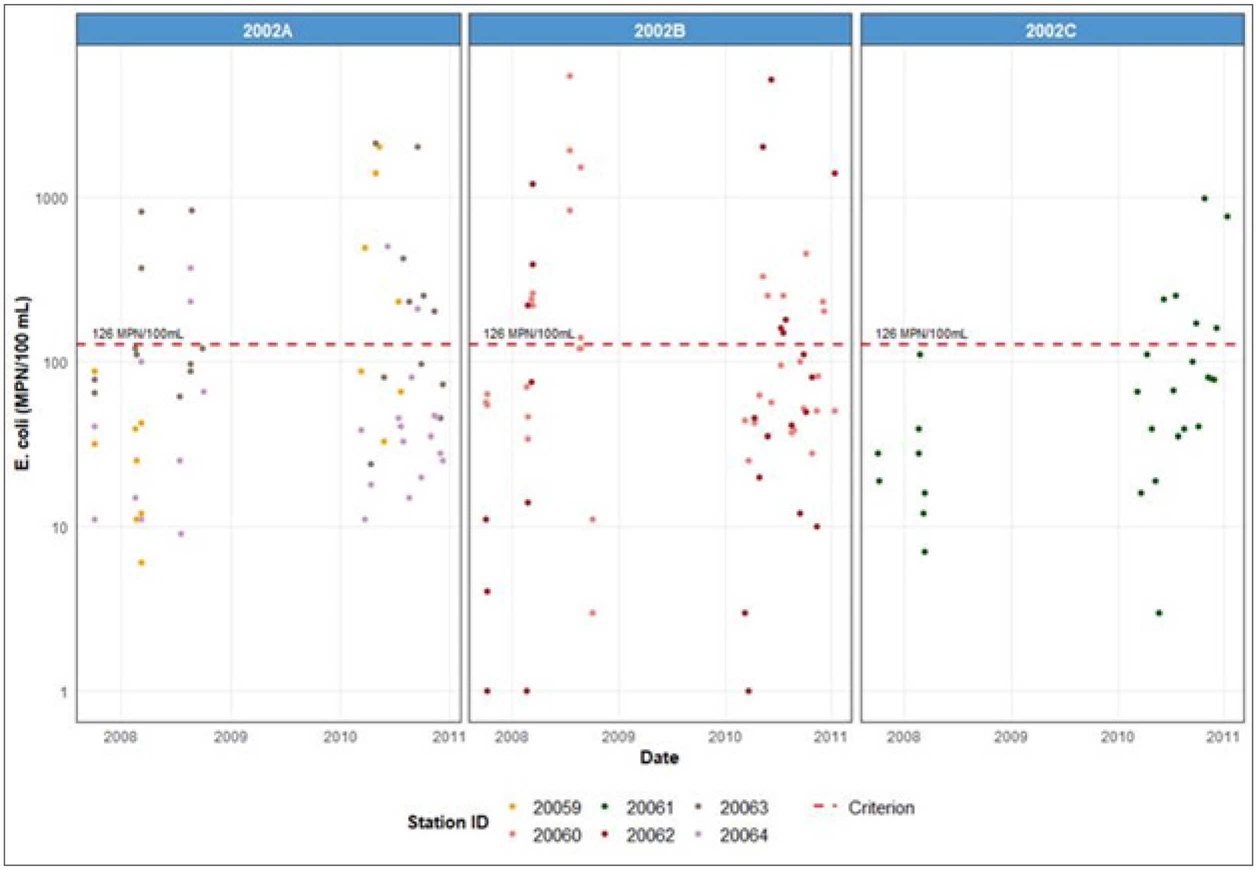


Figure 13. *E. coli* concentrations in impaired assessment units (AUs). The solid line indicates the running 7-year geometric mean.

Based on the collected data, all three creeks meet the geometric mean criterion standard for *E. coli.* The historical *E. coli* measurements for Medio, Sarco, and Blanco creeks are shown in Figure 13.

Water Quality Concerns

Dissolved Oxygen

Sufficient levels of DO are essential for the survival of aquatic species within water bodies. Consequently, if levels of DO are low, it may limit the quantity and types of aquatic species found within those bodies. When DO levels fall too low, fish and other organisms may begin to die off. Oxygen is dissolved into water through simple diffusion from the atmosphere, aeration of water as it flows over rough surfaces, and through aquatic plant photosynthesis. Typically, DO levels fluctuate throughout the day, with the highest levels occurring in mid to late afternoon due to plant photosynthesis. DO levels typically reach the lowest point just before dawn as both plants and animal respire and consume the available DO in the water column. Furthermore, seasonal fluctuations in DO are common because of decreased oxygen solubility as water temperature increases.

While DO can fluctuate naturally, human activities can also cause low DO levels. Elevated amounts of organic matter (vegetative material, untreated wastewater, etc.) can result in depressed DO as bacteria breaks down organic matter and consumes oxygen. Excessive nutrients from fertilizers and manures can also reduce DO as the quantity of plants and algae increase in response to higher amounts of nutrients. The increased respiration from plants and the decay of dead plant matter can also drive decreases in DO. The current DO screening level in freshwater streams is 3.0 mg/L. Concerns are indicated when the screening level is exceeded by at least 20% of the measurements during the assessment period. The 2014 Texas Integrated Report identified screening concerns for depressed DO in Poesta Creek (Table 7).

Nutrients

Nutrients, specifically nitrogen and phosphorous, are used by aquatic plants and algae to grow. However, excessive nutrients can lead to plant and algal blooms that can result in reduced DO levels. High levels of nitrates and nitrites can directly impact respiration in fish. Sources of nutrients can include fertilizers that run off from yards and agricultural fields in addition to effluent from WWTFs. Nutrients also bind to soil and sediment particles. Therefore, runoff and

Table 7. Integrated report summary indicating nutrient level screening concerns in Poesta Creek.

Water body	Assessment unit	Parameter	Date range	Number of samples assessed	Number of exceedances
Poesta Creek	2004B_02	Depressed dissolved oxygen	December 1, 2005–November 30, 2012	20	5

Table 8. Integrated report summary for nutrient screening concerns in Aransas River Above Tidal.

Water body	Assessment unit	Parameter	Date range	Number of samples assessed	Number of exceedances
Aransas River Above Tidal	2004_02	Nitrate	December 1, 2005–November 30, 2012	28	10
Aransas River Above Tidal	2004_02	Total Phosphorus	December 1, 2005–November 30, 2012	28	24

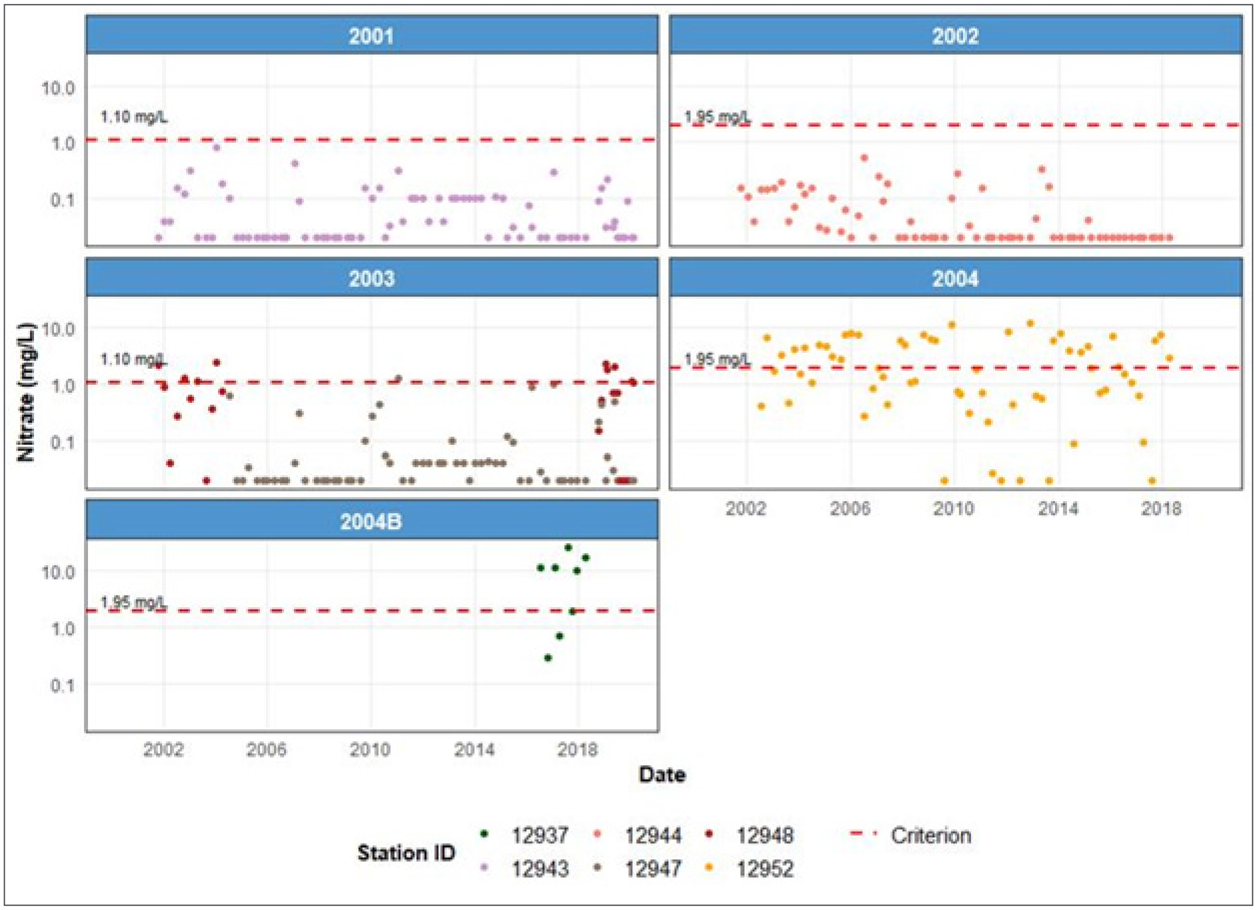


Figure 14. Historical nitrate concentrations for stream segments in the Mission and Aransas rivers watersheds.

erosion events that result in heavy loads of sediment can increase nutrient levels in water bodies as well.

Currently, TCEQ does not have approved numeric criteria for these nutrients in water bodies. Screening levels provided by TCEQ are used as a preliminary indication of possible concerns. The current screening level in freshwater streams for nitrate is 1.95 mg/L, and the screening level for total phosphorus is 0.69 mg/L. The current screening level in tidal streams for nitrate is 1.1 mg/L, and the screening level for total phosphorus is 0.66 mg/L. The 2014 Texas Integrated Report identified screening concerns for nitrate and total phosphorus in Aransas River Above Tidal (Table 8). Historical nitrate and total phosphorus data for segments in the Mission and Aransas rivers watersheds can be found in Figures 14 and 15. No nutrient data was collected during the special study on Medio, Sarco, and Blanco creeks.

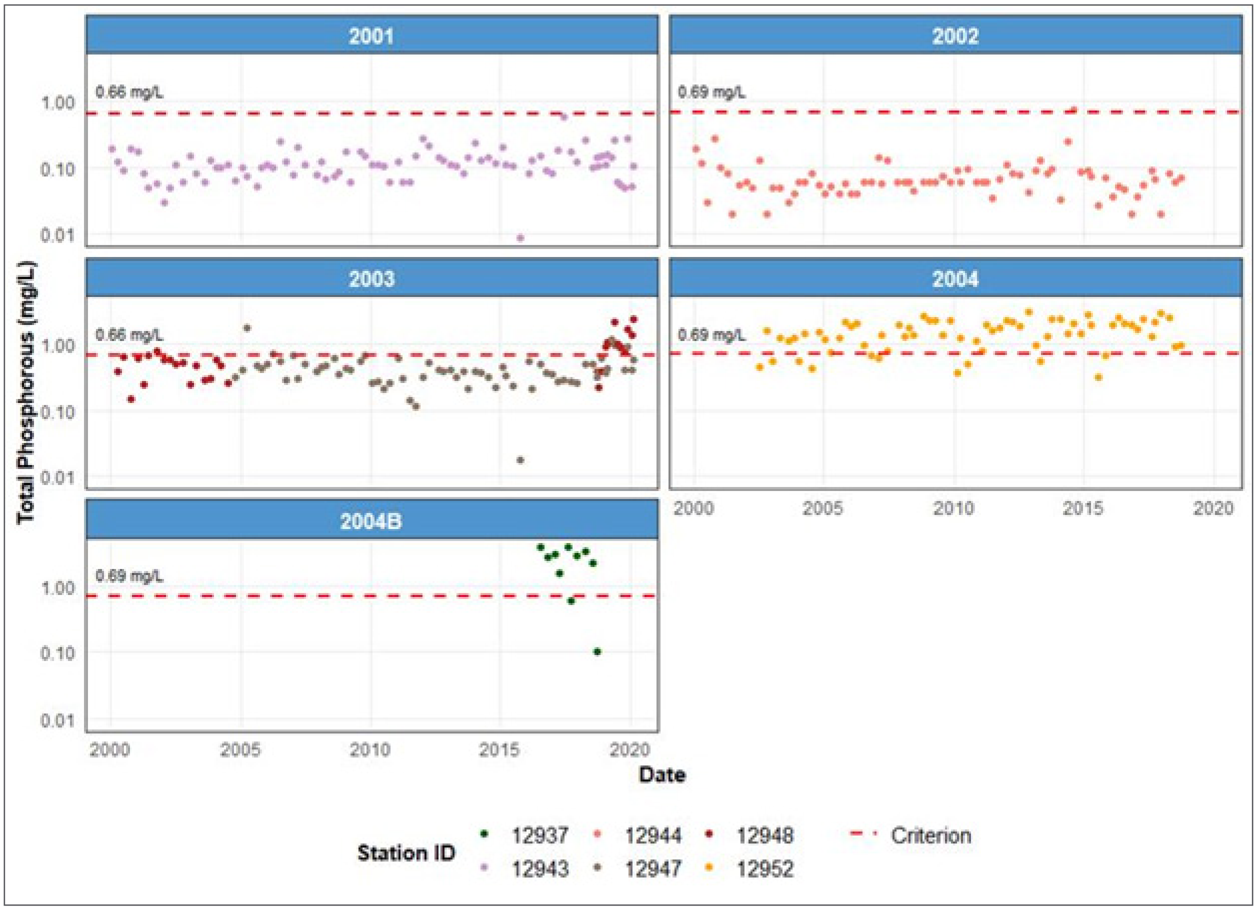


Figure 15. Historical total phosphorus concentrations for stream segments in the Mission and Aransas rivers watersheds.

Flow

Generally, streamflow (the amount of water flowing in a river at a given time) is dynamic and always changing in response to both natural (e.g., precipitation events) and anthropogenic (e.g., changes in land cover) factors. From a water quality perspective, streamflow is important because it influences the ability of a water body to assimilate pollutants. The relationships between water quality and streamflow are further detailed in Chapter 3.

There are two U.S. Geological Survey (USGS) streamflow gages in the watersheds. Streamflow gage 08189500 is located at the SWQM station 12944 at Refugio in the upper portion of Mission River Above Tidal. Instantaneous streamflow information is available at this station dating back to June 1988. A second streamflow gage (08189700) is located near SWQM station 12952 in the upper portion of the Aransas River watershed, just below the confluence of Poesta and Aransas creeks. This gage has instantaneous streamflow records dating back to October 1995. Instantaneous streamflow data for each gage was used to calculate the monthly aggregated streamflow from January 2008 through December 2018 (Figure 16 and Figure 17).

Potential Sources of Water Quality Issues

Domestic Livestock

Domestic livestock farms, particularly cattle, are common throughout the rural watershed. Runoff from rain events can transport fecal matter and bacteria from pastures and rangeland into nearby creeks and streams. Livestock with direct access to streams can also wade and defecate directly into water bodies resulting in direct contributions of bacteria to the water. Streamside riparian buffers, fencing, and grazing practices that reduce the time livestock spend near streams can reduce livestock impacts on water quality. Because watershed-level livestock numbers are not available, the livestock populations present in the Mission and Aransas rivers watersheds were estimated by Borel et al. (2015; Table 9). Activities, such as livestock grazing close to water bodies and farmers' use of manure as fertilizer, can contribute fecal indicator bacteria such as Enterococci to nearby water bodies.

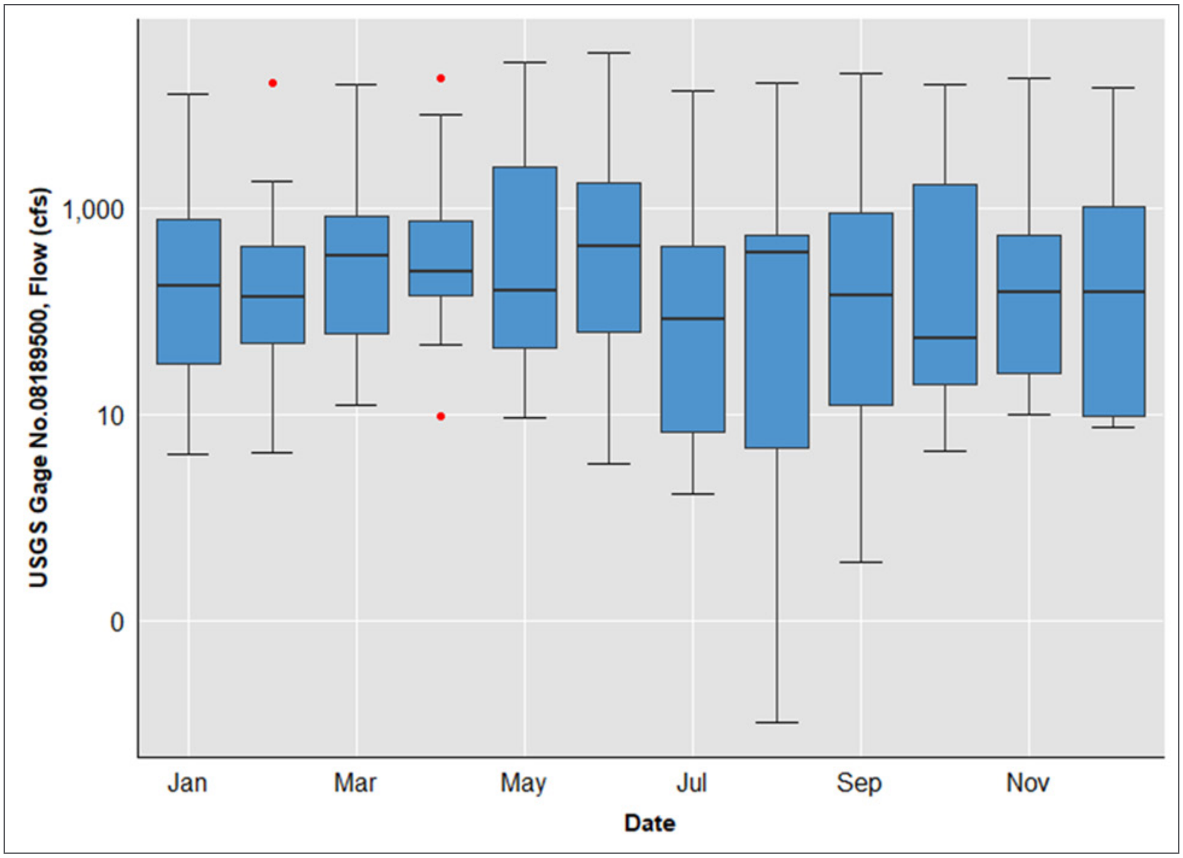


Figure 16. Aggregated monthly streamflow at U.S. Geological Survey (USGS) gage 08189500 from January 2008 through December 2018.

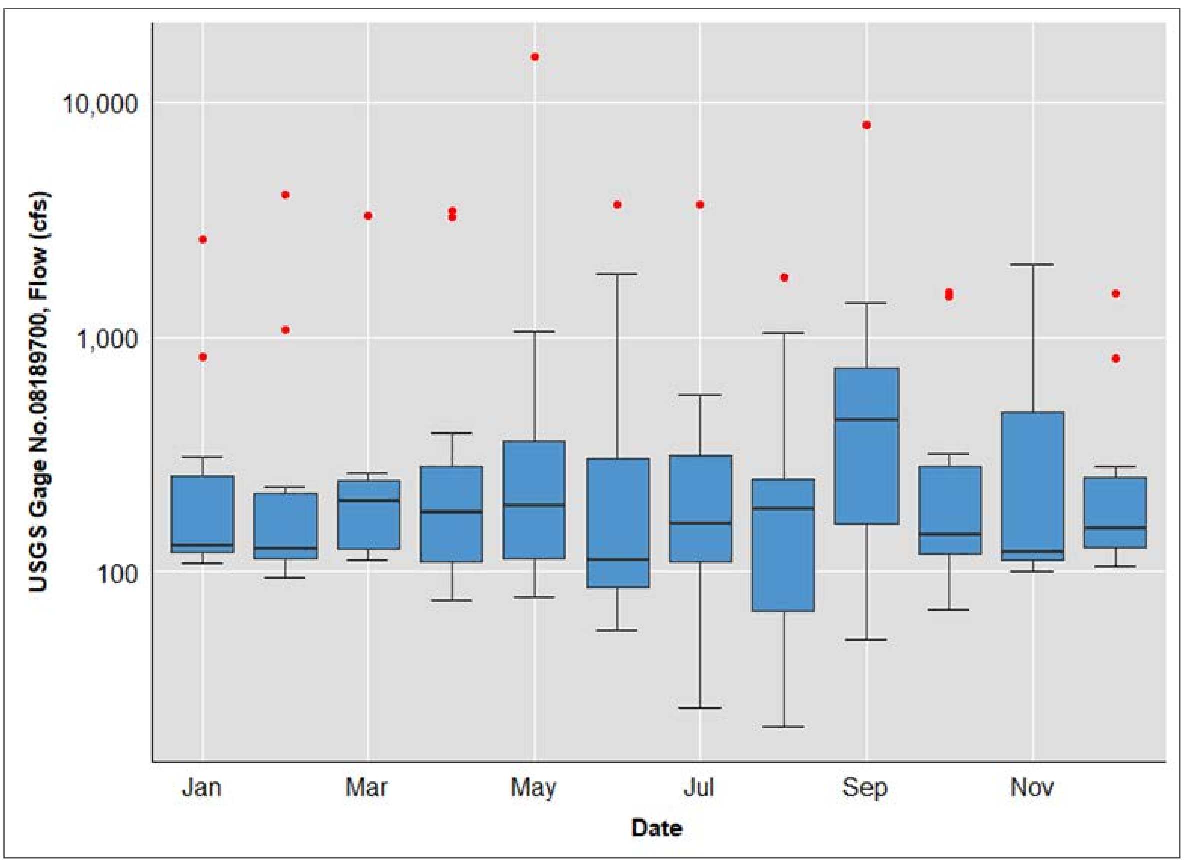


Figure 17. Aggregated monthly streamflow at U.S. Geological Survey (USGS) gage 08189700 from January 2008 through December 2018.

Table 9. Estimated livestock populations distributed by the watersheds. Populations in animal units of 1,000 pounds live weight. Source: Adapted from Tables 5 and 6 in Borel et al. (2015).

Watershed	Goats	Horses	Sheep	Total cattle
Aransas Above Tidal	198	812	34	15,022
Aransas Tidal	34	401	31	3,658
Mission Above Tidal	281	1,071	41	29,090
Mission Tidal	51	488	4	11,736
Total watersheds	**564**	**2,772**	**110**	**59,506**

Table 10. Estimated distributed deer and feral hog populations. Source: Adapted from Table 5 in Borel et al. (2015).

Watershed	Deer	Feral hogs
Aransas Above Tidal	2,462	1,089
Aransas Tidal	2,075	781
Mission Above Tidal	3,731	1,636
Mission Tidal	1,681	692
Total watersheds	**9,949**	**4,198**

Table 11. Estimated distributed dog population. Source: Adapted from Table 4 in Borel e al. (2015).

Watershed	Deer	Feral hogs
Aransas Above Tidal	2,462	1,089
Aransas Tidal	2,075	781
Mission Above Tidal	3,731	1,636
Mission Tidal	1,681	692
Total watersheds	**9,949**	**4,198**

Wildlife and Feral Hogs

Bacteria are common inhabitants of the intestines of all warm-blooded animals, including wildlife such as mammals and birds. Fecal wastes can also contribute nutrients in the form of ammonia, nitrite, nitrogen, and phosphorous. Wildlife are naturally attracted to riparian corridors of streams and rivers. With direct access to the stream channel, the direct deposition of wildlife waste can be a concentrated source of bacteria and nutrient loading to a water body. Fecal bacteria from wildlife are also deposited onto land surfaces, where it may be washed into nearby streams by rainfall runoff. While several bird and mammal species are likely to contribute bacteria loads in area waterways, feral hogs and whitetail deer are the only species with reasonable density and population estimates for significant bacteria load contribution. The estimated number of deer and feral hogs in the watersheds was estimated by Borel et al. (2015) and is shown in Table 10.

Domestic Pets

Fecal matter from pets can contribute to bacteria loads in the watershed when not picked up and disposed of properly. In rural areas, such as the Mission and Aransas rivers watersheds, pets often spend most their time roaming around outdoors, making proper waste disposal impractical. The estimated number of domestic dogs in the watersheds was estimated by Borel et al. (2015) and is shown in Table 11.

On-Site Sewage Facilities

Given the rural nature of the watershed, many homes are not connected to centralized sewage treatment facilities and therefore use OSSFs. Typical OSSF designs include either (a) anaerobic systems composed of septic tank(s) and an associated drainage or distribution field or (b) aerobic systems with aerated holding tanks and typically an above ground sprinkler system to distribute the effluent. Failing or undersized OSSFs will contribute nutrient and bacteria loads if the effluent from the systems moves through or over the ground into adjacent water bodies.

Table 12. Number of OSSFs by county and soil condition for the combined watersheds of the Mission and Aransas rivers. Source: Adapted from Borel et al. (2015), Table 3, and personal communication with Borel (April 2014).

Soil condition	Failure rate	Total OSSFs by watershed				Total OSSFs by soil condition	Estimated total failing OSSFs
		Aransas Above Tidal	Aransas Tidal	Mission Above Tidal	Mission Tidal		
Very limited	15%	3,515	3,815	2,112	617	10,059	1,509
Somewhat limited	10%	1,364	11	916	-	2,291	229
Not limited	5%	-	-	-	-	-	-
Not rated	15%	4	-	6	-	10	2
Totals		**4,883**	**3,826**	**3,034**	**617**	**12,360**	**1,740**

The USDA NRCS provides suitability ratings for septic tank absorption fields based on soil properties, depth to bedrock or groundwater, hydraulic conductivity, and other properties that may affect the absorption of OSSF effluent, installation, and maintenance. A "not limited" rating indicates soils with features favorable to OSSF use. "Somewhat limited" indicates soils that are moderately favorable, with limitations that can be overcome by design, planning, and installation. "Very limited" indicates soils that are very unfavorable for OSSF use, with expectation of poor performance and high amounts of maintenance. The majority of the soils in the watersheds are rated "very limited" for OSSF use, with small areas rated "somewhat limited" (Figure 4; USDA 2017).

For each of the four major watersheds (Aransas River Above Tidal, Aransas River Tidal, Mission River Above Tidal, and Mission River Tidal), the number of OSSFs was estimated from information in Borel et al. (2015) and personal communications with Borel in April 2014. Table 12 shows the total number of OSSFs, organized by the four major watersheds and the estimated total number of failing OSSFs based on soil limitation class and failure rates. An estimated 1,740 OSSFs may occur in the watershed, as shown in Figure 18. These estimated OSSF locations are based on visually validated county 911 data and areas of existing wastewater service (Borel et al 2015).

Although most well-maintained OSSFs are likely to function properly, failing OSSFs can leak or discharge untreated waste onto distribution fields. Runoff generated during storm events can transport this waste overland and into nearby water bodies. Untreated OSSF effluent can contribute to levels of indicator bacteria and nutrients.

Permitted Discharges

Permitted discharges are sources regulated by permit under the TPDES and the National Pollutant Discharge Elimination System (NPDES) programs. Examples of permitted discharges include WWTF discharges, industrial or construction site stormwater discharges, and discharges from municipal separate storm sewer systems (MS4) of regulated cities or agencies.

WWTFs treat municipal wastewater before discharging the treated effluent into a water body. WWTFs are required to test and report the levels of indicator bacteria and nutrients as a condition of their discharge permit. Plants that exceed their permitted levels may require infrastructure or process improvements to meet the permitted discharge requirements.

As of January 3, 2019, 12 facilities in the Mission and Aransas rivers watersheds treat domestic wastewater; three are in the Mission River watershed and nine are within the more populated Aransas River watershed (Table 13; Figure 19). None of the WWTFs in the watersheds discharge directly into either the impaired Mission or Aransas rivers tidal segments (segments 2001 and 2003). The only WWTF that discharges directly into a mainstem river is the Chase Field WWTF operated by the City of Beeville, which discharges into Aransas River Above Tidal (segment 2004). The Moore Street WWTF, also operated by the City of Beeville, does discharge directly into Poesta Creek (segment 2004B). Discharge for all 12 facilities is measured in millions of gallons per day (MGD).

All of the WWTFs had a history of noncompliance issues during the 12-quarter period (3 years) from October 1, 2015 through September 30, 2018 (EPA 2018). During this period, the following seven facilities reported exceedances in bacteria concentration discharge limits: City of Beeville – Moore Street WWTF, City of Sinton – Main WWTF, Pettus MUD (municipal utility district) WWTF, Skidmore Water Supply Corporation (WSC) WWTF, St. Paul WSC WWTF, Texas Department of Transportation – Sinton Engineering Building WWTF and the Town of Refugio WWTF. None of the bacteria effluent violations were reported as significant noncompliance effluent violations. Compliance status is based on the period of record available through EPA's Integrated Compliance Information System (ICIS) database (EPA 2019), which shows history of facility compliance with NPDES and TPDES permit requirements.

Table 13. Permitted wastewater treatment facilities in the Mission and Aransas rivers watersheds.

Facility name (TPDES[a] permit number)	Receiving stream	Flow (MGD[b])		Bacteria (MPN[c]/100 mL[d])		Number of quarters in violation for exceedance 10/2015–09/2018
		Final permitted	Reported	Mission Above Tidal	Mission Tidal	
City of Beeville – Chase Field WWTF[g] (WQ0010124-004)	Aransas River Above Tidal (2004_01)	2.5	0.4404	126[f]	1.071	1 (1 chlorine min.)
City of Beeville – Moore Street WWTF (WQ0010124-002)	Poesta Creek to Aransas River Above Tidal (2004_01)	3.000	2.1774	126[f]	6.943	3 (3 *E. coli* daily max., 1 whole effluent toxicity, 1 ammonia daily max., 1 chlorine min.)
City of Sinton – Main WWTF (WQ0010055-001)	Chiltipin Creek to Aransas River Tidal (2003_01)	0.8000	0.4560	35[e]	34.53	11 (1 Flow daily avg., 8 *Enterococcus* daily avg., 11 *Enterococcus* daily max., 7 dissolved oxygen (DO) min., 1 ammonia daily max.)
City of Sinton – Rod and Bessie Welder WWTF (WQ0013641-001)	San Patricio County Drainage District to unnamed tributary to Chiltipin Creek to Aransas River Tidal (2003_1)	0.0086	0.0033	126[f]	3.595	5 (2 TSS[h] daily avg., 5 chlorine max.)
City of Taft WWTF (WQ0010705-001)	Taft Drainage Ditch to Mud Flats to Copano Bay (2003_01)	0.9000	0.3511	35[e]	2.274	3 (3 chlorine min., 1 BOD[i] daily avg.)
Pettus MUD[j] WWTF (WQ0010748-001)	Medio Creek to Mission Creek Above Tidal (2002_01)	0.1050	0.0031	126[f]	636.4	3 (1 TSS single grab, 2 TSS daily avg., 1 chlorine min., 2 *E. coli* single grab, 2 *E. coli* daily avg.)
Skidmore WSC WWTF (WQ0014112-001)	Unnamed tributary to Aransas River Above Tidal (2004_01)	0.1310	0.0545	126[f]	74.03	9 (1 pH max., 1 pH min., 8 TSS daily avg., 1 TSS single grab, 1 *E. coli* single grab, 1 *E. coli* daily avg., 2 ammonia daily avg., 2 ammonia single grab, 4 chlorine min., 1 chlorine max., 2 BOD daily avg., 1 BOD single grab, 2 DO min.)
St. Paul WSC WWTF (WQ0014119-001)	Unnamed tributary to Chiltipin Creek to Aransas River Tidal (2003_01)	0.0500	0.0273	126[f]	754.9	7 (3 BOD single grab, 4 BOD daily avg., 6 *E. coli* single grab, 5 *E. coli* daily avg., 3 TSS daily avg., 2 DO monthly min., 1 TSS single grab, Flow daily avg., 1 PCBs annual max.)
Texas Department of Transportation – Sinton Engineering Building WWTF (WQ0013412-001)	Oliver Drainage Ditch to unnamed tributary to Chiltipin Creek to Aransas River Tidal (2003_01)	0.0004	0.0001	126[f]	1.458	6 (1 flow daily avg., 3 *E. coli* single grab, 3 TSS daily avg., 3 TSS single grab)

Facility name (TPDES[a] permit number)	Receiving stream	Flow (MGD[b])		Bacteria (MPN[c]/100 mL[d])		Number of quarters in violation for exceedance 10/2015–09/2018
		Final permitted	Reported	Mission Above Tidal	Mission Tidal	
Town of Woodsboro WWTF (WQ0010156-001)	Ditch to Willow Creek to Sous Creek to Mission River Tidal (2001_01)	0.2500	0.1169	126[f]	1.481	2 (1 TSS daily avg., 1 ammonia daily avg.)
Town of Refugio WWTF (WQ0010255-001)	Dry Creek to Mission River Above Tidal (2002_01)	0.5760	0.3044	126[f]	15.13	12 (6 ammonia daily avg., 8 ammonia daily max., 9 BOD daily avg., 1 pH max., 3 BOD daily max., 3 TSS max., 2 chlorine max., 3 TSS daily avg., 1 chlorine min., 1 flow daily avg., 1 *E. coli* daily avg.)
Tynan WSC[k] WWTF (WQ0014123-001)	Papalote Creek to Aransas River Above Tidal (2004_01)	0.0450	0.0164	126[f]	10.92	0

[a] Texas Pollutant Discharge Elimination System (TPDES)
[b] Million gallons per day (MGD)
[c] Most probable number (MPN)
[d] milliliters (mL)
[e] MPN/100 mL *Enterococcus*
[f] MPN/100 mL *E. coli*
[g] Wastewater Treatment Facility (WWTF)
[h] Total suspended solids (TSS)
[i] Biological oxygen demand (BOD)
[j] Municipal Utility District (MUD)
[k] Water Supply Corporation (WSC)

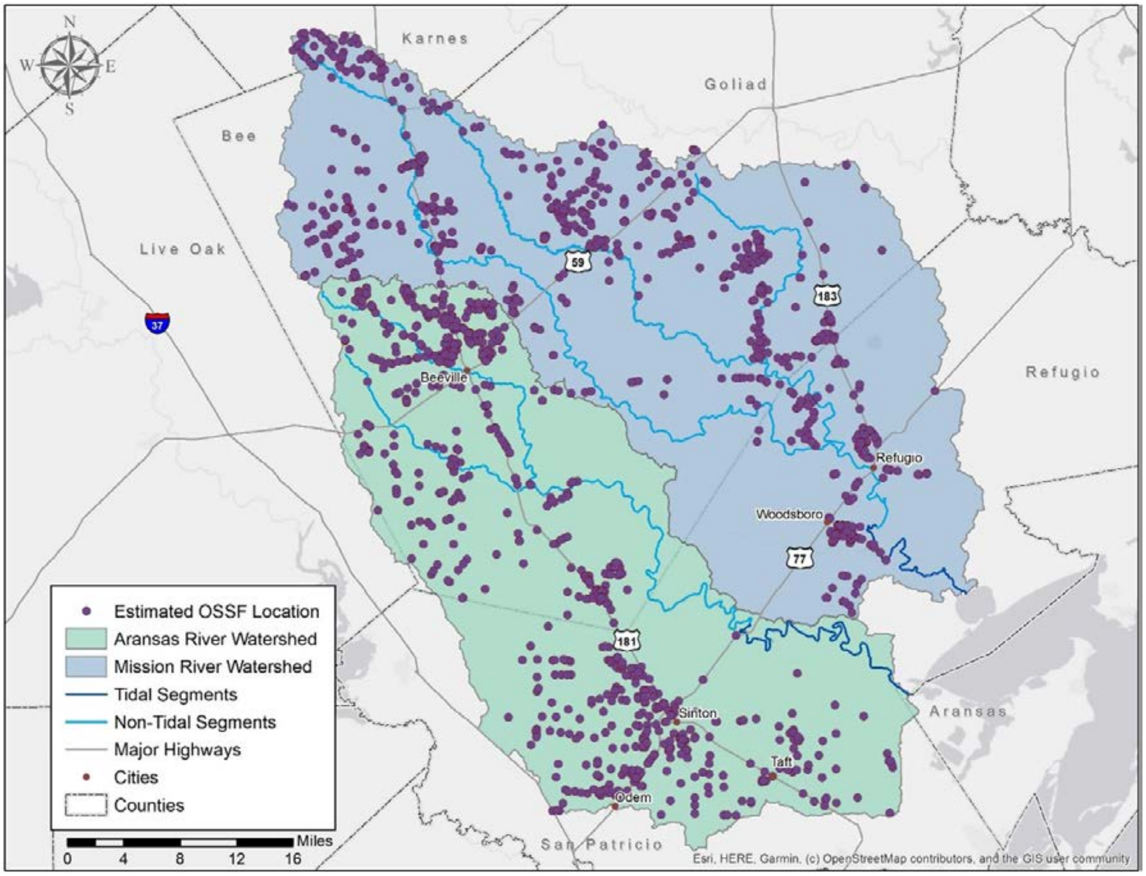


Figure 18. Estimated on-site sewage facility (OSSF) locations.

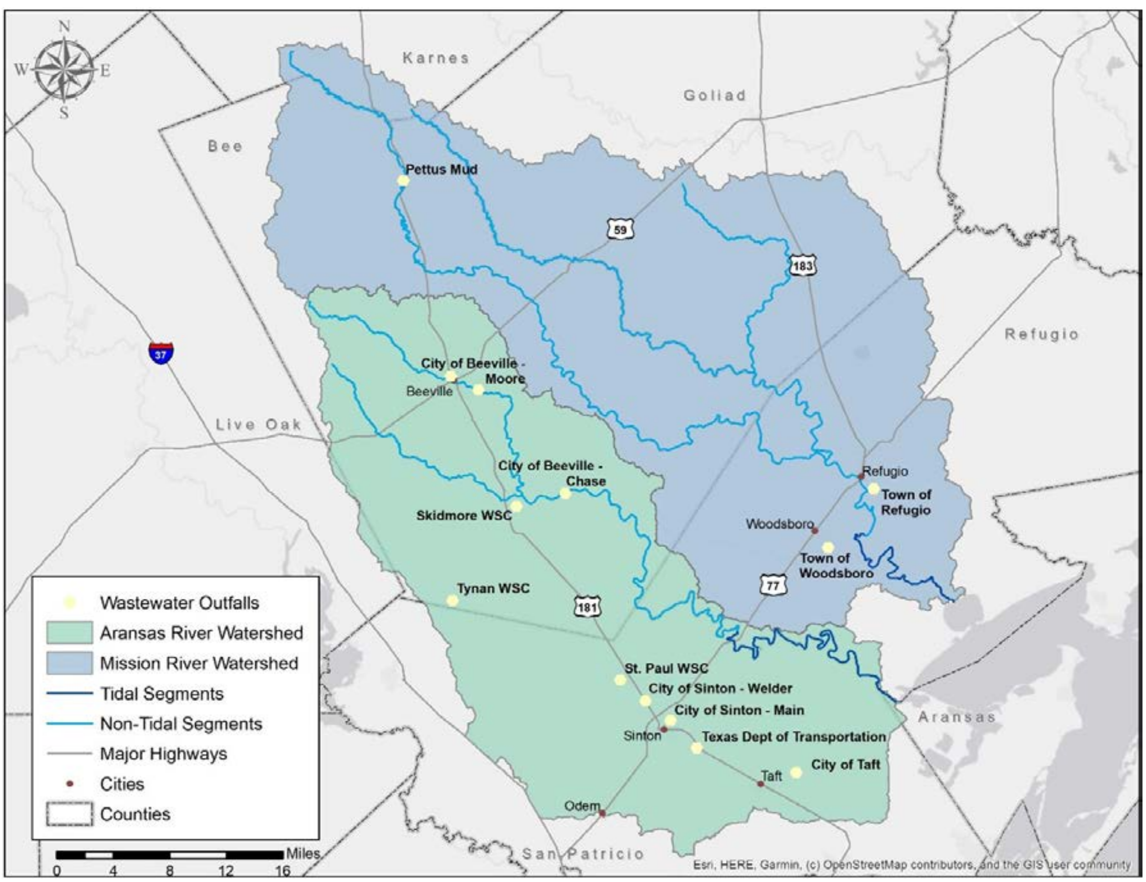


Figure 19. Active permitted wastewater discharge outfall locations.

Table 14. Summary of Enterococci and *E. coli* WWTF effluent data collected by the Nueces River Authority from October 2007 to January 2011.

TPDES[a] permit number	Facility	Enterococci			*E. coli*		
		N	Percent exceeding geometric mean criterion (35 MPN[b]/ 100 mL[c])	Geometric mean (MPN/ 100 mL)	N	Percent exceeding geometric mean criterion (126 MPN/ 100 mL)	Geometric mean (MPN/ 100 mL)
WQ0010124004	City of Beeville – Chase Field WWTF[d]	28	18%	8	28	0%	6
WQ0010124002	City of Beeville – Moore Street WWTF	27	0%	4	27	0%	5
WQ0010055001	City of Sinton – Main WWTF	31	61%	163	34	15%	65
WQ0010705001	City of Taft WWTF	32	6%	2	35	9%	2
WQ0010748001	Pettus MUD[e] WWTF	27	22%	7	27	22%	6
WQ0014112001	Skidmore WSC WWTF	27	7%	2	28	0%	2
WQ0014119001	St. Paul WSC[f] WWTF	31	68%	439	34	74%	419
WQ0010255001	Town of Refugio WWTF	31	23%	8	34	15%	6
WQ0010156001	Town of Woodsboro WWTF	28	0%	2	31	0%	2
WQ0014123001	Tynan WSC WWTF	24	29%	29	24	21%	31

[a] Texas Pollutant Discharge Elimination System
[b] Most probable number (MPN)
[c] milliliters (mL)
[d] Wastewater Treatment Facility (WWTF)
[e] Municipal Utility District (MUD)
[f] Water Supply Corporation (WSC)

Table 15. Sanitary sewer overflow incidents reported in the Mission and Aransas rivers watersheds August 2009–December 2018.

Facility name	Discharge date(s)	Duration (hours-minutes)	Volume (gallons)	Cause	Segment
Pettus MUD[a] WWTF[b]	Intermittent from at least 1/5/2011 thru 3/7/2011	Unknown	Unknown	Clogged rags/grease	2002
	5/16/2012	Unknown	Unknown	Power outage	2002
Town of Refugio WWTF	6/29/2009, 7/2/2009, and 7/8/2009	Unknown	Unknown	Concrete obstruction in the main line	2002
	8/23/2009	Unknown	Unknown	Unknown	2002
	4/16/2012	0-1	Less than 1	Inflow and infiltration (I&I)	2002
	2/6/2013c	1-15	2,000	I&I	2002
	2/6/2013c	2-0	5,000	I&I	2002
	4/21/2014	26-30	100,000	I&I	2002
	10/8/2015	2-0	6,000	Gas contractor damaged	2002
	6/4/2016	16-0	10,000	Unknown	2002
	6/20/2018	5-0	Unknown	I&I	2002
City of Sinton - Main WWTF	9/11/2009	43-45	28,200	I&I	2003
	5/21/2015	9-45	5,000	I&I	2003
	5/16/2016	8-0	50	I&I	2003
	9/16/2018[c]	Unknown	400	I&I	2003
	9/16/2018[c]	Unknown	800	I&I	2003
	9/16/2018[c]	Unknown	1,500	I&I	2003
	9/16/2018[c]	Unknown	3,000	I&I	2003
	9/16/2018[c]	Unknown	200	I&I	2003
	9/16/2018[c]	Unknown	300	I&I	2003
City of Taft WWTF	9/16/2009	0-20	5,000-8,000	Line break	2003
	11/20/2009	8-45	Unknown	I&I	2003
	4/10/2010	Unknown	500	Line break	2003
	9/21/2010	Unknown	Unknown	I&I	2003
	5/27/2014	8-0	2,300	Auxiliary pump connection failure	2003

City of Beeville – Chase Field WWTF	3/18/2013	8-30	200,000	Breakers tripped due to lizard getting electrocuted at control box	2004
	9/30/2013	23-0	Unknown	Plugged chlorination lines	2004
	5/13/2014	12-0	2,000	Electrical malfunction	2004
	9/27/2015	1-30	10,000	Surge overload, pump tripped	2004
	8/26/2017	17-0	150	Power failure due to Hurricane Harvey	2004
City of Beeville – Moore Street WWTF	10/17/2013	14-0	350	Aging infrastructure, and corrosion caused a vacuum relief valve to fail	2004B
	2/25/2014	57-0	1,000-2,000	Aging infrastructure and expansion and contraction of surrounding soil	2004B
	3/12/2014	28-0	1,000-2,000	Split pipe underneath concrete retaining wall	2004B
	3/13/2014	23-30	10,000	Grease buildup caused a sewer main blockage	2004B
	10/4/2014	9-0	1,000-2,000	Aging infrastructure and expansion and contraction of the surrounding soil	2004B
	4/19/2015	0-40	8,000	Blown control power fuse	2004B
	5/13/2015	9-0	40,000	I&I	2004B
	9/20/2016	4-23	50,000	Cracked wastewater line	2004B
	12/26/2016	6-0	48,000	Backup/blockage in main line	2004B
	12/27/2016	6-45	93,750	Blockage in main line	2004B
	2/10/2017	3-25	95,000	Power surge caused pump failure	2004B
	8/26/2017	12-25	150	Power failure due to Hurricane Harvey	2004B
	6/7/2018	1-0	10,000	Blockage in main line	2004B
	6/19/2018	Unknown	20,000	I&I	2004B
	9/27/2018	0-1	2,500	I&I	2004B
	10/15/2018	0-45	1,350	I&I	2004B
	10/16/2018	0-1	10,000	I&I	2004B
Town of Woodsboro WWTF	6/21/2016	2-0	900	Faulty electrical lines	2001
	9/18/2016	Unknown	800	Clogged pumps	2001
	9/20/2016	0-30	10	Torn gasket	2001
	11/5/2018	1-30	900	Trash making pumps trip	2001

[a] Municipal Utility District (MUD)
[b] Wastewater Treatment Facility (WWTF)
[c] Separate events on the same day

Bacteria data were collected under a special study by NRA. NRA sampled 14 stream sites and 12 WWTFs over a period from October 2007 to January 2011 (Rocky Freund, NRA, personal communication, 16 Sept 2013). A summary of bacteria sampling data collected at the 10 WWTF outfalls that were located within the Mission and Aransas rivers watersheds is presented in Table 14. The City of Odem and the City of Bayside outfalls are both outside of the subject watersheds, and therefore were not included in the Table 13. The data indicate that most WWTFs were providing disinfected effluent with indicator bacteria levels below state instream indicator bacteria criteria, though the data show that two facilities (City of Sinton – Main and St. Paul WSC) exceeded the criteria for one or both indicator bacteria more than 50% of the time. Note that TCEQ completed a total maximum daily load (TMDL) for bacteria in the tidal segments of the Mission and Aransas rivers in 2016 and a TMDL addendum for bacteria in Aransas River Above Tidal and Poesta Creek in 2017. Any point source issues will be addressed through the implementation of regulatory mechanisms.

Although stormwater is generally considered a nonpoint source, stormwater is subject to regulation if it originates from a regulated MS4 or is associated with industrial and/or construction activities. MS4 permits refer to the permitting of municipal stormwater systems that are separate from sanitary sewer systems. Systems are broken down into large Phase I and small Phase II permits based on population. Further details on MS4 permitting requirements are available on TCEQ's Stormwater Permits for Municipal Separate Storm Sewer Systems webpage: https://www.tceq.texas.gov/permitting/stormwater/ms4. TPDES general permits cover stormwater discharges from Phase II urbanized areas, industrial facilities, and construction sites over 1 ac (TCEQ 2019a). These urban and industrial stormwater sources may contain elevated levels of bacteria or nutrients as they wash accumulated materials from roads, parking lots, buildings, parks, and other developed areas. Potential pollutants can be managed from these sites through stormwater best management practices (BMPs), including structures such as detention ponds, riparian buffers, pervious pavement, and low impact design.

A review of active stormwater general permits coverage in the Mission River watershed, as of February 12, 2019, found six active industrial facilities and three active construction sites. A review of the active stormwater general permits coverage in the Aransas River watershed, as of February 12, 2019, found five active industrial facilities, two active construction sites, and one active concrete production facility. There are no MS4s or petroleum bulk stations and terminals facilities in either watershed. Based on the 2011 NLCD, only 80 square miles out of the 1,029 square mile Mission River watershed and 102 square miles out of the 843 square mile Aransas River watershed are urbanized or developed. Therefore, contributions to surface water impairments from regulated stormwater and urbanized development are assumed to be small based on the relatively low amount of stormwater permits and developed land.

Unauthorized Discharges

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. SSOs 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 SSOs under conditions of high flow in the WWTF system. Blockages in the line may exacerbate the I&I problem. Other causes, such as a collapsed sewer line, may occur under any condition. The TCEQ Region 14 office maintains a database of SSO data reported by municipalities. These SSO data typically contain estimates of the total gallons spilled, responsible entity, and a general location of the spill. The reports of SSO events that occurred within the watersheds of the Mission and Aransas rivers between August 2009 and December 2018 are shown in Table 15. There were 51 separate incidences reported for four different facilities. The reported data indicate that the SSOs occurred year-round, and that the durations lasted from 1 minute to 57 hours, and overflow volumes ranged from less than 1 gallon (gal) to 200,000 gal.

Table 16. Summary of potential bacteria sources contributing to the Mission and Aransas rivers impairments.

Pollutant source	Pollutant type	Potential cause	Potential impact
Livestock	Bacteria	- Runoff from pastures - Overgrazing - Manure transport to streams - Direct deposition into streams	Fecal material and bacteria directly deposited into stream or through runoff
Wildlife	Bacteria	- Manure transport to streams - Direct deposition into streams - Riparian degradation	Fecal material and bacteria directly deposited into stream or through runoff
OSSFs	Bacteria	- System failure - Improper design	Insufficiently or untreated water runoff to streams
Urban stormwater and domestic pets	Bacteria	- Increased runoff from impervious surface - Improper disposal of pet waste	Increased velocity and volume of stormwater quickly transport bacteria laden water to streams
Permitted dischargers/SSOs	Bacteria	- Inflow and infiltration - Overloaded or aging infrastructure	Untreated waste enters water body

Illicit Discharges

The term "illicit discharge" refers to an unauthorized release of pollutants either because it is not allowed by law, or because the release requires authorization from a permitting entity. Illicit discharges can be categorized as either direct or indirect. Bacteria loads can enter the streams from permitted stormwater outfalls or illicit discharges, under both dry and wet weather conditions. Examples of illicit discharges can be found in the Illicit Discharge Detection and Elimination Manual: A Handbook for Municipalities (NEIWPCC 2003) and include the following:

Examples of direct illicit discharges include:

- 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; and
- a cross-connection between the sanitary sewer and storm sewer systems.

Examples of indirect illicit discharges include:

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

Water Quality Summary

The Mission and Aransas rivers watersheds are predominantly rural, characterized by a vital agricultural community. Therefore, a significant portion of the watershed has been utilized for cropland, pasture, or grazing. The population of the watersheds are mostly concentrated in the small municipalities of Beeville, Odem, Refugio, Sinton, Taft, and Woodsboro and are projected to increase by small proportions over the next 50 years.

The primary water quality concerns are bacteria impairments in the tidal segments of the Mission and Aransas rivers, Poesta Creek, and Aransas River Above Tidal. Potential contributors to the bacteria impairments likely include some combination of managed livestock/cattle; unmanaged wildlife/feral hogs; failing OSSFs; stormwater runoff from urban areas and impervious surfaces (including contributions from household pets); and permitted discharges and SSOs (Table 16).

Chapter 4
Pollutant Source Assessment

Introduction

Water quality sampling, described in Chapter 3, established that the primary water quality concern in the Mission and Aransas rivers watersheds is excessive bacteria. The current water quality standard established by TCEQ for primary contact recreation is 126 MPN/100 mL for *E. coli* and 35 MPN/100 mL for Enterococci. The 2014 Texas Integrated Report lists Mission River Tidal (AU 2001_01) as impaired with a geometric mean of 71 MPN/100 mL Enterococci and Aransas River Tidal (AU 2003_01) as impaired with a geometric mean of 64 MPN/100 mL Enterococci. Aransas River Above Tidal is listed as impaired as well having a geometric mean of 166 MPN/100 mL *E. coli*. Poesta Creek (AU 2004B_01) was also listed as impaired in the 2014 Texas Integrated Report and 303(d) List as having a geometric mean of 310 MPN/100 mL *E. coli*.

In order to calculate the reductions needed to meet primary contact recreation standards, the bacteria loadings of Mission River Tidal and Aransas River Tidal were calculated. The bacteria loads for Mission River Tidal and Aransas River Tidal were calculated using water quality samples and a modified load duration curve (LDC) method. By taking the difference between the existing load and the relevant criterion, this WPP estimates the needed reductions to meet water quality standards. Bacteria loads were also calculated for Aransas River Above Tidal and Poesta Creek using a traditional LDC method.

Furthermore, this chapter estimates the relative load contributions from different potential fecal bacteria sources. A geographic information systems (GIS) analysis, which combined the best available data with stakeholder knowledge, provided relative load contribution estimates. By estimating the relative potential contribution of different fecal bacteria sources across the watershed, areas can be prioritized as to when and where management measures should occur. The number of measures needed to reach water quality goals can also be estimated.

Source and Load Determination

Modified Load Duration Curves

A modified LDC method was used to examine the relationship between instream water quality and the source of indicator bacteria loads for the tidal segments in the watersheds. LDCs are graphs of the frequency distribution of loads of pollutants in a stream. LDCs were used to determine the allowable load. Measured bacteria data was used to determine existing loads.

For the Mission and Aransas tidal segments, the loads shown are of Enterococci bacteria in MPN/day. LDCs are derived from flow duration curves (FDCs), which are graphs of the frequency distribution of flow in a stream. LDCs for the Mission and Aransas rivers watersheds represent the maximum acceptable load in the streams that will result in achievement of the water quality target. The Oregon Department of Environmental Quality (ODEQ) developed the modified LDC method for tidal streams of the Umpqua River Basin (ODEQ 2006) that was applied to Mission River Tidal (segment 2001) and Aransas River Tidal (segment 2003).

The modified LDC method assumes that combining of river water with seawater increases the loading capacity in the tidal river (through dilution) because seawater typically contains lower concentrations of indicator bacteria, such as Enterococci, than river water. The assumption of decreasing concentrations of Enterococci with distance from the tidal segments of the Mission and Aransas River into Copano Bay is borne out in the historical data.

The weaknesses of the LDC method include the limited information it provides regarding the magnitude or specific origin of the various sources. Only limited information is gathered regarding point and nonpoint sources in the watershed. The general difficulty in analyzing and characterizing Enterococci in the environment is also a weakness of this method.

Data requirements for the modified LDC method are minimal, consisting of continuous daily streamflow records and both historical bacteria and salinity data. A 15-year period of record from January 1, 1998 through December 31, 2012 was selected for LDC development, and this period included all available Enterococci data at the time of the study. A 15-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.

Modified LDCs were constructed for the most downstream monitoring station within Mission River Tidal (station 12943) and Aransas River Tidal (station 12947). The most downstream SWQM stations were selected because these locations encompass more of the drainage area of each watershed and are representative of conditions in a greater area of each watershed than stations located farther upstream.

On numerous creeks and rivers in Texas, USGS streamflow gauging stations have been in operation for a sufficient period to provide long-term streamflow records. The USGS streamflow gages used for LDC development and the area of application are:

- USGS gaging station 08189500 (Mission River at Refugio, Texas) applied to develop the freshwater flows for Mission River Tidal station 12943; and
- USGS gaging station 08189700 (Aransas River near Skidmore, Texas) applied to develop the freshwater flows for Aransas River Tidal station 12947.

Information on the modified LDC method is provided in the Technical Support Document for Total Maximum Daily Loads for Indicator Bacteria in the Watersheds of the Mission and Aransas Rivers (Painter and Hauck 2013).

For both the Mission and Aransas rivers watersheds, the historical Enterococci data indicate that elevated bacteria loadings occur under all flow conditions but become most elevated under the highest flows and are often below the geometric mean criterion under the lowest flows (Figure 20; Figure 21). Regulated stormwater comprises only a very small portion of the watershed (0.06% for the Mission River watershed and 0.04% for the Aransas River watershed) and is therefore considered only a minor contributor. Unregulated stormwater most likely comprises the majority of high-flow related loadings.

The elevated Enterococci loadings under the lower flow conditions cannot be reasonably attributed exclusively to WWTFs because the outfalls are typically located at significant distances from the SWQM stations. Therefore, other sources of bacteria loadings under lower flows and in the absence of overland flow contributions (i.e., without stormwater contribution) are most likely contributing bacteria directly to surface water. Bacteria loading under lower flows could occur through direct deposition of fecal material from wildlife, feral hogs, and livestock. The actual contribution of bacteria loadings attributable to these direct sources of fecal material deposition cannot be determined using LDCs.

Traditional Load Duration Curves

Traditional LDCs have a similar methodology to modified LDCs except they do not consider salinity. FDCs for Aransas River Above Tidal and Poesta Creek were calculated using USGS gage 08189700 (Aransas River near Skidmore, Texas), and a 15-year period of record from August 2001 through August 2016 was selected for LDC development. This period of record was selected to capture a reasonable range of extreme high and low streamflow and represents a period in which all the *E. coli* data were collected.

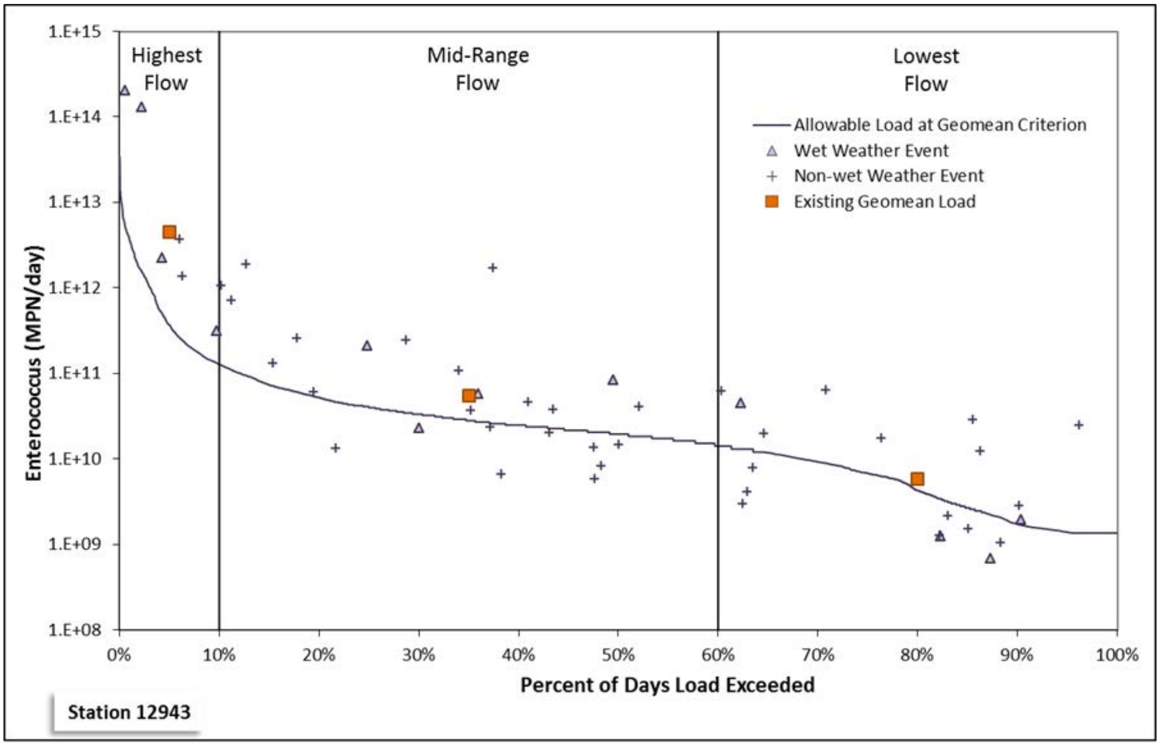


Figure 20. Load duration curve for Mission River Tidal surface water quality monitoring station 12943.

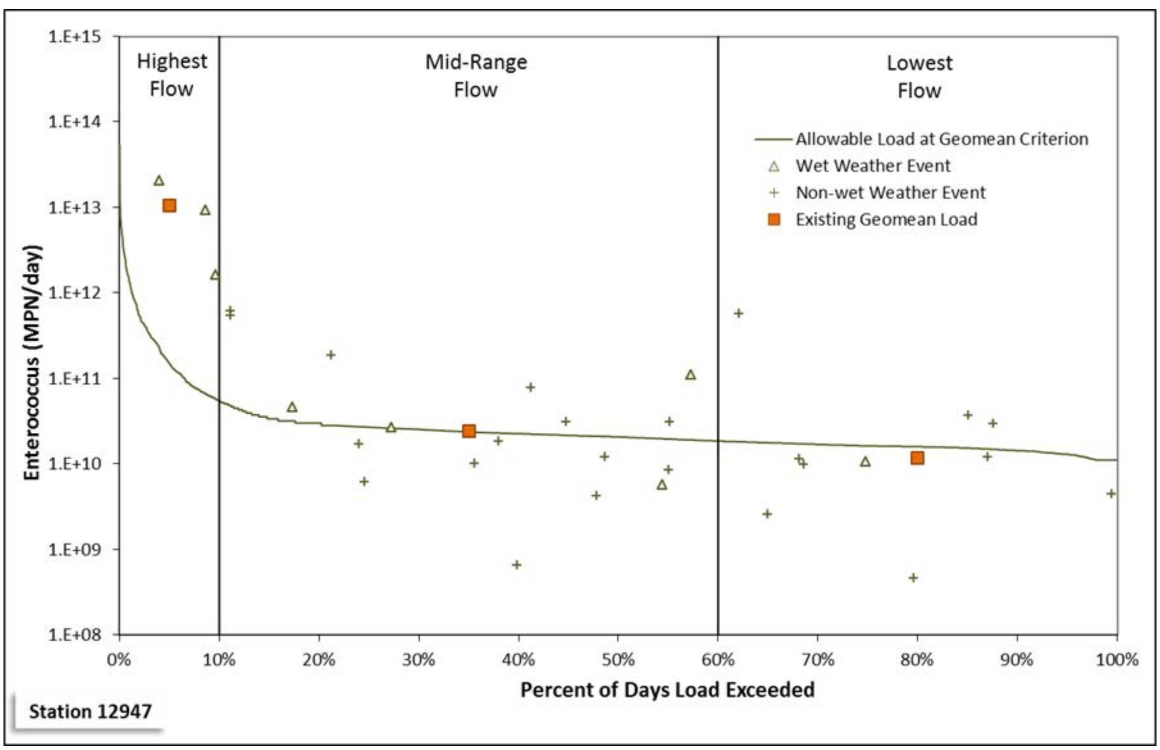


Figure 21. Load duration curve for Aransas River Tidal surface water quality monitoring station 12947.

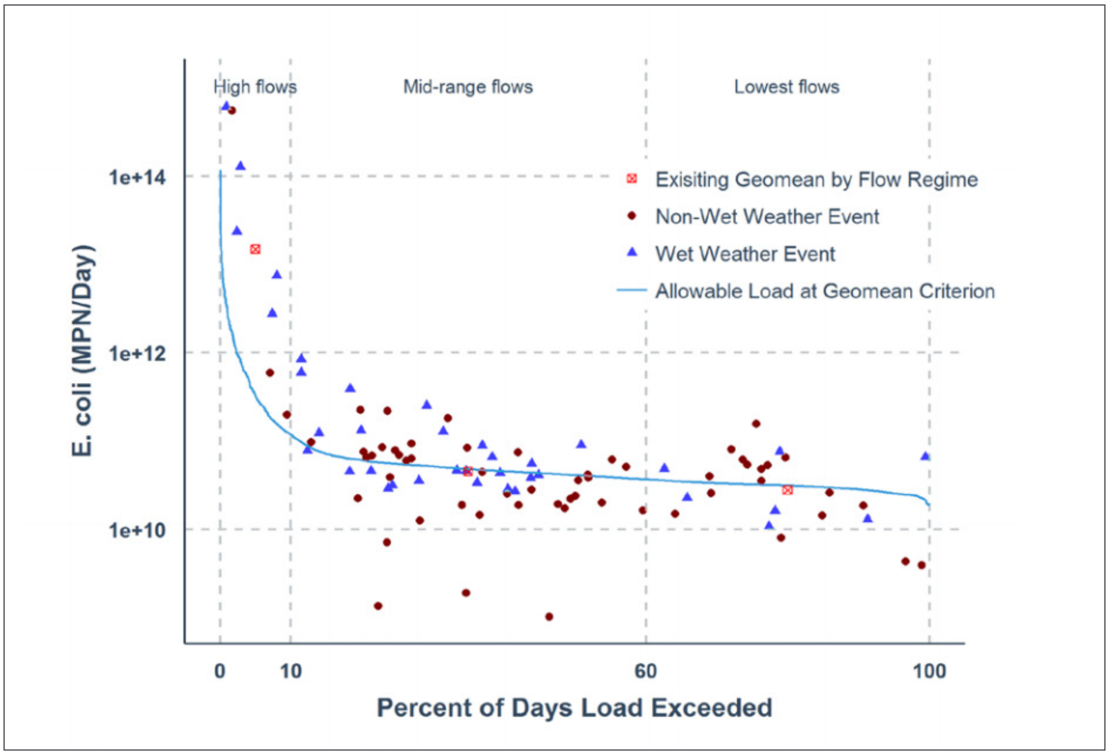


Figure 22. Load duration curve for Aransas River Above Tidal surface water quality monitoring station 12952.

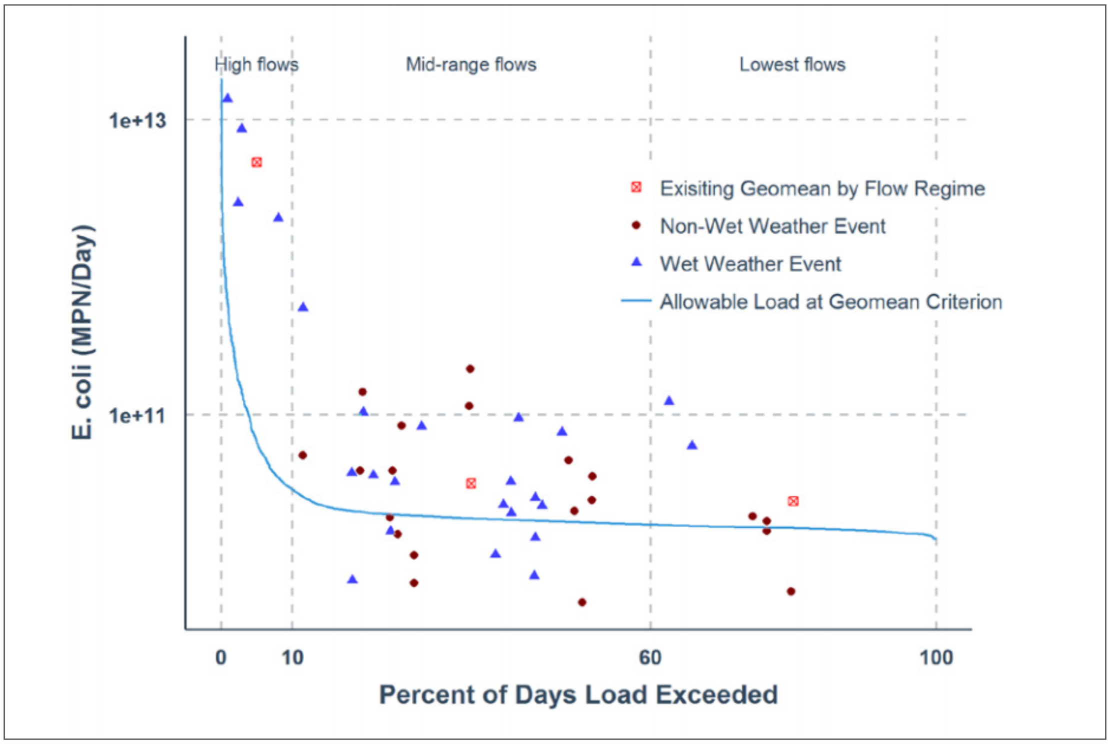


Figure 23. Load duration curve for Poesta Creek surface water quality Monitoring station 12932.

Table 17. Estimated daily loads and daily reductions required to meet primary contact water quality criteria as determined by load duration curve analysis for stations 12952 and 12932.

Flow condition	Percent days flow exceeded	Existing daily load (cfu[a]/day)	Allowable daily load (cfu/day)	Reduction needed (%)	Daily load reduction required
Station 12952 (Aransas River Above Tidal)					
High flows	0-10	9.79×10^{12}	3.19×10^{11}	97%	9.46×10^{12}
Mid-range flows	10-60	4.21×10^{10}	4.78×10^{10}	0%	0
Low flows	60-100	2.83×10^{10}	3.13×10^{10}	0%	0
Station 12932 (Poesta Creek)					
High flows	0-10	2.14×10^{12}	6.39×10^{10}	97%	2.07×10^{12}
Mid-range flows	10-60	3.28×10^{10}	1.97×10^{10}	40%	1.31×10^{10}
Low flows	60-100	2.53×10^{10}	1.70×10^{10}	33%	8.36×10^{9}

[a] colony forming units (cfu)

For Aransas River Above Tidal (AU 2004_02), *E. coli* loading exceedances occur frequently at high flows and are generally below or near the loading criterion at mid-range and low flows (Figure 22). However, elevated loadings occur under all flow conditions for the Poesta Creek (AU 2004B_02) watershed (Figure 23). Like the tidal segments, elevated loadings in Poesta Creek (AU 2004B_02) at low and median flow conditions cannot be attributed exclusively to WWTFs due to the WWTF outfall location occurring downstream of the SWQM sampling station. Once again, other sources of bacteria loadings under lower flow conditions in the absence of overland flow contributions (i.e., without stormwater contribution) are most likely to contribute bacteria directly to the water.

Modified LDCs were computed for SWQM stations in the impaired tidal segments, and load reduction values were calculated. Based on the modified LDCs for the tidal segments, a total reduction of 2.29×10^{15} colony forming units (cfu) per year is required at Mission River Tidal SWQM station 12943 and a total reduction of 2.19×10^{15} cfu/year is required at Aransas River Tidal SWQM station 12947 to reach primary contact recreation standards. The LDCs also indicated that nonpoint source pollution is an important contributor to elevated bacteria levels, while direct deposition or point source may also be contributing to elevated *Enterococcus* levels at lower flows.

A total reduction of 3.46×10^{14} cfu/year is required at Aransas River Above Tidal SWQM station 12952, and a total reduction of 7.93×10^{13} cfu/year is required at Poesta Creek SWQM station 12932. The largest reductions are needed during higher flows and under wet conditions where nonpoint source contribution of bacteria is a primary concern. Elevated loads at low flows indicate a continued need to address potential sources of direct deposition or other sources that may contribute loadings under low flow conditions.

Figure 22 presents the estimated daily loads and daily reductions needed under each flow category to achieve primary contact recreation water quality standards for stations 12952 and 12932. Figure 23 provides the estimated total annual loads and total required load reductions to achieve primary contact recreation standards for those stations. To establish this numeric target for total annual load reduction, the needed daily load reduction for each flow category was multiplied by the number of days per year within each respective flow category and then added together to yield a total annual load reduction.

The estimated loads and load reductions for stations 12943 and 12947 were calculated using a different method due to the modified LDCs. The total estimated load values for these stations were calculated by integrating all the historically observed data at each station (Table 17 and Table 18). Through integration, an existing load area under the observed data points was determined. The needed reduction for both stations was calculated by taking the difference between the existing load area and the area under the allowable load curve. The total estimated load for Mission River Tidal station 12943 was 2.35×10^{15} cfu/year and 2.22×10^{15} cfu/year for station 12947 on Aransas River Tidal.

Pollutant Source Load Estimates

GIS Analysis

To aid in identifying potential areas of *E. coli* and *Enterococcus* contributions within the watershed, a GIS analysis was applied using the methodology employed by the Spatially Explicit Load Enrichment Calculation Tool (SELECT; Borel et al. 2012). The best available information and stakeholder input were utilized to identify likely nonpoint sources of bacteria and calculate potential loadings.

Table 18. Estimated annual load reductions required to meet primary contact water quality criteria for stations 12952 and 12932.

Flow condition	Percent days flow exceeded	Existing annual load (cfu[a]/year)	Allowable annual load (cfu/year)	Reduction needed (%)	Annual load reduction required
Station 12952 (Aransas River Above Tidal)					
High flows	0-10	3.57×10^{14}	1.17×10^{13}	97%	3.46×10^{14}
Mid-range flows	10-60	7.68×10^{12}	8.72×10^{12}	0%	0
Low flows	60-100	4.14×10^{12}	4.57×10^{12}	0%	0
Station 12932 (Poesta Creek)					
High flows	0-10	7.80×10^{13}	2.33×10^{12}	97%	7.57×10^{13}
Mid-range flows	10-60	5.99×10^{12}	3.60×10^{12}	40%	5.98×10^{12}
Low flows	60-100	3.70×10^{12}	2.48×10^{12}	33%	3.68×10^{12}

[a] colony forming units (cfu)

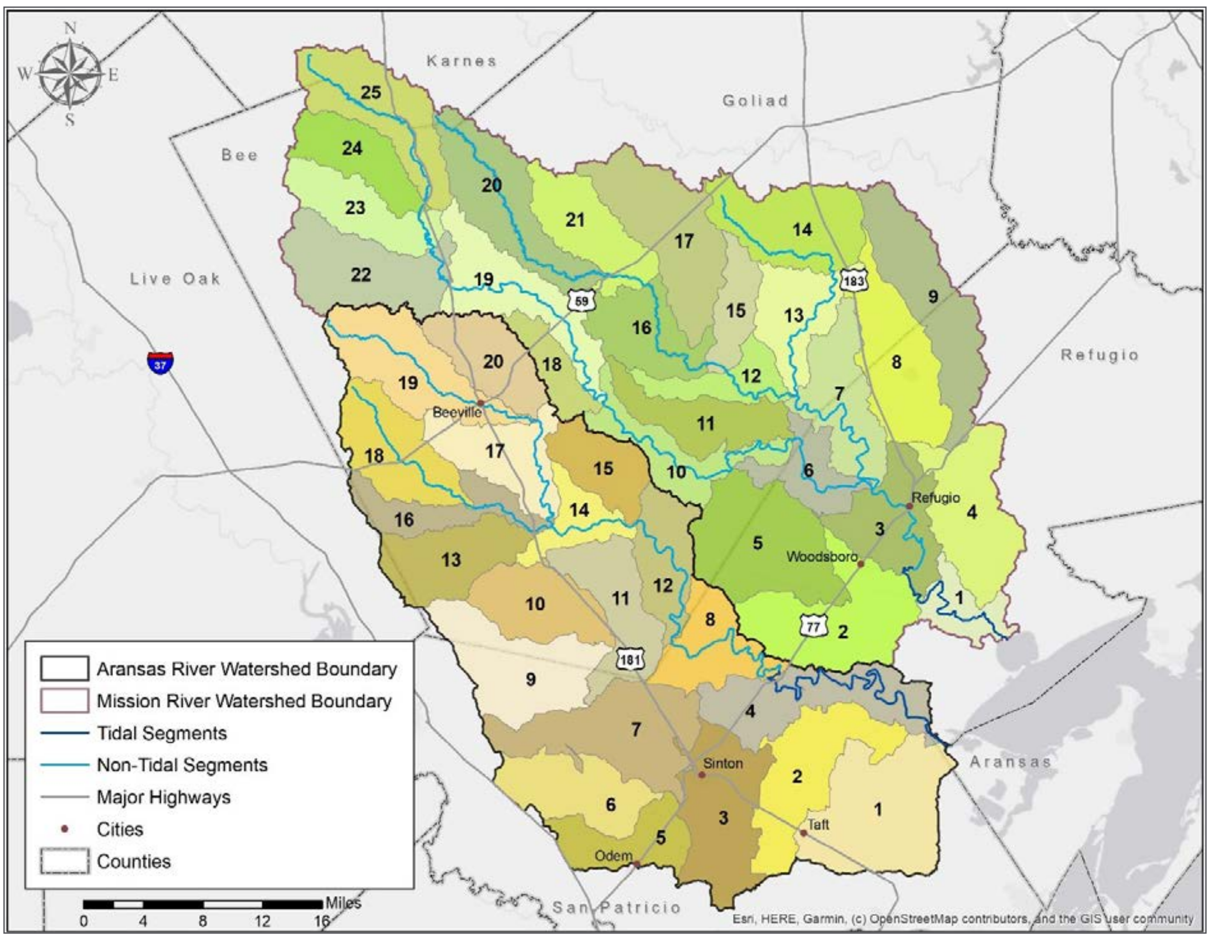


Figure 24. Subwatersheds for the Mission and Aransas rivers watersheds.

Using this GIS analysis approach, the relative potential for *E. coli* and *Enterococcus* loading from each source can be compared and used to prioritize management. The loading estimates for each source are potential loading estimates that do not account for bacteria fate and transport processes that occur between the points where they originate and where they enter the water body, if at all. As such, these analyses represent worst-case scenarios rather than the actual bacteria loadings expected to enter the creek. Potential loads for identified sources are summarized for each of the 25 subwatersheds found in the Mission River watershed and 20 subwatersheds found in the Aransas River watershed (Figure 24). This approach allows prioritization of management measures (Chapter 5) in subwatersheds with the highest potential for bacteria loadings.

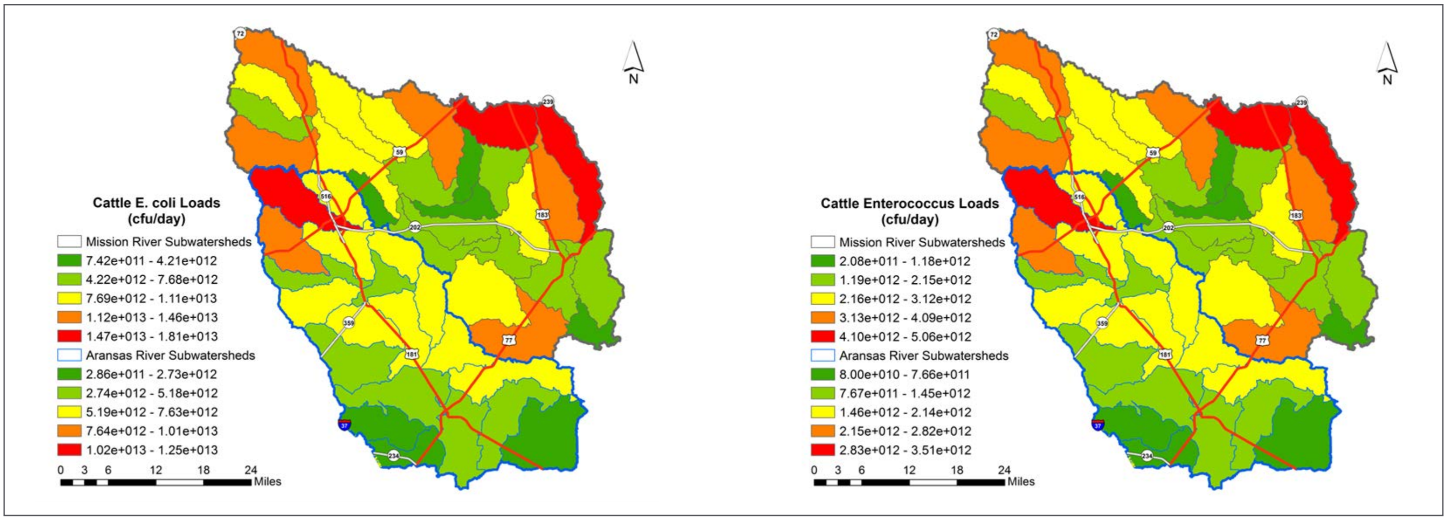


Figure 25. Potential *E. coli* and *Enterococcus* loads resulting from cattle for the Mission and Aransas rivers watersheds.

Livestock: Cattle

Cattle were uniformly applied according to four separate stocking rates derived from 2004 to 2008 Texas Agricultural Statistics and NRCS estimates from Wagner and Moench (2009). The four stocking rates were: 20 ac per animal unit for the land use classifications deciduous forest, evergreen forest, and mixed forest; 30 ac per animal unit for the shrub/scrub land use classification; 15.4 ac per animal unit for the land use classification grasslands/herbaceous; and 7.7 ac per animal unit for the pasture/hay classification. A total of 3,152 animal units were evenly distributed to all of the forested lands. 13,153 animal units of cattle were uniformly applied over shrub/scrub classifications. 3,148 animal units were evenly distributed over grassland/herbaceous land use classifications and 40,052 animal units were distributed over pasture/hay lands. The total cattle potential loads were estimated by adding together the results from the four separate stocking rate distributions. A fecal coliform production rate of 8.55 x 10^9 cfu per animal per day (Wagner and Moench 2009) was used in the model and converted from fecal coliform to *E. coli* using a conversion of 0.63. The total potential *E. coli* and *Enterococcus* loads for cattle (Figure 25) were estimated using the distributed cattle density production rate, fecal coliform production rate, and conversion factors.

Livestock: Horses

A total of 2,772 animal units of horses were evenly distributed over developed, open space, grassland/herbaceous, and pasture/hay. This number was derived from the 2007 USDA Census of Agriculture's county estimates multiplied by the percentage of the county in the watershed and the animal unit conversion of 1.25. The fecal coliform production rate used in the model was 2.91 x 10^8 cfu per animal per day (Wagner and Moench 2009) and converted from fecal coliform to *E. coli* using a conversion of 0.63. The total potential *E. coli* and *Enterococcus* loads for horses (Figure 26) were estimated using the distributed horse density, fecal coliform production rate, and conversion factors.

Livestock: Goats

565 animal units of goats were evenly distributed over developed, open space, shrub/scrub grassland/herbaceous, and pasture/hay. Wagner and Moench (2009) estimated the goat numbers by using the 2005–2008 Texas Agricultural Statistics for Bee, Goliad, and Karnes counties and district numbers for Aransas, Refugio, and San Patricio counties. The numbers were updated from Wagner and Moench (2009) by using an adjusted percent in watershed number because the watershed boundary differed from the original report. The fecal coliform production rate used in the model was 2.54 x 10^{10} cfu per animal per day (Wagner and Moench 2009) and converted from fecal coliform to *E. coli* using a conversion of 0.63. The total potential *E. coli* and *Enterococcus* loads for horses (Figure 27) were estimated using the distributed goat density, fecal coliform production rate, and conversion factors.

Livestock: Sheep

A total of 111 animal units of sheep were evenly distributed over developed, open space, shrub/scrub, grassland/herbaceous, and pasture/hay. This number was derived from the 2007 USDA Census of Agriculture's county estimates multiplied by the percentage of the county in the watershed and the animal unit conversion of 0.2. The fecal coliform production rate used in the model was 2.90 x 10^{11} cfu per animal per day (Wagner and Monch 2009) and converted from fecal coliform to *E. coli* using a conversion of 0.63. The total potential *E. coli* and *Enterococcus* loads for sheep (Figure 28) were estimated using the distributed sheep density, fecal coliform production rate, and conversion factors.

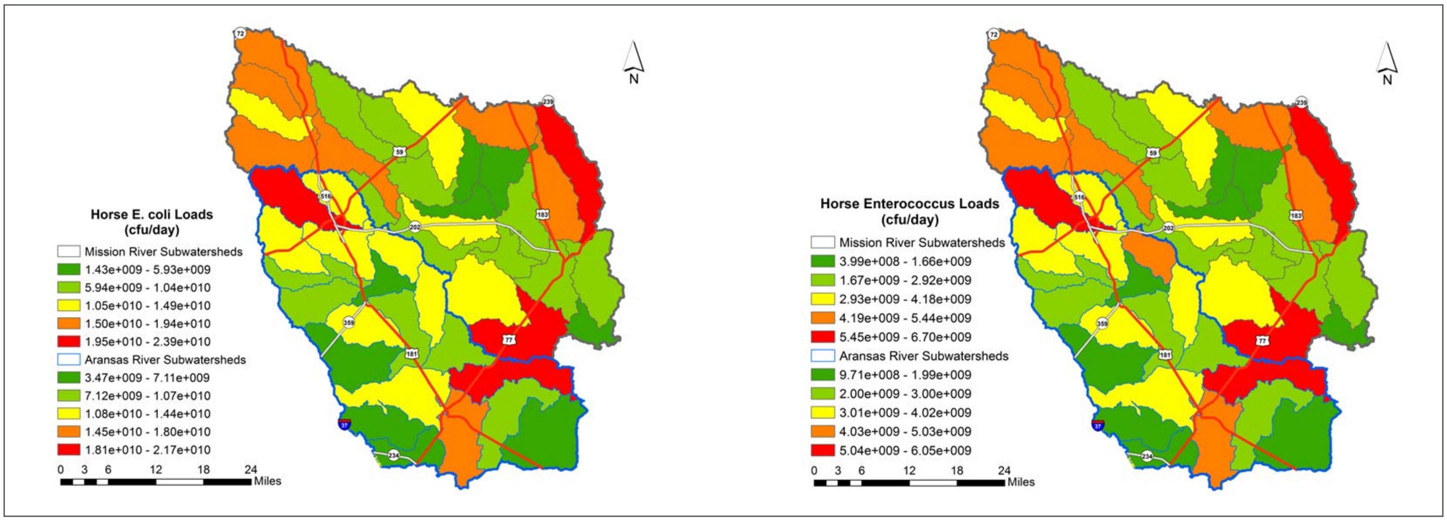


Figure 26. Potential *E. coli* and *Enterococcus* loads resulting from horses for the Mission and Aransas rivers watersheds.

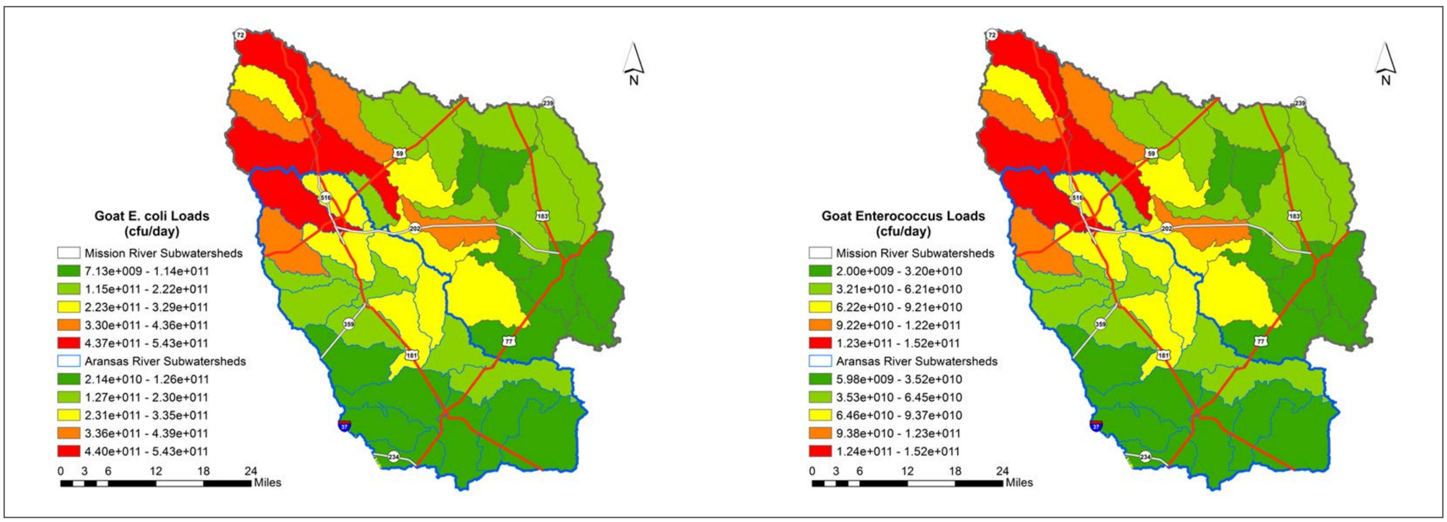


Figure 27. Potential *E. coli* and *Enterococcus* loads resulting from goats for the Mission and Aransas rivers watersheds.

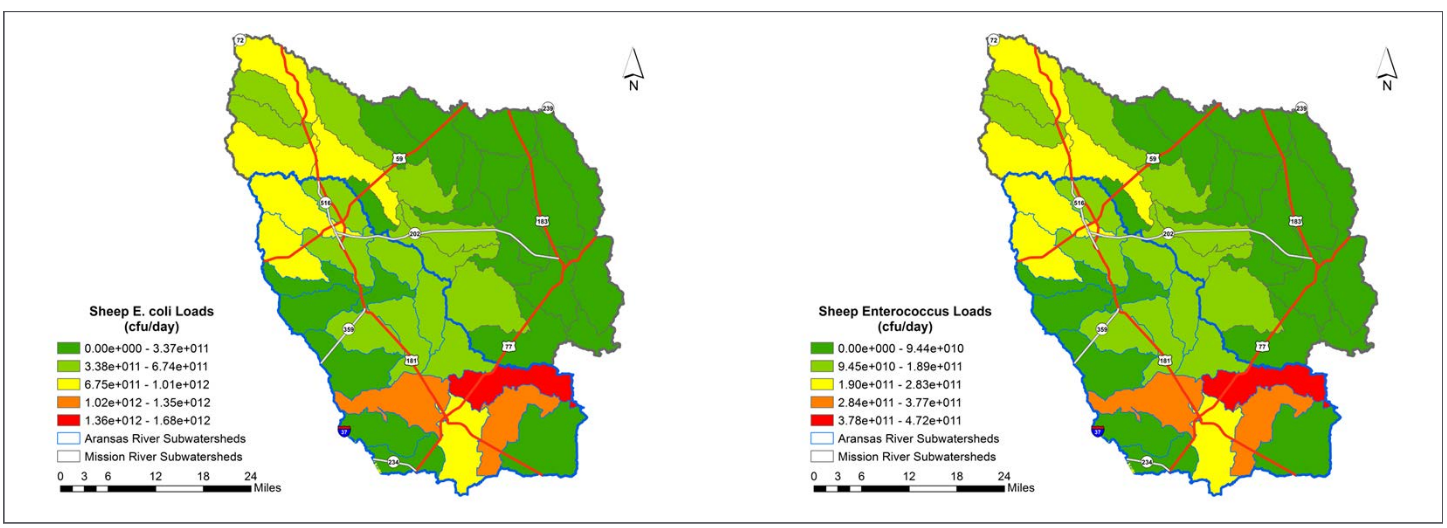


Figure 28. Potential *E. coli* and *Enterococcus* loads resulting from sheep for the Mission and Aransas rivers watersheds.

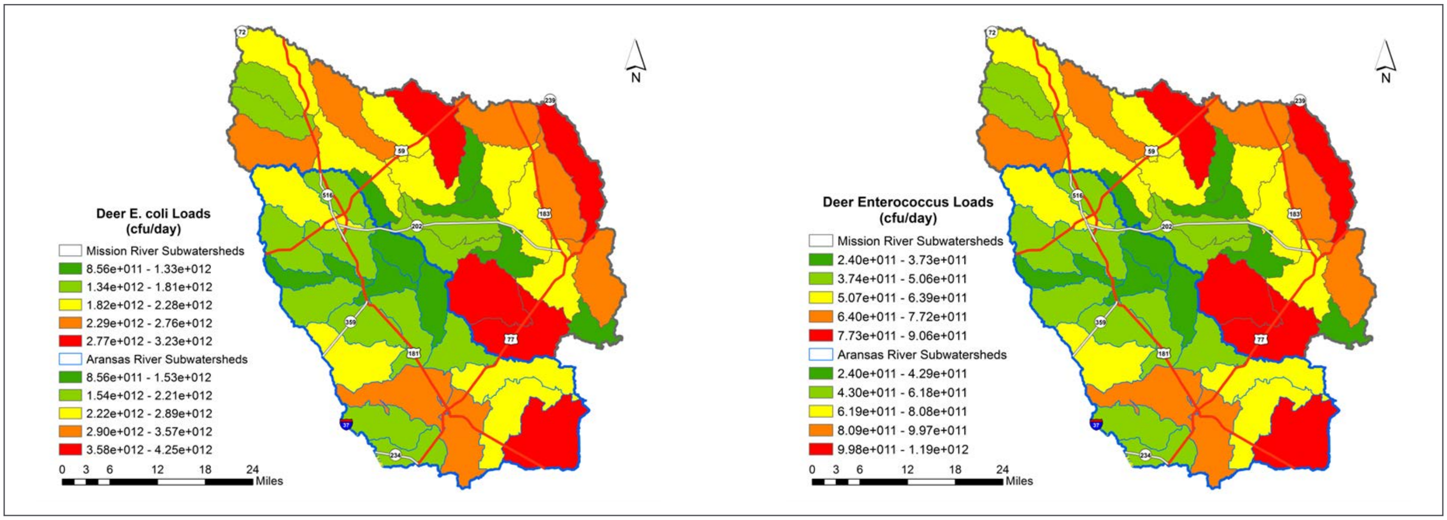


Figure 29. Potential *E. coli* and *Enterococcus* loads resulting from deer for the Mission and Aransas rivers watersheds.

Wildlife: Deer

A total of 9,951 deer animal units were evenly applied over the entire watershed. This is the population estimate produced by applying Wagner and Moench (2009) county densities calculated from Texas Parks and Wildlife Department (TPWD) surveys. The densities were multiplied by the number of acres of the county in the watershed and the animal unit conversion 0.112 to determine the number of deer AU in each county. The fecal coliform production rate used was 1.50×10^{10} cfu per animal unit per day. The total potential *E. coli* and *Enterococcus* loads for deer (Figure 29) were estimated using the distributed deer density, fecal coliform production rate, and conversion factors.

Wildlife: Feral Hogs

A total of 4,198 feral hog animal units were applied uniformly across deciduous forest, evergreen forest, mixed forest, shrub/scrub, grassland/herbaceous, pasture/hay, cultivated crops, and woody wetlands. This population estimate was derived by Wagner and Moench (2009) using a density of 33.3 ac/hog and an animal unit conversion of 0.125. The fecal coliform production rate used was 1.21×10^9 cfu per animal unit per day. The total potential *E. coli* and *Enterococcus* loads for feral hogs (Figure 30) were estimated using the distributed feral hog density, fecal coliform production rate, and conversion factors.

OSSFs

OSSFs were modeled using spatially distributed point data of each household obtained from residential 911 address data gathered from the Coastal Bend Council of Governments and the Golden Crescent Regional Planning Commission. Census data from 2010 was used for Karnes County because 911 address data was unavailable for this county. Households within Certificate of Convenience and Necessity (CCN) areas were removed to exclude households being serviced by a WWTF. The total number of households with OSSFs in the watershed was 10,047. The average persons per household for a census block were calculated using 2010 census data. A fecal coliform concentration of raw sewage 10×10^6 cfu per 100 mL (EPA 2001) was used to model failing OSSFs, as they are considered to provide little if any wastewater treatment. A constant sewage discharge of 70 gal per person per day was used. The appropriate OSSF failure rate was determined by applying the soil drain field limitation classes as follows: 15% very limited, 10% somewhat limited, 5% not limited, and 15% not rated. The percentage of *E. coli* and *Enterococcus* contributing to the watershed due to OSSF failures were calculated by multiplying the OSSF household densities, average person per household, fecal coliform concentration of raw sewage, sewage discharge, failure rate, and the conversion factors (Figure 31).

Dogs

A dog density of one dog per household was an updated density as reported by the American Veterinary Medical Association and used in the Geronimo Creek watershed analysis (AVMA 2012; Geronimo and Alligator Creek Watershed Partnership 2012). The density was applied to the residential 911 addresses, resulting in an estimated dog population of 10,065. The fecal coliform production rate of 5×10^9 cfu per dog per day (EPA 2001) multiplied by the conversion factors was used to determine the potential *E. coli* and *Enterococcus* loads resulting from dogs (Figure 32).

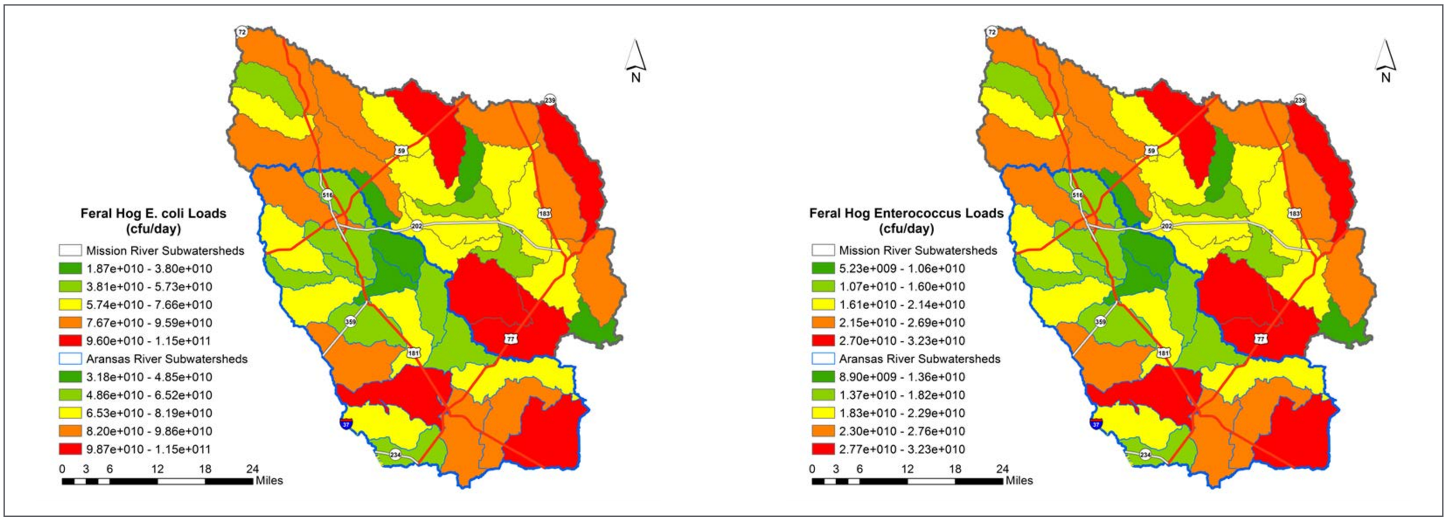


Figure 30. Potential *E. coli* and *Enterococcus* loads resulting from feral hogs for the Mission and Aransas rivers watersheds.

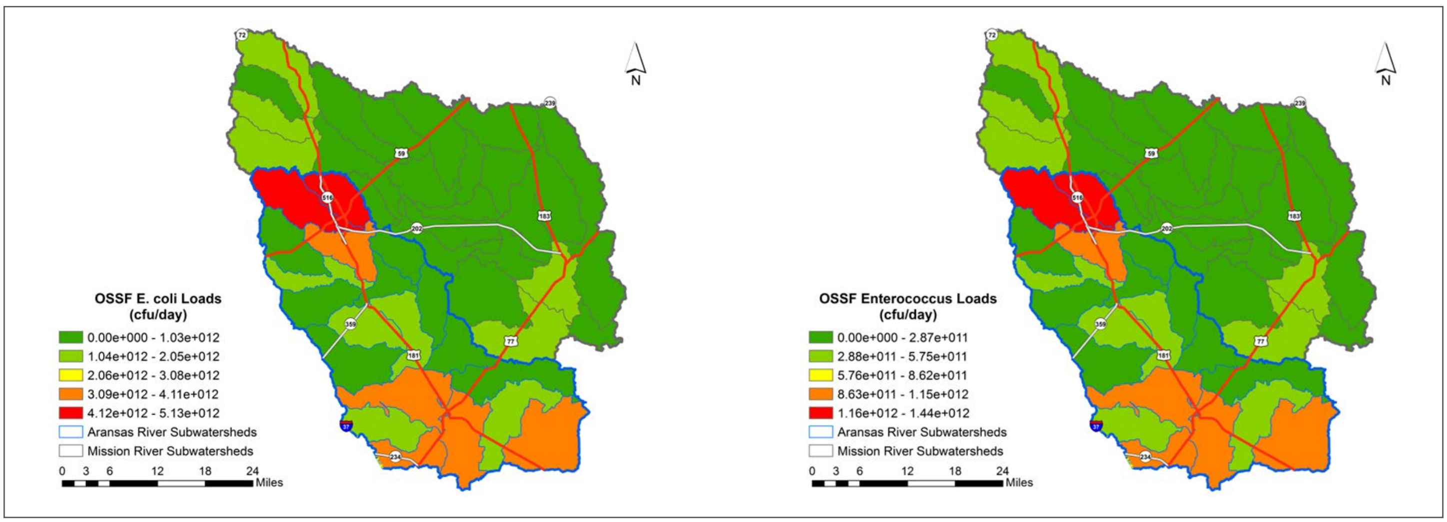


Figure 31. Potential *E. coli* and *Enterococcus* loads resulting from on-site sewage facilities for the Mission and Aransas rivers watersheds.

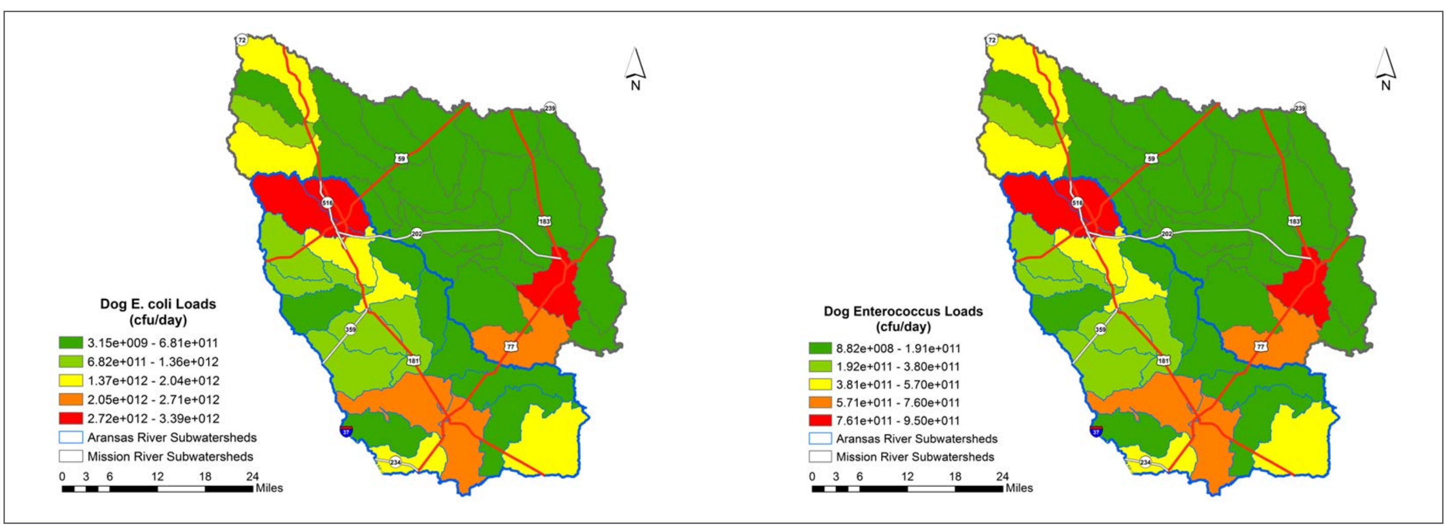


Figure 32. Potential *E. coli* and *Enterococcus* loads resulting from dogs for the Mission and Aransas rivers watersheds.

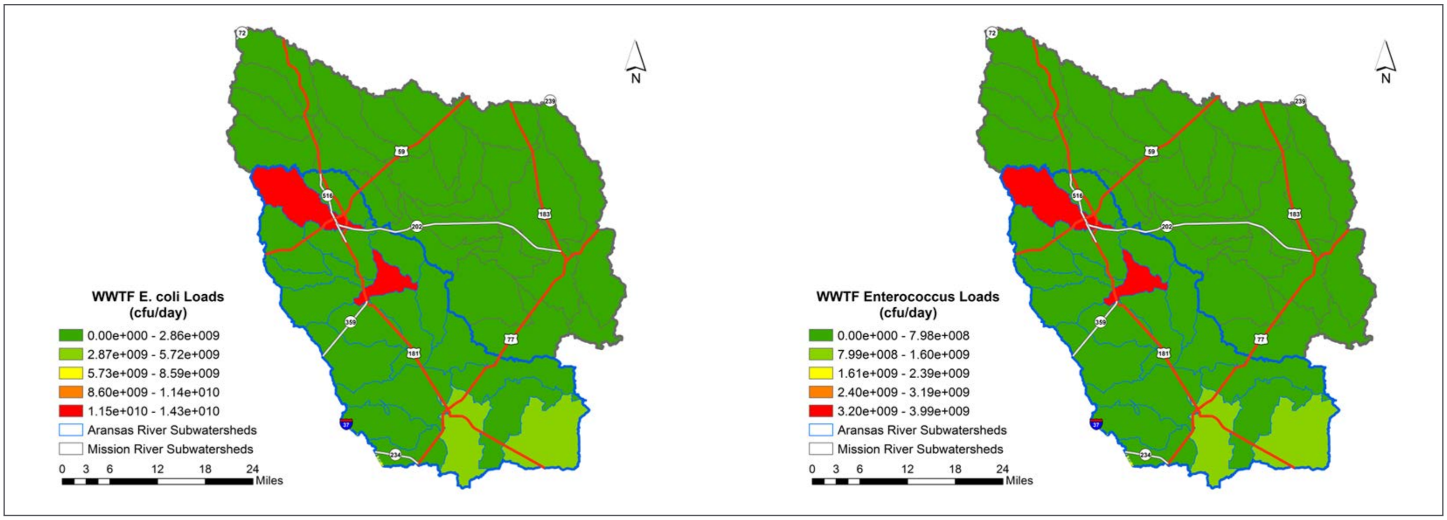


Figure 33. Potential *E. coli* and *Enterococcus* loads resulting from wastewater treatment facilities (WWTFs) for the Mission and Aransas rivers watersheds.

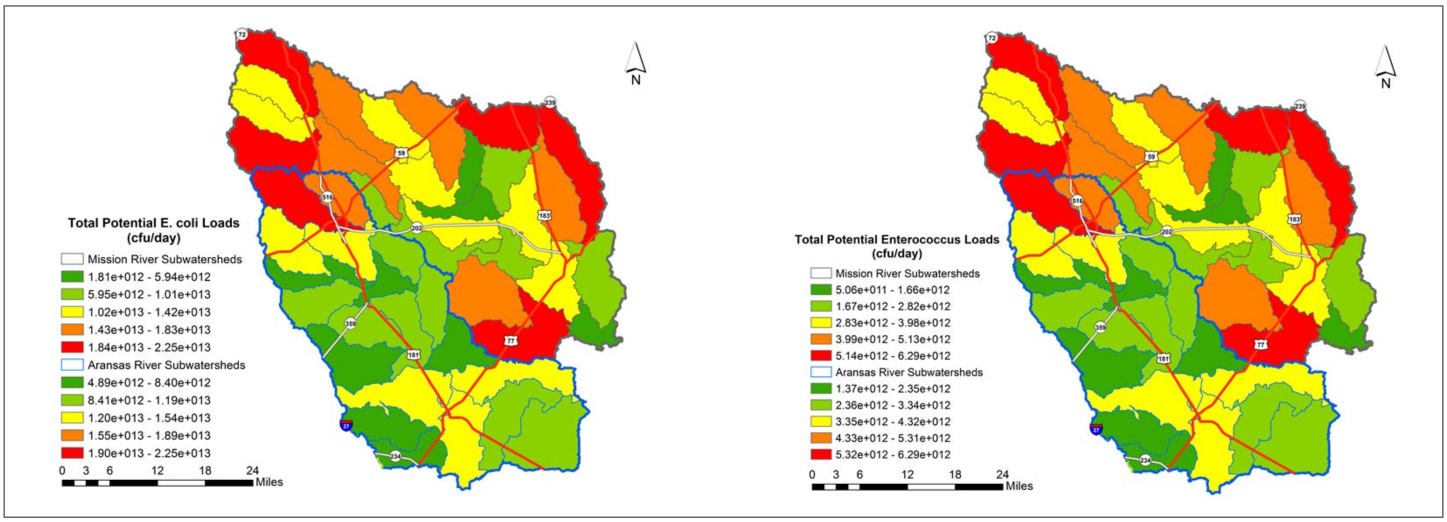


Figure 34. Daily total potential *E. coli* and *Enterococcus* loads for the Mission and Aransas rivers watersheds.

WWTFs

There are 12 WWTFs in the Mission and Aransas rivers watersheds. Three WWTFs are within the Mission River watershed: town of Refugio, town of Woodsboro, and Pettus MUD, with permitted discharges of 0.576, 0.25, and 0.105 MGD, respectively. Nine WWTFs are within the Aransas River watershed, including two for the City of Beeville, with permitted discharges of 3.0 and 2.5 MGD, and two for the City of Sinton, with permitted discharges of 0.015 and 0.8 MGD. The remaining WWTFs in the Aransas River watershed are the City of Taft, Skidmore Water Supply Corporation, St. Paul Water Supply Corporation, Tynan Water Supply Corporation, and Texas Department of Transportation, with permitted discharges of 0.9, 0.131, 0.05, 0.045 and 0.00038 MGD, respectively (Table 11). Each WWTF was modeled at its full permitted discharge, and an *E. coli* concentration of 126 cfu per 100 mL was used to model the potential impacts of WWTFs as monitoring data indicate that average *E. coli* levels observed in WWTF effluent are quite low. This as well as a conversion factor was utilized to produce the expected *E. coli* and *Enterococcus* loads seen in Figure 33.

Table 19. Daily potential *E. coli* ranges.

Potential sources	Daily potential *E. coli* Load (cfu[a]/day)	
	Mission River watershed	Aransas River watershed
Cattle	7.42×10^{11} - 1.81×10^{13}	2.86×10^{11} - 1.25×10^{13}
Horses	1.43×10^{9} - 2.39×10^{10}	3.47×10^{9} - 2.17×10^{10}
Goats	7.13×10^{9} - 5.43×10^{11}	2.14×10^{10} - 5.43×10^{11}
Sheep	0 - 1.68×10^{12}	0-1.68×10^{12}
Deer	8.56×10^{11} - 3.23×10^{12}	8.56×10^{11} - $4.25\ 10^{12}$
Feral hogs	1.87×10^{10} - 1.15×10^{11}	9.87×10^{10} - 1.15×10^{11}
OSSF	0 - 5.13×10^{12}	0 - 5.13×10^{12}
Dogs	3.15×10^{9} - 3.39×10^{12}	3.15×10^{9} - 3.39×10^{12}
WWTF	0 - 1.43×10^{10}	0 - 1.43×10^{10}

[a] colony forming units (cfu)

Table 20. Daily potential *Enterococcus* ranges.

Potential sources	Daily potential *Enterococcus* Load (cfu[a]/day)	
	Mission River watershed	Aransas River watershed
Cattle	2.08×10^{11} - 5.06×10^{12}	8.00×10^{10} - 3.51×10^{12}
Horses	3.99×10^{8} - 6.70×10^{9}	9.71×10^{8} - 6.05×10^{9}
Goats	2.00×10^{9} - 1.52×10^{11}	5.98×10^{9} - 1.52×10^{11}
Sheep	0 - 4.72×10^{11}	0 - 4.72×10^{11}
Deer	2.40×10^{11} - 9.06×10^{11}	9.98×10^{11} - 1.19×10^{12}
Feral hogs	5.23×10^{9} - 3.23×10^{10}	8.90×10^{9} - 3.23×10^{10}
OSSF	0 - 1.44×10^{12}	0 - 1.44×10^{12}
Dogs	8.82×10^{8} - 9.50×10^{11}	8.82×10^{8} - 9.50×10^{11}
WWTF	0 - 3.99×10^{9}	0 - 3.99×10^{9}

[a] colony forming units (cfu)

Load Reduction Sources and Summary

Combining the potential *E. coli* loading estimates of all modeled sources yielded a total daily potential *E. coli* load range for the Mission River watershed of 1.81×10^{12} to 2.25×10^{13} cfu per day and a range of 4.89×10^{12} to 2.25×10^{13} cfu per day for the Aransas River watershed (Figure 34). The total daily potential *Enterococcus* load range for the Mission and Aransas rivers watersheds were 5.06×10^{11} to 6.29×10^{12} and 1.37×10^{12} to 6.29×10^{12}, respectively. Potential loads are also aggregated at the subwatershed level, thus indicating which subwatershed has the highest potential for *E. coli* and *Enterococcus* loading to the watershed.

The source contributor with the highest daily potential *E. coli* and *Enterococcus* loads in both the Mission and Aransas rivers watersheds was cattle, while OSSFs, dogs, and deer where the next highest contributors. Sources with potential contributions in the middle of the range were sheep, feral hogs, and goats. The lowest contributors were horses and WWTFs. Tables 19 and 20 show these relative ranges of potential pollution contribution of each modeled source.

Chapter 5 Watershed Protection Plan Management Strategies

Introduction

Local and regional stakeholders identified and recommended management strategies to achieve bacteria reductions. Stakeholders identified strategies based on current understanding and knowledge of management effectiveness, feasibility, and local acceptance. Analysis to identify major sources of bacteria (Chapter 3), actual bacteria loads (Chapter 4), and potential loading distribution (Chapter 4) provided the information necessary for stakeholders to make informed decisions.

A variety of sources contribute *E. coli* and *Enterococcus* to the rivers. Therefore, an approach that addresses the diversity of sources is recommended to address *E. coli* and *Enterococcus* loads. The approach outlined in this WPP focuses on contributions that are most feasibly managed and have the highest chances of reducing instream *E. coli* and *Enterococcus*.

The management measures detailed in this chapter address the following sources: livestock, feral hogs, illicit dumping, OSSFs, urban stormwater, unauthorized discharges, illicit dumping, and WWTF discharges. These sources do not represent all prospective bacteria sources in the watershed, but they are the most manageable. For example, bacteria source tracking in similar watersheds nearby has identified wildlife as a significant contributor to bacteria; however, managing wildlife fecal deposition from all sources of wildlife in the watersheds is not practical and does not have a high likelihood of success.

Priority areas in the watershed were identified for each management recommendation using results from the GIS analysis (Chapter 4) and stakeholder feedback. These priority locations are areas that will maximize the effectiveness of the management recommendations. The voluntary nature of most BMPs in these watersheds presents a challenge for targeted implementation and measuring progress. In particular, agricultural BMPs often come with privacy and data restrictions that make tracking implementation and progress at fine scales difficult at best. Development of BMP tracking databases in these rural watersheds is infeasible given local privacy concerns. However, by working closely with the local soil and water conservation districts (SWCDs) and USDA NRCS, participation from landowners in priority locations can be targeted through outreach and education efforts. Assessment of progress through pre- and post-BMP water quality monitoring will provide indicators of progress and effectiveness.

Finally, stakeholder feedback was crucial in developing and selecting management strategies. Stakeholders are responsible for the implementation of these voluntary management strategies. Therefore, their recommendations to include particular management measures indicate feasibility and willingness and an increased likelihood that they will implement those recommendations. Only measures that are both suggested and agreed upon by stakeholders are included in this WPP.

Load reductions resulting from the implementation of management measures were calculated for Mission River Tidal, Aransas River Tidal, Aransas River Above Tidal, and Poesta Creek. Load reduction calculations are detailed in Appendix D.

Management Measures

Management Measure 1: Develop and Implement Conservation Plans in Priority Areas of the Watershed

The majority of land uses within the Mission and Aransas rivers watersheds are associated with cattle grazing operations and farming operations. The implementation of proven BMPs within the priority subwatersheds can lead to instream water quality improvements by minimizing the deposition of fecal matter directly into ditches, creeks, and rivers or in their riparian areas. To accomplish this goal, participating stakeholders will partner with state and federal agencies to garner necessary technical and financial assistance to help implement these practices.

To successfully implement this management measure, an intensive education and outreach program will be needed to broadly promote the adoption of management practices through the appropriate regional, state, or federal programs. Awareness of programs, management practices, and their benefits is often one of the biggest factors affecting the adoption of BMPs.

There are several parties responsible for the successful implementation of this management measure. Local stakeholders will evaluate the educational programs and work with state and federal agencies to develop conservation plans to mitigate impacts on water quality. Texas A&M AgriLife Extension Service will continue to provide continuing education programs and services. TSSWCB is the lead agency in Texas responsible for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural nonpoint source pollution. Entities such as SWCDs, USDA NRCS, TPWD, and NRA also play a vital role in educating stakeholders and providing incentive programs to reduce nonpoint source pollution.

Priority areas for this measure will be focused on land areas that have the highest potential for raising livestock, specifically, subwatersheds 4, 8, 10, 11, 12, 13, 15, 17, 18, 19, and 20 in the Aransas River watershed and subwatersheds 2, 5, 7, 8, 9, 14, 17, 19, 21, 22, 24, and 25 in the Mission River watershed (Figure 35).

Management Measure 2: Explore Feasibility of Altering Tax Exemption Requirement for Small Acreage Landowners

This measure is a stakeholder-initiated effort to reduce overstocking of livestock on small acreage land parcels. Currently, small acreage landowners apply for agricultural property tax exemptions and must stock their land to meet the tax requirement, which can sometimes exceed the carrying capacity of the land. The purpose of this measure is to explore alternatives for property tax exemptions that would encourage the adoption of practices that mitigate the effects of overstocking on small acreage properties receiving agricultural property tax exemptions.

To initiate this process, representatives from state and local governmental entities and watershed stakeholders will convene and discuss the feasibility of using existing tax exemptions and/or developing new (or altering existing) tax exemption frameworks. Part of this process will require an educational component as well. Educational outreach for this measure is geared towards elected officials to ensure responsible parties understand the need for improved water quality. There are no geographic priorities for this management measure other than focusing on small acreage properties with agricultural tax exemptions within the counties of the watershed. Potential pollutant load reductions from establishing new tax exemption requirements cannot be quantified at this time.

Management Measure 3: Promote the Management of Feral Hogs and Control Their Populations

Feral hogs have been identified as significant contributors of pollutants to surface water bodies. Fecal matter deposited directly in streams by feral hogs contributes bacteria and nutrients, polluting water bodies with their waste. The purpose of this management measure is to control the feral hog population in the watersheds. Population control efforts

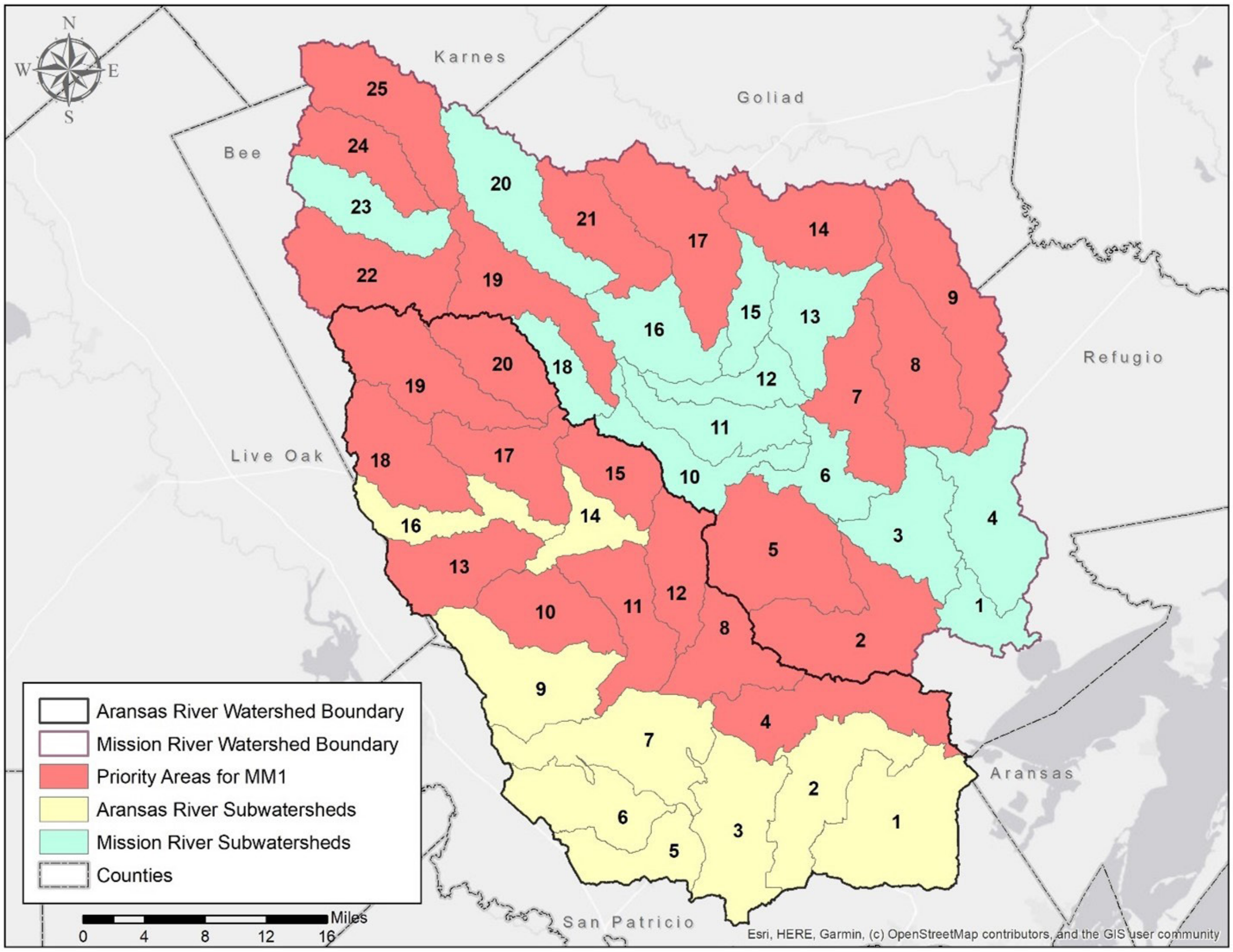


Figure 35. Priority areas for Management Measure 1 in the Mission and Aransas rivers watersheds.

currently used include live trapping, shooting, hunting with dogs, aerial hunting, exclusion, and habitat management. The continuation and increased intensity of these practices, especially in priority areas, will help reduce the impact feral hogs have on bacterial water quality in the watersheds.

In order to track the progress of this management measure, the Texas A&M AgriLife Extension Service's Feral Hog Reporting tool will be utilized in addition to other tracking techniques. Education and outreach for this measure is needed to ensure that stakeholders understand the importance of managing feral hog populations and the economic benefits associated with doing so.

Implementation for much of this management measure is dependent on available funding. Funding assistance will be needed for personnel and supplies for feral hog management activities and education.

Priority areas for this management measure will be targeted to where feral hogs have the highest potential for congregating based on land cover. Specific directed subwatersheds include 1, 2, 3, 4, 6, 7, 9, and 11 for the Aransas River watershed and subwatersheds 2, 4, 5, 8, 9, and 14 for the Mission River watershed (Figure 36).

Management Measure 4: Promote the Reduction of Illicit Dumping and Proper Disposal of Animal Carcasses

Illicit dumping has been identified as a concern by stakeholders. Trash, household items, waste products, and animal carcasses have been known to be dumped into some local creeks. Challenges in enforcing illicit dumping include (1) lack of available personnel for education and enforcement and (2) lack of equipment to reduce dumping and monitor sites for enforcement. This management measure works to reduce the amount of illicit dumping occurring in and near local water bodies. Specific actions to be taken include education focusing on proper disposal for local officials and residents, signage at water bodies, enforcement, and other community-based efforts.

The main target areas for this management measure consist of common sites for illicit dumping, which tend to be located at or near road bridge crossings. Education initiatives will focus on areas where there is a high demand for hunting and high density of recreational vehicles. Potential load

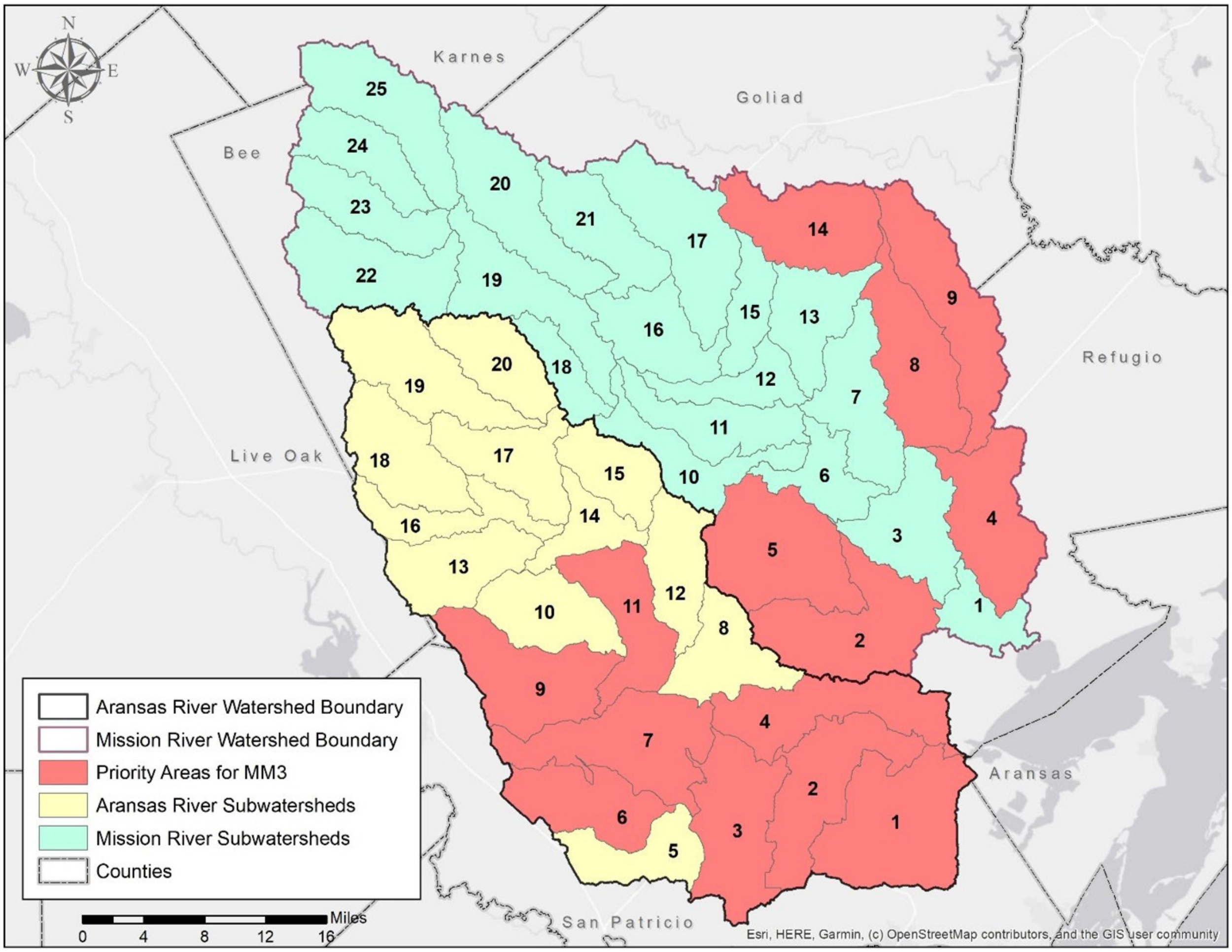


Figure 36. Priority areas for Management Measure 3 in the Mission and Aransas rivers watersheds.

reductions from reducing illicit dumping and properly disposing of animal carcasses cannot be quantified at this time.

Management Measure 5: Identify OSSFs, Prioritize OSSF Problem Areas, and Systematically Work to Bring Failing OSSF Systems to Compliance

Failing OSSFs have been known to contribute to bacteria impairments in surface water bodies. The TMDLs and implementation plan identified approximately 10,000 OSSFs in the Mission and Aransas rivers watersheds. It is the purpose of this management measure to improve the identification, inspection, pre-installation planning, education, operation, maintenance, and tracking of all OSSFs in the watershed to minimize the impacts of malfunctioning onsite systems. Information transfer will be coordinated with the Texas Coastal Nonpoint Source Pollution Control Program to maximize efficiency.

Physical inspections are necessary to identify problematic and failing OSSFs. The additional work required for county employees to identify these OSSFs necessitates additional funding to enable more personnel to conduct these inspections. The level of knowledge and understanding of operation and maintenance requirements for OSSFs is thought to be low in the watersheds. Therefore, education and outreach are also important components of this measure. Texas A&M AgriLife Extension Service currently has an educational program for homeowners about proper maintenance requirements. These programs provide an overview of general OSSF requirements, including permitting, collection, storage, pretreatment (and advanced pretreatment), disinfection, final treatment, and dispersal.

This management measure recommends the replacement of 562 systems by acquiring programmatic resources and funding to replace high priority systems. This management measure will also be used to support Texas' Coastal Nonpoint Source Program by prioritizing systems in the coastal zone boundary that are failing and/or proximity to nitrogen-limited waters. A detailed OSSF GIS-based inventory database was completed by TCEQ in 2017, in support of the Texas Coastal Nonpoint Source Program. Further, education on system operation and maintenance, as well as proper installation, inspection, and repair procedures, should be delivered.

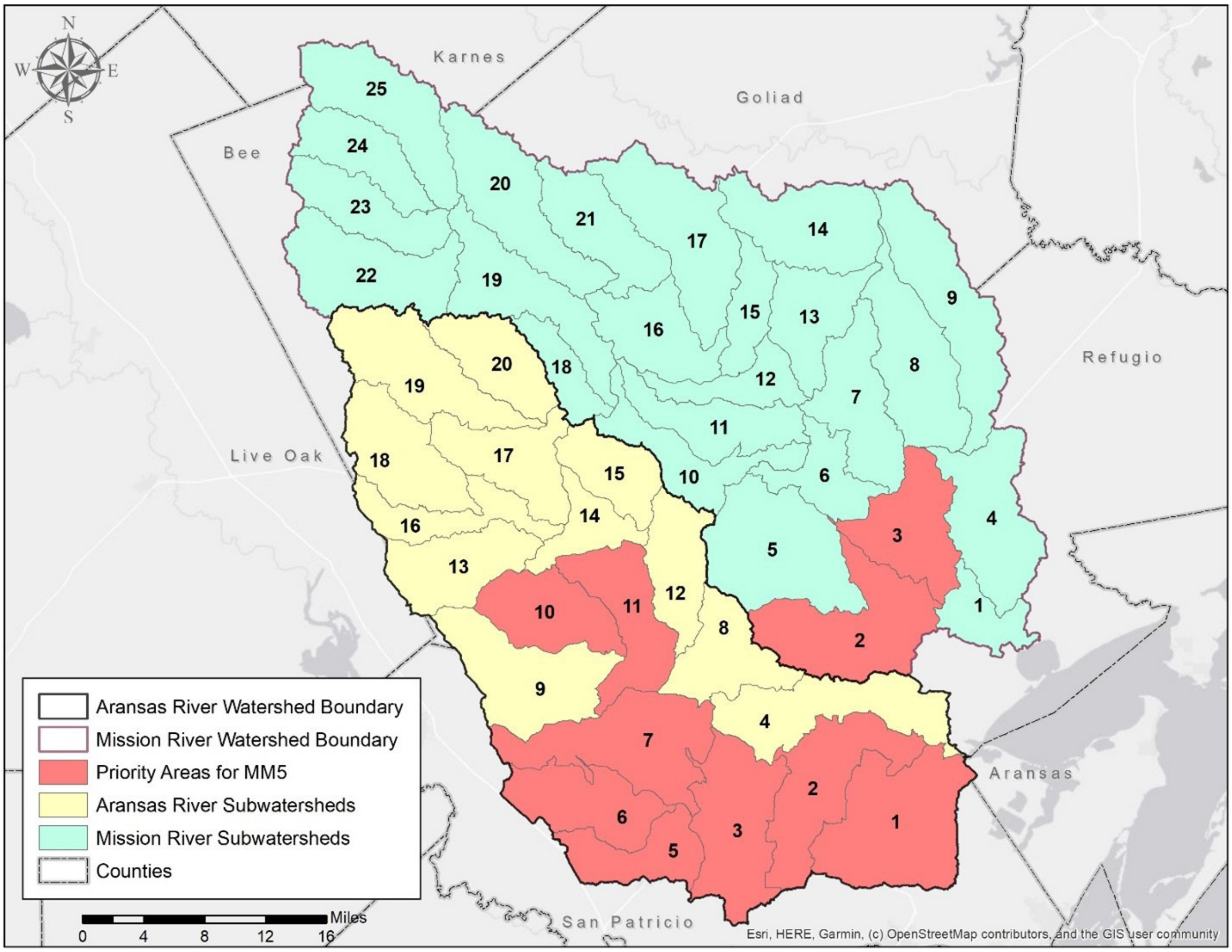


Figure 37. Priority areas for Management Measure 5 in the Mission and Aransas rivers watersheds.

Priority areas for this management measure are subwatersheds 1, 2, 3, 5, 6, 7, 10, and 11 for the Aransas River watershed and subwatersheds 2 and 3 for the Mission River watershed (Figure 37).

Management Measure 6: Promote the Improved Quality and Management of Urban Stormwater

Bacteria from pets, wildlife, and human waste can be washed into storm drains and then discharged into local waterways. Because stormwater systems are designed to quickly move water away from developed areas, stormwater often bypasses the natural vegetative barriers that can assist in filtering runoff. As of 2016, there are no large Phase I or small Phase II MS4 stormwater permits in the Mission and Aransas rivers watersheds; therefore, urban stormwater is not regulated in the watersheds. However, urban runoff contributes to the loading of pollutants in these water bodies.

Structural BMPs, such as modification to stormwater retention, detention, and conveyance systems designed to increase settling, aeration, treatment by sunlight, or physical removal of contaminants, have the potential to reduce bacteria loading into waterways. There are also nonstructural BMPs, such as municipal pet waste programs, and education and outreach programs that target local officials and residents that also work to reduce pollutant loadings from stormwater. The goal of this measure is to decrease nonpoint source pollution from stormwater runoff in urban areas in the watersheds through the adoption of structural and nonstructural BMPs.

Areas of focus for this management measure are urban areas within the Mission and Aransas rivers watersheds. Priority will be given to areas of the watersheds that discharge stormwater into or near the impaired segments (Figure 38).

Management Measure 7: Coordinated Efforts to Reduce Unauthorized Discharges

This strategy focuses on the prevention of unauthorized discharges of wastewater from treatment facilities or collection system infrastructure, such as underground sewer lines. To reduce unauthorized discharges, city and utility districts will (1) conduct routine sewer pipe inspections, (2) undertake visual inspections of existing manholes, and (3) engage

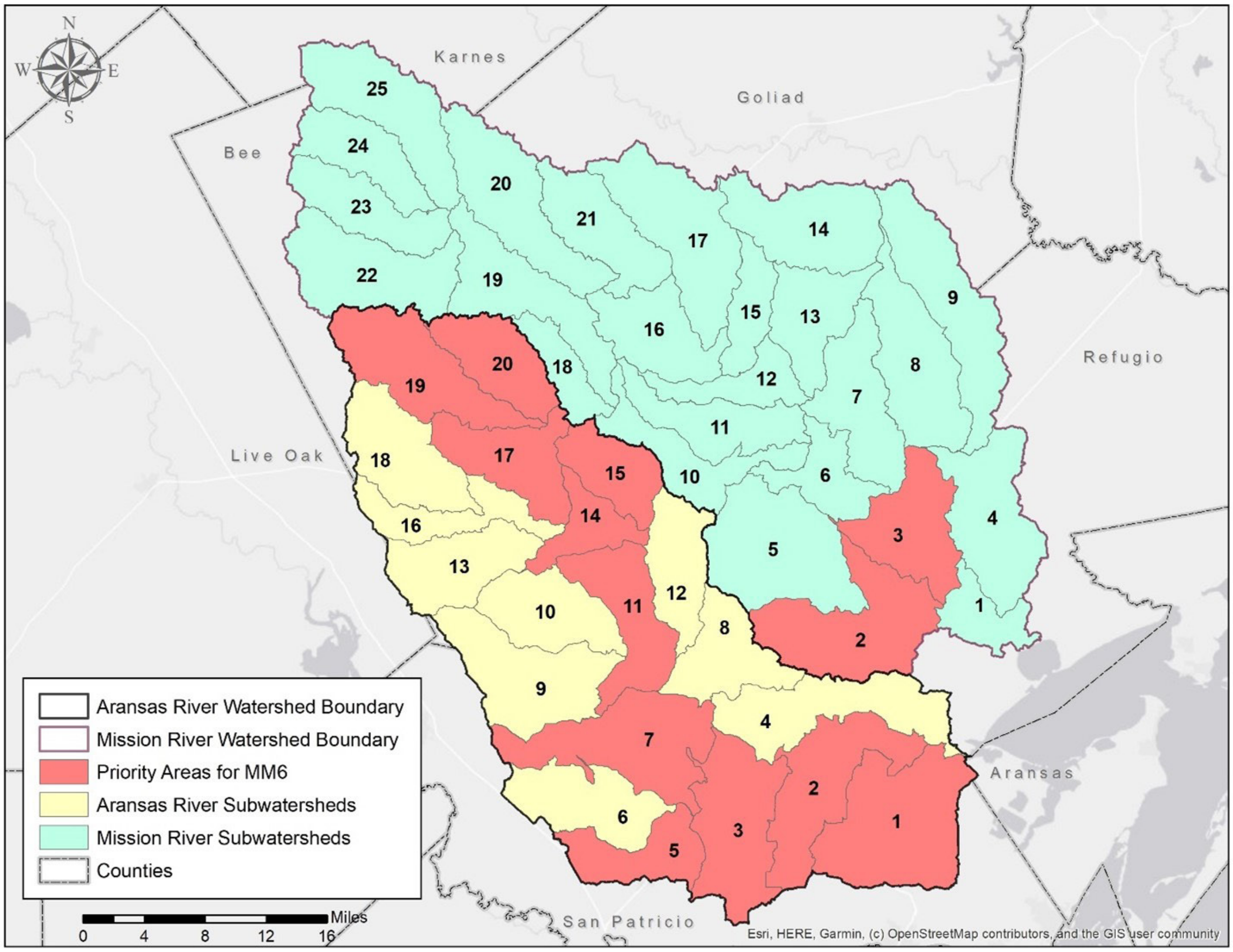


Figure 38. Priority areas for Management Measure 6 in the Mission and Aransas rivers watersheds.

in other surveillance activities, identified by each entity, to mitigate unauthorized discharges of wastewater.

To prioritize future repairs, districts will use I&I studies, as well as GIS to track and document infrastructure. Education is needed for both city/utility personnel and citizens who reside within the priority boundaries. Personnel need to understand how to inspect infrastructure for needed repairs and how to identify areas that have the potential of failing. Residents also need to be educated on how they can prevent wastewater infrastructure failures.

Priority areas for this management measure are the CCN boundaries that fall within the Mission and Aransas rivers watersheds, with a focus on areas near impaired water bodies (Figure 39).

Management Measure 8: Reduce WWTF Contributions by Meeting Half of the Permitted Bacteria Limit

This measure focuses on reducing the amount of bacteria contributed by WWTFs to surface water in the watersheds. Currently, WWTFs are permitted to discharge wastewater containing bacteria concentrations that do not exceed surface water quality standards (126 MPN/100 ml *E. coli* for freshwater bodies and 35 MPN/100mL *Enterococcus* for saline water bodies). Of the 12 WWTFs discharging treated effluent in the watersheds, four facilities (the City of Beeville's Moore Street and Chase Field WWTFs, the City of Taft WWTF, and the Skidmore Water Supply Corporation [WSC] WWTF) have agreed to limit the concentrations of bacteria in their discharges to half the level currently specified in their permits (i.e., 63 MPN *E. coli* and 17.5 MPN *Enterococcus*). Although the remaining eight WWTFs in the watersheds are not currently participating in this management measure, it is conceivable that the owners of these nonparticipating facilities may be persuaded to participate through focused educational efforts.

Education is needed for both city personnel, as well as elected officials for two reasons. First, it is important to educate elected officials, especially of nonparticipating jurisdictions, about the environmental and economic benefits of voluntarily reducing bacteria concentrations in treated wastewater effluent, so that better informed fiscal decisions can be made at the local level. Second, it is important to

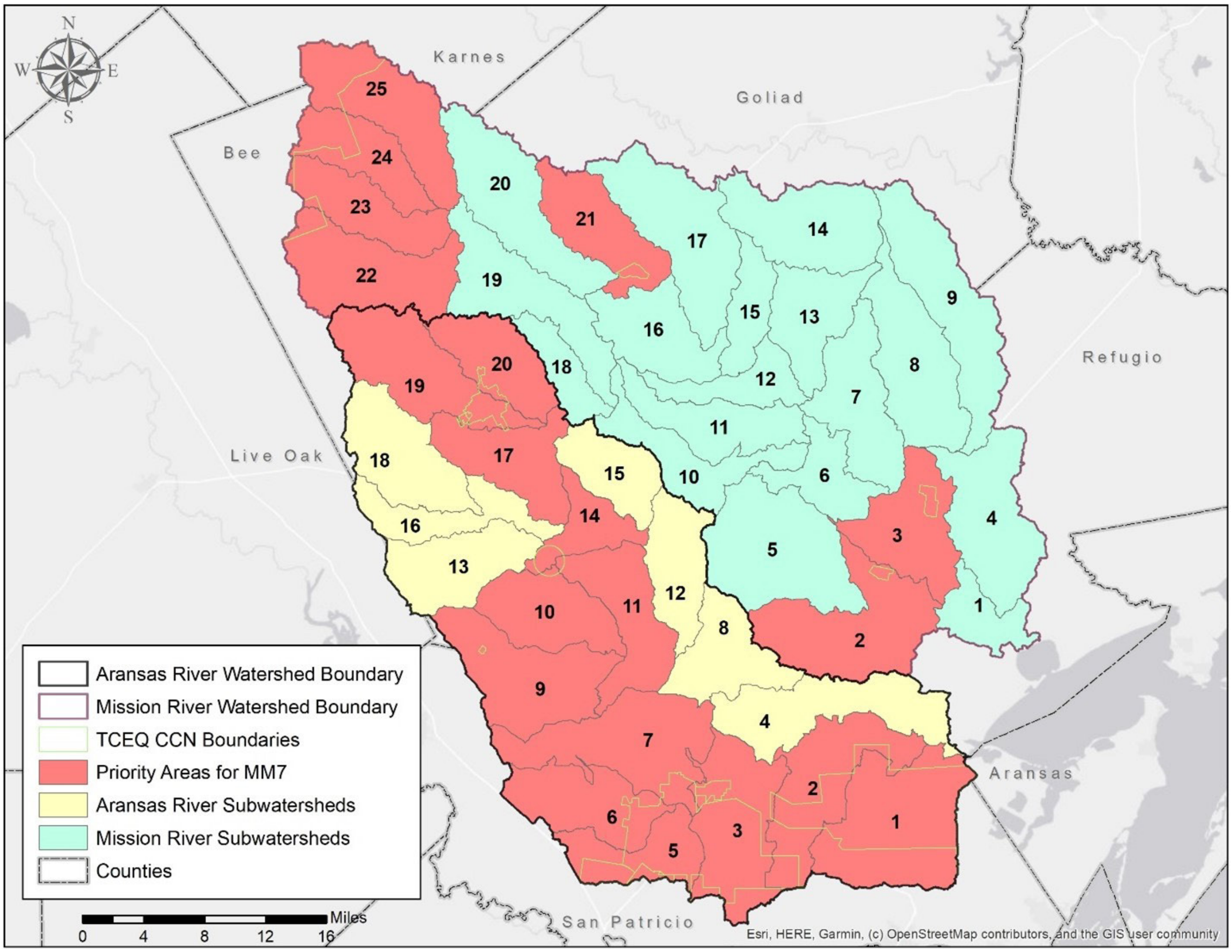


Figure 39. Priority areas for Management Measure 7 in the Mission and Aransas rivers watersheds.

educate WWTF operators and personnel about the capabilities of their respective WWTF systems and about methods and practices that can be adopted to maximize the treatment potential of each facility.

Priority areas will be all the WWTFs within the Mission and Aransas rivers watersheds. The focus will be on those WWTFs located near the impaired water bodies. The four WWTFs currently participating in Management Measure 8 are all located in the Aransas River watershed

Management Measure 9: Coordinate and Expand Existing Water Quality Monitoring in the Watersheds

One of the major goals of the stakeholder groups within the Mission and Aransas rivers watersheds is to expand water quality monitoring in these river systems. Currently, monitoring occurs on a quarterly basis, which is regarded as the minimum needed to assess the health of the rivers. However, this monitoring frequency is considered inadequate to aid watershed managers in identifying and addressing the causes of water quality problems in any detail. Monitoring is essential to (1) better define where the problem areas are in the watersheds, (2) accurately identify the causes of water quality problems, (3) monitor long-term trends in water quality, and (4) assess the effectiveness of BMP implementation.

The overall purpose of this management measure is to develop a more refined understanding of the spatial and temporal dynamics of bacteria loading in the Mission River Tidal and Aransas River Tidal segments. The data produced will provide valuable information to state agencies and watershed stakeholders, aiding them in better managing local water resources and planning future improvements in water quality.

Educating stakeholders about ongoing monitoring and how to access monitoring data would allow stakeholders to track water quality in the Mission and Aransas rivers throughout the I-Plan and WPP implementation process. A watershed website containing monitoring data and other useful information would also be a beneficial learning tool for stakeholders, as monitoring results could be easily accessed and tracked.

Priority areas for this management measure will be identified by the stakeholders as data quality objectives are refined.

Table 21. Permitted wastewater treatment facilities (WWTFs) in the Mission and Aransas rivers watersheds.

Entity name	Permit number	*E. coli/ Enterococcus* monitoring	Permit expiration date	Sampling frequency	Bacteria treatment type
Moore Street WWTF[a] (City of Beeville)	WQ0010124-002	*E. coli*	3/1/2020	One/week	Chlorination
Chase Field (City of Beeville)	WQ0010124-004	*E. coli*	3/1/2020	Two/month	Chlorination
City of Sinton	WQ0010055-001	*Enterococcus*	3/1/2019	One/month	Chlorination
Rod and Bessie Welder WWTF (City of Sinton)	WQ0013641001	*E. coli*	10/24/2023	Five/week	Chlorination
Town of Woodsboro	WQ0010156-001	*E. coli*	3/1/2020	One/month	Chlorination
Town of Refugio	WQ0010255-001	*E. coli*	3/1/2020	Two/month	Chlorination
City of Taft	WQ0010705-001	*Enterococcus*	3/1/2020	Two/month	Chlorination
Pettus MUD[b]	WQ0010748-001	*E. coli*	3/1/2020	One/month	Chlorination
Skidmore WSC[c]	WQ0014112-001	*E. coli*	3/1/2020	One/month	Chlorination
St. Paul WSC	WQ0014119-001	*E. coli*	3/1/2020	One/quarter	Chlorination
Tynan WSC	WQ0014123-001	*E. coli*	3/1/2020	One/quarter	Chlorination
Sinton Engineer Building WWTF (Texas Department of Transportation)	WQ0013412-001	*E. coli*	3/1/2020	One/week	Chlorination

[a] Wastewater Treatment Facility (WWTF)
[b] Municipal Utility District (MUD)
[c] Water Supply Corporation (WSC)

Management Measure 10: Improved Monitoring of WWTF Effluent to Ensure Permit Compliance

In November 2009, TCEQ commissioners approved Rule Project No. 2009-005-309-PR. The rule requires the addition of bacteria limits for all TPDES domestic permits and places discharge limits for *E. coli* and *Enterococcus*. This rule requires WWTF permit holders to begin or continue to monitor *E. coli* or *Enterococcus* concentrations in their WWTF effluent as required by individual WWTF permits and any subsequent permit amendments or revisions.

Currently there are 12 permitted WWTFs in the Mission and Aransas rivers watersheds. Nine are required to monitor *E. coli,* and one is required to monitor *Enterococcus* levels in its wastewater effluent. The other two WWTFs will be required to monitor for *E. coli* or *Enterococcus* upon renewal of (or amendment to) their permits. Table 21 provides information regarding current bacteria limits, treatment type, and monitoring frequency for each individual WWTF.

Priority areas for this management measure consist of the location of each WWTF and their respective outfalls but especially those WWTFs that discharge into or near the impaired waterbodies.

Management Measure 11: Improve and Upgrade WWTFs

All WWTFs in the Mission and Aransas rivers watersheds collect and treat wastewater before discharging it into receiving water bodies in the watershed. The goal of this management measure is to improve the effluent quality of WWTFs that are not currently treating their effluent to the lowest bacteria levels possible. In addition, WWTFs located in the watersheds may need to improve/upgrade their treatment process to accommodate population growth and reduce periodic exceedances of bacteria levels in their discharge. In addition to the technical and financial resources needed for the upgrades, education is needed to improve the efficiency of existing WWTF systems.

The main educational components of this management measure will consist of general WWTF operator training, which will help staff increase the efficiency of their processes, identify malfunctioning equipment, determine the need for upgrades, and anticipate problems with plant capacity. Priority areas for this management measure will be the locations of each WWTF, with the highest priority given to those WWTFs that discharge into or near the impaired water bodies. Table 22 documents the WWTFs improvements needed and the estimated cost of these improvements.

Table 22. Needed wastewater treatment facility (WWTF) improvements and estimated costs.

Entity	Activities needed*	Estimated costs
Moore Street WWTF[a] (City of Beeville)	Complete upgrade	$5–10 million
Chase Field (City of Beeville)	Complete upgrade	$150,000
City of Sinton	Chamber for chlorination	$600,000
Rob and Bessie Welder Park (City of Sinton)	Chamber for chlorination	$400,000
Town of Refugio	New clarifier	$2 million
City of Taft	Complete upgrade	$3 million
For all responsible parties	Education for city employees, elected officials, etc., estimated $2,000 for one event annually in each city	$120,000

[a] Wastewater Treatment Facility (WWTF)

Chapter 6
Plan Implementation

Introduction

Implementing the WPP is a complex operation that will require active participation by many parties for a 5-year implementation period. Implementation will focus on addressing readily manageable sources of *E. coli* and *Enterococcus* in the Mission and Aransas rivers watersheds to achieve water quality targets. This effort will require significant financial commitments, technical assistance, continued water quality education and outreach, and a strong desire to improve and protect local land and water resources to meet the reasonable implementation schedule, targets, and costs.

Schedule, Milestones, and Estimated Costs

Implementing the Mission and Aransas rivers WPP will occur over a 5-year period; however, additional management and time may be needed as identified through adaptive management. The schedule, milestones, and estimated costs associated with planned implementation were discussed and developed in coordination with watershed stakeholders during the implementation plan (I-Plan) development process. Management measures were selected based on their ability to address bacteria loading in the watersheds and effectively manage the target source at a reasonable cost.

A complete list of management activities, goals, responsible parties, and estimated costs are included in Tables 23-33. Implementation goals are included incrementally to reflect anticipated implementation timeframes. In specific cases, funding acquisition, personnel hiring, or program initiation may delay the start of implementation. This approach provides incremental implementation targets that can be used as a gage to measure implementation progress. If sufficient progress is not made, adjustments will ensue to increase implementation and meet established goals. Adaptive management may also be utilized to adjust the planned approach if the original strategy is no longer feasible or effective.

Table 23. Management Measure 1 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1	Stakeholders; USDA NRCS[a]; TSSWCB[b]; TPWD[c]	Promote existing conservation programs and develop new conservation plans	24 conservation plans developed in the Aransas River watershed and 16 in the Mission River watershed
	Educational entities	Pursue funding for educational programs	Successfully secure funding for education programs
2	Stakeholders; USDA NRCS; TSSWCB; TPWD	Promote existing conservation programs and develop new conservation plans	24 conservation plans in the Aransas River watershed and 16 in the Mission River watershed
	Educational entities	Begin education activities	Secure funding and initiate education campaign
3-5	Stakeholders; USDA NRCS; TSSWCB; TPWD	Continue promoting existing conservation programs and develop new conservation plans	74 additional conservation plans in the Aransas River watershed and 49 in the Mission River watershed
	Educational entities	Deliver education programs	Deliver six education programs annually
	All responsible parties	Assess overall efforts and revise strategy as appropriate	Assess progress and develop or continue implementation utilizing the same strategy
	Responsible parties	**Activities needed**	**Estimated costs**
	USDA NRCS; TSSWCB; TPWD	Implementation of 203 conservation plans at $15,000	$3,045,000
	Entities administering education/outreach programs	Education and outreach programs at $50,000 each	$300,0000

[a] United States Department of Agriculture National Resources Conservation Service (USDA NRCS)
[b] Texas State Soil and Water Conservation Board (TSSWCB)
[c] Texas Parks and Wildlife Department (TPWD)

Table 24. Management Measure 2 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1-2	Watershed stakeholders; local taxing authorities; representatives of small landowners; Texas Comptroller	Convene to discuss alternative property tax exemptions	Number of meetings will be used to measure progress
	Texas Water Resources Institute (TWRI); Texas A&M AgriLife Extension; other educational entities	Pursue funding for education	Successfully submit proposal for funding educational programs
3-4	Watershed stakeholders; local taxing authorities; representatives of small landowners; Texas Comptroller	Develop framework for altering property tax exemptions	Number of meetings will be used to measure progress
	Developed framework for altering property tax exemptions	Begin education activities	Secure funding and initiate education campaign
5	TWRI; Texas A&M AgriLife Extension; other educational entities	Secured funding for education and delivery of education programs	Number of individuals educated
	Measured adoption rate of changes	Deliver education programs	Deliver six education programs annually
	Responsible parties	**Activities needed**	**Estimated costs**
	Educational entities	Education for elected officials and other responsible parties	$115,000

Table 25. Management Measure 3 responsible party, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1	Texas AgriLife Extension; Texas Department of Agriculture (TDA); Texas Wildlife Services (TWS); United States Department of Agriculture (USDA)	Contact landowners in priority areas	Number of landowners contacted
	Texas AgriLife Extension; TSSWCB; TDA; TWS; USDA	Pursue funding for educational programs	Successfully submit proposal to fund educational programs
	TWS; TDA; USDA; watershed stakeholders	Removal of feral hogs and pursue funds for local assistance	Successfully submit proposals for funding feral hog removal activities
2	Texas AgriLife Extension; TDA; TWS; USDA	Continue contacting landowners in priority areas	Number of landowners contacted
	Texas AgriLife Extension; TSSWCB; TDA; TWS; USDA	Secure funding for educational programs and host educational programs	Successfully secured funding and number of educational programs held
	TWS; TDA; USDA; watershed stakeholders	Continue to remove feral hogs from watersheds and secured funding for local assistance	Remove 2,149 hogs (1,198 from Mission River watershed and 951 from Aransas River watershed)
3-4	TWS; TDA; USDA; watershed stakeholders	Continue to remove feral hogs	Remove 4,298 feral hogs (2,396 from Mission River watershed and 1,902 from Aransas River watershed)
	Texas AgriLife Extension; TSSWCB; TDA; TWS; USDA	Continue education programs	Number of materials developed and disseminated Number of educational programs held Number of persons reached through educational programs
5	Texas AgriLife Extension; TSSWCB; TDA; TWS; USDA	Continue education programs	Number of materials developed and disseminated Number of educational programs held Number of persons reached through educational programs
	TWS; TDA; USDA; watershed stakeholders	Continue to remove feral hogs	Remove 2,149 feral hogs (1,198 from Mission River watershed and 951 from Aransas River watershed)
	All responsible parties	Assess overall efforts and revise strategy as appropriate	Assess progress and develop or continue implementation utilizing the same strategy
	Responsible parties	**Activities needed**	**Estimated Costs**
	Responsible parties	Purchase additional feral hog equipment	$5,000
	Responsible parties	Formulate, maintain, and implement online tracking data management	$10,000
	Responsible parties	Hunting and trapping	$15,000
	Responsible parties	Regional trapper	$350,000
	Responsible parties	Landowner voluntary aerial gunning events ($2,000 per event at two per year per county)	$100,000
	Responsible parties	Feral hog workshops ($7,500 each at 1 annually)	$37,500

Table 26. Management Measure 4 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1	Watershed stakeholders; counties and Certificate of Convenience and Necessity (CCN) holders within the watersheds	Submit a grant proposal in pursuit of funding for educational programs, illicit dumping mitigation activities, and/or personnel	Successfully submitted grant proposal in pursuit of funding
	Watershed stakeholders; counties and CCN holders within the watersheds	Develop a strategy on how to best reduce illicit dumping	Completed strategy on how to reduce illicit dumping
	All responsible parties	Reduce the number of fines written and the number of reports of illicit dumping	A 5% increase in the number of fines for illicit dumping and a 5% reduction in the number of reports of illicit dumping
2-5	Successful educational entities	Implement education programs	Number of educational materials developed, programs delivered, and individuals educated
	All responsible parties	Reduce the number of fines written and the number of reports of illicit dumping	A 5% reduction in the number of reports of illicit dumping annually
	Responsible parties	**Activities needed**	**Estimated costs**
	Educational entities	Postage of signs at bridge, warnings of fines for improper disposal	$48,000
	Educational entities	Outreach and education	$115,000

Table 27. Management Measure 5 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1	Watershed stakeholders; counties within the watersheds	Pursue funds for additional personnel, education, and On-Site Sewage Facilities (OSSF) replacements/upgrades	Successfully submit grant proposals in pursuit of funds for all activities
	Watershed stakeholders; counties within the watersheds; Texas AgriLife Extension	Identify priority areas for OSSF inspections	Identify the subwatersheds where individuals should be contacted and OSSF owners should be contacted
	Watershed stakeholders; counties within the watersheds; Texas AgriLife Extension	Develop a tracking tool/update existing tracking tools	Successfully develop a tracking tool to identify age and other relevant information for OSSFs
	Counties within the watersheds	Begin contacting OSSF owners	Number of OSSF owners contacted
2-5	Texas AgriLife Extension; counties within the watersheds	Initiate education programs	Number of materials developed, number of education programs held, and number of individuals contacted
	Texas AgriLife Extension; counties within the watersheds	Begin replacements/upgrades	Replace 562 failing OSSFs (76 in Mission River watershed and 486 in Aransas River watershed)
	Texas AgriLife Extension; counties within the watersheds	Continue tracking OSSFs	Contact 2% of OSSF owners annually
	Texas AgriLife Extension; counties within the watersheds	Continue inspecting OSSFs	Inspect 1% of OSSFs annually
	Responsible parties	**Activities needed**	**Estimated costs**
	Responsible parties	OSSF repair and replacement ($8,000 per system)	$13,904,000
	Educational entities	Education and outreach events to homeowners and installers/ maintenance providers	$75,000
	Educational entities	OSSF tailoring of online training modules	$10,000

Table 28. Management Measure 6 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1	Watershed stakeholders	Pursue funding for stormwater education	Successfully submit grant proposals in pursuit of funds for educational activities
	Cities, towns, and counties in the watersheds; watershed stakeholders	Identify feasible locations of urban best management practice (BMP) installation	Number of sites identified for stormwater BMP instillation
2	Texas AgriLife Extension; counties within the watersheds	Initiate education programs	Number of materials developed, number of education programs held, and number of individuals contacted
3-5	Texas Commission on Environmental Quality (TCEQ) and other stormwater education providers	Continuation of educational activities	Number of materials developed, number of education programs held, and number of individuals contacted
	Cities, towns, and counties in the watersheds	Completion of urban stormwater BMP installation, as funding allows	Completion of urban BMP installation of 74 acres in the Mission River watershed and 517 in the Aransas River watershed
	Responsible parties	**Activities needed**	**Estimated costs**
	Responsible parties	Pet waste programs ($3,500 per program; one per Certificate of Convenience and Necessity (CCN) annually)	$175,000
	Responsible parties	Comprehensive urban stormwater assessment ($35,000 per assessment at one per county)	$175,000
	Responsible parties	Design and submittal of proposals for funding of BMP installation to cover 591 acres of urban land (one proposal per CCN; $7,500 per design/proposal)	$75,000
	Educational entities	Urban pollution workshops ($2,500 per workshop at one per CCN annually)	$125,000

Table 29. Management Measure 7 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1	All Certificate of Convenience and Necessity (CCN) holders in the watersheds	Conduct visual inspections and make repairs as necessary	Number of repairs made and a reduction of 5% in unauthorized discharges identified
	Watershed stakeholders; all CCN holders in the watersheds	Develop a plan for the upcoming year to help prioritize efforts	Development of a plan for the upcoming year that prioritizes efforts
	Education providers	Initiate education programs, if possible and pursue funds as needed	Number of materials developed, distributed, and individuals contacted. If needed, successful submission of grant proposal
2-5	All CCN holders in the watersheds	Continue conducting visual inspections of infrastructure and making repairs as necessary	Number of repairs made and a reduction of 10% in unauthorized discharges identified annually
	Watershed stakeholders; all CCN holders in the watersheds	Continue planning for upcoming year repairs	Continue the development of an annual plan for the upcoming year that prioritizes efforts
	Watershed stakeholders; all CCN holders in the watersheds	Continue to pursue and secure funds for education programs	Successfully secured funding for education programs as needed
	Watershed stakeholders; all CCN holders in the watersheds	Continue education and outreach programs as appropriate	Number of materials developed, distributed, and individuals contacted.
	Responsible parties	**Activities needed**	**Estimated costs**
	City of Taft	Upgrading infrastructure	$2,700,000
	Other responsible parties	Upgrading infrastructure	Unknown

Table 30. Management Measure 8 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1-5	The City of Beeville, the City of Taft and Skidmore WSC	Adopt the goal of achieving half the permitted bacteria limits	Successfully maintain effluent bacteria concentrations at half of permitted limits
	All permitted wastewater facilities (WWTFs) in the watersheds with assistance from TCEQ; Texas A&M Engineering Extension Service (TEEX)	Assess the feasibility of achieving half the permitted bacteria limits	Increased number of WWTFs that adopt the goal of achieving half the permitted bacteria limits
	Responsible parties	**Activities needed**	**Estimated costs**
	Stakeholders and monitoring entities	Additional data collection, assessment of monitoring data and research (proposals for refinement of water quality monitoring, source assessment and dung beetle research projects)	$370,000

Table 31. Management Measure 9 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
1	Watershed stakeholders with help from Texas Water Resources Institute (TWRI), Nueces River Authority (NRA), Texas Commission on Environmental Quality (TCEQ) and Texas State Soil and Water Conservation Board (TSSWCB)	Establish data quality objectives for monitoring and pursue funding for monitoring	Successful identification of data quality objectives and successful submission of a proposal for monitoring programs
	NRA and TWRI	Enhanced/updated website with water quality monitoring data	Enhanced/updated website
	Watershed stakeholders with help from TCEQ and Texas Stream Team	Establish a volunteer monitoring program	Initiated volunteer monitoring program
2-5	NRA; TWRI; volunteer monitors with help from TCEQ and TSSWCB	Initiate and continue both volunteer monitoring and monitoring conducted under quality assurance project plans	Secure funding for monitoring and initiate/complete monitoring activities
	TWRI; Texas Stream Team (Texas State University); other educational entities	Continue education using monitoring results	Number of educational events held and number of people in attendance
	Responsible parties	**Activities needed**	**Estimated costs**
	Stakeholders/volunteers	Volunteer monitoring activities	Stakeholders/volunteers

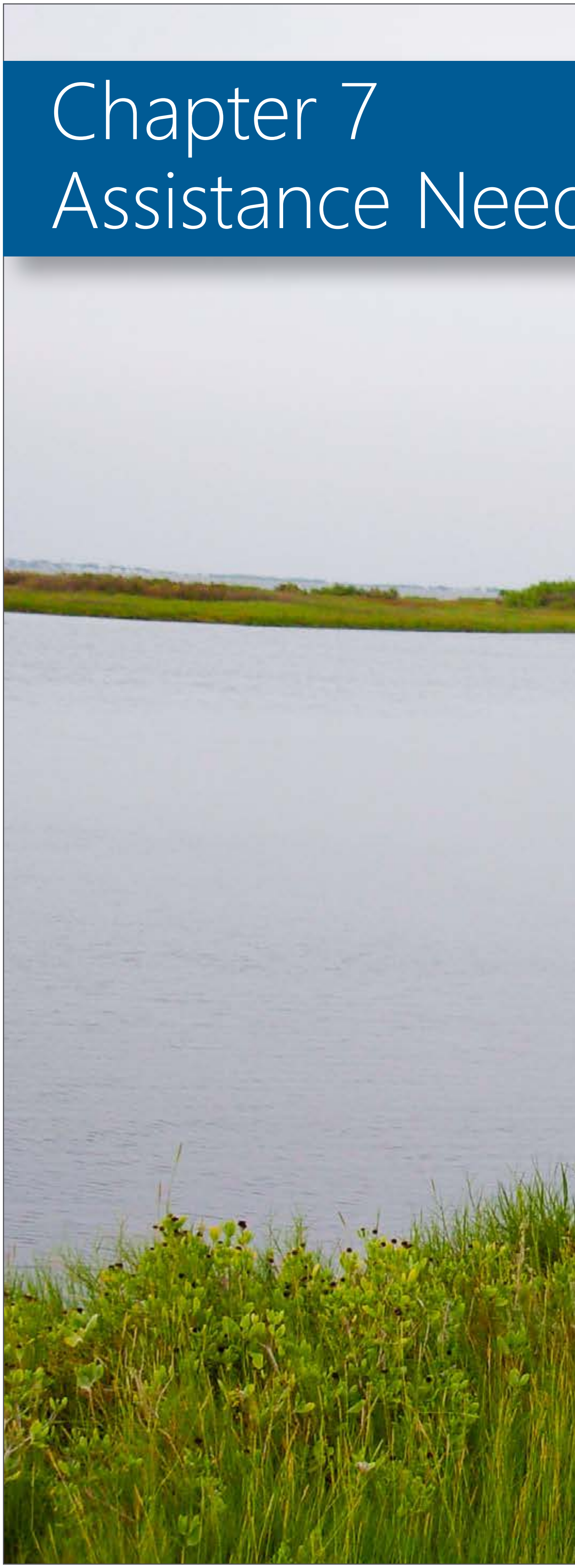
Table 32. Management Measure 10 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
All years	All permitted wastewater facilities (WWTFs) in the watersheds with assistance from Texas Rural Water Association (TRWA), Texas Commission on Environmental Quality (TCEQ), Texas A&M Engineering Extension Service (TEEX)	Monitoring effluent to ensure permit compliance	Reduction in the number of non-reported sampling events
	Responsible parties	**Activities needed**	**Estimated costs**
	All responsible parties (education providers and WWTF owners/operators)	Education for city personnel, city officials, etc., at least one event annually for the entire watershed	$25,000

Table 33. Management Measure 11 responsible parties, implementation goals, milestones, and estimated costs 2021–2026.

Plan year	Responsible Parties	Implementation measure	Interim milestones
All years	All permitted wastewater facilities (WWTFs) in the watersheds	Implement needed WWTF improvements and upgrades (see Table 32)	Number of improved and/or upgraded WWTFs
	All permitted WWTFs in the watersheds with assistance from Texas Rural Water Association (TRWA), Texas Commission on Environmental Quality (TCEQ), Texas A&M Engineering Extension Service (TEEX)	Identify when WWTF capacity is reached	Expanded capacity when WWTFs reach threshold outlined in permit
	All permitted WWTFs in the watersheds with assistance from TRWA, TCEQ, TEEX	Pursue funds to expand capacity as appropriate	Successfully secure funds for improvements as appropriate
	Responsible parties	**Activities needed**	**Estimated costs**
	Moore Street WWTF (City of Beeville)	Complete upgrade	$5–10 million
	Chase Field (City of Beeville)	Complete upgrade	$150,000
	City of Sinton	Chamber for chlorination	$600,000
	Rob and Bessie Welder Park (City of Sinton)	Chamber for chlorination	$400,000
	Town of Refugio	New clarifier	$2 million
	City of Taft	Complete upgrade	$3 million
	For all responsible parties	Education for city employees, elected officials, etc., estimated $2,000 for one event annually in each city	$120,000

Chapter 7
Assistance Needs



Introduction

The Mission and Aransas rivers watersheds are largely rural watersheds with limited resources available for the implementation of the management measures identified by stakeholders. This chapter identifies the potential sources of technical and financial assistance available to maximize the implementation of management measures. Grant funding will likely be a substantial source of implementation funding given the availability of resources identified thus far.

Technical Assistance

Designing, planning, and implementing some of the management recommendations in the plan will require technical expertise. In these cases, appropriate support will be sought to provide needed technical guidance. Funds required to secure needed expertise will be included in requests for specific projects and may come from a variety of sources. Table 34 provides a summary of the potential sources of technical assistance for each management measure.

Livestock Management

Developing and implementing practices to improve livestock management will require significant technical assistance from TSSWCB, TPWD, AgriLife Extension, and local NRCS personnel. Producers requesting planning assistance in the watershed will work with these entities to define operation-specific management goals and objectives and develop a management plan that prescribes effective practices that will achieve stated goals while also improving water quality.

Tax Exemption

Technical assistance for altering tax exemption requirements for small acreage landowners will be provided by the Texas Comptroller of Public Accounts to ensure that all requirements of the tax code have been met. Technical resources can be found at the V.G. Young Institute of County Government's website: https://vgyi.tamu.edu/.

Table 34. Summary of potential sources of technical assistance.

Management Measure (MM)	Technical Assistance
MM 1: Develop and implement conservation plans in priority areas of the watershed	Texas State Soil and Water Conservation Board (TSSWCB), Texas A&M AgriLife Service, United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), and Texas Parks and Wildlife Department (TPWD)
MM 2: Explore feasibility of altering Tax exemption requirements for small acreage landowners	Texas Comptroller of Public Accounts office to ensure that all requirements of the tax code have been met
MM 3: Promote the management of and control feral hog populations	Texas A&M AgriLife Extension Service Texas Wildlife Services (TWS)
MM 4: Promote the reduction of illicit dumping and proper disposal of animal carcasses	Texas A&M AgriLife County Extension Agents TCEQ Region 14 TCEQ Small Business and Local Government Assistance Program
MM 5: Identify OSSFs, prioritize problem areas, and systematically Work to bring failing systems into compliance	TCEQ Region 14 TCEQ Small Business and Local Government Assistance Program
MM 6: Promote the improved quality of and management of urban stormwater	TCEQ Region 14
MM 7: Coordinate efforts to reduce unauthorized discharges	TCEQ Region 14
MM 8: Reduce WWTF contributions by meeting half of the permitted bacteria limit	TCEQ, Texas A&M Engineering Extension Service (TEEX)
MM 9: Coordinate and expand existing water quality monitoring in the watershed	Texas Water Resources Institute (TWRI) TCEQ TSSWCB Local stakeholders Nueces River Authority (NRA)
MM 10: Improve monitoring of WWTF effluent to ensure permit compliance	TCEQ permit compliance assistance TEEX – WWTF operation and maintenance Texas Rural Water Association (TRWA) – sample collection and handling Private engineering firms – general civil engineering services
MM 11: Improve and upgrade WWTFs	TCEQ permit compliance assistance TEEX – WWTF operation and maintenance TRWA and private engineering firms

Feral Hog Management

Watershed stakeholders will benefit from technical assistance regarding feral hog control approaches, options, best practices, and regulations. AgriLife Extension and Texas Wildlife Services (TWS) provide educational resources through local programs and public events. Technical resources regarding trap and transport regulations, trap construction and design, exclusion fencing construction, and other related feral hog resources are available through AgriLife Extension as publications and videos for homeowners: https://feralhogs.tamu.edu/.

Illicit Dumping

Efforts to reduce illicit dumping will focus on education and outreach. AgriLife Extension will provide technical assistance with education and outreach efforts. TCEQ Region 14 will, as resources are available, provide local governments with support for efforts to mitigate illicit dumping. TCEQ's Small Business and Local Government Assistance Program will provide technical assistance to local governments for developing the best approaches to reducing illicit dumping.

OSSF Management

Technical support is needed to address failing OSSFs throughout the Mission and Aransas rivers watersheds. Technical assistance will be sought from TCEQ Region 14 and TCEQ's Small Business and Local Government Assistance Program who will provide local governments will support and/assistance in implementing OSSF activities as well as identifying the best approach for addressing OSSF issues as funds become available.

Urban Stormwater

Limited technical assistance is available to address urban stormwater in these largely rural watersheds. TCEQ Region 14 will provide local governments with support and/or assistance in implementing structural and projects and education by providing general information on stormwater management.

Unauthorized Discharges

TCEQ Region 14 will receive and record unauthorized discharge information from respective CCN holders and assist cities with TCEQ rules and regulations.

WWTFs

Texas A&M Engineering Extension Service (TEEX) and other relevant organizations can provide technical assistance to the WWTF owners and operators in the watersheds. TCEQ's Small Business and Local Government Assistance Program can also provide, as resources are available, technical assistance to local governments for evaluating the capabilities and operating procedures of existing wastewater systems. TEEX provides education and training to wastewater operators and focuses training on optimizing treatment quality.

Watershed Monitoring

Texas Water Resources Institute (TWRI) will assist, as funding allows, in coordinating monitoring efforts in the watershed. TWRI will assist watershed stakeholders in the development of monitoring proposals and will manage the monitoring projects to ensure that they are completed as described. NRA can provide monitoring services through TCEQ's CRP or through grant-funded projects, as funding allows. NRA can also provide technical assistance to other responsible parties. TCEQ's CRP can provide further technical assistance in determining monitoring frequency and locations.

Education and Outreach

Continued delivery of education and outreach resources to watershed stakeholders is critical for successful implementation of the WPP. The education program will address relevant topical areas and will require cooperation, coordination, and participation by multiple entities. Topical experts, local entity staff, and others as appropriate will be relied upon to deliver necessary content to targeted audiences. Existing resources will be used where possible, and local efforts to provide these resources to broad-based and targeted audiences will be continued. Should additional funding needs arise for content development or delivery, supplemental funds from external sources will be sought.

Education delivery will focus on primary sources of bacteria and other pollutants identified throughout the watershed. Landscape and water resource management, OSSF operation and maintenance, OSSF design and installation, stormwater management, feral hog biology and management, and livestock management programming will all be delivered in the watershed in multiple locations as demand warrants (Table 35).

Training for city and county staff is also necessary for effectively reducing pollutant loading in the watershed. Many staff are required to obtain continuing education credits on an incremental basis in their respective areas of expertise. This education will further protect and improve local water resources by ensuring that appropriate personnel are informed of new techniques, requirements and resources.

Financial Assistance Sources

Successful implementation of the Mission and Aransas Rivers WPP, as written, will require substantial fiscal resources. Diverse funding will be sought to meet these needs. Resources will be leveraged where possible to extend the impacts of acquired and contributed implementation funds.

Many landowners are already engaged in implementing the WPP through the development and implementation of WQMPs and instal¬lation of other conservation practices through Farm Bill-funded programs such as USDA NRCS Environmental Quality Incentives Program (EQIP). The continued funding support from federal and state governments will provide a large portion of funds needed to implement this WPP.

Table 35. Education component listed for each management measure and costs.

Management Measure (MM)	Technical Assistance	Cost
MM 1: Develop and implement conservation plans in priority areas of the watershed	Lone Star Healthy Streams Program Riparian Stream Ecosystem Education Program Nueces River Authority's (NRA) South Texas Land and Water Initiative Remarkable Riparian Online Resources	$300,000
MM 2: Explore feasibility of altering Tax exemption requirements for small acreage landowners	Deliver materials and messages about small acreage impacts on water qualtiy to elected officials. Education to small acreage landowners about the impact of overstocking and the importance of adopting a conservation plan.	$115,000
MM 3: Promote the management of and control feral hog populations	Texas A&M AgriLife programs on feral hog removal TWS Feral Hog Abatement Program	$37,500
MM 4: Promote the reduction of illicit dumping and proper disposal of animal carcasses	Education for local officials and stakeholders about the impact and reduction of illicit dumping. Strategies include signage at bridge crossings and educational inserts in water bills. Education strategies for showing hunters how to properly dispose animal caracasses incude: flyers at feed stores, direct mailing, newspaper and magazine articles, and billboards.	$115,000
MM 5: Identify OSSFs, prioritize problem areas, and systematically work to bring failing systems into compliance	Texas A&M AgriLife Extension Programs for homeowners about proper operation and maintenance requirements and general OSSF requirements. Online materials can be found at http://ossf.tamu.edu/.	$85,000
MM 6: Promote the improved quality of and management of urban stormwater	Public service announcements, utility bill inserts, direct mailing, educational kiosks, and pet waste stations at parks and public environmental events.	$125,000
MM 7: Coordinate efforts to reduce unauthorized discharges	Education for city personnel to know how to inspect infrastructure to identify repairs and areas that may fail in the future. Education for local residents about how to identify wastewater infrastructure failures and how to report these failures to the appropriate authorities.	N/A*
MM 8: Reduce WWTF contributions by meeting half of the permitted bacteria limit	Education for both city personnel and elected officials in order to reduce WWTF contributions.	N/A*
MM 9: Coordinate and expand existing water quality monitoring in the watershed	Educate stakeholders about ongoing water quality monitoring and how to access results. Results will be placed on a website that can be located easily and that contains multiple information components such as land use, hydrology, soils, historical water quality data, and other information of interest to stakeholders. Establish voluntary monitoring program	N/A*
MM 10: Improve monitoring of WWTF effluent to ensure permit compliance	Educating stakeholders about monitoring and accessing data. A watershed website for the Mission and Aransas rivers should be created as well as forums for stakeholder input.	$25,000
MM 11: Improve and upgrade WWTFs	Training staff to properly collect and handle samples of treated effluent, identify malfunctioning equipment, and determine need for system upgrades.	$120,000

*Additional funding not required; currently funded through existing resources

Table 36. Summary of financial assistance programs listed by management measure.

Management Measure (MM)	Technical Assistance
MM 1: Develop and implement conservation plans in priority areas of the watershed	Agricultural Conservation Easement Program (ACEP) Agricultural Food Research Initiative Competitive Fellowship Grants Program Coastal Wetlands Conservation Grants Coastal Zone Management Act (CZMA) Awards Conservation Innovation Grants Conservation Stewardship Program Environmental Education Grants Environmental Quality Incentives Program (EQIP) Farm Business Management and Benchmarking (FBMB) Program Federal and state Clean Water Act (CWA) §319(h) Grants (U.S. Environmental Protection Agency/Texas Commission on Environmental Quality [TCEQ]/Texas State Soil and Water Conservation Board [TSSWCB]) Integrated Programs National Integrated Water Quality Program Regional Conservation Partnership Program (RCPP) Sustainable Agriculture Research and Education (SARE) Targeted Watershed Grants Program
MM 2: Explore feasibility of altering Tax exemption requirements for small acreage landowners	State CWA §319(h) Grants (TCEQ/TSSWCB)
MM 3: Promote the management of and control feral hog populations	State CWA §319(h) Grants (TSSWCB) or other available opportunities. Texas Department of Agriculture (TDA) Texas Wildlife Services
MM 4: Promote the reduction of illicit dumping and proper disposal of animal carcasses	State CWA §319(h) Grants (TCEQ/TSSWCB) USDA Rural Utilities Service Water and Waste Disposal Loans and Grants
MM 5: Identify OSSFs, prioritize problem areas, and systematically Work to bring failing systems into compliance	Coastal Impact Assistance Program Coastal Management Program (CMP) and Coastal Zone Management Program (CZM) State CWA §319(h) grants (TCEQ)
MM 6: Promote the improved quality of and management of urban stormwater	Clean Water State Revolving Fund (CWSRF) Environmental Education Grants State CWA §319(h) Grants Urban Water Small Grants
MM 7: Coordinate efforts to reduce unauthorized discharges	CWSRF Economically Distressed Areas Program (EDAP) Water and Waste Disposal Loans and Grants (SRF)
MM 8: Reduce WWTF contributions by meeting half of the permitted bacteria limit	CWSRF EDAP CWSRF
MM 9: Coordinate and expand existing water quality monitoring in the watershed	TCEQ's Surface Water Quality Program TCEQ and NRA's Clean Rivers Program Texas General Land Office's CMP
MM 10: Improve monitoring of WWTF effluent to ensure permit compliance	CWSRF EDAP Water and Waste Disposal Loans and Grants
MM 11: Improve and upgrade WWTFs	CWSRF EDAP Water and Waste Disposal Loans and Grants

Grant funds will be relied upon to initiate implementation efforts. Existing state and federal programs will also be expanded or leveraged with acquired funding to further implementation activities. Grant funds are not a sustainable source of financial assistance but are necessary to assist in WPP implementation. Other sources of funding will be utilized, and creative funding approaches will be sought where appropriate. Sources of funding that are applicable to this WPP and will be sought as appropriate are described in this chapter. Table 36 provides a summary of the potential sources of financial assistance for each management measure.

Federal Sources

Agricultural Conservation Easement Program (ACEP)

ACEP provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps Native American tribes, state, and local governments, as well as nongovernmental organizations, protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands.

Coastal Zone Management Program (CZM) and Coastal Management Program (CMP)

The CZM Program, administered by the National Oceanographic and Atmospheric Administration and the Texas General Land Office (TGLO), is a voluntary partnership between the federal government and U.S. coastal and great lake states and territories and is authorized by the Coastal Zone Management Act (CZMA) of 1972 to address national coastal issues. The CZMA provides funding for protecting, restoring, and responsibly developing the United States' diverse coastal communities and resources. To meet the CZMA goals, the CZM Program takes a comprehensive approach to coastal resource management, balancing the often competing and occasionally conflicting demands of coastal resource use, economic development, and resource conservation. Some of the key elements of the CZM Program include:

- protecting natural resources;
- managing development in high hazard areas;
- giving development priority to coastal-dependent uses;
- providing public access for recreation; and
- coordinating state and federal actions.

The CZM Program provides pass-through funding to TGLO, which in turn, uses the funding to finance coastal restoration, conservation, and protection projects under TGLO's CMP.

Clean Water Act §319(h) Nonpoint Source Grant Program

EPA provides grant funding to the state of Texas to implement projects that reduce nonpoint source pollution through the §319(h) Nonpoint Source Grant Program. These grants are administered by TCEQ and TSSWCB in the state of Texas. WPPs that satisfy the nine key elements of successful watershed-based plans are eligible for funding through this program. To be eligible for funding, implementation measures must be included in the accepted WPP and meet other program rules. Some commonly funded items include:

- development and delivery of educational programs;
- water quality monitoring; and
- OSSF repairs and replacements, land BMPs, water body clean-up events and others.

Further information can be found at https://www.tceq.texas.gov/waterquality/nonpoint-source/grants/grant-pgm.html and http://www.tsswcb.texas.gov/managementprogram.

Conservation Innovation Grants (CIG)

The USDA administers the CIG program, which is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environ¬mental enhancement and protection, in conjunction with agricultural production. Under CIG, EQIP funds are used to award competitive grants to non-federal governmental or nongovernmental organizations, tribes, or individuals.

Coastal Impact Assistance Program (CIAP)

CIAP provides federal grant funds derived from federal offshore lease revenues in oil producing states for conservation, protection, and/or restoration of coastal areas including wetlands. The program also provides funding for mitigation of damage to fish, wildlife, or natural resources; planning assistance and administrative costs of complying with planning objectives; implementation of a federally approved marine, coastal, or comprehensive conservation management plan; and mitigation of the impact of outer continental shelf activities through funding of onshore infrastructure projects and public services.

Conservation Stewardship Program (CSP)

CSP is a voluntary conservation program administered by USDA NRCS that encourages producers to address resource concerns in a comprehensive manner by undertaking additional conservation activities as well as improving, maintaining, and managing existing conservation activities. The program is available for private agricultural lands including cropland, grassland, prairie land, improved pasture, and rangeland. CSP encourages landowners and stewards to improve conservation activities on their land by installing and adopting additional conservation practices. Practices may include, but are not limited to, prescribed grazing, nutrient management planning, precision nutrient application, manure application, and integrated pest management. Program information can be found at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/.

Environmental Education (EE) Grants

Under the EE Grant Program, EPA seeks grant proposals from eligible applicants to support environmental education projects that promote environmental stewardship and help develop knowledgeable and responsible students, teachers, and citizens. This grant program provides financial support for projects that design, demonstrate, and/or disseminate environmental education practices, methods, or techniques as described in requests for proposals.

Environmental Quality Incentives Program (EQIP)

Operated by USDA NRCS, EQIP is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of 10 years. These contracts provide financial assistance to help plan and implement conservation practices that address natural resource concerns in addition to opportunities to improve soil, water, plant, animal, air, and related resources on agricultural land and non-industrial private forestland. Individuals engaged in livestock or agricultural production on eligible land are permitted to participate in EQIP. Practices selected address natural resource concerns and are subject to the NRCS technical standards adapted for local conditions. They also must be approved by the local SWCD. Local work groups are formed to provide recommendations to the USDA NRCS that advise the agency on allocations of EQIP county-based funds and identify local resource concerns. Watershed stakeholders are strongly encouraged to participate in their local work group to promote the objectives of this WPP with the resource concerns and conservation priorities of EQIP. Information regarding EQIP can be found at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.

Fish and Wildlife Service National Coastal Wetlands Conservation Grants

The Coastal Wetlands Conservation Grants Program is an effective approach that assists states to acquire, restore, manage, and enhance their coastal wetland resources. The program's emphasis on encouraging partnerships, supporting watershed planning, and leveraging existing funds produces maximum benefits.

National Institute of Food and Agriculture (NIFA) Farm Business Management and Benchmarking (FBMB) Competitive Grants Program

The FBMB Competitive Grants Program provides funds to (1) improve the farm management knowledge and skills of agricultural producers; and (2) establish and maintain a national, publicly available, farm financial management database to support improved farm management.

NIFA Integrated Programs

NIFA Integrated Programs provide support for integrated research, education, and extension activities. Integrated, multifunctional projects are particularly effective in addressing important agricultural issues through the conduct of problem-focused research that is combined with education and extension of knowledge to those in need of solutions. These activities address critical national, regional, and multistate agricultural issues, priorities, or problems. Integrated programs hold the greatest potential to produce and disseminate knowledge and technology directly to end users while providing for educational opportunities to assure agricultural expertise in future generations.

NIFA Agricultural Food Research Initiative Competitive Fellowship Grants

The goal of the NIFA Agricultural Food Research Initiative Competitive Fellowship Grants Programs is to provide funding for fundamental and applied research, extension, and education to address food and agricultural sciences. Six topic areas are eligible for funding: (1) plant health and production and plant products; (2) animal health and production and animal products (3); food safety, nutrition, and health (4); renewable energy, natural resources, and environment (5); agriculture systems and technology; and (6) agriculture economics and rural communities.

National Integrated Water Quality Program (NIWQP)

The NIWQP provides funding for research, education, and extension projects aimed at improving water quality in agricultural and rural watersheds. The NIWQP has identified eight themes that are being promoted in research, education, and extension. The eight themes are (1) animal manure and waste management; (2) drinking water and human health; (3) environmental restoration; (4) nutrient and pesticide management; (5) pollution assessment and prevention; (6) watershed management; (7) water conservation and agricultural water management; and (8) water policy and economics. Awards are made in four program areas: national projects, regional coordination projects, extension education projects, and integrated research, education, and extension projects. It is important to note that funding from this program is only available to universities.

Regional Conservation Partnership Program (RCPP)

RCPP is a new, comprehensive, and flexible program that uses partnerships to stretch and multiply conservation investments and reach conservation goals on a regional or watershed scale. Through RCPP and NRCS, state, local, and regional partners coordinate resources to help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved. Information regarding RCPP can be found at https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/rcpp/.

Rural Development Water and Environmental Programs

USDA Rural Development provides grants and low interest loans to rural communities for potable water and wastewater system construction, repair, or rehabilitation. Funding options include:

- Rural Repair and Rehabilitation Loans and Grants: Provide assistance to make repairs to low-income homeowners' housing to improve or remove health and safety hazards.
- Technical Assistance and Training Grants for Rural Waste Systems: Provide grants to nonprofit organizations that offer technical assistance and training for water delivery and waste disposal.
- Water and Waste Disposal Direct Loans and Grants: Assist in developing water and waste disposal systems in rural communities with populations less than 10,000 individuals.

More Information about the Rural Development Program can be found at http://www.rd.usda.gov/programs-services/all-programs/water-environmental-programs.

Sustainable Agriculture Research and Education (SARE)

The SARE program funds efforts that enhance the capabilities of Texas agricultural professionals in the area of sustainable agriculture. Grants and education are available to advance innovations in sustainable agriculture. The grants are aimed at advancing sustainable innovations and have contributed to an impressive portfolio of sustainable agriculture efforts across the nation.

Targeted Watershed Grant Program

The Targeted Watersheds Grant Program is designed to encourage successful community-based approaches and management techniques to protect and restore the nation's watersheds. The Targeted Watersheds Grant Program is a competitive grant program based on the fundamental principles of environmental improvement: collaboration, new technologies, market incentives, and results-oriented strategies. The Targeted Watersheds Grant Program focuses on multi-faceted plans for protecting and restoring water resources that are developed using partnership efforts of diverse stakeholders.

Urban Water Small Grants Program

The objective of the Urban Waters Small Grants Program, administered by EPA, is to fund projects that will foster a comprehensive understanding of local urban water issues, identify and address these issues at the local level, and educate and empower the community. In particular, the Urban Waters Small Grants Program seeks to help restore and protect urban water quality and revitalize adjacent neighborhoods by engaging communities in activities that increase their connection to, understanding of, and stewardship of local urban waterways.

More information about the Urban Waters Small Grants Program can be found at https://www.epa.gov/urbanwaters/urban-waters-small-grants.

State Sources

Clean Rivers Program

TCEQ administers Texas CRP, a state fee-funded program that provides SWQM, assessment, and public outreach. Allocations are made to 15 partner agencies (primarily river authorities) throughout the state to assist in routine monitoring efforts, special studies, and outreach efforts. NRA is the CRP partner for the Mission and Aransas rivers watersheds. The program supports water quality monitoring and annual water quality assessments and engages stakeholders in addressing water quality concerns in the San Antonio-Nueces Coastal Basin.

More information about the CRP is available at https://www.nueces-ra.org/CP/CRP/.

Clean Water State Revolving Fund (CWSRF)

The CWSRF, authorized through the CWA and administered by TWDB, provides low-interest loans to local governments and service providers for infrastructure projects that include stormwater BMPs, WWTFs, and collection systems. The loans can spread project costs over a repayment period of up to 20 years. Repayments are cycled back into the fund and used to pay for additional projects. More information on CWSRF is available at http://www.twdb.texas.gov/financial/programs/CWSRF/.

Economically Distressed Areas Program (EDAP)

EDAP provides financial assistance to fund water and wastewater services in economically distressed areas where such services do not exist or where services do not meet minimum state standards.

Feral Hog Abatement Grant Program

The Texas Department of Agriculture (TDA) provides grant funding to governmental agencies (counties, cities, etc.) and Texas higher education institutions for practical and effective projects to develop and implement long-term feral hog abatement strategies. AgriLife Extension and TPWD currently receive funding through this program. In the past, individual and groups of counties have applied to receive funds for programs to control feral hogs, including providing community traps or bounty payments. More information is available at https://www.texasagriculture.gov/GrantsServices/TradeandBusinessDevelopment/FeralHogGrantProgram.

Landowner Incentive Program

TPWD administers the Landowner Incentive Program to work with private landowners to implement conservation practices that benefit healthy aquatic and terrestrial ecosystems and create, restore, protect, or enhance habitat for rare or at-risk species. The program provides financial assistance but does require the landowner to contribute through labor, materials, or other means. Further information about this program is available at http://tpwd.texas.gov/landwater/land/private/lip/.

Texas Wildlife Services

TWS is available to provide assistance in addressing feral hog issues and will remain available to all citizens of the state. Since 2008, TDA has awarded grants to TWS for a feral hog abatement program. The grants are used to carry out a number of specifically identified direct control projects where control efforts can be measured. Certain areas of the state have been targeted due to the contributions from feral hogs to impaired water quality and bacteria loading.

OSSF Training Reconnaissance and Replacement Program

Funded by TCEQ's CWA Section 319(h) Nonpoint Source Program, the purpose of this program is to fund reconnaissance efforts in coastal counties to identify areas of chronic OSSF failure and to offer funding for OSSF maintenance and/or replacement costs and for training on OSSF maintenance and inspection. This project is designed to address measures necessary to achieve a federally approved CMP as required under the Coastal Zone Act Reauthorization Amendments of the CZMA.

Other Sources

Private foundations, nonprofit organizations, land trusts, and individuals can potentially assist with implementation funding of some aspects of the WPP. Funding eligibility requirements for each program should be reviewed before applying to ensure applicability. Some groups that may be able to provide funding include but are not limited to:

- Cynthia and George Mitchell Foundation: Provides grants for water and land conservation programs to support sustainable protection and conservation of Texas' land and water resources
- Dixon Water Foundation: Provides grants to nonprofit organizations to assist in improving/maintaining watershed health through sustainable land management
- Meadows Foundation: Provides grants to nonprofit organizations, agencies, and universities engaged in protecting water quality and promoting land conservation practices to maintain water quality and water availability on private lands
- Texas Agricultural Land Trust: Provides funding to assist in establishing conservation easements for enrolled lands

Chapter 8 Implementation Support and Success

Introduction

Effectively implementing this WPP will take concerted efforts by many dedicated stakeholders; however, they will need additional support in many cases. Coordinating actual implementation efforts, working to secure funding, tracking implementation progress, and monitoring to demonstrate implementation success are all activities that are beyond the responsibility of a single stakeholder. Additional implementation support needs are described below.

Water Quality Monitoring

Because the goal of the WPP is to improve and restore water quality in the Mission and Aransas rivers watersheds, continued monitoring is necessary. Monitoring data are also necessary to track changes in water quality that result from WPP implementation. However, water quality is affected by many factors in a watershed, and any changes that occur from WPP implementation may be difficult to identify in the rivers. A focused monitoring approach that utilizes several types of monitoring is recommended to provide needed data to gage implementation success.

Watershed Coordinator

Implementing the WPP will require significant time and effort. Therefore, we recommend a dedicated, funded watershed coordinator to support plan implementation. This position will be responsible for working with stakeholders to identify funding opportunities, develop and file funding applications, administer projects, keep stakeholders engaged, coordinate and organize educational programming, track implementation progress, and document changes in water quality condition. With the proximity of the Tres Palacios watershed and overlapping stakeholder groups common to these watersheds, it might be cost effective to share watershed coordinator resources with this watershed. A full-time watershed coordinator is estimated at $95,000 per year with salary, benefits, travel, and supplies required for the position. Without municipalities, local NGOs, and other potential organizations that could fund this position, grant funding will be critical.

Routine Water Quality Monitoring

Quarterly water quality monitoring conducted in the watershed by NRA through the CRP program has and will continue to be the standard for assessing instream water quality. NRA currently monitors six stations in the Mission and Aransas rivers watersheds and plans to continue monitoring at this level for the foreseeable future. All of these stations are monitored on a quarterly basis. Stations monitored include 12943 (FM 2678) and 12944 (US 77) on the Mission River and stations 12947 (FM 629), 12948 (US 77), 12952 (County Road E of Skidmore), and 12937 (State Highway 202). Data collected at these sites includes bacteria, temperature, pH, DO, conductivity, nitrate, ammonia, total phosphorus, chlorophyll-a, and other observational data. Flow rate is only recorded at stations 12944, 12952, and 12937. Data collected at these sites will be useful for tracking long-term WPP implementation effects and will provide the benchmark for water quality improvements in the watershed as reported in biennial water quality assessments conducted by TCEQ (the *Texas Integrated Report*). This data will provide needed water quality trend information and demonstrate the cumulative effects on instream water quality.

TWRI is also conducting supplemental water quality monitoring at stations 12943, 12947, and 12948 in between the quarters that NRA is collecting data. This additional monitoring will help provide more detail on the current water quality issues and needs in both the Mission and Aransas rivers. Future supplemental monitoring is also suggested for Poesta Creek and Aransas River Above Tidal segments.

Implementation Success

WPP implementation success will be measured by progress made in achieving numerical implementation targets. Each management recommendation includes implementation targets for the 5-year implementation period (Chapter 6; Tables 22-32), which is presumed to begin in 2021. Incremental targets are also provided as benchmarks for implementation success. Water quality changes will be monitored in association with implementation success to further quantify WPP success. TWRI will track implementation across the watershed and report findings to stakeholders at least annually.

In some cases, implementation targets may not be met at the pace outlined in the WPP (Tables 22-32). This may occur due to lack of funds, stakeholder will, or other unforeseen circumstances. Should this occur, adaptive management will be utilized to adjust the WPP implementation strategy as appropriate. Adaptive management is the act of changing strategies as information is gained.

Progress toward achieving the established water quality targets of 126 MPN/100 mL for *E. coli* and 35 MPN/100 mL of *Enterococcus* will also be used to evaluate the need for adaptive management. It is understood that changes in water quality are influenced by many factors and that implementation efforts may take considerable time to appear in water quality data. Because of this, sufficient time will be allowed for implementation to occur before adaptive management will be triggered by water quality measures. Progress toward meeting the water quality target will be gaged with geometric mean assessments of the most recent 3 years of available data within TCEQ's surface water quality monitoring information system.

The *Texas Integrated Report* will also be used to gage implementation effectiveness. This document uses a 7-year moving assessment time frame that is delayed by 2 years. The 2028 *Texas Integrated Report* will be the first assessment to use data collected exclusively within the WPP implementation period. Water quality improvements may be harder to identify using this longer data window, thus these biennial assessments will not be the primary measure of implementation success. However, the *Texas Integrated Report* is the water quality benchmark for Texas and will be used to gage long-term implementation success. The watershed coordinator will be responsible for tracking implementation targets and water quality in the watershed to quantify WPP success. Data will be summarized and reported to watershed stakeholders at least annually.

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Appendix A: WPP Checklist

Name of Water Body	Mission and Aransas rivers
Assessment Units	2001_01, 2002_01, 2003_01, 2004_02, 2004_01, 2004_02, 2004A_01, 2004B_01, 2004B_02
Impairments Addressed	Bacteria: *E. coli* and *Enterococcus*
Concerns Addressed	Nitrate, total phosphorus, dissolved oxygen

Element	Report Section(s) and Page Number(s)
Element A: Identification of Causes and Sources	
1. Sources identified, described, and mapped	Chapters 2, 3, 4; pp. 6-14, pp. 22-33, pp. 35-45
2. Subwatershed sources	Chapter 4; pp. 35-45
3. Data sources are accurate and verifiable	Chapters 2, 3, 4; pp. 6-14, pp. 22-33, pp. 35-45
4. Data gaps identified	Chapter 3; pp. 15-31
Element B: Expected Load Reductions	
1. Load reductions achieve environmental goal	Chapter 4; p. 45
2. Load reductions linked to sources	Appendix D; pp. 83-92
3. Model complexity is appropriate	Appendix D; pp. 83-92
4. Basis of effectiveness estimates explained	Appendix D; pp. 83-92
5. Methods and data cited and verifiable	Appendix D; pp. 83-92
Element C: Management Measures Identified	
1. Specific management measures are identified	Chapter 5; pp. 46-54
2. Priority areas	Chapter 5; pp. 46-54
3. Measure selection rationale documented	Chapter 5; pp. 46-54
4. Technically sound	Chapter 5; pp. 46-54
Element D: Technical and Financial Assistance	
1. Estimate of technical assistance	Chapter 7; pp. 64-66
2. Estimate of financial assistance	Chapter 6, 7; pp. 55-63, pp. 64-72
Element E: Education/Outreach	
1. Public education/information	Chapter 7; p. 66
2. All relevant stakeholders are identified in outreach process	Chapter 7; p. 66
3. Stakeholder outreach	Chapter 7; p. 66
4. Public participation in plan development	Chapter 1; p. 5
5. Emphasis on achieving water quality standards	Chapter 8; p. 74
6. Operation and maintenance of best management practices	Chapter 7; pp. 64-66

Element	Report Section(s) and Page Number(s)
Element F: Implementation Schedule	
1. Includes completion dates	Chapter 6; pp. 55-63
2. Schedule is appropriate	Chapter 6; pp. 55-63
Element G: Milestones	
1. Milestones are measurable and attainable	Chapter 6; pp. 55-63
2. Milestones include completion dates	Chapter 6; pp. 55-63
3. Progress evaluation and course correction	Chapter 6; pp. 55-63
4. Milestones linked to schedule	Chapter 6; pp. 55-63
Element H: Load Reduction Criteria	
1. Criteria are measurable and quantifiable	Chapter 4; pp. 34-38
2. Criteria measure progress toward load reduction goal	Chapter 4; pp. 34-38
3. Data and models identified	Chapter 4; pp. 34-38
4. Target achievement dates for reduction	Chapter 8; p. 74
5. Review of progress toward goals	Chapter 8; p. 74
6. Criteria for revision	Chapter 8; p. 74
7. Adaptive management	Chapter 8; p. 74
Element I: Monitoring	
1. Description of how monitoring used to evaluate implementation	Chapter 8; p. 74
2. Monitoring measures evaluation criteria	Chapter 8; pp 73-74
3. Routine reporting of progress and methods	Chapter 8; pp 73-74
4. Parameters are appropriate	Chapter 8; pp 73-74
5. Number of sites is adequate	Chapter 8; pp 73-74
6. Frequency of sampling is adequate	Chapter 8; pp 73-74
7. Monitoring tied to QAPP	Chapter 8; pp 73-74
8. Can link implementation to improved water quality	Chapter 8; pp 73-74

Appendix B: Land Use/Land Cover Definitions and Methods

Watershed land use and land cover information was obtained from the 2011 NLCD (Dewitz & USGS 2014). ArcGIS 10.3 software by Esri was used to process the data and quantify land use and land cover categories within defined subwatersheds (Table 1). Category definitions are:

- Developed: Land use category that includes areas of high, medium, and low development and developed open space. Development includes areas where people live or work in high numbers, areas with a mixture of vegetation and constructed materials. Open space includes areas where vegetation cover is dominant with some development, such as golf courses, parks, and large homes. Impervious surfaces account for 50–100% for development areas and less than 20% for open space. For this combined category, development is present and impervious surfaces are between 0% and 100%.
- Barren land: Bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material compose the barren land classification. Generally, vegetation accounts for less than 15% of total cover.
- Cultivated crops: Areas used to produce annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
- Forest: Areas dominated by trees generally taller than 5 meters and greater than 20% of total vegetation cover. Species include deciduous, evergreen, and those that do not fall into either category.
- Wetlands: Includes wetlands and emergent herbaceous wetlands. The vegetation in wetlands consists of forests, shrublands, and/or perennial herbaceous vegetation, accounting for 25–100% of cover. Emergent herbaceous wetlands consist of 75–100% of perennial herbaceous vegetation and the soil or substrate is covered or periodically saturated with water.
- Hay/pasture: Areas that include a variety of grasses, legumes, or grass-legume mixtures plant for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
- Herbaceous: Areas that are dominated by graminoid (grasses) or herbaceous vegetation with the areas consisting of 80% total vegetation. The areas may be utilized for grazing, but not for intensive BMPs.
- Open water: All areas of open water, generally with less than 25% cover of vegetation or soil.
- Shrub/scrub: Areas that are dominated by woody plants or shrubs that are less than 5 meters tall and a canopy typically greater than 20% of total vegetation.

References

Dewitz J, and U.S. Geological Survey. 2021. National Land Cover Database 2019 Products (ver. 2.0, June 2021): U.S. Geological Survey data release, Reston, VA: U.S. Geological Survey. https://doi.org/10.5066/P9KZCM54.

Appendix C: Load Duration Curve Development

Modified Load Duration Curves

Traditionally, the LDC approach has been restricted in TMDL development to freshwater, non-tidally influenced streams and rivers. The reason for excluding application of LDCs in TMDL development for tidally influenced stream and river systems is the presence of seawater in these river systems, i.e., an additional flow that has a loading. An assumption behind the LDC approach is that the loadings of bacteria are derived exclusively from the sources of the stream flows. These sources and their associated loadings may be varied, but it is inherently assumed that they may be computationally determined based on the streamflow at the selected exceedance frequency on the LDC used for the load allocation (LA). But in a tidal system, there is other water (i.e., seawater) that is a source with an associated loading that must be considered.

If the LDC approach is to be adapted to tidally influenced streams and rivers, some means of addressing the additional water and loadings from the seawater that mixes with freshwater in tidal rivers is needed. Oregon's Umpqua Basin Bacteria TMDL provides a modification of the LDC approach that accounts for the seawater component (ODEQ 2006).

The Umpqua Basin Bacteria TMDL approach is based on determining the volume of seawater that must be mixed with the volume of freshwater going down the river to arrive at the observed salinity using a simple mass balance approach as provided in the following:

$$(V_r + V_s) \times S_t = V_r \times S_r + V_s \times S_s \qquad \text{(A-1)}$$

Where:

V_r = volume daily river flow (cubic meters) = Q (cfs)×86,400 (seconds/day); where Q = river flow (cfs)
V_s = volume of seawater
S_t = salinity in river (parts per thousand [ppt])
S_r = background salinity of river water (ppt); assumed to be close to 0 ppt
S_s = salinity of seawater (35 ppt)

As noted in the computation of V_r, the volumes are time-associated using a day as the temporal measure, thus providing the proper association for the daily pollutant load computation. Through algebraic manipulation this mass balance equation can be solved for the daily volume of seawater required to be mixed with freshwater (again, freshwater having an assumed salinity of 0 ppt) giving the equation found in the ODEQ (2006) technical information:

$$V_s = V_r/(S_s/S_t - 1) \qquad \text{(A-2)}$$

for St > than background salinity; otherwise $V_s = 0$

For the Umpqua Basin tidal streams (Figure 40), as well as the present application to Mission River Tidal and Aransas River Tidal, regressions were developed of S_t to Q using measured salinity data (S_t) with freshwater flows (Q). These regressions all had some streamflow above which $S_t = 0$. The daily Q and regression-developed S_t were then used to compute V_s. As S_t approaches zero, V_s likewise approaches a value of zero in Equation A-2, meaning the only flow present is the river flow (Q or V_r).

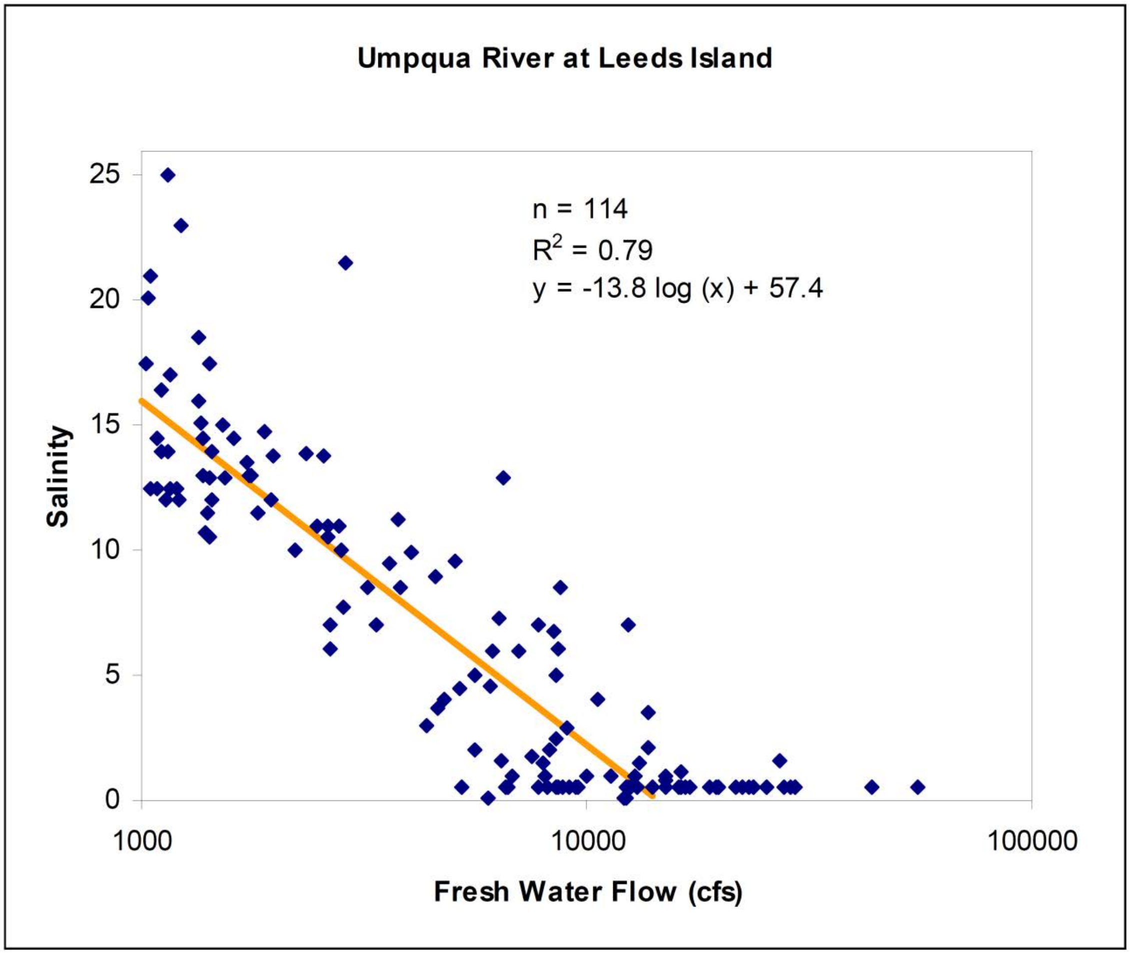

Figure 40. Example salinity to flow regression from Umpqua Basin tidal streams (ODEQ 2006).

It is also relevant to discuss the response of measured salinities at assessment stations to streamflow and the streamflows above which salinities approach background levels (again, assumed to be 0 ppt) within the context of FDCs for the Mission and Aransas rivers. These FDCs and the plotted flow exceedance values where salinities approach background should be viewed from the perspective of TCEQ's approach for bacteria TMDLs. Within the TCEQ TMDL approach with indicator bacteria, the highest flow regime is selected for developing the pollutant LA. This flow regime is defined as the range of 0–10% for Mission River Tidal and Aransas River Tidal. All the flows in the highest flow regime are greater than the amount of streamflow indicated by the regression analysis as needed to result in an absence of seawater.

The significance of the above observation is related to what happens within the modified LDC approach when salinities are at background. As salinity approaches background, V_s in Equation A-2 approaches a value of zero and in fact would be defined as zero when salinities are at background levels, resulting in the modified LDC flow volume ($V_s + V_r$) defaulting to the flow of the river, i.e., no modification occurring to that portion of the LDC. Therefore, regarding the pollutant LA process for Mission River Tidal and Aransas River Tidal, the modified LDC method provides identical allowable loadings in the highest flow regime to those that would be computed using the standard LDC method that does not include tidal influences. The identical results of the modified and standard LDC method for the highest flow regime is the physical reality indicated in the observed salinity data. The data indicate that, at these elevated streamflows, seawater is effectively pushed completely out into Copano Bay. But the other implication, in hindsight, is that for these two tidal rivers, the same pollutant LA results would be determined with the LDC method with or without tidal influences being considered due to development of the TMDL for the higher streamflows.

Continuing with the theoretical development of the modified LDC for the Umpqua TMDLs, a total daily volume (V_t) is comprised of V_r computed from Q and the volume of seawater (V_s):

$$V_t = V_r + V_s \qquad \text{(A-3)}$$

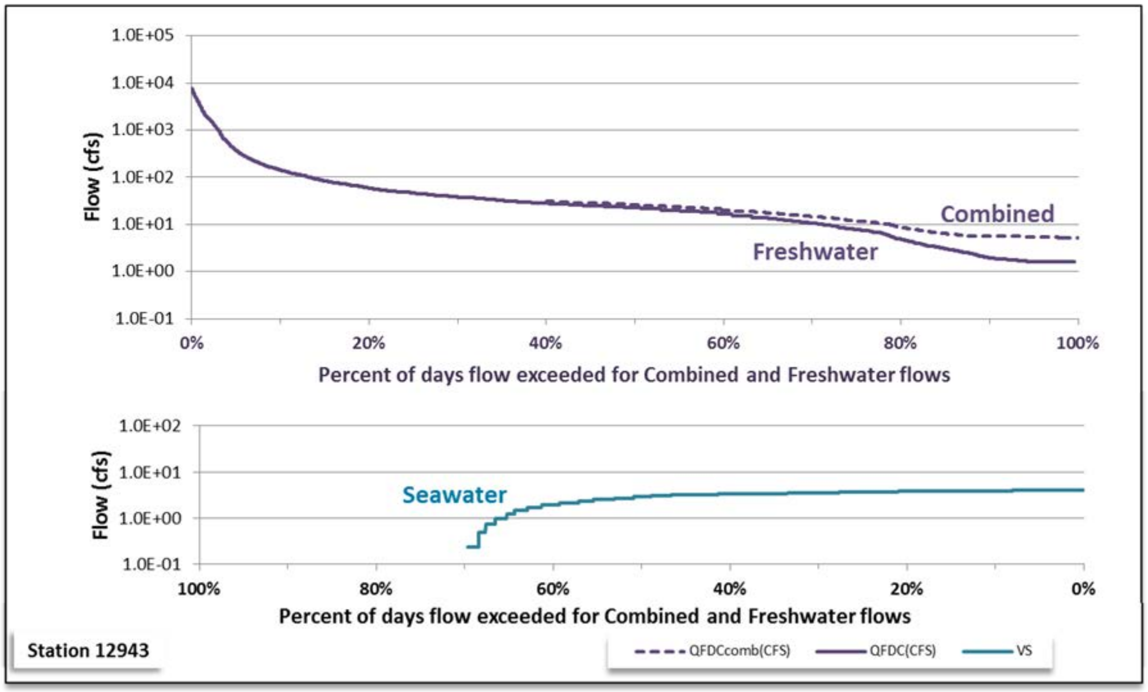

Figure 41. Flow duration curves for station 12943, Mission River Tidal.

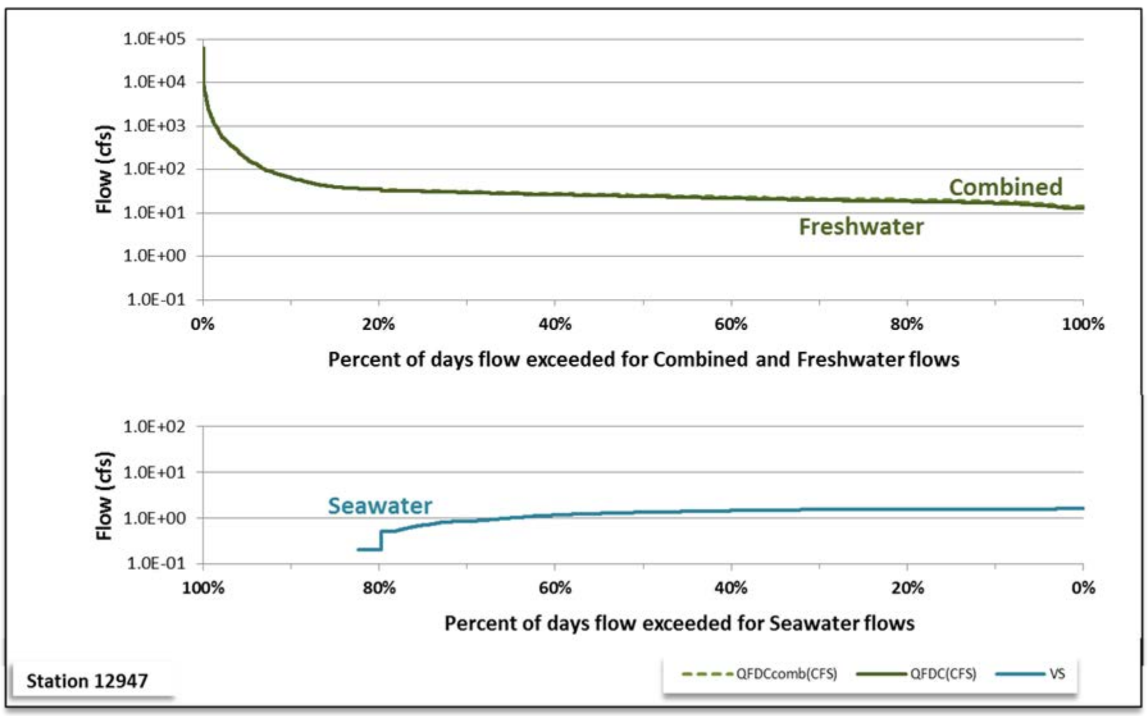

Figure 42. Flow duration curves for station 12947, Aransas River Tidal.

Resulting in

$$\text{TMDL (MPN/day)} = \text{criterion} \times V_t \times \text{conversion factor} \qquad \text{(A-4)}$$

The actual FDCs developed for this TMDL using the modified LDC contain both a freshwater riverine flow component and a seawater component. For Mission River Tidal, one FDC was created for station 12943 (Figure 41); for Aransas River Tidal, the FDC used for the pollutant LA was created for station 12947 (Figure 42). For both station 12943 on Mission River Tidal and station 12947 on Aransas River Tidal, the amount of estimated seawater is provided on the FDC graphs. As expected from the equations, the amount of seawater present increases as both the freshwater flow decreases and the percent of days the flow is exceeded increases. Note that the x-axis direction of increase on the seawater plot is reversed from that on the FDC.

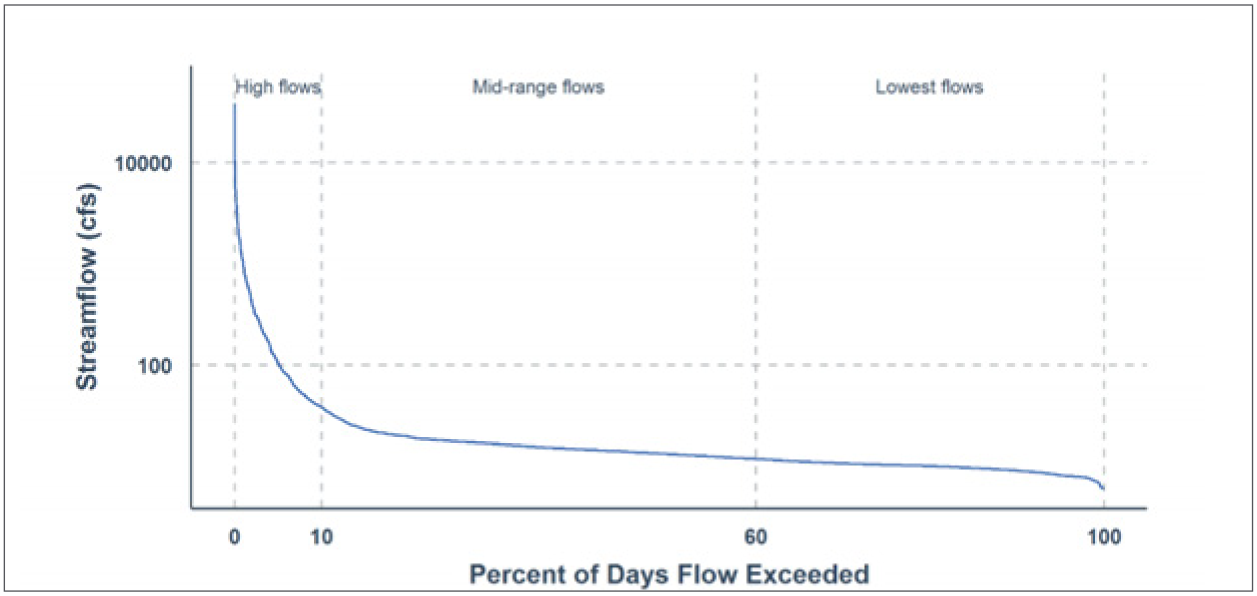

Figure 43. Flow duration curve for station 12952, Aransas River Above Tidal.

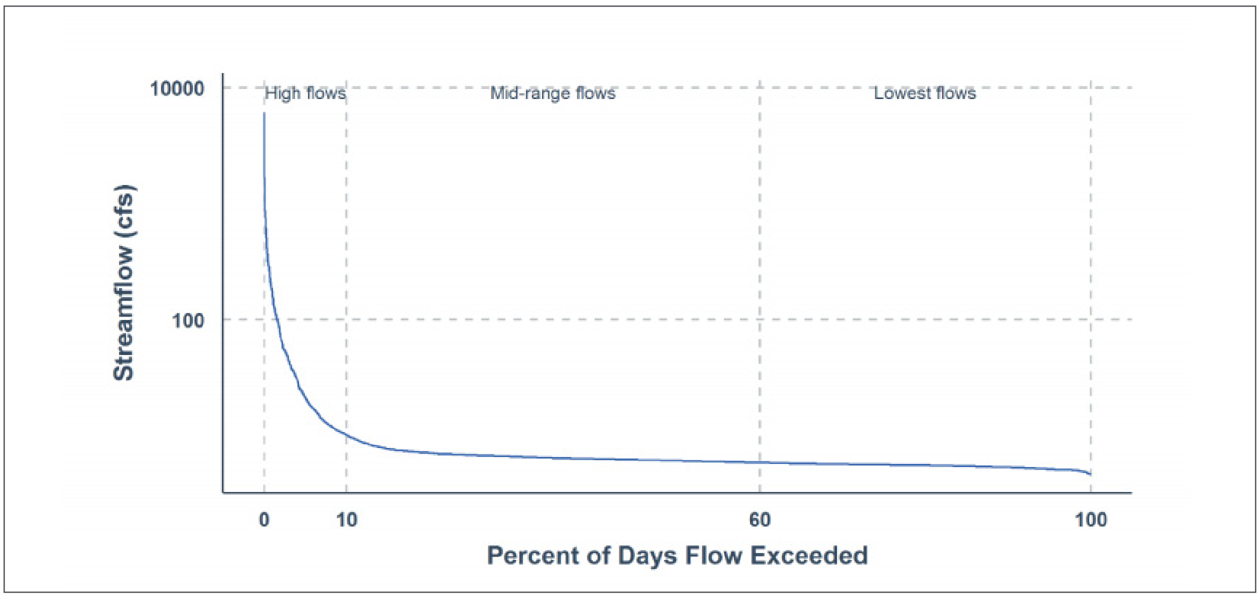

Figure 44. Flow duration curve for station 12937, Poesta Creek.

Traditional Load Duration Curves

Figures 43 and 44 are FDCs developed for the traditional LDCs using the drainage area ratio method and USGS gage data from (2001–2016). Monitored *E. coli* loads were overlain on the graph to create the LDCs. Regression analysis for the LDCs was completed using a USGS program called Load Estimator (LOADEST).

Appendix D: Load Reduction Calculations

Management Measure 1: Develop and Implement Conservation Plans in Priority Areas of the Watershed

Landowners participating in the agricultural work group of the Mission and Aransas River Tidal TMDL coordinating committee indicated that approximately one-third of the agricultural landowners in the Mission and Aransas rivers watersheds would be willing to agree to a conservation plan if riparian fencing was not included as a practice. If riparian fencing was required, less than 5% participation was expected.

Based on the grazeable land in each watershed (excluding developed acreage, open water, barren, cultivated crops, and wetlands), there are approximately 567,539 ac of agricultural lands in the Mission River watershed and 246,720 ac of range- and pastureland in the Aransas River watershed. Based on the 2012 National Agricultural Statistics, the average farm size in the Mission River watershed is 935.6 ac based on county estimates for Bee (553 ac), Goliad (421 ac), and Refugio (1833 ac) counties. The average farm size in the Aransas River watershed is 543.5 ac, based on county estimates for Bee (553 ac) and San Patricio (534 ac) counties. Based on the grazeable lands in each watershed listed above and the average farm size previously discussed, it is estimated that there are approximately 607 ranches in the Mission River watershed and 454 ranches in the Aransas River watershed. Based on stakeholder indications that one-third of the ranches in each watershed would be willing to agree to a conservation plan if riparian fencing was not required, it is estimated that 202 ranches in the Mission River watershed and 151 in the Aransas River watershed would potentially be willing to participate.

Wagner et al. (2012) found that *E. coli* loading from a heavily grazed pasture was 0.41 trillion cfu per hectare (ha; cfu/ha) or 0.17 trillion cfu/ac compared to 0.15 trillion cfu/ha (0.06 trillion cfu/ac) from a properly grazed pasture. Thus, by adopting proper grazing management, *E. coli* reductions of 0.26 trillion cfu/ha (0.11 trillion cfu/ac) may be observed. Note that this *E. coli* reduction per acre is comparable to those calculated in other watersheds (i.e., 0.4 trillion cfu/ac in Buck Creek; 0.17 trillion in Geronimo; 0.067 trillion in Plum Creek).

Potential annual conservation plan *E. coli* load reduction = # ranches × average ranch size × 0.11 trillion cfu/ac × 0.2777

Where:
ranches = number of participating ranches (202 in Mission and 151 in Aransas)
Ranch size = average farm size (935.6 ac/ranch in Mission and 543.5 ac/ranch in Aransas)
0.11 trillion cfu/ac = *E. coli* reductions from adopting proper grazing management (Wagner et al. 2012)

Potential annual agricultural nonpoint source *E. coli* load reduction – Aransas River watershed:
= 151 × 543.5 × 0.11 trillion = 9,027.54 trillion cfu

Potential annual agricultural nonpoint source *E. coli* load reduction – Mission River watershed:
= 202 × 935.6 × 0.11 trillion = 20,789.03 trillion cfu

Total potential annual agricultural nonpoint source *E. coli* load reduction – Mission and Aransas rivers watersheds:
29,816.57 trillion cfu

Potential annual conservation plan *Enterococcus* load reduction = # ranches × average ranch size × 0.11 trillion cfu/ac × 0.2777

Where:
ranches = number of participating ranches (202 in Mission and 151 in Aransas)
Ranch size = average farm size (935.6 ac/ranch in Mission and 543.5 ac/ranch in Aransas)
0.11 trillion cfu/ac = *E. coli* reductions from adopting proper grazing management (Wagner et al. 2012)
0.2777 = conversion factor to convert between *E. coli* and *Enterococcus* (35/126)

Potential annual ag nonpoint source *Enterococcus* load reduction – Aransas River watershed:
= 151 × 543.5 × 0.11 trillion × 0.2777 = 2,393.66 trillion cfu

Potential annual agricultural nonpoint source *Enterococcus* load reduction – Mission River watershed:
= 202 × 935.6 × 0.11 trillion × 0.2777 = 5,512.24 trillion cfu

Total potential annual agricultural nonpoint source *Enterococcus* load reduction – Mission and Aransas rivers watersheds:
7,905.91 trillion cfu

To achieve the goals of the TMDL, this level of implementation is not expected to be required. Implementation of an estimated 122 conservation plans in the Aransas River watershed and 81 in the Mission River watershed is projected to provide the needed reductions to meet the TMDL. Based on this level of implementation, the following loading reductions are estimated.

Potential annual agricultural nonpoint source *Enterococcus* load reduction – Aransas River watershed:
= 122 × 543.5 × 0.11 trillion × 0.2777 = 1,933.95 trillion cfu

Potential annual agricultural nonpoint source *Enterococcus* load reduction – Mission River watershed:
= 81 × 935.6 × 0.11 trillion × 0.2777 = 2,201.36 trillion cfu

Total potential annual agricultural nonpoint source *Enterococcus* load reduction – Mission and Aransas rivers watersheds:
4,144.31 trillion cfu

In the Aransas River watershed, subbasins 4, 8, 10-13, 15, and 17-20 are of highest priority for conservation plan development due to their proximity to the impaired segment and on the estimated loadings from livestock in these subbasins (Borel et al. 2015). Similarly, in the Mission River watershed, subbasins 2, 5, 7-9, 14, 17, 19-22, and 24-25 are of highest priority.

These potential load reductions are loadings that would normally be deposited to land surfaces; only some fraction of this load would be expected to reach the receiving water bodies under normal circumstances. Nevertheless, the potential load reductions that could be achieved by implementing conservation plans through the TSSWCB WQMP Program, the USDA NRCS' EQIP, and other conservation programs will depend specifically on the BMPs implemented by each individual landowner, the location and characteristics of the land to which suite of BMPs are applied, and the number of livestock in each landowner's operation. Landowners indicated that the practices most feasible for inclusion in conservation plans for the watersheds area included but were not limited to brush management, cross fencing, prescribed burning, and water wells. Other practices considered highly feasible for the area included mechanical treatment (aeration) of grazing land, installation of ponds, prescribed grazing, supplemental feeding locations, supplemental watering facilities, conservation cover, early successional habitat development, restoration and management of declining habitats, wetland wildlife habitat management, and installation of wildlife watering facilities.

References

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Management Measure 3: Promote the Management of Feral Hogs and Control Their Populations

The feral hog population is estimated to be 33,573 animals, which is estimated to be equivalent to 4,198 animal units for the Mission and Aransas rivers watersheds (Borel et al. 2015). Animal unit equivalents, which are simply the animal population numbers multiplied by the ratio of the mean animal weights for each animal type to the mean weight of cattle, provide a more useful way of comparing the pollution impact, per capita, of different animal types. Of the 4,198 animal units in the watershed, 1,870 animal units are estimated in the Aransas River watershed and 2,328 animal units in the Mission River watershed. This population estimate was derived using a density of 33.3 ac/hog and an animal unit conversion of 0.125 applied uniformly across deciduous forest, evergreen forest, mixed forest, shrub/scrub, grassland/herbaceous, pasture/hay, cultivated crops, and woody wetlands (Wagner and Moench 2009).

Management reduction goals for feral hogs focus on removing animals from each watershed and keeping populations at a static level. The goal established by the Mission and Aransas River Tidal Bacteria TMDL Coordination Committee, based largely on feasibility of implementation, is to remove 32% of the total hog population from each watershed (i.e., remove 598 animal units from the Aransas River watershed and 745 animal units from the Mission River watershed). This equates to removal of 4,786 individual hogs from the Aransas River watershed and 5,958 from the Mission River watershed. By removing the hogs from each watershed completely, the potential *E. coli* and *Enterococcus* loads from feral hogs will be removed by an equal amount times the average daily cfu fecal coliform production rate per hog. In the Aransas River watershed, subbasins 1-4, 6, 7, 9, and 11 are of highest priority due to their proximity to the impaired segment of the Aransas River and the estimated feral hog populations in these subbasins (Borel et al. 2015). Similarly, in the Mission River watershed, subbasins 2, 4, 5, 8, 9, and 14 are of highest priority.

The potential annual *E. coli* load reduction from feral hogs was estimated using:
Annual feral hog load reduction = # hog animal units removed × 1.21 billion × 365

Where:
1.21 billion = average daily cfu fecal coliform production rate per hog animal units (Wagner and Moench 2009)
365 = days per year

Potential annual feral hog *E. coli* load reduction – Aransas River watershed:
= 598 feral hog animal units removed × 1.21 billion cfu (fecal coliforms)/animal unit-day × 365 days/year = 264.12 trillion cfu

Potential annual feral hog *E. coli* load reduction – Mission River watershed:
= 745 feral hog animal units removed × 1.21billion cfu (fecal coliforms)/animal unit-day × 365 days/year = 329.03 trillion cfu

Total potential annual feral hog *E. coli* Reduction – Mission and Aransas rivers watersheds:
593.15 trillion cfu

The potential annual *Enterococcus* load reduction from feral hogs was estimated using:
Annual feral hog load reduction = # hog animal units removed × 1.21 billion × 0.175 × 365

Where:
1.21 billion = average daily cfu fecal coliform production rate per hog animal units (Wagner and Moench 2009)
0.175 = conversion factor to convert between fecal coliform and *Enterococcus* by dividing the current *Enterococcus* standard of 35 cfu/100 mL by the previously used fecal coliform standard of 200 cfu/100 mL
365 = days per year

Potential annual feral hog *Enterococcus* load reduction – Aransas River watershed:
=598 feral hog animal units removed × 1.21 billion cfu (fecal coliforms)/animal unit-day × 0.175 × 365 days/year = 46.22 trillion cfu

Potential annual feral hog *Enterococcus* load reduction – Mission River watershed:
= 745 feral hog animal units removed × 1.21billion cfu (fecal coliforms)/animal unit-day × 0.175 × 365 days/year = 57.58 trillion cfu

Total potential annual feral hog *Enterococcus* Reduction – Mission and Aransas rivers watersheds:
103.80 trillion cfu

These annual load reduction estimates represent the total annual reduction in potential *E. coli* and *Enterococcus* production in the watersheds after full implementation of Management Measure 3 is achieved. The estimate assumes feral hog populations will remain at 68% of their current levels after implementation is completed. However, the validity of this assumption hinges on a commitment to sustain the efforts associated for this management measure.

Although reproduction rates are implicitly incorporated in the initial estimates of animal densities per unit of land, the calculations presented above do not explicitly take reproduction rates into account.

The yearly *E. coli* and *Enterococcus* reductions over the 5-year implementation period will vary, increasing gradually every year until implementation is completed.

References

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Management Measure 5: Identify OSSFs, Prioritize Problem Areas, and Systematically Work to Bring Systems into Compliance

According to Borel et al. (2015), the total number of households with OSSFs in the Mission and Aransas rivers watersheds was 10,047. Using an OSSF failure rate determined by applying the soil drainfield limitation classes — 15% very limited, 10% somewhat, 5% not limited, and 15% not rated — it was estimated that 1,408 of these systems are potentially failing. Of these, 562 OSSFs are located in high priority subbasins (subbasins 1-3, 5-7, and 10-11 of the lower Aransas River watershed and subbasins 2-3 of the lower Mission River watershed) as identified by Borel et al. (2015). A further breakdown of these potentially failing OSSFs reveals that 76 OSSFs are located in the Mission River watershed and 486 in the Aransas River watershed. These high priority subwatersheds of the lower Mission and Aransas rivers are predominately in San Patricio and Refugio counties where the impaired segments are located.

Potential loading from these failing OSSFs was estimated using the methodology presented in EPA (2001) and used in many other watersheds in Texas as well as watershed-specific population estimates and other assumptions.

The potential annual *E. coli* load reduction from OSSFs was estimated using:
Annual OSSF load reduction = # failing OSSFs × 1 million cfu/100 mL × 60 × 3785.2 × 2.53 (or 2.9) × 365

Where:
562 failing OSSFs in the critical area of the watersheds may be replaced
1 million cfu/100 mL fecal coliform concentration in OSSF effluent as reported by Metcalf & Eddy (1991)
3785.2 mL/gallon = number of milliliters in a gallon
60 gal per person per day is estimated discharge in OSSFs as reported by Horsley and Witten (1996)
2.53 persons per household in Refugio County (Mission River watershed) and 2.9 in San Patricio County (Aransas River watershed) (USCB 2012)

Potential annual OSSF *E. coli* load reduction – Mission River watershed:
= 76 failing septic systems × 1 million fecal coliforms/100 mL × 60 gal/person/day × 3785.2 mL/gal × 2.53 persons/household × 365 days/year = 159.39 trillion cfu

Potential annual OSSF *E. coli* load reduction – Aransas River watershed:
= 486 failing septic systems × 1 million fecal coliforms/100 mL × 60 gal/person/day × 3785.2 mL/gal × 2.9 persons/household × 365 days/year = 1,168.33 trillion cfu

Total potential annual OSSF *E. coli* load reduction – Mission and Aransas rivers watersheds:
= 1,327.72 trillion cfu

The potential annual *Enterococcus* load reduction from OSSFs was estimated using:
Annual OSSF load reduction = # failing OSSFs × 1 million cfu/100 mL × 0.175 ×60 × 3785.2 × 2.53 (or 2.9) × 365

Where:
562 failing OSSFs in the critical area of the watersheds may be replaced
1 million cfu/100 mL fecal coliform concentration in OSSF effluent as reported by Metcalf & Eddy (1991)
0.175 = conversion factor to convert between fecal coliform and *Enterococcus* by dividing the current *Enterococcus* standard of 35 cfu/100 mL by the previously used fecal coliform standard of 200 cfu/100 mL
3785.2 mL/gallon = number of milliliters in a gallon
60 gal per person per day is estimated discharge in OSSFs as reported by Horsley and Witten (1996)
2.53 persons per household in Refugio County (Mission River watershed) (USCB 2012) and 2.9 in San Patricio County (Aransas River watershed) (USCB 2012)

Potential annual OSSF *Enterococcus* load reduction – Mission River watershed:
= 76 failing septic systems × 1 million fecal coliforms/100 mL × 0.175 × 60 gal/person/day × 3785.2 mL/gal × 2.53 persons/household × 365 days/year = 27.89 trillion cfu

Potential annual OSSF *Enterococcus* load reduction – Aransas River watershed:
= 486 failing septic systems × 1 million fecal coliforms/100 mL × 0.175 × 60 gal/person/day × 3785.2 mL/gal × 2.9 persons/household × 365 days/year = 204.46 trillion cfu

Total potential annual OSSF *Enterococcus* load Reduction – Mission and Aransas rivers watersheds:
= 232.35 trillion cfu

References

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Management Measure 6: Promote the Improved Quality and Management of Urban Stormwater

According to the *Technical Support Document for Two Total Maximum Daily Loads for Indicator Bacteria in Tidal Portions of the Mission and Aransas Rivers* (Painter and Hauck 2013), regulated stormwater comprises only a very small portion of the areas of the subject watersheds (0.06% for Mission River watershed and 0.04% for Aransas River watershed) and must be considered only a minor contributor.

In both the Mission and Aransas rivers watersheds, stakeholders indicated that there is very little stormwater management implemented in the towns and communities within the watershed. This is primarily a factor of the size of these communities. Phase II (small) MS4 permit requirements generally do not apply to these predominantly small, rural communities. Further, these communities lack the funding to implement stormwater management BMPs. However, this is an area of significant opportunity for pollutant load reductions. If funding is available, these communities indicated they would be willing to adopt and implement BMPs to better manage their stormwater. However, the type and number of these BMPs has not been determined at this point.

Land use and land cover information indicates that there are 25,698 ac developed in the Mission River watershed and 32,661 ac developed in the Aransas River watershed. Of these, there are 74 high intensity developed acres in the Mission River watershed and 517 ac of this category in the Aransas River watershed that could be targeted for long-term management. According to Adamus Resource Assessment, Inc et al. (2011), median fecal coliform loading from commercial land use is 5.6 billion cfu/ha/year. It is assumed that high intensity developed acres in the Mission and Aransas rivers watersheds are primarily commercial land uses.

A wide variety of urban BMPs are available for addressing urban nonpoint source runoff. One such practice is the construction of dry basins. According to the Center for Watershed Protection (2007) *National Pollutant Removal Performance Database (version 3)*, construction of dry basins to control runoff could result in an 88% reduction in bacteria loads. Using stormwater practices such as this could result in substantial decreases in urban nonpoint source runoff and loading. To evaluate potential annual *E. coli* and *Enterococcus* load reductions from voluntarily implementing dry basins to treat runoff from the high intensity developed acres in each watershed, the following equation was used:

The potential annual *E. coli* urban nonpoint source load reduction = acres treated × 5.6 billion × 0.404686 × .88

Where:
Acres treated = high intensity developed acres in each watershed (i.e., 74 and 517 ac)
5.6 billion = typical fecal coliform loading in cfu/ha/year (Adamus Resource Assessment, Inc. et al. 2011)
0.404686 = conversion factor to convert between hectares and acres
0.88 = 88% reduction resulting from construction of dry basins to control runoff

Potential annual urban nonpoint source *E. coli* load reduction – Aransas River watershed:
= 517 ac treated × 5.6 billion × 0.404686 × .88 = 1.03 trillion cfu

Potential annual urban nonpoint source *E. coli* load reduction – Mission River watershed:
= 74 ac treated × 5.6 billion × 0.404686 × .88 = 147.58 billion cfu

Total potential annual urban nonpoint source *E. coli* load reduction – Mission and Aransas rivers watersheds:
1.18 trillion cfu

The potential annual *Enterococcus* urban nonpoint source load reduction
= acres treated × 5.6 billion × 0.175 × 0.404686 × .88

Where:
Acres treated = high intensity developed acres in each watershed (i.e., 74 and 517 ac)
5.6 billion = typical fecal coliform loading in cfu/ha/year (Herrera 2011)
0.175 = conversion factor to convert between fecal coliform and *Enterococcus* by dividing the current *Enterococcus* standard of 35 cfu/100 mL by the previously used fecal coliform standard of 200 cfu/100 mL
0.404686 = conversion factor to convert between hectares and acres
0.88 = 88% reduction resulting from construction of dry basins to control runoff

Potential annual urban nonpoint source *Enterococcus* load reduction – Aransas River watershed:
= 517 ac treated × 5.6 billion × 0.175 × 0.404686 × .88 = 180.43 billion cfu

Potential annual urban nonpoint source *Enterococcus* load reduction – Mission River watershed:
= 74 ac treated × 5.6 billion × 0.175 × 0.404686 × .88 = 25.83billion cfu

Total potential annual urban nonpoint source *Enterococcus* load reduction – Mission and Aransas rivers watersheds:
206.26 billion cfu

References

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Management Measure 7: Coordinate Efforts to Reduce Unauthorized Discharges

SSOs were identified as a minor contributor of *E. coli* and *Enterococcus*, with only 10 events occurring over a 3.5-year (August 2009–January 2013) period (five in the Mission River watershed and five in the Aransas River watershed). Another 41 SSOs occurred between January 2013 and December 2018, but the load reduction calculation is based on SSO information presented in the *Technical Support Document for Two Total Maximum Daily Loads for Indicator Bacteria in Tidal Portions of the Mission and Aransas Rivers* (Painter and Hauck 2013) because that is the information stakeholders used to determine the total needed load reduction for the implementation plan.

One management measure that can produce quantifiable *E. coli* and *Enterococcus* load reductions is to have managers actively identifying these SSOs and subsequently work with wastewater collection system personnel to rectify these problems. Using published literature values identified below, the following equation was derived to estimate the potential load reduction resulting from a 15% overall reduction goal in SSO discharges. The 15% was derived by taking the median from surveys that meeting participants had completed.

The potential annual *E. coli* SSO load reduction
= 2.86 SSOs/year × 9175 gal/SSO × 10 million cfu/100 mL × 3,785.2 mL/gallon × 0.15

Where:

2.86 SSOs/year = 10 SSOs recorded over a 3.5-year period
9175 gal/SSO = 36,700 gal of sewage documented from 4 events (volumes were unknown for the remaining 6 events)
10 million cfu/100 mL = fecal coliform concentration rate in raw sewage as reported by Metcalf & Eddy (1991)
3,785.2 = number of milliliters in a gallon
0.15 = 15% overall reduction goal

Total potential annual SSO *E. coli* load reduction – Mission and Aransas rivers watersheds:
1.49 trillion cfu

The potential annual *Enterococcus* SSO load reduction
= 2.86 SSOs/year × 0.175 × 9175 gal/SSO × 10 million cfu/100 mL × 3,785.2 mL/gallon × 0.15

In this equation, the inputs are as follows:

2.86 SSOs/year = 10 SSOs recorded over a 3.5-year period
9175 gal/SSO = 36,700 gal of sewage documented from 4 events (volumes were unknown for the remaining 6 events)
10 million cfu/100 mL = fecal coliform concentration rate in raw sewage as reported by Metcalf & Eddy (1991)
3,785.2 = number of milliliters in a gallon
0.15 = 15% overall reduction goal
0.175 = conversion factor to convert between fecal coliform and *Enterococcus* by dividing the current *Enterococcus* standard of 35 cfu/100 mL by the previously used fecal coliform standard of 200 cfu/100 mL

Total potential annual SSO *Enterococcus* load reduction – Mission and Aransas rivers watersheds:
260.73 billion cfu

Assuming that a 15% load reduction can be achieved, the average annual load to the two watersheds will be reduced by 1.49 trillion cfu *E. coli* and 260.73 billion cfu *Enterococcus*. Because documented SSOs were equally distributed among the watersheds (five in each), it is assumed that reductions will be equally distributed as well and equal 744.94 billion cfu *E. coli* and 130.36 billion cfu *Enterococcus* in each watershed.

References

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Management Measure 8: Reduce WWTF Contributions by Meeting Half of the Permitted Bacteria Limit

There are 12 WWTFs in the Mission and Aransas rivers watersheds. Voluntary adoption of half the permitted discharge limit by four WWTFs in the Aransas River watershed would result in considerable reductions in *Enterococcus* loading. Current and proposed future wastewater treatment levels and loads for each WWTF and watershed are presented in Table 37.

With the exception of the City of Taft, WWTF permits are based on *E. coli*. To calculate *Enterococcus* loads, it was presumed that plants achieving an *E. coli* treatment level of 126 cfu/100 mL were also achieving an *Enterococcus* treatment level of 35 cfu/100 mL, the indicator bacteria, and concentration pertinent to the bacteria impairments. Further, four WWTFs in the Aransas River watershed (Taft, Sinton, and both Beeville WWTFs) agreed to work voluntarily to achieve a wastewater effluent level of half the current surface water quality standards (17.5 cfu/100 mL *Enterococcus*). Based on these values, current and proposed future *Enterococcus* loads were estimated using each WWTF's full permitted discharge flow rate multiplied by the current and future proposed criterion. This is expressed in the following equation:

The potential annual *Enterococcus* WWTF load reduction (cfu/day) = criterion/100 × 3,785.2 × flow

Where:
Criterion = 35 cfu/100 mL or 17.5 cfu/100 mL *(Enterococcus)*
3,785.2 = number of milliliters in a gallon
Flow = permitted flows reported in gal/day

Resulting reductions in the WWTF *Enterococcus* load to the Aransas River are estimated to be 4.33 billion cfu/day or 1.58 trillion cfu annually.

Management Measure 11: Improve and Upgrade WWTFs

Data from NRA and EPA's Environmental Compliance and History Online (ECHO) database indicate that WWTFs discharging to water bodies in the Mission and Aransas rivers watersheds are generally meeting TPDES permit limits and requirements. However, most facilities have periodic exceedances. The *Nueces River Authority 2012 Basin Highlights Report* and analysis of data collected at watershed WWTFs from October 2007 through January 2011 show that the geometric mean of bacteria concentrations in effluents from the City of Sinton (163 cfu/100 mL) and St. Paul WSC (439 cfu/100 mL), both in the Aransas River watershed, exceeded water quality standards. Therefore, the goal of this management measure is to ensure that the geometric mean of bacteria concentrations in the effluents of all the WWTFs in the watersheds remain compliant with water quality standards and to reduce the number and severity of periodic exceedances.

Bacteria load reductions for this management measure were conservatively calculated using 5-year median flows reported in ECHO for 2008–2012 and *Enterococcus* geometric means reported by NRA (2012) and estimated reductions from bringing all WWTFs into compliance. Five-year median flows reported in ECHO for 2008–2012 were 343,000 gal/day for the City of

Table 37. Current permitted and proposed future voluntarily achieved wastewater treatment levels and resulting estimated loadings of *Enterococcus* in the Mission and Aransas rivers watersheds.

TPDES[a] permit number	Facility	Current versus future	Flow (MGD[b])	*E. coli* (cfu[c]/100 mL[d])	*Enterococcus* (cfu/100 mL)	*Enterococcus* load (billion cfu/day)
WQ0010055001	City of Sinton - Main WWTF[e]	C	0.8	n/a	n/a (35)	1.06
		PF	0.8	n/a	n/a (35)	1.06
WQ0010124002	City of Beeville - Moore Street WWTF	C	3	126	n/a (35)	3.97
		PF	3	63	n/a (17.5)	1.99
WQ0010124004*	City of Beeville - Chase Field WWTF	C	2.5	126	n/a (35)	3.31
		PF	2.5	63	n/a (17.5)	1.66
WQ0010705001	City of Taft WWTF	C	0.9	n/a	35	1.19
		PF	0.9	n/a	17.5	0.60
WQ0013412001	Texas Department of Transportation - Sinton Engineering Building WWTF	C	0.0004	126	n/a (35)	0.00
		PF	0.0004	126	n/a (35)	0.00
WQ0013641001	City of Sinton - Rod and Bessie Welder WWTF	C	0.015	126	n/a (35)	0.02
		PF	0.015	126	n/a (35)	0.02
WQ0014112001	Skidmore WSC[f] WWTF	C	0.131	n/a	n/a (35)	0.17
		PF	0.131	n/a	n/a (17.5)	0.09
WQ0014119001	St. Paul WSC WWTF	C	0.05	126	n/a (35)	0.07
		PF	0.05	126	n/a (35)	0.07
WQ0014123001	Tynan WSC WWTF	C	0.045	126	n/a (35)	0.06
		PF	0.045	126	n/a (35)	0.06
Aransas River Tidal total		**C**				**9.86**
		PF				**5.53**
WQ0010156001	Town of Woodsboro WWTF	C	0.25	126	n/a (35)	0.33
		PF	0.25	126	n/a (35)	0.33
WQ0010255001	Town of Refugio WWTF	C	0.576	126	n/a (35)	0.76
		PF	0.576	126	n/a (35)	0.76
WQ0010748001	Pettus MUD[g] WWTF	C	0.105	126	n/a (35)	0.14
		PF	0.105	126	n/a (35)	0.14
Mission River Tidal total		**C**				**1.23**
		PF				**1.23**

[a] Texas Pollutant Discharge Elimination System (TPDES)
[b] million gallons per day (MGD)
[c] colony forming unit (cfu)
[d] milliliters (mL)
[e] wastewater treatment facility (WWTF)
[f] Water Supply Corporation (WSC)
[g] Municipal Utility District (MUD)
C - Current permitted wastewater treatment level
PF - Proposed future permitted or voluntarily achieved wastewater treatment level
n/a (35) - Not included in permit (presumed to be the treatment level)
n/a (17.5) - Not included in permit (proposed future voluntarily achieved wastewater treatment level)

Sinton and 23,480 gal/day for St. Paul WSC. Load reductions for this management measure were calculated as follows:

Potential annual *Enterococcus* WWTF load reduction = (measured geomean - criterion)/100 × 3785.2 × Flow × 365

Where:
Measured geomean = *Enterococcus* geomean reported by NRA (2012)
Criterion = 35 cfu/100 mL *(Enterococcus)*
3,785.2 = number of milliliters in a gallon
Flow = 5-year median flows reported in ECHO for 2008–2012 in gal/day
365 = days/year

Potential annual WWTF *Enterococcus* load reduction – Sinton:
= (163-35)/100 × 3,785.2 × 343,000 × 365 = 606.58 billion cfu

Potential annual WWTF *Enterococcus* load reduction – St. Paul:
= (439-35)/100 × 3,785.2 × 23,480 × 365 = 131.06 billion cfu

Potential annual WWTF *Enterococcus* load reduction – Aransas River watershed:
= 737.63 billion cfu

Because both WWTFs are in the Aransas River watershed, all reductions from Management Measure 11 (737.63 billion) were applied to the Aransas River and no reductions are reflected for the Mission River.

Additional, and yet unknown, reductions in WWTF excursions from permitted effluent limits are expected because of the increased frequency of monitoring proposed at each facility, as described in Management Measure 10. Finally, WWTF operators indicated that very little wastewater reuse was occurring in the watershed, which provides a significant opportunity for further reductions in discharges in the future, through the development and implementation of wastewater reuse projects.

References

NRA (Nueces River Authority). 2012. Nueces River Authority 2012 Basin Highlights Report. Uvalde, TX: Nueces River Authority. 54 p. https://www.nueces-ra.org/CP/CRP/pdfs/Final_BHR_2012.pdf.

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