Approved August 14, 2019

Implementation Plan for Two Total Maximum Daily Loads for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek

Segments 1602 and 1602B

Assessment Units 1602_03 and 1602B_01

Prepared by the Lavaca River Stakeholders

With Support from the Texas Water Resources Institute and the TMDL Team, Water Quality Planning Division, Office of Water

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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Texas State Soil and Water Conservation Board
Texas Water Resources Institute

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Abbreviations

AgriLife Extension	Texas A&M AgriLife Extension Service
AnU	animal unit
AU	assessment unit
BMP	best management practice
CFU	colony forming units
CFS	cubic feet per second
CIG	Conservation Innovation Grants
CMP	Coastal Management Program
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CWA	Clean Water Act
CZM	Coastal Zone Management Program
CZMA	Coastal Zone Management Act
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FG	Future Growth
GIS	geographic information system
I&I	inflow and infiltration
IRNR	Institute of Renewable and Natural Resources
I-Plan	implementation plan

km	kilometer
LA	load allocation
mL	milliliter
MGD	million gallons per day
MOS	margin of safety
MPN	most probable number
MS4	municipal separate storm sewer system
MSGP	multi-sector general permit
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Database
NOAA	National Oceanographic and Atmospheric Administration
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
OSSF	on-site sewage facility
RCPP	Regional Conservation Partnership Program
SEP	Supplemental Environmental Projects
SSO	sanitary sewer overflow
SWCD	Soil and Water Conservation District
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TGLO	Texas General Land Office
TMDL	total maximum daily load
TPDES	Texas Pollutant Discharge Elimination System
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
TWS	Texas Wildlife Services
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WCID	Water Control and Improvement District
WLA	wasteload allocation
WQMP	Water Quality Management Plan
WWTF	wastewater treatment facility

Implementation Plan for Two TMDLs for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek

Executive Summary

In 2019, the Texas Commission on Environmental Quality (TCEQ) will consider adoption of *Two Total Maximum Daily Loads for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek* (Segments 1602 and 1602B).

This implementation plan, or I-Plan:

- describes the steps that watershed stakeholders and the TCEQ will take toward achieving the pollutant reductions identified in the total maximum daily load (TMDL) report, and
- outlines the schedule for implementation activities.

The ultimate goal of this I-Plan is to restore the primary contact recreation uses in Segments 1602 and 1602B by reducing concentrations of indicator bacteria to levels established in the TMDLs.

The TMDLs identified regulated and unregulated sources of indicator bacteria in the watershed that could contribute to water quality impairment. Regulated sources identified include domestic wastewater treatment facilities (WWTFs) and regulated stormwater. Sanitary sewer overflows (SSOs), dry weather discharges, and illicit discharges are a subset of these regulated sources.

Unregulated sources that could contribute to the indicator bacteria load in the watershed include domestic animals (e.g., cattle, dogs, and horses), neglected and failing on-site sewage facilities (OSSFs), and wildlife and other unmanaged animals (e.g., deer and feral hogs).

This I-Plan includes seven management measures that will be used to reduce indicator bacteria in the Lavaca River Above Tidal and Rocky Creek watersheds. Management measures are related to managing nonpoint sources (NPS) (unregulated), such as working to identify, repair, and replace OSSFs in the watershed. Control actions are related to point sources (regulated discharges), such as implementing industrial or domestic WWTFs or municipal separate storm sewer system (MS4) Phase II Stormwater Management Programs. No control actions related to regulated discharges are included in this plan.

Management Measures

1. *Promote and implement Water Quality Management Plans or conservation plans.*
2. *Promote technical and direct operational assistance to landowners for feral hog control.*
3. *Identify and repair or replace failing OSSFs.*
4. *Promote proper pet waste management.*
5. *Implement and expand urban and impervious surface stormwater runoff management.*
6. *Address inflow and infiltration (I&I).*
7. *Reduce illicit dumping.*

For each of the measures, this plan identifies the responsible parties, technical and financial needs, monitoring and outreach efforts, and a schedule of activities. Implementation of the management measures will largely be dependent upon the availability of funding.

The stakeholders and the TCEQ will review progress under the TCEQ's adaptive management process. The plan may be adjusted periodically as a result of progress reviews.

Introduction

To keep Texas' commitment to restore and maintain water quality in impaired rivers, lakes, and bays, the TCEQ works with stakeholders to develop an I-Plan for each adopted TMDL. A TMDL is a technical analysis that:

- determines the amount of a particular pollutant that a water body can receive and still meet applicable water quality standards, and
- sets limits on categories of sources that will result in achieving standards.

This I-Plan is designed to guide activities that will achieve the water quality goals for the Lavaca River Above Tidal and Rocky Creek watersheds as defined in the TMDL report. It is a flexible tool that governmental and nongovernmental organizations involved in implementation use to guide their activities to improve water quality. The participating partners may accomplish the activities described in the plan through rule, order, guidance, or other appropriate formal or informal action.

This I-Plan contains the following components:

1) a description of management measures that will be implemented to achieve the water quality target;
2) a schedule for implementing activities (Appendix A);

3) a follow-up tracking and monitoring plan to determine the effectiveness of the management measures undertaken;
4) identification of measurable outcomes and other considerations the TCEQ and stakeholders will use to determine whether the I-Plan has been properly executed, water quality standards are being achieved, or the plan needs to be modified;
5) identification of the communication strategies the TCEQ will use to disseminate information to stakeholders; and
6) a review strategy that stakeholders will use to periodically review and revise the plan to ensure there is continued progress in improving water quality.

This plan also includes possible causes and sources of the impairments, management measure descriptions, estimated potential load reductions, technical and financial assistance needed, educational components for each measure, schedule of implementation, measurable milestones, indicators to measure progress, monitoring components, and responsible entities as outlined in the Nonpoint Source Program Grants Guidelines for States and Territories (EPA, 2003). Consequently, projects developed to implement nonpoint source (unregulated) elements of this plan that also meet the grant program conditions may be eligible for funding under the Environmental Protection Agency's (EPA) Section 319(h) incremental grant program.

Watershed Overview

The Lavaca River, located along the Texas Gulf Coast, is comprised of three segments — the upstream segment is designated as "Lavaca River Above Campbell Branch (Segment 1602C)", the next segment is designated as "Lavaca River Above Tidal (Segment 1602)", and the most downstream segment is designated as "Lavaca River Tidal (Segment 1601)". The above tidal portion of the creek is a perennial freshwater stream, while the below tidal portion is influenced by saline water from Lavaca Bay. The Lavaca River Above Tidal flows from a point 5.5 km (3.4 miles) upstream of State Highway 95 in Lavaca County, to a point 8.6 km (5.3 miles) downstream of US 59 in Jackson County. Lavaca River Tidal (Segment 1601) begins at its outlet into Lavaca Bay and ends at the point 8.6 km (5.3 miles) downstream of US 59, where Segment 1602 begins. The Lavaca River watershed drains an area of approximately 909 square miles in Calhoun, DeWitt, Fayette, Gonzales, Jackson, Lavaca, and Victoria counties.

Rocky Creek (Segment 1602B) is a freshwater perennial stream that is a tributary of the Lavaca River. It flows 37.82 kilometers (km) (23.5 miles) through Lavaca County and ends at the confluence of the Lavaca River Above Tidal, downstream of the city of Hallettsville. This study incorporates a watershed approach where the entire drainage area of these water bodies is considered

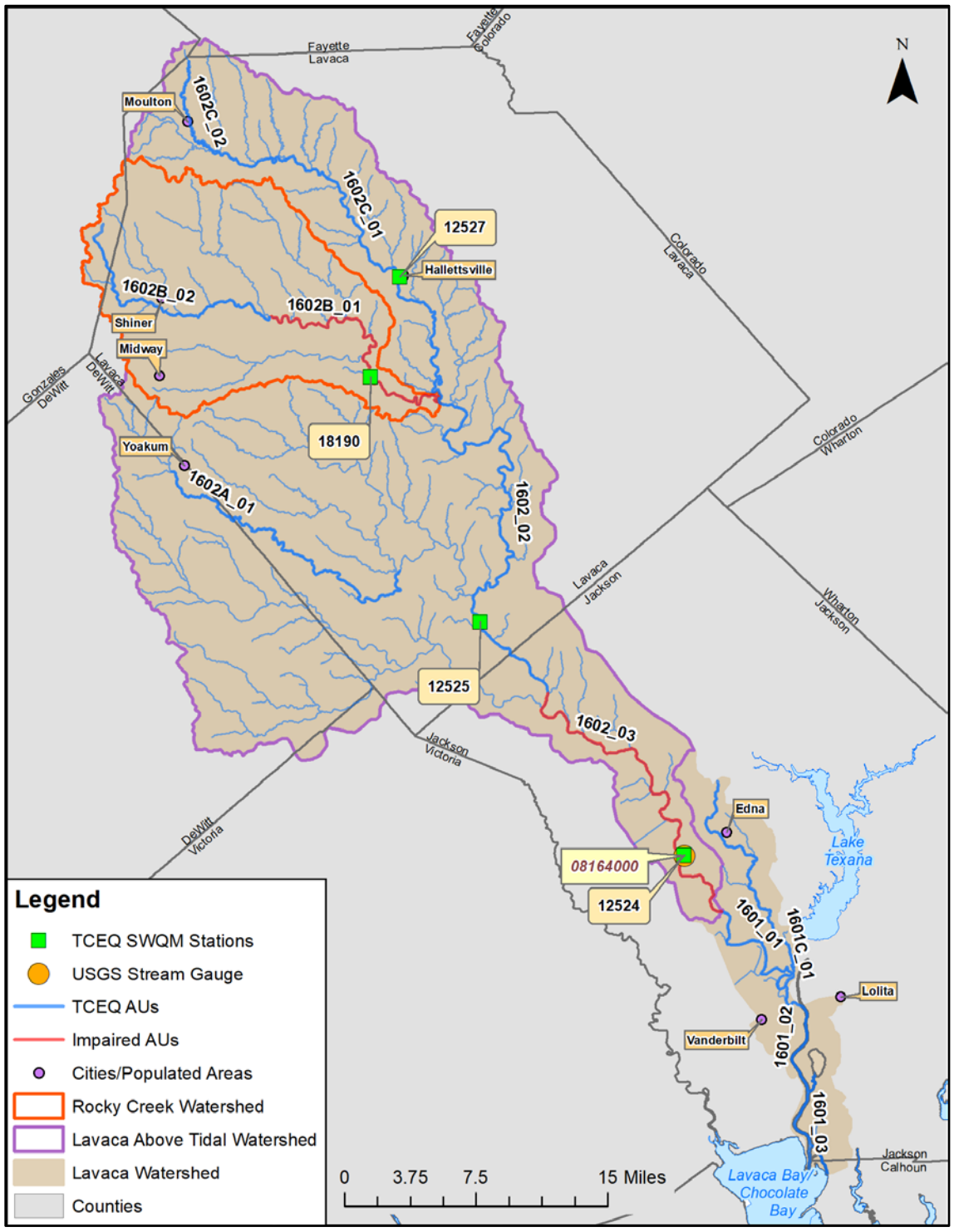

Figure 1. Overview map showing the watersheds, assessment units, wastewater outfalls, and impairments

(Figure 1). Throughout this document, the Lavaca River watershed (TMDL watershed), refers to the entire catchment area of the Lavaca River (Segment 1601), excluding the catchment area of the Navidad River (Segment 1603). The Lavaca River Above Tidal watershed is specified for the catchment area of the Lavaca River Above Tidal (Segment 1602) inclusive of Rocky Creek (Segment 1602B). The Rocky Creek watershed is specified for the catchment area of Rocky Creek (Segment 1602B).

Watershed Population and Population Projections

According to the 2010 Census, the Lavaca River watershed (including Rocky Creek) has a total population of 30,156 and a population density of about 33 people per square mile (Table 1 and Figure 2). The larger municipalities in the Lavaca River watershed include Shiner, Hallettsville, Yoakum, and Edna. Population projections developed by the Office of the State Demographer and the Texas Water Development Board (TWDB, 2014) indicate that the populations of the seven counties within the Lavaca River watershed are projected to increase, with the exception of Lavaca County (Table 2). Data in Table 2 were based on the U.S. Census block population data for the portion of the county within the Lavaca River Above Tidal and Rocky Creek watersheds.

Calculations based on population projections developed by the Office of the State Demographer and the TWDB (2014) indicate that between 2010 and 2070, the populations of seven counties in the Lavaca River watershed are expected to increase. Lavaca County, encompassing the majority of the watershed, is not expected to increase in population. Population percent increases range from zero percent to 68.93 percent (Table 2).

Table 1. 2010 population for the Lavaca River watershed and Rocky Creek watershed

Source: Calculated from Census Blocks (USCB, 2010)

Watershed	Segment	2010 Census Population
Lavaca River (incl. Rocky Creek)	Above Tidal (1602) & Tidal (1601)	30,156
Rocky Creek	1602B	5,884

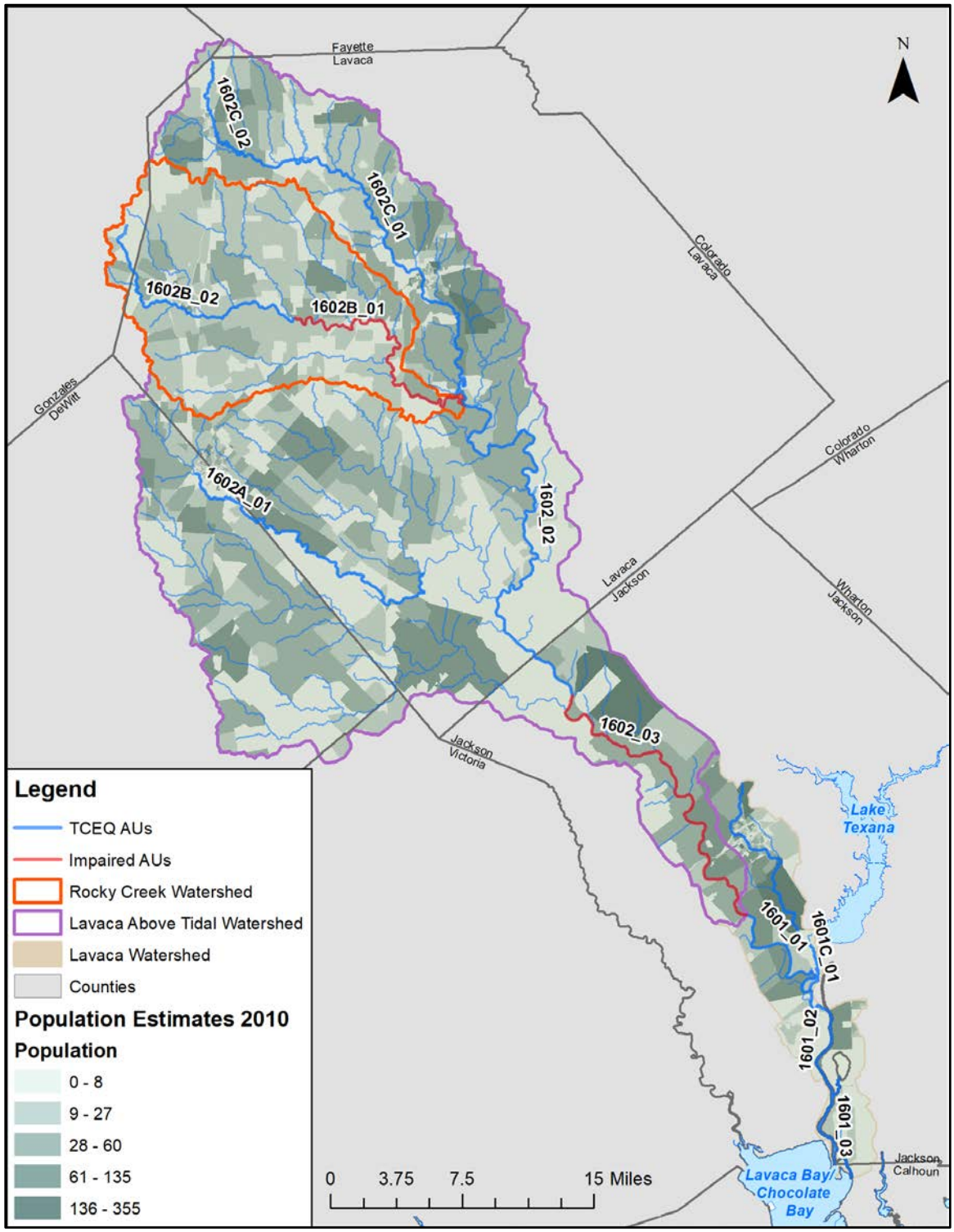

Figure 2. 2010 total population by census block

Source: StratMap city boundaries (Texas Natural Resources Information System, 2012), Census Blocks [United States Census Bureau (USCB), 2010]

Table 2. Projected population growth for counties in the Lavaca River watershed including Rocky Creek

Source: TWDB, 2014

County	2010	2020	2030	2040	2050	2060	2070	Percent Increase (2010-2070)
DeWitt	20,052	20,855	21,555	21,900	22,216	22,425	22,572	12.57%
Lavaca	19,263	19,263	19,263	19,263	19,263	19,263	19,263	0.00%
Jackson	14,002	14,606	15,119	15,336	15,515	15,627	15,699	12.12%
Fayette	24,397	28,373	32,384	35,108	37,351	29,119	40,476	65.91%
Calhoun	21,240	24,037	26,866	29,622	32,276	34,906	37,454	76.34%
Gonzales	19,686	21,751	23,921	25,963	28,330	30,738	33,256	68.93%
Victoria	86,410	93,857	100,260	105,298	109,785	113,470	116,522	34.85%

Land Use

The land use/land cover data for the Lavaca River watershed was obtained from the United States Geological Survey (USGS) 2011 National Land Cover Database (NLCD) and are displayed in Figure 3.

The land use/land cover is represented by the following categories and definitions (USGS, 2014):

Open Water - areas of open water, generally with less than 25 percent cover of vegetation or soil.

Developed, Open Space - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

Developed, Low Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20 percent to 49 percent of total cover. These areas most commonly include single-family housing units.

Developed, Medium Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50 percent to 79 percent of the total cover. These areas most commonly include single-family housing units.

Developed High Intensity - highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 percent to 100 percent of the total cover.

Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.

Deciduous Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.

Evergreen Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.

Mixed Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.

Shrub/Scrub - areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation. This class includes true shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.

Grassland/Herbaceous - areas dominated by grammanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

Pasture/Hay - areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.

Cultivated Crops - areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

Woody Wetlands - areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

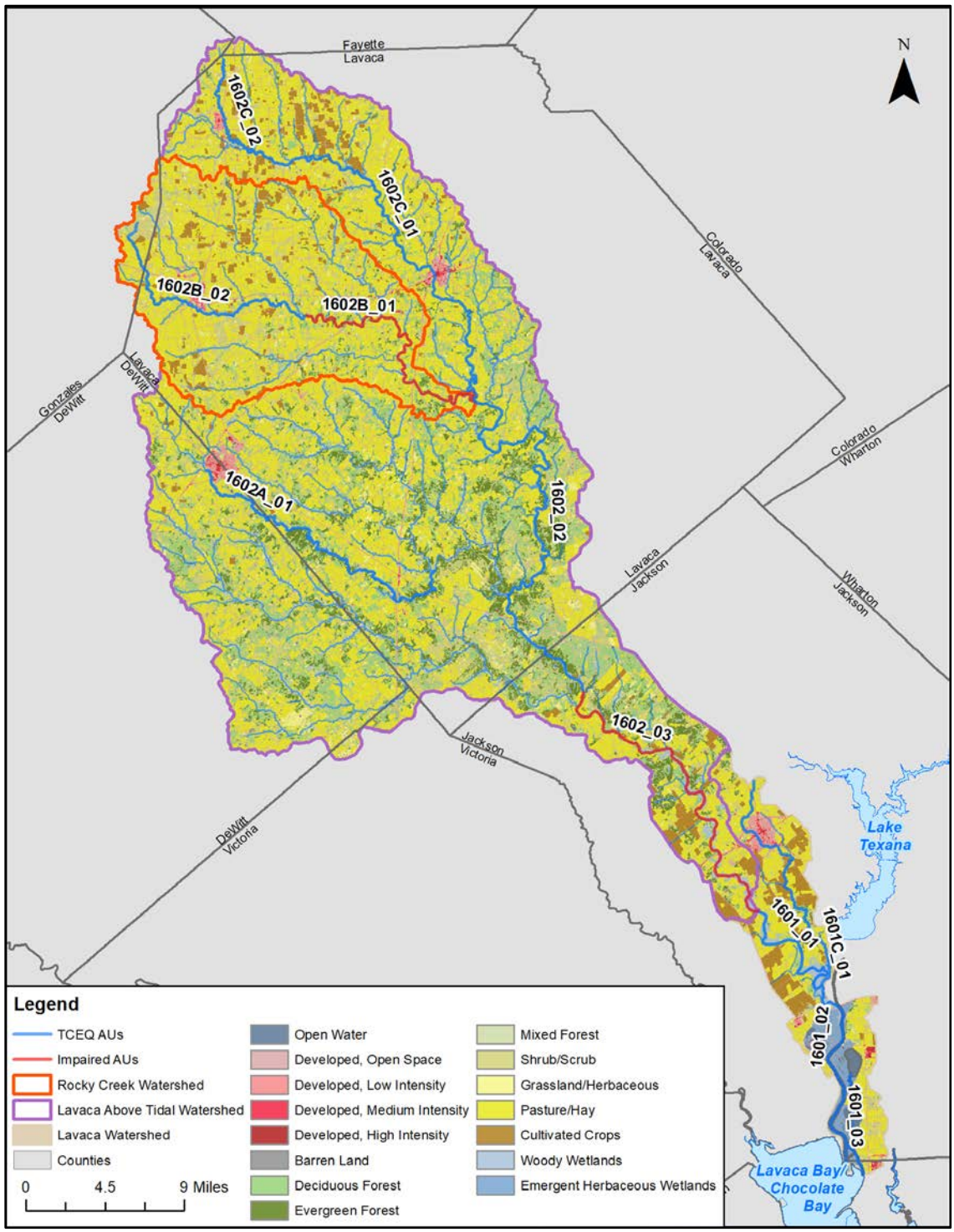

Figure 3. 2011 NLCD land use/land cover within the Lavaca River watershed

Source: USGS, 2014

As displayed in Table 3, the dominant land use in the Lavaca River watershed, which includes Rocky Creek, is Hay/Pasture (44.48 percent) followed by Shrub/Scrub (14.12 percent). The watershed is predominantly rural in land-use, as only approximately six percent of the area is classified as Developed (open space, low intensity, medium intensity, and high intensity).

In solely the Rocky Creek watershed, the predominant land use is also Hay/Pasture (56.32 percent) followed by shrub/scrub (16.10 percent) as displayed in Table 3. The watershed is only seven percent developed (open space, low intensity, medium intensity, and high intensity).

Table 3. Land use/land cover within the Lavaca River watershed and Rocky Creek watershed

Source: USGS, 2014

2011 NLCD	Lavaca Watershed (including Rocky Creek)		Rocky Creek Watershed	
Classification	**Acres**	**% of Total**	**Acres**	**% of Total**
Open Water	4,287.32	0.74%	147.67	0.13%
Developed, Open Space	29,417.23	5.05%	6,421.86	5.65%
Developed, Low Intensity	4,329.35	0.74%	704.77	0.62%
Developed, Medium Intensity	1,381.29	0.24%	231.74	0.20%
Developed, High Intensity	527.07	0.09%	68.72	0.06%
Barren Land	662.51	0.11%	33.58	0.03%
Deciduous Forest	80,410.07	13.81%	7,782.92	6.84%
Evergreen Forest	36,604.80	6.29%	1,930.16	1.70%
Mixed Forest	7,431.09	1.28%	742.13	0.65%
Shrub/Scrub	82,232.15	14.12%	18,310.18	16.10%
Herbaceous	19,505.33	3.35%	3,011.00	2.65%
Hay/Pasture	258,964.83	44.48%	64,035.16	56.32%
Cultivated Crops	26,085.99	4.48%	7,214.70	6.35%
Woody Wetlands	24,186.07	4.15%	2,929.60	2.58%
Emergent Herbaceous Wetlands	6,229.94	1.07%	140.33	0.12%
Total	**582,255.04**	***100%***	***113,704.52***	***100%***

Wastewater Treatment Facilities

As of March 2016, there were seven facilities with Texas Pollutant Discharge Elimination System (TPDES)/National Pollutant Discharge Elimination System (NPDES) permits that operated within the watershed (Figure 4 and Table 4). Four of the WWTFs are located in the watershed of the Lavaca River Above Tidal (Segment 1602), with one located within the boundaries of Rocky Creek (Segment 1602B). These four facilities treat solely domestic wastewater. Two discharge directly into the non-tidal section of the Lavaca River, one discharges into Rocky Creek, and the last one discharges into Big Brushy Creek (a tributary of Lavaca River).

Jackson County Water Control and Improvement District (WCID) No. 2 WWTF, Inteplast Group LTD, and the Edna WWTF are located within the project watershed, but all discharge below the impaired AUs 1602_03 and 1602B_01. They are listed in Table 4 but are not included in TMDL analysis.

A review of the EPA Enforcement and Compliance History Online database (EPA, 2014), conducted on June 9, 2016 for records between January 1, 2013 and March 31, 2016, revealed several non-compliance issues regarding bacteria for three of the seven WWTFs in the Lavaca River watershed (see Table 5). As of March 2016, the City of Moulton had experienced bacteria exceedances in one of 28 months from January 2014 through April 2016. The City of Hallettsville reported daily maximum bacteria violations in four of 21 months from September 2014 through April 2016. The City of Edna reported daily maximum bacteria exceedances in 25 of the 37 months from March 2013 through March 2016. However, none of the bacteria effluent violations were reported as "Significant Non-compliance" effluent violations.

The City of Shiner, City of Yoakum, Jackson County WCID No. 2, and Inteplast Group LTD had no compliance issues within the past three years due to elevated bacteria loads within the reporting time period (January 1, 2013 to March 31, 2016).

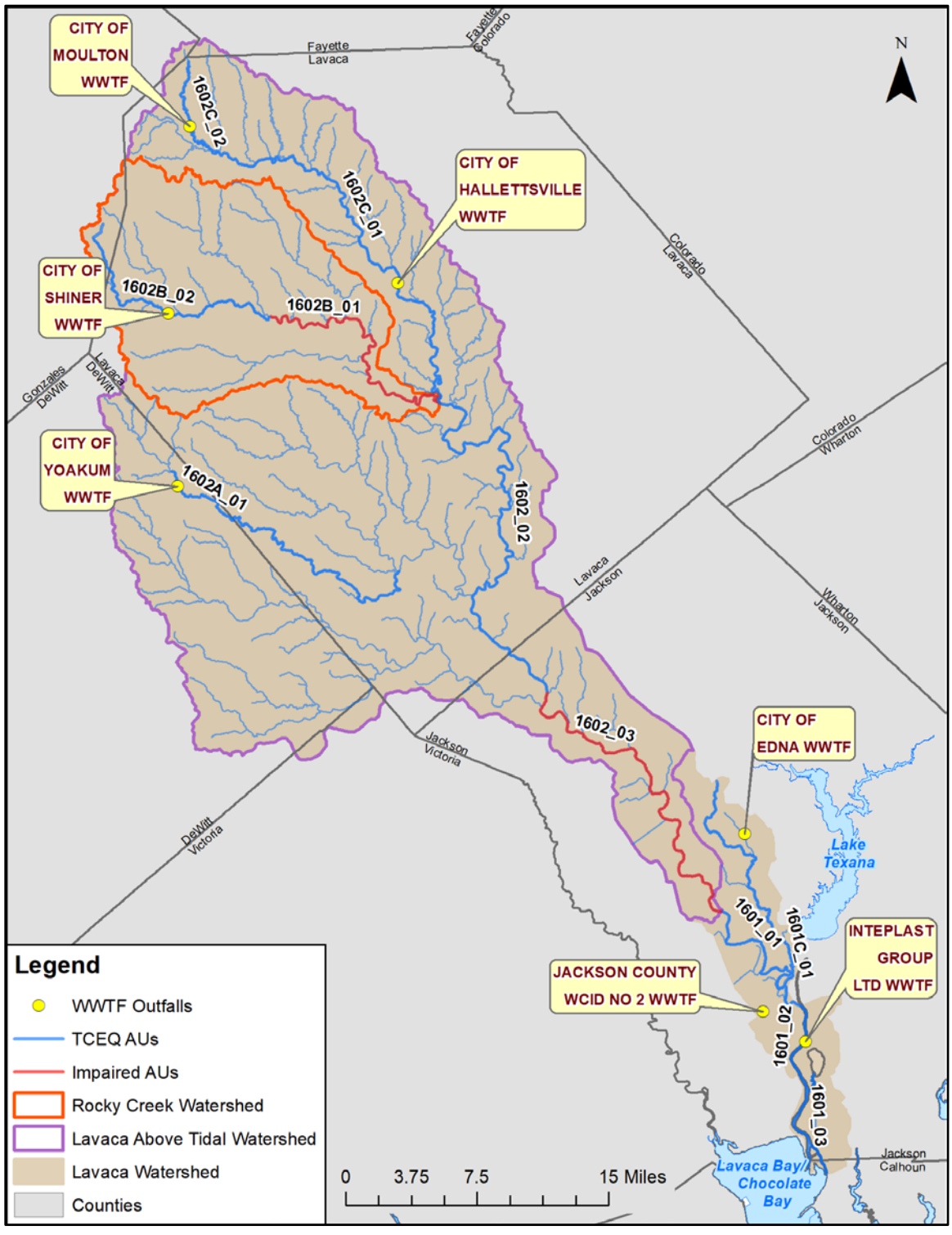

Figure 4. Lavaca River watershed showing WWTF outfalls

Source: Regulated outfalls (TCEQ, 2012)

Table 4. Regulated WWTFs in the Lavaca River watershed and Rocky Creek watershed

Source: Individual TPDES permits

TPDES Permit Number	Facility	AU	Receiving Water	Discharge Type	Permitted Discharge (MGD[a])	Recent Discharge (MGD[a])[b]
WQ0010013001	City of Hallettsville WWTF	1602_02[c]	Lavaca River Above Tidal	Treated domestic wastewater	0.800	0.595
WQ0010227001	City of Moulton WWTF	1602C_02[c]	Lavaca River Above Tidal	Treated domestic wastewater	0.242	0.079
WQ0010463001	City of Yoakum WWTF	1602A_01[c]	Big Brushy Creek	Treated domestic wastewater	0.950	0.592
WQ0010280001	City of Shiner WWTF	1602B_02[d]	Rocky Creek to Lavaca River	Treated domestic wastewater	0.850	0.736
WQ0010196001	Jackson County WCID NO 2 WWTF	ditch to 1601_03[e]	Drainage ditch, unnamed tributary	Treated domestic wastewater	0.045	0.008
WQ0003477000	Inteplast Group Corporation	1601_02[e]	Lavaca River Tidal	Wastewater (> or = 1 MGD domestic sewage or process water including WTP discharge)	0.045	0.04
WQ0010164001	City of Edna WWTF	tributary to 1601C_01[e]	Dry Creek to Lavaca River Tidal	Wastewater (> or = 1 MGD domestic sewage or process water including WTP discharge)	1.800	0.484

[a] MGD = million gallons per day
[b] Based on average discharge from January 1, 2013 to March 31, 2016
[c] Discharges upstream of 1602_03 but included in the 1602_03 TMDL calculations
[d] Included in 1602B_01 and 1602_03 TMDL calculations
[e] Discharge below the impaired assessment units and are not included in TMDL calculations

Table 5. Bacteria monitoring requirements and compliance status for WWTFs in the Lavaca River and Rocky Creek watersheds

Source: EPA, 2014

NPDES Permit No.	Facility	Bacteria Monitoring Requirements	Minimum Frequency	Daily Average (Geomean) Limitation	Single Grab (Daily Max) Limitation	% Monthly Exceedances Daily Avg	% Monthly Exceedances Single Grab
TX0053287	City of Moulton WWTF	*E. coli*	One per month	126	399	3.57%[a]	3.57%[a]
TX0026042	City of Shiner WWTF	*E. coli*	Two per month	126	399	0.00%[b]	0.00%[b]
TX0025232	City of Hallettsville	*E. coli*	Two per month	126	399	14.29%[c]	19.05%[c]
TX0026034	City of Yoakum WWTF	*E. coli*	Two per month	126	399	0.00%[d]	0.00%[d]

[a] 28 monthly *E. coli* records (1/2014 – 4/2016)

[b] 19 monthly *E. coli* records (11/2014 – 5/2016)

[c] 21 monthly *E. coli* records (9/2014 – 5/2016)

[d] 20 monthly *E. coli* records (10/2014 - 6/2016)

In addition to the individual wastewater discharge permits listed in Table 4, dischargers of processed wastewater from certain types of facilities are required to be covered by one of several TPDES general permits:

- TXG110000 – concrete production facilities
- TXG130000 – aquaculture production facilities
- TXG340000 – petroleum bulk stations and terminals
- TXG670000 – hydrostatic test water discharges
- TXG830000 – water contaminated by petroleum fuel or petroleum substances
- TXG920000 – concentrated animal feeding operations
- WQG20000 – livestock manure compost operations (irrigation only)

A review of active general permit coverage (TCEQ, 2015b) in the Lavaca River and Rocky Creek watersheds as of June 9, 2016 found three concrete production facilities covered by the general permit. These facilities are located in Jackson and Lavaca counties. The facilities are located in Segments 1602 – Lavaca River Above Tidal and 1602B – Rocky Creek. The three concrete production facilities do not have bacteria reporting or limits in their permits. All three facilities were

assumed to contain inconsequential amounts of indicator bacteria in their effluent.

No other active general wastewater permit facilities or operations were found. There were no facilities covered under the general permits for aquaculture, petroleum bulk stations and terminals, petroleum fuel or petroleum substances, hydrostatic test water discharges, concentrated animal feeding operations, or livestock manure compost operations.

Summary of TMDLs

This section summarizes the information developed for *Two Total Maximum Daily Loads for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek* (TCEQ, 2017). Additional background information, including the problem definition, endpoint identification, source analysis, linkages between sources and receiving waters, and pollutant load allocations can be found in the TMDL report. Table 6 provides a summary of *Two Total Maximum Daily Loads for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek.*

Table 6. Summary of TMDLS for Lavaca River Above Tidal and Rocky Creek

(Source: TCEQ, 2017)

AU	Stream Name	TMDL	WLA_{WWTF}	WLA_{SW}	LA	MOS
1602_03	Lavaca River Above Tidal	3,976.657	15.014	1.881	3,760.929	198.833
1602B_01	Rocky Creek	828.224	4.946	0.235	781.632	41.411

Units expressed as billion most probable number (MPN) per day *E. coli*

Pollutant Sources and Loads

Wasteload Allocation (WLA)

The WLA is the wasteload allocation for regulated source contributions in the watershed including WWTFs (WLA_{WWTF}) and regulated stormwater (WLA_{SW}).

Wastewater Treatment Facilities

WWTFs regulated under the TPDES were allocated a daily waste load (WLA_{WWTF}), calculated as their full permitted discharge flow rate multiplied by the instream geometric criterion after reductions for a margin of safety (MOS). This is expressed in the following equation:

$$WLA_{WWTF} = \text{criterion} * \text{flow (MGD)} * \text{conversion factor}$$

Where:

Criterion = 126 MPN/100 milliliter (mL) for *E. coli* primary contact recreation

Flow (MGD) = full permitted flow

Conversion factor (to MPN/day) = 1.54723 cubic feet per second (cfs)/MGD *283.168 100 mL/cubic feet (ft^3) * 86,400 seconds per day (s/d)

Table 7 provides a summary of the wasteload allocation attributed to WWTFs.

Table 7. Wasteload allocations for TPDES regulated facilities

Segment	Receiving Waters	TPDES Permit No.	Outfall Number	NPDES Permit No.	Facility	Full Permitted Flow (MGD)	*E. coli* WLA_{WWTF} (Billion MPN/day)
1602	Lavaca River above Tidal	WQ0010 013001	001	TX002 5232	City of Hallettsville WWTF	0.80	3.816
1602	Lavaca River above Tidal	WQ0010 227001	001	TX005 3287	City of Moulton WWTF	0.242	1.154
1602A	Big Brushy Creek	WQ0010 463001	001	TX002 6034	City of Yoakum WWTF	0.95	4.531
1602B	Rocky Creek to Lavaca River	WQ0010 280001	001	TX002 6042	City of Shiner WWTF	0.85	4.054
Lavaca River Above Tidal (including Rocky Creek) Watershed Total							**13.555**
Rocky Creek Watershed Total							**4.054**

Regulated Stormwater

Stormwater discharges from MS4, industrial, multi-sector general permit (MSGP) facilities, and construction areas are regulated point sources. Regulated stormwater discharges (WLA_{SW}) must be included in the WLA. Further detail on how the WLA_{SW} was calculated can be found in the *Two Total Maximum Daily Loads for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek.* The calculation for allowable loads from regulated stormwater is expressed by the following equation:

$$WLA_{SW} = (TMDL - WLA_{WWTF} - FG - MOS) * FDA_{SWP}$$

Where:

WLA_{SW} = sum of all regulated stormwater loads

TMDL = total maximum daily load

WLA_{WWTF} = sum of all WWTF loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety

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

Table 8 provides a summary of the regulated stormwater area. Table 9 provides the information needed to compute WLA_{SW}. Table 10 provides a summary of the wasteload allocation attributed to regulated stormwater.

Table 8. Stormwater General Permit areas and calculation of the FDA_{SWP} term

Watershed	MS4 General Permit (acres)	MSGP (acres)	Construction Activities (acres)	Concrete Production Facilities (acres)	Petroleum Bulk Stations (acres)	Total Area of Permits (acres)	Watershed Area (acres)	FDA_{SWP}
Lavaca River Above Tidal (including Rocky Creek)	0	249.98	28.19	13.25	0	291.42	582,255.04	0.05 %
Rocky Creek	0	15.62	12.84	2.69	0	31.15	113,704.50	0.03%

Once the WLA_{SW} and WLA_{WWTF} terms are known, the WLA term can be calculated as the sum of the two parts, as shown in Table 10.

Table 9. Regulated stormwater allocation calculations

Watershed	TMDL	WLA_{WWTF}	FG	MOS	FDA_{SWP}	WLA_{SW}
Lavaca River Above Tidal (including Rocky Creek)	3,976.657	13.555	1.459	198.833	0.05%	1.881
Rocky Creek	828.224	4.054	0.892	41.411	0.03%	0.235

Table 10. Wasteload allocation calculations

Watershed	WLA_{WWTF}	WLA_{SW}	WLA
Lavaca River Above Tidal (including Rocky Creek)	13.555	1.881	15.436

Watershed	WLA_{WWTF}	WLA_{SW}	WLA
Rocky Creek	4.054	0.235	4.289

Load Allocation (LA)

The LA is the sum of loads from unregulated sources. The LA is expressed as follows.

$$LA = TMDL - WLA_{WWTF} - WLA_{SW} - FG - MOS$$

Where:

LA = allowable load from unregulated sources

TMDL = total maximum daily load

WLA_{WWTF} = sum of all WWTF loads

WLA_{SW} = sum of all regulated stormwater loads

FG = sum of future growth loads from potential regulated facilities

MOS = margin of safety

The calculation results are shown in Table 11.

Table 11. Load allocation calculations

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

Watershed	TMDL	WLA_{WWTF}	WLA_{SW}	FG	MOS	LA
Lavaca River Above Tidal (including Rocky Creek)	3,976.657	13.555	1.881	1.459	198.833	3,760.929
Rocky Creek	828.224	4.054	0.235	0.892	41.411	781.632

Allowance for Future Growth

The Future Growth (FG) component addresses the requirement of TMDLs to account for future loadings that may occur as a result of population growth, changes in community infrastructure, and development. The assimilative capacity of streams increases as the amount of flow increases. Increases in flow allow for additional loads if the pollutant concentrations meet the criteria in the Texas Water Quality Standards.

To account for the FG component of impaired AU 1602_03, the loading from all WWTFs was included in the FG computation, which was based on the WLA_{WWTF} formula. The FG equation (below) contained an additional term to account for

projected population growth between 2010 and 2070 in the watershed counties (provided previously in Table 2). To calculate the FG component of the impaired AU 1602B_01 the loading from only the Shiner WWTF was included, as well as the projected population growth for Lavaca County. The FG calculation was hampered by a zero-growth projection in the Rocky Creek watershed. Therefore, the FG term was calculated with a hypothetical new WWTF with enough discharge to service half the watershed residents not currently serviced by the Shiner WWTF (Table 12). Further detail on how the FG was calculated can be found in the *Two Total Maximum Daily Loads for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek.*

$$FG = Criterion * [\%POP_{2010\text{-}2070} * WWTF_{FP}] * Conversion\ Factor$$

Where:

Criterion = 126 MPN/100 mL for *E. coli*

$\%POP_{2010\text{-}2070}$ = estimated % increase in population between 2010 and 2070

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

Conversion Factor = 1.547 cfs/MGD *283.168 100 mL/ft^3 * 86,400 s/d

The calculation results for the total FG in each watershed is shown in Table 13.

Table 12. Future Growth calculation for potential WWTF in the Rocky Creek watershed

Rocky Creek Watershed Population	City of Shiner Population	Potential WWTF Service Population	Potential WWTF Discharge (MGD)	FG (*E. coli* Billion MPN/ day)
5,884	2,137	1,874	0.187	0.892

Table 13. Future growth calculations

AU	Receiving Waters	Facility	Full Permitted Flow (MGD)	County	% Increase (2010-2070)	Future Growth (MGD)	FG (*E. coli* Billion MPN/ day)
1602_01	Lavaca River Above Tidal	City of Hallettsville WWTF	0.800	Lavaca	0.0%	0.000	0.000
1602C_02	Lavaca River Above Tidal	City of Moulton WWTF	0.242	Lavaca	0.0%	0.000	0.000
1602A_01	Big Brushy Creek	City of Yoakum WWTF	0.950	DeWitt	12.57%	0.119	0.567
1602B_02	Rocky Creek to Lavaca River Above Tidal	City of Shiner WWTF	0.850	Lavaca	0.0%	0.000	0.000
1602B_02	Rocky Creek to Lavaca River Above Tidal	Future Facility	NA	Lavaca	NA	0.187	0.892[1]
Lavaca River Above Tidal (including Rocky Creek) Total						**0.306**	**1.459**
Rocky Creek Total						**0.187**	**0.892**

[1] Calculated in Table 12

Total Maximum Daily Load

Table 14 summarizes the TMDL calculations for Lavaca River Above Tidal (1602_03) and Rocky Creek (1602B_01). The TMDLs were based on the median flow in the zero – 10 percentile range (five percent exceedance) for flow exceedance from the load duration curves developed for the Lavaca River Above Tidal and Rocky Creek. Allocations were based on the current geometric mean criterion for *E. coli* of 126 MPN/100 mL for each component of the TMDL.

The TMDL equation can be expanded to show the components of WLA and LA:

$$TMDL = MOS + WLA_{WWTF} + WLA_{SW} + LA + FG$$

Table 14. TMDL allocation summaries

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

AU	Stream Name	TMDL	MOS	WLA_{WWTF}	WLA_{SW}	LA	Future Growth
1602_03	Lavaca River Above Tidal	3,976.657	198.833	13.555	1.881	3,760.929	1.459
1602B_01	Rocky Creek	828.224	41.411	4.054	0.235	781.632	0.892

Implementation Strategy

This plan documents seven management measures to reduce bacteria loads. Management measures were selected based on feasibility, costs, support, and timing. Activities can be implemented in phases based on the needs of the stakeholders, availability of funding, and the progress made in improving water quality.

Adaptive Implementation

All I-Plans are implemented using an adaptive management approach in which measures are periodically assessed for efficiency and effectiveness. This adaptive management approach is one of the most important elements of the I-Plan. The iterative process of evaluation and adjustment ensures continuing progress toward achieving water quality goals and expresses stakeholder commitment to the process.

At annual meetings, the stakeholders will periodically assess progress using the schedule of implementation, interim measurable milestones, water quality data, and the communication plan included in this document. If periodic assessments find that insufficient progress has been made or that implementation activities have improved water quality, the implementation strategy will be adjusted.

Activities and Milestones

The stakeholders of the Lavaca River watershed directing the I-Plan formed an agriculture and wildlife work group to work on technical issues associated with agricultural and wildlife management measures. Collectively, the stakeholders of the Lavaca River watershed and work group held seven meetings to develop this I-Plan.

The work group and stakeholder group developed detailed, consensus-based action plans. The planned implementation activities are described in the following section.

Management Measures

The implementation plan for *Two Total Maximum Daily Loads for Indicator Bacteria in Lavaca River Above Tidal and Rocky Creek* includes the following seven management measures.

1. *Promote and implement Water Quality Management Plans or conservation plans.*
2. *Promote technical and direct operational assistance to landowners for feral hog control.*
3. *Identify and repair or replace failing OSSFs.*
4. *Promote proper pet waste management.*
5. *Implement and expand urban and impervious surface stormwater runoff management.*
6. *Address inflow and infiltration (I&I).*
7. *Reduce illicit dumping.*

Management Measure 1

Promote and implement Water Quality Management Plans or conservation plans.

The purpose of this management measure is to develop and implement Water Quality Management Plans (WQMPs) or conservation plans on grazed lands in prioritized subwatersheds. Bacteria loadings in the Lavaca River watershed from grazed lands are likely to be relatively high compared to other evaluated sources. Compared to other sources, the fate and transport of fecal bacteria in livestock waste is less certain. Livestock waste is often deposited in upland areas and transported to water bodies during runoff events. In between deposition and transport, much of the *E. coli* bacteria in livestock waste dies; however, livestock may spend significant amounts of time in and around water bodies, thus resulting in more direct impact on water quality.

Importantly, livestock behavior and where they spend time can be modified through changes to their food, shelter, and water availability. Cattle grazing is highly dependent upon proximity to these resources, especially water. Fecal loading is subsequently also strongly tied to resource utilization, as it is directly related to the amount of time an animal spends in an area. Therefore, reducing the amount of time that livestock spend in riparian pastures through rotational grazing, alternative water supplies, shade structures, and supplemental feeding locations can directly reduce the potential for bacteria to enter the creek.

A variety of best management practices (BMPs) are available to achieve goals of improving forage quality, distributing livestock across a property, and making water resources available to livestock. Table 15 provides a list of identified practices available to producers. However, the list of practices available to producers is not limited to those in the table. The actual appropriate practices will vary by operation and should be determined through technical assistance

from the Natural Resources Conservation Service (NRCS), the Texas State Soil and Water Conservation Board (TSSWCB), and local soil and water conservation districts (SWCDs) as appropriate.

The NRCS and the TSSWCB provide technical and financial assistance to producers to plan and implement property-specific BMPs. The NRCS offers a variety of programs to implement operation-specific conservation plans. The TSSWCB, through local SWCDs, provides technical and financial assistance to develop and implement property-specific WQMPs through planning, implementation, and maintenance of each practice.

Table 15. Available pasture and rangeland practices to improve water quality

Practice	NRCS Code	Focus Area or Benefit
Brush Management	314	Livestock, water quality, water quantity, wildlife
Fencing	382	Livestock, water quality
Filter strips	393	Livestock, water quality, wildlife
Grade stabilization structures	410	Water quality
Grazing land mechanical treatment	548	Livestock, water quality, wildlife
Heavy use area protection	562	Livestock, water quantity, water quality
Pond	378	Livestock, water quantity, water quality, wildlife
Prescribed burning	338	Livestock, water quality, wildlife
Prescribed grazing	528	Livestock, water quality, wildlife
Range/Pasture planting	550/512	Livestock, water quality, wildlife
Shade structure	NA	Livestock, water quality, wildlife
Stream crossing	578	Livestock, water quality
Supplemental feed location	NA	Livestock, water quality
Water well	642	Livestock, water quantity, wildlife
Watering facility	614	Livestock, water quantity

Education and outreach will be an important component of this management measure to increase adoption of practices. The watershed coordinator and AgriLife Extension will work to provide delivery of workshops such as Lone Star Healthy Streams, which educate landowners on how to reduce operation impacts on water quality. Agricultural Management Practice Field Days will also be held to demonstrate the implementation of various practices on actual agricultural operations.

Although this management measure mainly addresses and calculates bacteria sources from cattle, the use of conservation planning and WQMPs can reduce fecal loading from all types of livestock. The implementation of conservation

plans and WQMPs is beneficial, regardless of location in the watershed; however, effectiveness is likely greater on properties with riparian habitat. Therefore, all properties with riparian areas are considered a priority; however, properties without riparian habitat are also encouraged to participate in implementation activities. Priority areas will include subwatersheds 1, 3, 5, 6, 9, 10, 12, and 20, as shown in Figure 5.

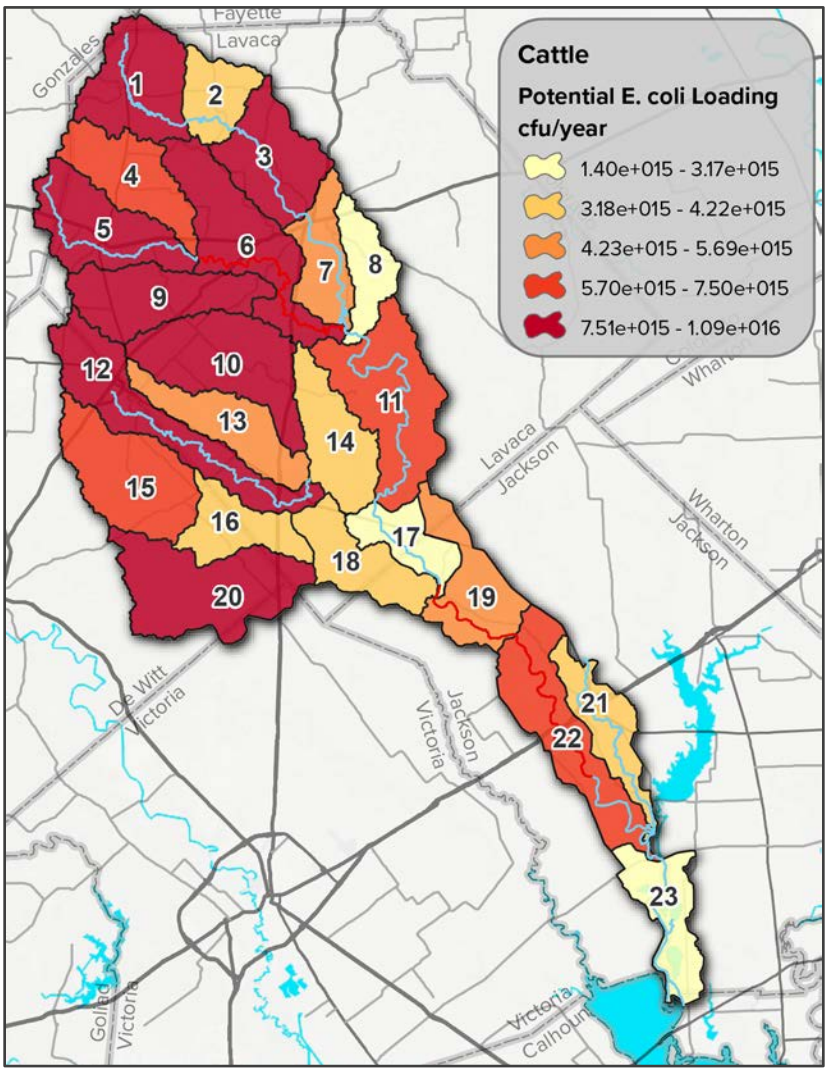

Figure 5. Potential annual bacteria loadings from cattle

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts.

- **Watershed coordinator** – Texas Water Resources Institute (TWRI) will serve as the watershed coordinator for the watershed. The watershed coordinator will work with other responsible parties to develop needed funding

resources. The watershed coordinator will work with other entities to organize, develop, and/or deliver education and outreach components of Management Measure 1.

- **Local stakeholders** – Local stakeholders, specifically landowners and producers, will evaluate the option of adopting WQMPs and conservation plans. If found feasible, the individual stakeholder is responsible for approaching the appropriate agency and working with that agency to develop the WQMP or conservation plans to mitigate operation impacts on water quality. Stakeholders that adopt WQMPs or conservation plans should adhere to the requirements written into their specific plan. Stakeholders will receive assistance from other responsible parties to adopt and implement conservation plans.
- **Texas A&M AgriLife Extension Service** – Texas A&M AgriLife Extension (AgriLife Extension) will work with the watershed coordinator in the continued development and delivery of education and outreach programs related to this management measure.
- **Texas State Soil and Water Conservation Board** – The TSSWCB is the lead agency in Texas responsible for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural NPS pollution. The TSSWCB is responsible for administering the certified WQMP program that provides, through SWCDs, cost-share assistance for management practices on agricultural and silvicultural lands; however, not all WQMPs receive financial assistance. The TSSWCB, in collaboration with NRCS and SWCDs, will continue to provide technical assistance to landowners in developing and implementing WQMPs in the watershed.
- **Soil and Water Conservation Districts** – Local SWCDs (Lavaca SWCD #334 and Jackson SWCD #336) in collaboration with the TSSWCB and NRCS are responsible for providing technical assistance to local stakeholders for the preparation and completion of WQMPs and conservation plans.
- **U.S. Department of Agriculture Natural Resources Conservation Service** – The NRCS is responsible for providing conservation planning and technical assistance to landowners, groups, and units of government to develop and implement conservation plans that protect, conserve, and enhance their natural resources. The NRCS, with assistance from local SWCDs, TSSWCB, and the watershed coordinator, will work with local stakeholders to develop and implement conservation plans. The NRCS also administers numerous Farm Bill Programs authorized by the U.S. Congress that provide financial assistance for many conservation activities. All practices are subject to NRCS technical standards described in the Field Office Technical Guide and adapted for local conditions. The local SWCD approves the conservation plan. Local work groups provide recommendations to NRCS on allocating Environmental Quality Incentives Program (EQIP) county base funds and on resource concerns for other United States Department of Agriculture (USDA)

Farm Bill programs. The Lavaca River watershed stakeholders are encouraged to participate in local work groups to promote the goals of this I-Plan, as compatible with the resource concerns and conservation priorities for EQIP.

The entities mentioned in this section provide technical and financial assistance for Management Measure 1, but funding sources for this management measure need not be limited to these entities. The intent of the previously mentioned programs is for the agencies listed under Management Measure 1 to work with landowners to voluntarily implement WQMPs and conservation plans. Technical assistance to agricultural producers for developing WQMPs and conservation plans is provided through the TSSWCB's WQMP Program, which is funded through state general revenue.

The TSSWCB, SWCDs, and NRCS will continue to provide appropriate levels of cost-share assistance to agricultural producers that will facilitate the implementation of BMPs and conservation programs in the Lavaca River watershed, as described in Management Measure 1. However, it is anticipated that additional levels of funding will be needed to meet implementation needs. Potential outside sources of funding to assist implementation are outlined below.

- **Coastal Zone Management Program and Coastal Management Program** (CZM and CMP) – The CZM Program, administered by National Oceanic and Atmospheric Administration (NOAA) 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 Act provides funding for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources. To meet the goals of the CZMA, the National 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 National CZM Program include:
    - protecting natural resources
    - managing development in high hazard areas
    - giving development priority to coastal-dependent uses
    - providing public access for recreation
    - 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.

- **Conservation Innovation Grants** (CIG) – The CIG is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental 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.
- **Conservation Stewardship Program** (CSP) – The CSP helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance — the higher the performance, the higher the payment.
- **Conservation Reserve Program** (CRP) – The CRP is a voluntary program for agricultural landowners administered by the USDA Farm Service Agency. Individuals may receive annual rental payments to establish long-term, resource conserving covers on environmentally sensitive land. The goal of the program is to reduce runoff and sedimentation to protect and improve lakes, rivers, ponds, and streams. Financial assistance covering up to 50 percent of the costs to establish approved conservation practices, enrollment payments, and performance payments are available through the program.
- **Environmental Quality Incentives Program** – EQIP is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years. These contracts provide financial assistance to help plan and implement conservation practices that address natural resource concerns and for opportunities to improve soil, water, plant, animal, air, and related resources on agricultural land and non-industrial private forestland. An additional purpose of EQIP is to help producers meet federal, state, tribal, and local environmental regulations.
- **Federal and State Clean Water Act (CWA) §319(h) Grants** (EPA/TCEQ/TSSWCB) – The EPA provides grant funding to Texas to implement the state's approved Nonpoint Source Management Program. The EPA-approved Texas program provides the framework for determining which activities are eligible for funding under CWA Section 319(h). In general, these activities include non-regulatory programs and are related to controlling NPS pollution. EPA-approved NPS programs cover costs associated with technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS projects. This program requires a 40 percent match through local funding or in-kind services.
- **Regional Conservation Partnership Program** (RCPP) – The 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, the NRCS and 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.

- **TSSWCB Water Quality Management Plan Program** – WQMPs are property-specific plans that prescribe management practices that, when implemented, will improve the quality of land and water on the property. Once the plans are developed, the TSSWCB may be able to provide financial assistance for implementing a portion of the practices. It should be noted that the TSSWCB's WQMP Program is dependent on continued appropriations from the Texas Legislature.

Estimated Load Reductions

Prescribed management will reduce loadings associated with livestock by reducing runoff from pastures and rangeland as well as reducing direct deposition by livestock. Through this Management Measure, 100 WQMPs or conservation plans will be developed and implemented in the Lavaca River watershed. Of the 100 WQMPs or conservation plans, 30 WQMPs or conservation plans will be developed and implemented in the Rocky Creek watershed. Implementation of 100 WQMPs and conservation plans is estimated to reduce annual loads from livestock by 9.78×10^{14} colony forming units (cfu) *E. coli* per year in the Lavaca River watershed (Table 16). Implementation of 30 WQMPs and conservation plans in the Rocky Creek watershed is estimated to reduce loads by 2.10×10^{14} cfu *E. coli* per year in that watershed. The 30 plans for Rocky Creek watershed are included as part of the 100 plans for the Lavaca River watershed.

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

Year 1:

- The watershed coordinator, TSSWCB, SWCDs, and NRCS will work to secure funding for a regional or watershed field technician to develop WQMPs.

Year 2:

- The TSSWCB, SWCDs, NRCS, and local stakeholders will develop and implement twenty WQMPs or conservation plans across the Lavaca River watershed, including six in the Rocky Creek watershed over the first two years.
- The watershed coordinator, in collaboration with AgriLife Extension, will provide one Lone Star Healthy Streams workshop.

Year 3:

- The watershed coordinator, AgriLife Extension, local SWCDs, and NRCS will provide one Agricultural Management Practice Field Day focused on improved livestock grazing practices.

Year 4:

- The TSSWCB, SWCDs, NRCS, and local stakeholders will develop and implement twenty additional WQMPs or conservation plans across the Lavaca River watershed, including six in the Rocky Creek watershed.
- The watershed coordinator, in collaboration with AgriLife Extension, will provide one Lone Star Healthy Streams workshop.

Year 5:

- The watershed coordinator, AgriLife Extension, local SWCDs, and NRCS will provide one Agricultural Management Practice Field Day focused on improved livestock grazing practices.

Year 6:

- The TSSWCB, SWCDs, NRCS, and local stakeholders will develop and implement twenty additional WQMPs or conservation plans across the Lavaca River watershed, including six in the Rocky Creek watershed.
- The watershed coordinator, in collaboration with AgriLife Extension, will provide one Lone Star Healthy Streams workshop.

Year 7:

- The watershed coordinator, AgriLife Extension, local SWCDs, and NRCS will provide one Agricultural Management Practice Field Day focused on improved livestock grazing practices.

Year 8:

- The TSSWCB, SWCDs, NRCS, and local stakeholders will develop and implement twenty additional WQMPs or conservation plans across the Lavaca River watershed, including six in the Rocky Creek watershed.
- The watershed coordinator, in collaboration with AgriLife Extension, will provide one Lone Star Healthy Streams workshop.

Year 9:

- The watershed coordinator, AgriLife Extension, local SWCDs, and NRCS will provide one Agricultural Management Practice Field Day focused on improved livestock grazing practices.

Year 10:

- TSSWCB, SWCDs, NRCS, and local stakeholders will develop and implement twenty additional WQMPs or conservation plans across the Lavaca River watershed, including six in the Rocky Creek watershed.
- The watershed coordinator, in collaboration with AgriLife Extension will provide one Lone Star Healthy Streams workshop.

Table 16. Summary of Management Measure 1: Promote and implement Water Quality Management Plans or conservation plans

Causes and Sources: Fecal deposition from cattle and other livestock in pastures, rangeland, and direct deposition in streams

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entities
Lavaca River 9.78×10^{14} cfu/year Rocky Creek 2.10×10^{14} cfu/year	Technical – A WQMP technician will be needed to provide technical assistance with development of WQMPs. Financial – Significant financial needs are anticipated with an estimated $75,000 per year for a WQMP technician; and an estimated $15,000 to develop, implement, and provide cost share per conservation plan or WQMP.	Education and outreach will be required to demonstrate benefits to producers and their operations. The Lone Star Healthy Streams program and Management Practice Field days will be delivered to livestock producers in the watershed.	– Years 1-10: Develop 100 plans across the Lavaca River watershed, including 30 in the Rocky Creek watershed. – Years 1-2: Hire a WQMP field technician. Develop 20 plans across the watershed. Deliver one Lone Star Healthy Streams workshop. – Years 3-4: Develop 20 additional plans across the watershed. Deliver one Lone Star Healthy Streams workshop and one Agriculture Management Practice Field Day. – Years 5-6: Develop 20 additional plans across the watershed. Deliver one Lone Star Healthy Streams workshop and one Agriculture Management Practice Field Day. – Years 7-8: Develop 20 additional plans across the watershed. Deliver one Lone Star Healthy Streams workshop and one Agriculture Management Practice Field Day. – Years 9-10: Develop 20 additional plans across the watershed. Deliver one Lone Star Healthy Streams workshop and one Agriculture Management Practice Field Day.	– Number of WQMP and conservation plans developed – Education and outreach programs delivered – Agricultural management practice field days delivered	– Funding leveraged for a WQMP technician – Number of plans developed – Amount of funding leveraged for WQMP and conservation plan development and implementation – Number of education and outreach programs delivered	The watershed coordinator will request reports from TSSWCB, local SWCDs, and NRCS on the number of plans developed and implemented. The watershed coordinator will track grants and other funding applied for. The watershed coordinator will track education and outreach delivered in the watershed.	Watershed coordinator Local stakeholders AgriLife Extension TSSWCB SWCDs NRCS

Management Measure 2

Promote technical and direct operational assistance to landowners for feral hog control.

The purpose of this management measure is to reduce and manage feral hog populations within the watershed. Spatial analysis indicated that potential bacteria loadings from feral hogs were moderate compared to other sources. While other sources of potential *E. coli* loadings were higher, feral hogs demonstrate a preference for the dense habitat, water, and shade provided by riparian areas. Feral hog behavior and habitat preferences suggest a high likelihood for negative impacts on riparian habitat and water quality.

While the complete eradication of feral hogs from the watershed is not feasible, a variety of methods are available to manage or reduce populations. Trapping animals is likely the most effective method available to landowners for removing large numbers of feral hogs. Shooting feral hogs removes comparatively fewer individuals before they begin to move to other parts of the watershed. Trapping requires some amount of effort and proper planning to maximize effectiveness, but it also provides landowners a means to recoup costs associated with trapping efforts through the sale of live hogs. Specifically, the State of Texas allows transport of live feral hogs to approved holding facilities for sale. The purchase price will vary by facility and comparative market prices. Furthermore, costs of purchasing or building live traps can also be split amongst landowners.

Additionally, given the opportunistic feeding nature of feral hogs, minimizing available food from deer feeders is important. Feeders can help support the survival of local feral hog populations while also lowering trapping success by reducing the likelihood of feral hogs entering traps. Feeders located in or near riparian zones may also help maintain populations in areas that maximize their potential impact on water quality. Therefore, constructing exclusion fences around feeders and locating feeders away from riparian areas are other important strategies for minimizing feral hog impacts on water quality.

Education programs and workshops will be used to improve feral hog removal effectiveness. Currently, AgriLife Extension provides a variety of educational resources for landowners at <https://feralhogs.tamu.edu/>. Delivering up-to-date information and resources to landowners through workshops and demonstrations is critical to maximizing landowner success in removing feral hogs.

Based on spatial analysis, the highest potentials for loadings from feral hogs are in subwatersheds 6, 10, 11, 12, 15, 20, and 22 (Figure 6). However, given feral hogs' propensity to travel great distances along riparian corridors in search of suitable food and habitat, priority areas will include all subwatersheds with high importance placed on properties with riparian habitat.

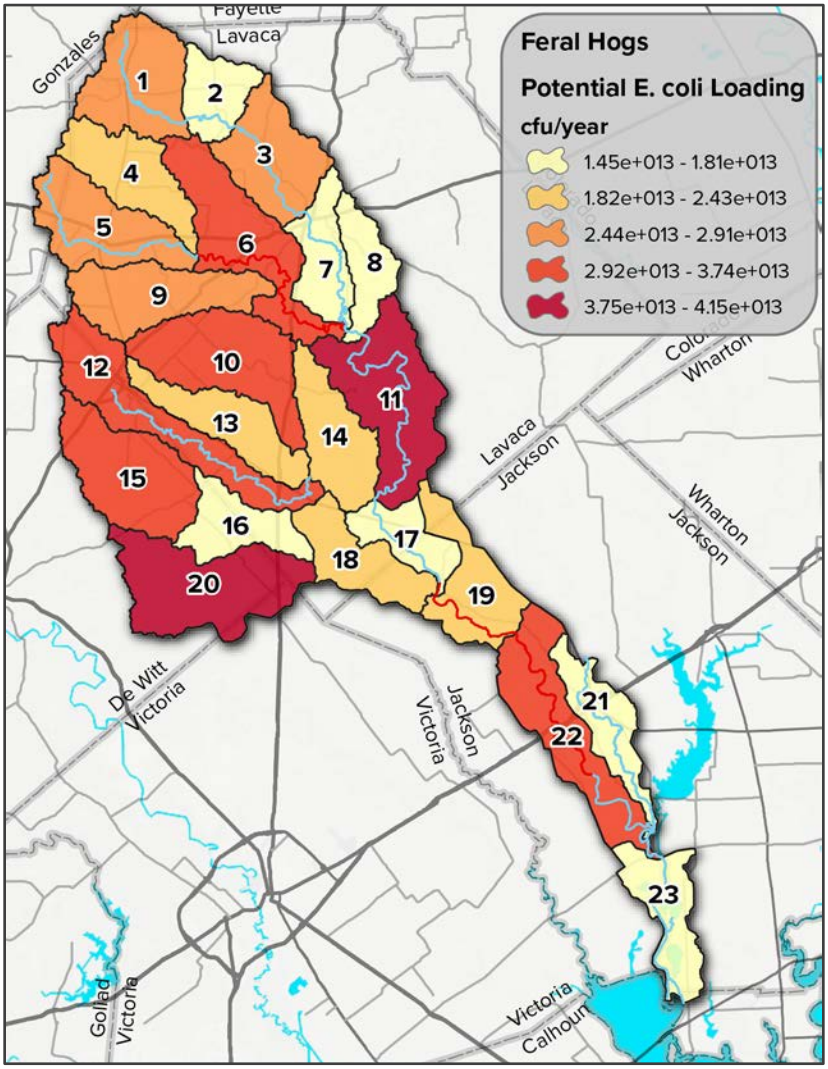

Figure 6. Potential annual bacteria loadings from feral hogs

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts.

- **Watershed coordinator** – The TWRI will serve as the watershed coordinator for the watershed. The watershed coordinator will work with other responsible parties to develop needed funding resources. The watershed coordinator will work with other entities to organize, develop, and/or deliver education and outreach components of Management Measure 2.
- **Local stakeholders** – Local stakeholders, specifically landowners, will evaluate the option of constructing exclusionary fencing around deer feeders. Landowners will also be responsible for voluntarily trapping, hunting, and removal of feral hogs to reduce numbers as feasible. Finally, individual landowners will evaluate the option of developing wildlife habitat

management plans or wildlife practices within conservation plans and WQMPs. If found feasible, the individual stakeholder is responsible for approaching the appropriate agency and working with that agency to develop the plan. Stakeholders will receive assistance from other responsible parties to adopt and implement these plans.

- **Texas A&M AgriLife Extension Service** – AgriLife Extension will work with the watershed coordinator in the continued development and delivery of education and outreach programs related to this management measure.
- **Texas Wildlife Services** – Texas Wildlife Services (TWS), through cooperative agreements between AgriLife Extension and the USDA's Animal and Plant Health Inspection Service, provides statewide leadership in the science, education, and practice of wildlife and invasive species management, including feral hogs, to protect the state's agricultural, industrial, and natural resources, as well as the public's health, safety, and property. TWS will work with AgriLife Extension to deliver education and outreach resources to local stakeholders.
- **Texas Parks and Wildlife Department** - The TPWD's Private Lands Services is a program for private landowners to provide practical information on ways to manage wildlife resources consistent with other land use goals, to ensure plant and animal diversity, to provide aesthetic and economic benefits, and to conserve soil, water, and related natural resources. To participate, landowners may request assistance by contacting the TPWD district serving their county. The TPWD also provides a cost share program through the Landowner Incentive Program to assist landowners in the development and implementation of wildlife management plans. TPWD will work with interested local landowners in the development and implementation of wildlife management plans.
- **Texas State Soil and Water Conservation Board** – The TSSWCB is the lead agency in Texas responsible for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural NPS pollution. The TSSWCB provides technical assistance to landowners under the WQMP program. Some of the practices implemented under this program can include benefits for wildlife and water quality. Although funding for direct abatement for feral hogs is not included, TSSWCB funds the delivery of feral hog control and abatement education for landowners.
- **Soil and Water Conservation Districts** – Local SWCDs (Lavaca SWCD #334 and Jackson SWCD #336), in collaboration with TSSWCB and NRCS, are responsible for providing technical assistance to local stakeholders for the preparation and completion of WQMPs and conservation plans. Through WQMPs and conservation plans, landowners can implement practices to benefit wildlife and water quality while minimizing available food and resources for feral hogs, based on operation goals and needs.

- **U.S. Department of Agriculture Natural Resources Conservation Service** – The NRCS is responsible for providing conservation planning and technical assistance to landowners, groups, and units of government to develop and implement conservation plans that protect, conserve, and enhance their natural resources. The NRCS, with assistance from local SWCDs, TSSWCB, and the watershed coordinator, will work with local stakeholders to develop and implement conservation plans. Based on landowner goals, conservation plans can be developed with wildlife management and water quality protection priorities in mind.

The entities mentioned in this section provide technical and/or financial assistance for Management Measure 2, but funding sources for this management measure need not be limited to these entities. The intent of the previously mentioned programs is for the agencies listed under Management Measure 2 to work with landowners to voluntarily implement the measure.

The TSSWCB, SWCDs, and NRCS will continue to provide appropriate levels of cost-share assistance to agricultural producers that will facilitate the implementation of BMPs and conservation programs in the Lavaca River watershed. However, it is anticipated that additional levels of funding will be needed to meet implementation needs. Potential outside sources of funding to assist implementation are outlined below.

- **Texas Department of Agriculture** – The Texas Department of Agriculture provides grant funding to governmental agencies and Texas higher education institutions for practical and effective projects to develop and implement long-term feral hog abatement strategies. AgriLife Extension and the TPWD currently receive funding through the Texas Department of Agriculture. 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.
- **Landowner Incentive Program** – The 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.

Estimated Load Reductions

Removing and maintaining feral hog populations directly reduces fecal loading potential to water bodies in the watershed. Reducing the population by 15 percent in the Lavaca River watershed is estimated to reduce potential annual loads by 8.42×10^{13} cfu *E. coli* annually (Table 17). Reducing the population by 15 percent in the Rocky Creek watershed is estimated to reduce potential annual loads by 1.68×10^{13} cfu *E. coli* annually (Table 17).

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

Years 1-10:

- Local stakeholders will work to install as many feral hog exclosures around deer feeders as is feasible.
- Local stakeholders will trap/hunt/remove feral hogs, with a goal of removing 15% or approximately 2,439 feral hogs annually.
- The TPWD, TSSWCB, SWCDs, NRCS, and local stakeholders will develop and implement wildlife management plans and practices where feasible.
- The watershed coordinator and AgriLife Extension, in coordination with TWS, will deliver a feral hog management workshop every other year.

Table 17. Summary of Management Measure 2: Promote technical and direct operational assistance to landowners for feral hog control

Causes and Sources: Fecal deposition from feral hogs directly in streams and in riparian habitats

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entity
Lavaca River 8.42×10^{13} cfu/year Rocky Creek 1.68×10^{13} cfu/year	Technical – Education and outreach workshops will provide landowners and managers with knowledge of available management options. Technical assistance for landowners implementing wildlife management practices through wildlife habitat management plans, WQMPs, or conservation plans. Financial – Estimated at $200 per feral hog exclosure; and $7,500 per feral hog workshop.	Landowners will receive knowledge on available management practices and options for feral hog control through feral hog management workshops conducted by AgriLife Extension in collaboration with TPWD, TWS, NRCS, and other agencies as appropriate.	– Years 1-10: Landowners will install as many feral hog exclosures around deer feeders as possible. – Years 1-10: Landowners will aim for a 15% reduction and maintenance of feral hog populations in each watershed. – Years: 1-10: Landowners will work with appropriate agencies to implement wildlife management plans and practices. – Years: 1-10: Feral Hog Management workshop will be delivered every other year.	– Number of workshops held – Number of landowners attending workshops – Estimated number of feral hogs removed	– Funding leveraged for education and workshop delivery – Number of education and outreach programs delivered – Number of individuals reporting feral hogs removed – Number of feral hogs removed	Landowners will be requested to report feral hogs trapped and removed to the TAMU feral hog tracker and the watershed coordinator will request data as appropriate. The watershed coordinator will track number of attendees and workshops delivered.	Watershed coordinator Local stakeholders AgriLife Extension TPWD TWS TSSWCB SWCD NRCS

Management Measure 3

Identify and repair or replace failing OSSFs.

The purpose of this management measure is to reduce the number of failing OSSFs within the watershed. Geographic Information System (GIS) analysis indicated OSSFs are a relatively moderate contributor to potential bacterial loadings across the watershed. Nearly all the soils in the watershed are classified as "somewhat limited" or "severely limited" for OSSF drain fields. This indicates that conventional septic tank systems are not suitable for the proper treatment of household wastewater. In these areas, advanced treatment systems, most commonly aerobic treatment units, are suitable alternative options for wastewater treatment. While advanced treatment systems are highly effective, the operation and maintenance needs for these systems are rigorous compared to conventional septic systems. Limited awareness and lack of maintenance can lead to system failures.

Failing OSSFs were a concern raised by stakeholders. The exact number of failing systems is unknown. Based on stakeholder feedback and literature failure rates, as many as 780 systems may be malfunctioning across the watershed. Improper system design or selection, improper maintenance, and lack of education are likely reasons contributing to OSSF failure. In some cases, systems can be treated and repaired, while in other cases, systems need to be redesigned and replaced; however, homeowners must have the awareness and resources to address OSSF problems when they arise.

To address these needs, efforts will focus on expanding and providing education and workshops to homeowners. Additionally, resources should be secured to assist homeowners that do not have access to resources to repair or replace OSSF systems should issues arise.

GIS analysis indicated the highest potential annual loadings occur in subwatersheds 6 and 12 (Figure 7). Priority areas include subwatersheds 1, 5, 6, 9, 10, and 12, and systems within any subwatershed and within 150 yards of a perennial water body.

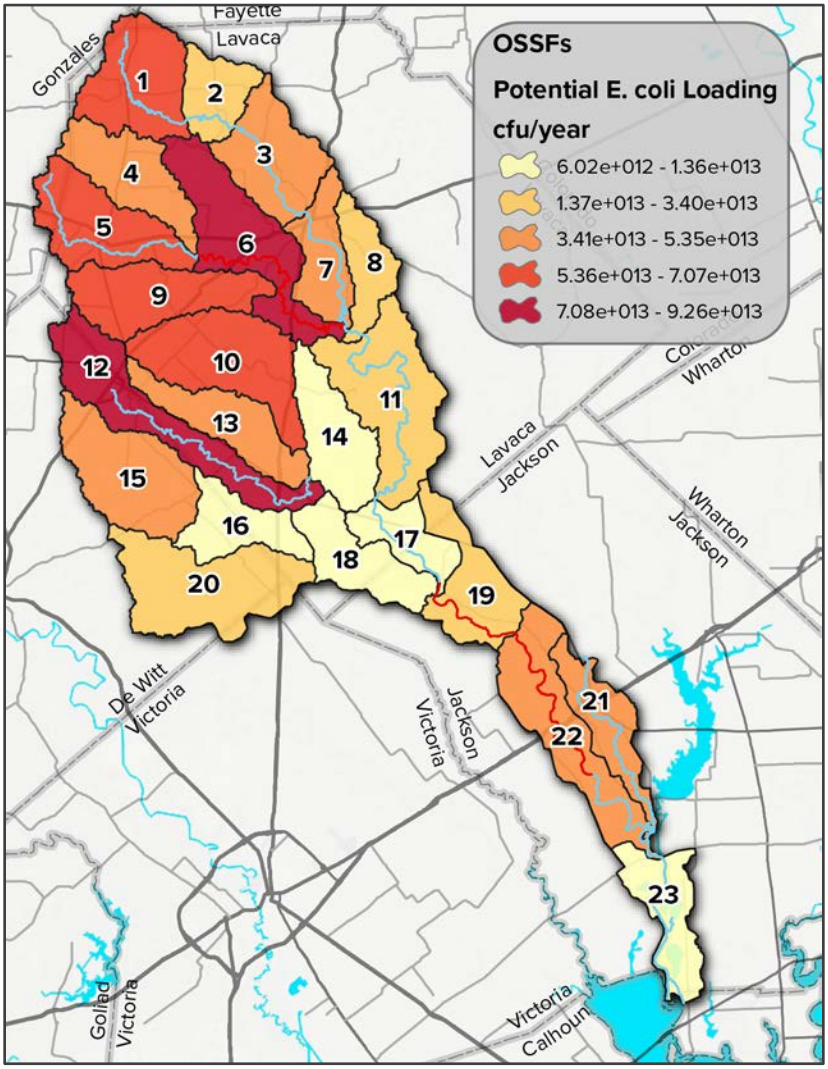

Figure 7. Potential annual bacteria loadings from OSSFs

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts.

- **Watershed coordinator** – The TWRI will serve as the watershed coordinator for the watershed. The watershed coordinator will work with other responsible parties to develop needed funding resources. The watershed coordinator will work with other entities to organize, develop, and/or deliver education and outreach components of Management Measure 3.
- **Texas A&M AgriLife Extension Service** – AgriLife Extension will work with the watershed coordinator in the continued development and delivery of education and outreach programs related to this management measure.
- **Local stakeholders** – Local stakeholders, specifically homeowners, are responsible for repairing or replacing faulty OSSFs on their own property.

The watershed coordinator will work with local stakeholders and organizations to leverage funding resources where needed to provide cost share if the need is identified.

- **Jackson County Office of Septic and Development Permitting** – As an authorized agent of the TCEQ, Jackson County is responsible for implementing and enforcing rules pertaining to OSSFs under the Texas Health and Safety Code and Texas Administrative Code. These codes establish minimum standards for the planning, permitting, construction, and maintenance of OSSFs. The office will work with the watershed coordinator as needed in the identification and development of programmatic needs, such as OSSF repair and replacement programs.
- **Lavaca County Designated Representative** – OSSF construction or replacement in Lavaca County requires a permit on file with Lavaca County. Permits must be applied for through a TCEQ licensed professional installer. The County Designated Representative is responsible for approving or denying permits. Site evaluations in Lavaca County must be done by a TCEQ licensed Site and Soil Evaluator, licensed maintenance provider, or licensed professional installer. The County Designated Representative will work with the watershed coordinator as needed in the identification and development of programmatic needs, such as OSSF repair and replacement programs.

The entities mentioned in this section provide technical and/or financial assistance for Management Measure 3, but funding sources for this management measure need not be limited to these entities. Potential outside sources of funding to assist implementation are outlined below.

- **Federal and State CWA §319(h) Grants** (EPA/TCEQ/TSSWCB) – The EPA provides grant funding to Texas to implement the state's approved Nonpoint Source Management Program. The EPA-approved Texas program provides the framework for determining which activities are eligible for funding under CWA Section 319(h). In general, these activities include non-regulatory programs and are related to controlling NPS pollution. EPA-approved NPS programs cover costs associated with technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS projects. This program requires a 40 percent match through local funding or in-kind services.
- **Rural Development Water and Environment Program** – 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: provides 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: provides grants to non-profit organizations that offer technical assistance and training for water delivery and waste disposal.
  - Water and Waste Disposal Direct Loans and Grants: assists in developing water and waste disposal systems in rural communities with populations less than 10,000 individuals.
- **Urban Water Small Grants Program** – The objective of the Urban Waters Small Grants Program, administered by the 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.
- **Texas General Land Office Coastal Impact Assistance Program** – The Coastal Impact Assistance Program 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; for planning assistance and the administrative costs of complying with planning objectives; for implementation of a federally-approved marine, coastal, or comprehensive conservation management plan; and for mitigation of the impact of outer Continental Shelf activities through funding of onshore infrastructure projects and public service.
- **Coastal Zone Management Program and Coastal Management Program** – The CZM Program, administered by NOAA and the TGLO, is a voluntary partnership between the federal government and U.S. coastal and Great Lake states and territories, and is authorized by the CZMA of 1972 to address national coastal issues. The Act provides funding for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources. To meet the goals of the CZMA, the National 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 National CZM Program include:
  - protecting natural resources
  - managing development in high hazard areas
  - giving development priority to coastal-dependent uses
  - providing public access for recreation
  - 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.

- **Supplemental Environmental Projects** (SEP) – The SEP program, administered by the TCEQ, directs fines, fees, and penalties for environmental violations toward environmentally beneficial uses. Through this program, a respondent in an enforcement matter can choose to invest penalty dollars in improving the environment, rather than paying into the Texas General Revenue Fund. Program dollars may be directed to OSSF repair, trash dump clean up, and wildlife habitat restoration or improvement, among other things. Program dollars may be directed to entities for single, one-time projects that require special approval from the TCEQ or directed to entities (such as Resource Conservation and Development Councils) with pre-approved "umbrella" projects.

Estimated Load Reductions

As planned, repair or replacement of 40 failing systems in the Lavaca River watershed results in a potential load reduction of 4.72×10^{13} cfu *E. coli* per year (Table 18). Of these 40 systems, at least 11 should be targeted towards Rocky Creek subwatersheds, which would result in a potential load reduction of 1.30×10^{13} cfu *E. coli* annually in Rocky Creek.

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

Years 1-10:

- The watershed coordinator, Jackson County Office of Septic and Development Permitting, Lavaca County Designated Representative, AgriLife Extension, and local stakeholders will coordinate to secure funding and resources to develop an OSSF repair/replacement program.

Years 1-2:

- The watershed coordinator and AgriLife Extension will deliver one OSSF Operations and Maintenance Program.

Years 3-4:

- Local homeowners, in coordination with appropriate local agencies, will repair or replace 10 failing OSSFs. The watershed coordinator will coordinate with local stakeholders, AgriLife Extension, and local agencies to leverage funding to provide cost-share assistance where needed.

- The watershed coordinator and AgriLife Extension will deliver one OSSF Operations and Maintenance Program.

Years 5-6:

- Local homeowners, in coordination with appropriate local agencies, will repair or replace 10 additional failing OSSFs. The watershed coordinator will coordinate with local stakeholders, AgriLife Extension, and local agencies to leverage funding to provide cost-share assistance where needed.
- The watershed coordinator and AgriLife Extension will deliver one OSSF Operations and Maintenance Program.

Years 7-8:

- Local homeowners, in coordination with appropriate local agencies, will repair or replace 10 additional failing OSSFs. The watershed coordinator will coordinate with local stakeholders, AgriLife Extension, and local agencies to leverage funding to provide cost-share assistance where needed.
- The watershed coordinator and AgriLife Extension will deliver one OSSF Operations and Maintenance Program.

Years 9-10:

- Local homeowners, in coordination with appropriate local agencies, will repair or replace 10 additional failing OSSFs. The watershed coordinator will coordinate with local stakeholders, AgriLife Extension, and local agencies to leverage funding to provide cost-share assistance where needed.
- The watershed coordinator and AgriLife Extension will deliver one OSSF Operations and Maintenance Program.

Table 18. Summary of Management Measure 3: Identify and repair or replace failing OSSFs

Causes and Sources: Fecal bacteria loading reaching streams from untreated or insufficiently treated household sewage discharged from faulty OSSFs

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entity
Lavaca River 4.72×10^{13} cfu/year Rocky Creek 1.30×10^{13} cfu/year	Technical – Resources/staff to identify and prioritize repair and replacement of failing OSSFs. Financial – Costs incurred for OSSF repair or replacement, estimated at $8,000 to $10,000 per system.	Expanded efforts to develop and deliver OSSF operations and maintenance workshops will be delivered to local stakeholders.	– Years 1-10: Secure funding and resources to develop and deliver a repair and replacement program. – Years 1-10: Repair or replace 40 failing OSSFs, including 11 in the Rocky Creek watershed. Deliver five OSSF workshops. – Years 1-2: Deliver one OSSF Operations and Maintenance Program. – Years 3-4: Repair or replace 10 failing OSSFs and deliver one OSSF Operations and Maintenance Program. – Years 5-6: Repair or replace an additional 10 OSSFs and deliver one OSSF Operations and Maintenance Program. – Years 7-8: Repair or replace an additional 10 OSSFs and deliver one OSSF Operations and Maintenance Program. – Years 9-10: Repair or replace an additional 10 OSSFs and deliver one OSSF Operations and Maintenance Program.	– Number of workshops held – Number of homeowners attending workshops – Number of OSSFs replaced	– Funding leveraged for OSSF repair and replacement program – Number of attendees at education and outreach programs – Number of education and outreach programs – Number of failing OSSFs repaired or replaced	The watershed coordinator will track funding applied for and any OSSFs repaired or replaced. The watershed coordinator will also track education and outreach programming delivered in the watershed.	Watershed coordinator Local stakeholders AgriLife Extension Jackson County Office of Septic and Development Permitting Lavaca County Designated Representative

Management Measure 4

Promote proper pet waste management.

The purpose of this management measure is to reduce the bacteria loadings associated with pet waste. Potential loading from dog waste was identified as the second largest potential source in the watershed. Given the association between dogs and human activity, addressing the waste and bacteria loads generated by dogs is relatively simple compared to other sources. Properly disposing of pet waste into a trash can is a simple and effective way of reducing *E. coli* loads in the watershed.

Adoption of this practice across the watershed, however, is not very probable and will require effort to encourage pet owners to implement it. First, expanded education and outreach efforts to educate and encourage pet owners to pick up pet waste are needed. Second, pet owners can be encouraged to pick up pet waste when pet waste bags and disposal bins are easier to access in public areas. The priority areas for this management measure are urbanized and public areas located in subwatersheds 5, 7, 12, and 21 (Figure 8).

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts.

- **Watershed coordinator** – The TWRI will serve as the watershed coordinator for the watershed. The watershed coordinator will work with other responsible parties to develop needed funding resources. The watershed coordinator will work with other entities to organize, develop, and/or deliver education and outreach components of Management Measure 4.
- **Texas A&M AgriLife Extension Service** – AgriLife Extension will work with the watershed coordinator in the continued development and delivery of education and outreach programs related to this management measure.
- **Local public works and/or parks departments** – Local municipalities will work to install at least five pet waste stations and signage in public parks across the watershed.

The entities mentioned in this section provide technical and/or financial assistance for Management Measure 4, but funding sources for this management measure need not be limited to these entities. Potential outside sources of funding to assist implementation are outlined below.

- **Federal and State CWA §319(h) Grants** (EPA/TCEQ/TSSWCB) –The EPA provides grant funding to Texas to implement the state's approved Nonpoint Source Management Program. The EPA-approved Texas program provides the framework for determining which activities are eligible for funding under

CWA Section 319(h). In general, these activities include non-regulatory programs and are related to controlling NPS pollution. EPA-approved NPS programs cover costs associated with technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS projects. This program requires a 40 percent match through local funding or in-kind services.

- **Urban Water Small Grants Program** – The objective of the Urban Waters Small Grants Program, administered by the 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.

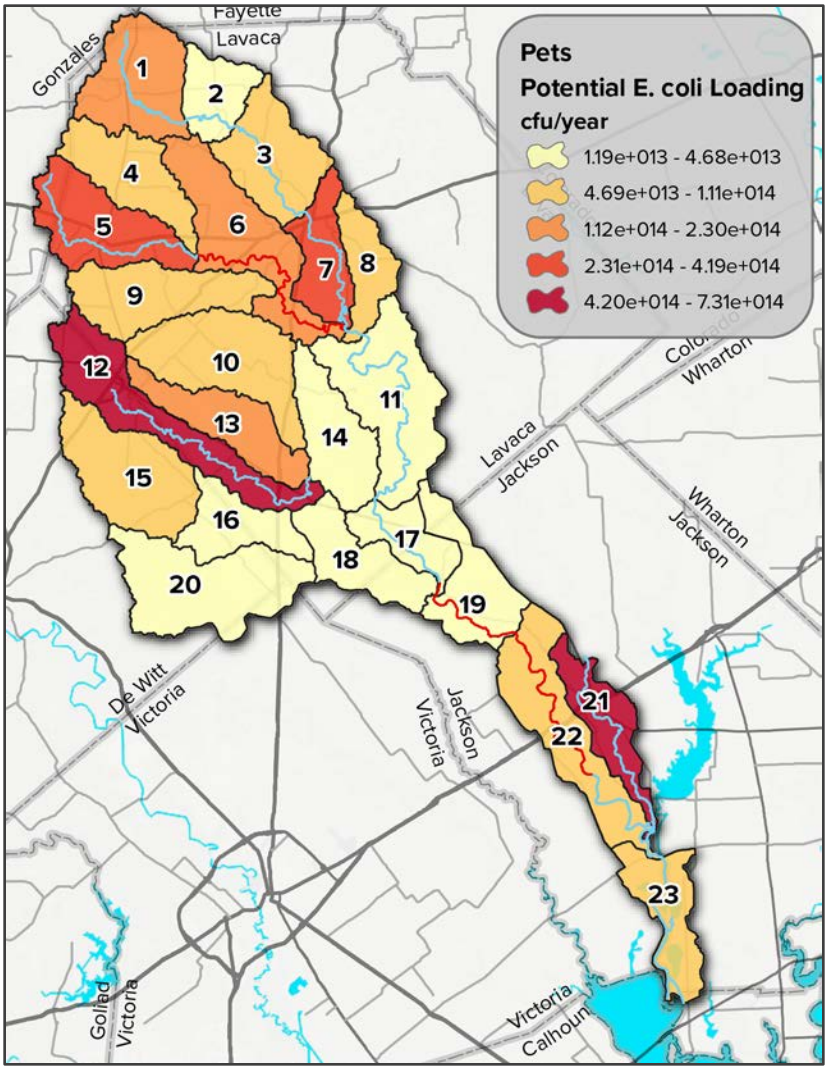

Figure 8. Potential annual bacteria loadings from domestic pets

Estimated Load Reductions

Load reductions resulting from this management measure are reliant on changes in people's behavior, and therefore uncertain. Assuming 20 percent of targeted individuals respond by properly disposing of pet waste, an annual load reduction of 3.95×10^{13} cfu *E. coli* per year is expected in the Lavaca River and 8.45×10^{12} cfu *E. coli* per year in Rocky Creek (Table 19).

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

Years 1-10:

- The watershed coordinator will coordinate with local municipalities and AgriLife Extension to develop and deliver educational and outreach materials to residents across the watershed.

Years 2-3:

- Watershed municipalities will install at least two pet waste stations in local parks or other public areas.

Years 4-5:

- Watershed municipalities will install at least one additional pet waste station in local parks or other public areas.

Years 6-7:

- Watershed municipalities will install at least one additional pet waste station in local parks or other public areas.

Years 8-10:

- Watershed municipalities will install at least one additional pet waste station in local parks or other public areas.

Table 19. Summary of Management Measure 4: Promote proper pet waste management

Causes and Sources: Direct and indirect fecal bacteria loading from improperly disposed pet waste

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entity
Lavaca River Above Tidal 3.95×10^{13} cfu/year Rocky Creek 8.45×10^{12} cfu/year	Technical – Municipal and public works/parks staff can provide technical assistance with locating and installing pet waste stations. Financial – Moderate financial needs are anticipated for installing pet waste stations, which are estimated at $500 per station plus supplies in addition to an estimated $100 per year in maintenance costs per station.	The watershed coordinator will develop and deliver educational materials targeted to local communities in coordination with local cities, counties, and AgriLife Extension.	– Years 1-10: Install five pet waste stations in area parks and other high concentration areas. – Years 1-10: Annually develop and deliver educational and outreach materials to area residents. – Years 2-3: Install two pet waste stations. – Years 4-5: Install one pet waste station. – Years 6-7: Install one pet waste. station – Years 8-10: Install one pet waste station.	– Number of pet waste stations installed – Number of educational materials developed and delivered	– Funding leveraged to obtain and install pet waste stations – Number of stations installed – Number of educational materials developed and delivered	The watershed coordinator will track funding resources applied for and obtained. The watershed coordinator will also track the number of stations installed and educational materials developed and delivered.	Watershed coordinator AgriLife Extension Local public works and/or parks departments

Management Measure 5

Implement and expand urban and impervious surface stormwater runoff management.

Potential bacteria loading from urban and impervious surface runoff is likely relatively low compared to other sources, based on GIS analysis. Implementing stormwater BMPs on municipality-owned property is subject to political and economic feasibility and may result in relatively low load reductions compared to other management options, given the rural nature of the watershed. However, strategically placed demonstration projects provide valuable educational opportunities for residents on the water quality impacts of stormwater runoff.

The objective of this management measure is to work with local municipalities to identify and install demonstration BMPs that manage stormwater runoff as appropriate, and as funding permits. Potential BMPs include, but are not limited to, rain gardens, rain barrels/cisterns, green roofs, permeable pavement, bioretention, swales, and detention ponds. These BMPs can help reduce stormwater runoff quantity and directly or indirectly improve runoff quality. Furthermore, stormwater volume reductions from BMPs can reduce stormwater entering local sewage collection systems through I&I. The second objective is to deliver education programs in the watershed that educate residents about the impacts of stormwater on riparian areas and water quality. Priorities include urbanized areas in subwatersheds 5, 7, 12, and 21 (Figure 9).

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts.

- **Watershed coordinator** – The TWRI will serve as the watershed coordinator for the watershed. The watershed coordinator will work with other responsible parties to develop needed funding resources. The watershed coordinator will work with other entities to organize, develop, and/or deliver education and outreach components of Management Measure 5.
- **Texas A&M AgriLife Extension Service** – AgriLife Extension will work with the watershed coordinator in the continued development and delivery of education and outreach programs related to this management measure.
- **Local municipalities** – Local municipalities will collaborate with the watershed coordinator, property owners, and other potential partners to identify potential stormwater BMP demonstration projects.

The entities mentioned in this section provide technical and/or financial assistance for Management Measure 5, but funding sources for this management measure need not be limited to these entities. Potential outside sources of funding to assist implementation are outlined following.

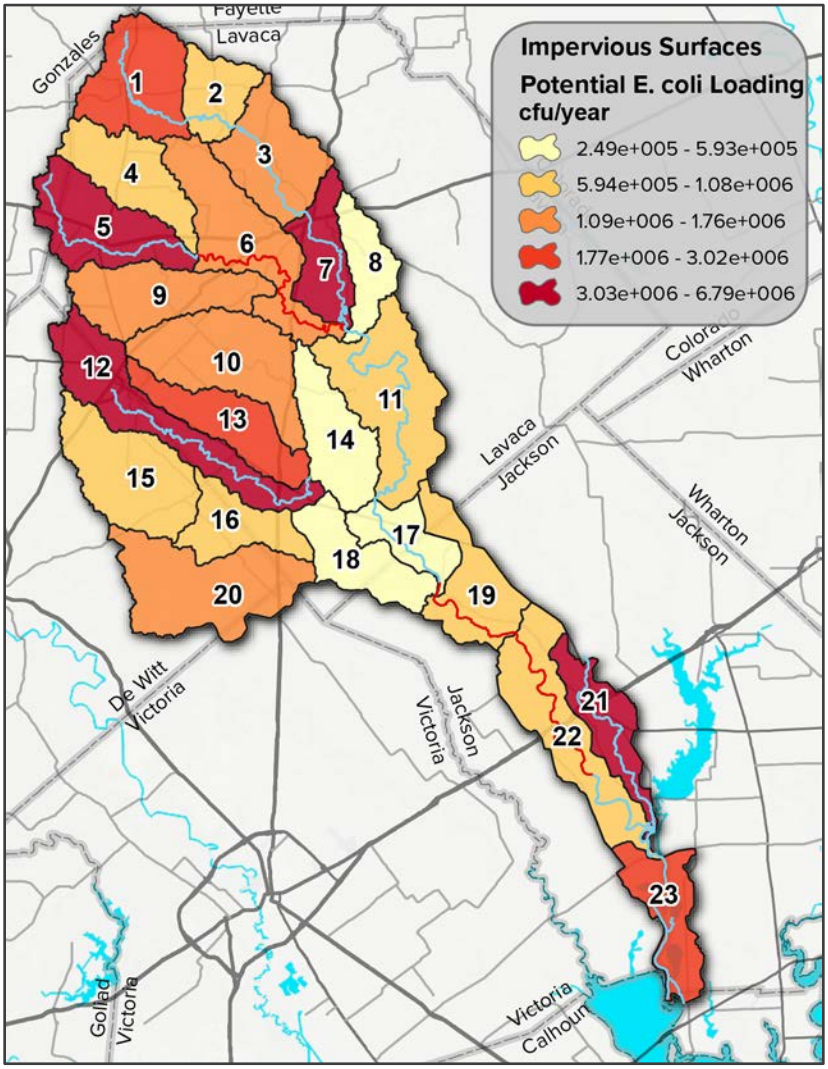

Figure 9. Potential annual bacteria loadings from urban and impervious stormwater runoff

- **Clean Water State Revolving Fund** – Through the TWDB, the Clean Water State Revolving Fund program provides low-interest loans to local governments and service providers for infrastructure projects, including stormwater BMPs. The loans can spread project costs over a repayment period of up to twenty years. Repayments are cycled back into the fund and used to pay for additional projects.
- **Federal and State CWA §319(h) Grants** (EPA/TCEQ/TSSWCB) – The EPA provides grant funding to Texas to implement the state's approved Nonpoint Source Management Program. The EPA-approved Texas program provides the framework for determining which activities are eligible for funding under CWA Section 319(h). In general, these activities include non-regulatory programs and are related to controlling NPS pollution. EPA-approved NPS programs cover costs associated with technical assistance, financial

assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS projects. This program requires a 40 percent match through local funding or in-kind services.

- **Urban Water Small Grants Program** – The objective of the Urban Waters Small Grants Program, administered by the 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.

Estimated Load Reductions

Installation of stormwater BMPs that reduce runoff or treat bacteria will result in direct reductions in bacteria loadings in the watershed. Potential load reductions were not calculated because the location, type, and sizes of projects installed will dictate the potential load reductions. However, the projects have not been identified yet (Table 20).

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

Years 1-10:

- The watershed coordinator will work with local municipalities to identify potential locations for and to install stormwater BMP demonstration projects.

Year 1:

- The watershed coordinator and AgriLife Extension will deliver one Texas Riparian and Ecosystem Training.

Year 3:

- The watershed coordinator and AgriLife Extension will deliver one Texas Riparian and Ecosystem Training.

Year 5:

- The watershed coordinator and AgriLife Extension will deliver one Texas Riparian and Ecosystem Training.

Year 7:

- The watershed coordinator and AgriLife Extension will deliver one Texas Riparian and Ecosystem Training.

Year 9:

- The watershed coordinator and AgriLife Extension will deliver one Texas Riparian and Ecosystem Training.

Table 20. Summary of Management Measure 5: Implement and expand urban and impervious surface stormwater runoff management

Causes and Sources: Fecal bacteria loading associated with urban and impervious surface stormwater runoff in developed and urbanized areas

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entity
Load reductions were not estimated for this management measure, although most stormwater BMPs are expected to directly reduce bacteria loadings to some extent. The reduction will be dependent on location and amount of runoff intercepted.	Technical – Technical expertise on appropriate BMPs, siting, design, and installation might be provided through outside contractors or consultants, in addition to AgriLife Extension. Financial – Financial needs are high, as most municipalities in the area are unlikely to pursue projects without significant financial assistance. Project costs may range from $4,000 to $45,000 per acre captured.	The watershed coordinator will collaborate with AgriLife Extension to direct the delivery of Riparian and Stream Ecosystem workshops and other education programs as appropriate to the watershed.	– Years 1-10: Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed. – Years 1-10: Deliver five Riparian and Stream Ecosystem workshops (one every other year beginning in Year 1).	– Number of stormwater demonstration projects installed – Number of education and outreach workshops delivered	– Funding leveraged to plan and install stormwater BMP projects – Number of stormwater BMP projects installed, and acres treated – Number of attendees for education events – Number of education and outreach events	The watershed coordinator will track funding resources applied for and obtained. The watershed coordinator will also track the number of stormwater BMP projects installed and education programs delivered.	Watershed coordinator AgriLife Extension Local municipalities

Management Measure 6

Address inflow and infiltration.

Although infrequent, SSOs and unauthorized WWTF discharges can contribute to bacteria loads, particularly during high runoff events. I&I is surface runoff that enters the sewer collection system through manhole covers, sewer cleanouts, damaged pipes, and faulty connections. As runoff enters the sewer collection system, there is increased potential for overloading the collection system or even the WWTF, resulting in an unauthorized discharge. Furthermore, I&I can have a diluting effect that sometimes decreases treatment efficiency and can increase utility pumping and treatment costs.

Some utilities in the watershed have conducted smoke testing of collection systems to identify connections and infrastructure contributing to increased I&I. Smoke testing is recommended for utilities that have not conducted it yet. I&I that occurs due to damaged pipes or cleanouts beyond the municipal utility connection is the responsibility of the property owner. Although the utility will inform customers of issues and their responsibility to repair the connection, homeowners might not be compelled to repair the issue. This could be attributed to capital costs, lack of concern, or the perception that it is the city's responsibility to fix the problem. Therefore, utilities are interested in developing programs to encourage the repair of damaged sewage piping or cleanouts. In addition to repairing and replacing connections contributing to I&I, providing education to customers is critical. It is recommended materials be developed and delivered that educate and inform residents about I&I, fats/oils/greases, and to discourage draining yards through sewer cleanouts. Priorities include urbanized areas in subwatersheds 5, 7, 12, and 21 (Figure 10).

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts.

- **Watershed coordinator** – The TWRI will serve as the watershed coordinator for the watershed. The watershed coordinator will work with other responsible parties to develop needed funding resources. The watershed coordinator will work with other entities to organize, develop, and/or deliver the education and outreach components of Management Measure 6.
- **Texas A&M AgriLife Extension Service** – AgriLife Extension will work with the watershed coordinator in the continued development and delivery of education and outreach programs related to this management measure.

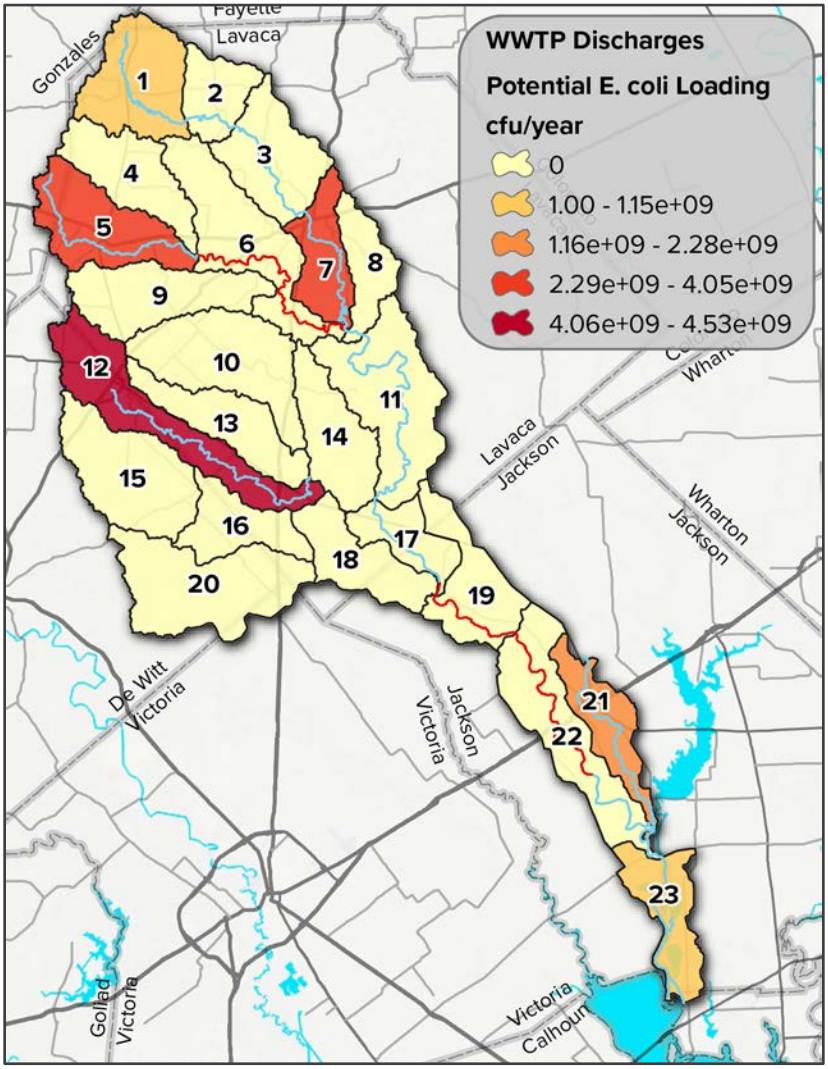

Figure 10. Potential annual bacteria loadings from wastewater discharges

- **Local stakeholders** – Local stakeholders, specifically homeowners, are responsible for maintaining and repairing sewage drain pipes on private property. The watershed coordinator will work with local stakeholders and organizations to leverage funding resources where needed to provide cost share, if the need is identified.
- **Local municipalities and public works departments** – Local municipalities and their departments are responsible for identifying damaged infrastructure (through smoke testing and other techniques), informing private homeowners of damaged private drain lines, and repairing or replacing damaged public infrastructure as funding permits. Local municipalities will collaborate with the watershed coordinator to develop and deliver educational programs as needed. Local municipalities will also work with the coordinator as needed to develop cost-share or other

programs to assist or encourage homeowners to maintain and/or repair damage sewage pipes on private property.

The entities mentioned in this section provide resources of technical and/or financial assistance for Management Measure 6, but funding sources for this management measure need not be limited to these entities. Potential outside sources of funding to assist implementation are outlined below.

- **Federal and State CWA §319(h) Grants** (EPA/TCEQ/TSSWCB) - The EPA provides grant funding to Texas to implement the state's approved Nonpoint Source Management Program. The EPA-approved Texas program provides the framework for determining which activities are eligible for funding under CWA Section 319(h). In general, these activities include non-regulatory programs and are related to controlling NPS pollution. EPA-approved NPS programs cover costs associated with technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS projects. This program requires a 40 percent match through local funding or in-kind services.
- **Clean Water State Revolving Fund** – This loan program, administered by the 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.
- **Urban Water Small Grants Program** – The objective of the Urban Waters Small Grants Program, administered by the 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.

Estimated Load Reductions

Reduction of SSOs and discharges associated with I&I will result in direct reductions in bacteria loads. However, because the response to education efforts and the development of resources to repair sewage lines is uncertain, load reductions were not calculated (Table 21).

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

Years 1-10:

- The watershed coordinator will work with AgriLife Extension, local municipalities and local stakeholders to design and develop a program and associated funding to encourage and/or assist homeowners with the repair and/or replacement of sewage drain lines that contribute to I&I.
- The watershed coordinator will annually develop and deliver educational material in coordination with local municipalities and AgriLife Extension.
- Local municipalities and contractors will utilize smoke testing (and other techniques) to identify infrastructure contributing to I&I as funding permits. Local municipalities and contractors will also repair identified infrastructure issues as funding permits.

Table 21. Summary of Management Measure 6: Address inflow and infiltration

Causes and Sources: Fecal bacteria loading from unauthorized discharges and SSOs caused by excessive water entering sanitary sewer systems

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entity
Load reductions are not estimated for this management measure. However, reduced SSOs and unauthorized discharges will result in decreased direct loadings of fecal bacteria to water bodies. The amount of infrastructure replaced, and response to education efforts are uncertain; therefore, load reductions were not calculated.	Technical – Moderate technical assistance is required as most municipalities are able to conduct smoke testing (or other techniques) or hire contractors. Infrastructure repair or replacement may require hiring outside contractors depending on the scope of the issue. Financial – Repair and replacement of sewage infrastructure can be costly. Private drain lines may cost $3,000 to $20,000 per site. Smoke testing is estimated at around $2,000 to $2,500 per mile.	The watershed coordinator will coordinate with AgriLife Extension and local municipalities to develop and deliver education resources to utility customers on proper upkeep of sewage lines, appropriate liquids for disposing into sewage lines, and the connection to local water quality.	– Years 1-10: Develop program and educational materials to assist homeowners with repair or upkeep of sewage drain lines. – Years 1-10: Continue testing and repairing faulty lines as funding allows.	– Miles or feet of line tested – Number of lines repaired – Number of customers reached with education and outreach materials	– Funding leveraged to develop an I&I program – Number of lines with I&I issues identified – Number of faulty lines repaired – Number of education and outreach materials developed – Number of customers targeted	The watershed coordinator will track funding resources applied for and obtained. The watershed coordinator will also work with cities to track results of testing and lines repaired or replaced. The watershed coordinator will develop and track educational resource delivery.	Watershed coordinator AgriLife Extension Local municipalities

Management Measure 7

Reduce illicit dumping.

Stakeholders indicate that illicit dumping, particularly of animal carcasses, can be problematic. These issues typically occur at or near bridge crossings where individuals may dispose of deer, hogs, or small livestock carcasses in addition to other trash. The scope of the problem is not entirely known or quantified, but is anticipated to be a relatively minor contributor to bacteria loadings in the watershed compared to other sources. However, development and delivery of educational and outreach materials to local residents on proper disposal of carcasses and other trash could help reduce illicit dumping and associated potential bacteria loadings. Efforts will focus across the entire watershed.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts.

- **Watershed coordinator** – The TWRI will serve as the watershed coordinator for the watershed. The watershed coordinator will work with other responsible parties to develop needed funding resources. The watershed coordinator will work with other entities to organize, develop, and/or deliver the education and outreach components of Management Measure 7.
- **Texas A&M AgriLife Extension Service** – AgriLife Extension will work with the watershed coordinator in the continued development and delivery of education and outreach programs related to this management measure.
- **Local municipalities and counties** – Local government agencies will work with the watershed coordinator and AgriLife Extension to develop and deliver educational and outreach materials to local residents.

The entities mentioned in this section provide resources of technical and/or financial assistance for Management Measure 7, but funding sources for this management measure need not be limited to these entities. Potential outside sources of funding to assist implementation are outlined below.

- **Federal and State CWA §319(h) Grants** (EPA/TCEQ/TSSWCB) – The EPA provides grant funding to Texas to implement the state's approved Nonpoint Source Management Program. The EPA-approved Texas program provides the framework for determining which activities are eligible for funding under CWA Section 319(h). In general, these activities include non-regulatory programs and are related to controlling NPS pollution. EPA-approved NPS programs cover costs associated with technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS projects. This program requires a 40 percent match through local funding or in-kind services.

- **Clean Water State Revolving Fund** – This loan program, administered by the 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.
- **Urban Water Small Grants Program** – The objective of the Urban Waters Small Grants Program, administered by the 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.

Estimated Load Reductions

Load reductions from this management measure were not quantified (Table 22).

Measurable Milestones

Contingent upon the receipt of proposed project funding, the measurable milestones are as follows.

Years 1-10:

- The watershed coordinator will work with AgriLife Extension and local municipalities and counties to design, develop, and deliver educational and outreach materials about illicit dumping to local residents on an annual basis.

Table 22. Summary of Management Measure 7: Reduce illicit dumping

Causes and Sources: Illegal and illicit dumping of trash and animal carcasses that may contribute to direct fecal bacteria loading

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entity
Load reductions are not estimated for this management measure.	Technical – AgriLife Extension will provide technical assistance with outreach and education efforts. Financial – Moderate financial needs are anticipated to develop educational material and might be incorporated into existing efforts. Factsheets and handouts estimated to cost $1,700 to develop. Printing costs are approximately $0.09 to $0.50 per page depending on quantity.	This management measure will primarily focus on the development and delivery of educational material to area residents. These materials may include fliers, one-pagers, or other appropriate material as identified.	– Years 1-10: Annually develop and deliver educational materials about illicit dumping to area residents.	– Number of educational materials developed – Number of residents reached with education and outreach materials	– Funding leveraged to develop educational materials – Number of educational materials developed – Number of residents reached	The watershed coordinator will track funding resources applied for and obtained. The watershed coordinator will develop and track educational resource delivery.	Watershed coordinator AgriLife Extension Local municipalities and counties

Sustainability

The TCEQ and stakeholders in TMDL implementation projects periodically assess the results of the planned activities, along with other information, to evaluate the effectiveness of the I-Plan. Stakeholders evaluate several factors, such as the pace of implementation, the effectiveness of BMPs, load reductions, and progress toward meeting water quality standards. The TCEQ will document the results of these evaluations and the rationale for maintaining or revising elements of the I-Plan.

The TCEQ and stakeholders will track progress using both implementation milestones and water quality indicators. These terms are defined as:

- **Implementation Milestones** – A measure of administrative actions undertaken to effect an improvement in water quality.
- **Water Quality Indicator** – A measure of water quality conditions for comparison to pre-existing conditions, constituent loadings, and water quality standards.

Water Quality Indicators

The TCEQ and its Clean Rivers Program partner, the Lavaca-Navidad River Authority, will continue to monitor the status of water quality during implementation as funding and resources allow. The indicator that will be used to measure improvement in water quality is *E. coli*.

Implementation Milestones

Implementation tracking provides information that can be used to determine if progress is being made toward meeting goals of the TMDL. Tracking also allows stakeholders to evaluate actions taken, identify those which may not be working, and make any changes that may be necessary to get the plan back on target.

Schedules of implementation activities and milestones for this I-Plan are included in Appendix A.

Communication Strategy

The TCEQ will host annual meetings for up to five years so stakeholders may evaluate their progress. Stakeholders and responsible parties will continue to take part in annual meetings over the five-year period to evaluate implementation efforts. At the completion of the scheduled I-Plan activities (10-years), stakeholders will assemble and evaluate the actions, overall impacts, and results of their implementation efforts.

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Appendix A.
I-Plan Matrix

Table A-1. Promote and implement Water Quality Management Plans or conservation plans — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1	Watershed coordinator TSSWCB SWCDs NRCS	Leverage funding to employ a regional or local WQMP technician.	– One technician hired
2	Local stakeholders TSSWCB SWCDs NRCS	Develop and implement WQMPs or conservation plans.	– 20 WQMPs or conservation plans developed and implemented in the first two years
	Watershed coordinator AgriLife Extension	Deliver education programing.	– One Lone Star Healthy Streams workshop delivered
3	Watershed coordinator AgriLife Extension NRCS SWCD	Deliver education programing.	– Management practice field day held
4	Local stakeholders TSSWCB SWCDs NRCS	Develop and implement WQMPs or conservation plans.	– 20 WQMPs or conservation plans developed and implemented in years three and four
	Watershed coordinator AgriLife Extension	Deliver education programing.	– One Lone Star Healthy Streams workshop delivered
5	Watershed coordinator AgriLife Extension NRCS SWCD	Deliver education programing.	– Management practice field day held

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
6	Local stakeholders TSSWCB SWCDs NRCS	Develop and implement WQMPs or conservation plans.	– 20 WQMPs or conservation plans developed and implemented in years five and six
	Watershed coordinator AgriLife Extension	Deliver education programing.	– One Lone Star Healthy Streams workshop delivered
7	Watershed coordinator AgriLife Extension NRCS SWCD	Deliver education programing.	– Management practice field day held
8	Local stakeholders TSSWCB SWCDs NRCS	Develop and implement WQMPs or conservation plans.	– 20 WQMPs or conservation plans developed and implemented in years seven and eight
	Watershed coordinator AgriLife Extension	Deliver education programing.	– One Lone Star Healthy Streams workshop delivered
9	Watershed coordinator AgriLife Extension NRCS SWCD	Deliver education programing.	– Management practice field day held
10	Local stakeholders TSSWCB SWCDs NRCS	Develop and implement WQMPs or conservation plans.	– 20 WQMPs or conservation plans developed and implemented in years nine and ten
	Watershed coordinator AgriLife Extension	Deliver education programing	– One Lone Star Healthy Streams workshop delivered

Table A-2. Promote technical and direct operational assistance to landowners for feral hog control — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
	Watershed coordinator AgriLife Extension TWS	Deliver a feral hog management workshop.	– Number of people attending workshop
2	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
3	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
	Watershed coordinator AgriLife Extension TWS	Deliver a feral hog management workshop.	– Number of people attending workshop
4	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
4 cont.	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
5	Local stakeholders	Install feral hog exclosures around deer feeders Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
	Watershed coordinator AgriLife Extension TWS	Deliver a feral hog management workshop.	– Number of people attending workshop
6	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
7	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
	Watershed coordinator AgriLife Extension TWS	Deliver a feral hog management workshop.	– Number of people attending workshop
8	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
8 cont.	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
9	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented
	Watershed coordinator AgriLife Extension TWS	Deliver a feral hog management workshop.	– Number of people attending workshop
10	Local stakeholders	Install feral hog exclosures around deer feeders. Trap, hunt, and/or remove feral hogs.	– Number of exclosures built – Number of hogs trapped, killed, or removed
	Local stakeholders TPWD TSSWCB SWCD NRCS	Implement wildlife management practices through wildlife management plans, conservation plans, or WQMPs.	– Number of plans implemented

Table A-3. Identify and repair or replace failing OSSFs — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1-10	Watershed coordinator; AgriLife Extension; Jackson County Office of Septic and Development Permitting; Lavaca County Designated Representative	Secure funding and resources to develop and deliver a repair and replacement program. Repair or replace 40 OSSFs.	– Programs and funding leveraged – Number of OSSFs replaces
1-2	Watershed coordinator; AgriLife Extension	Deliver one OSSF operations and maintenance workshop.	– One workshop offered and number of attendees
3-4	Local stakeholders; Jackson County Office of Septic and Development Permitting; Lavaca County Designated Representative	Repair or replace 10 OSSFs.	– Number of OSSFs replaced
	Watershed coordinator; AgriLife Extension	Deliver one OSSF operations and maintenance workshop.	– One workshop offered and number of attendees
5-6	Local stakeholders; Jackson County Office of Septic and Development Permitting; Lavaca County Designated Representative	Repair or replace 10 OSSFs.	– Number of OSSFs replaced
	Watershed coordinator; AgriLife Extension	Deliver one OSSF operations and maintenance workshop.	– One workshop offered and number of attendees
7-8	Local stakeholders; Jackson County Office of Septic and Development Permitting; Lavaca County Designated Representative	Repair or replace 10 OSSFs.	– Number of OSSFs replaced
	Watershed coordinator; AgriLife Extension	Deliver one OSSF operations and maintenance workshop.	– One workshop offered and number of attendees

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
9-10	Watershed coordinator; AgriLife Extension	Deliver one OSSF operations and maintenance workshop.	– One workshop offered and number of attendees
	Local stakeholders; Jackson County Office of Septic and Development Permitting; Lavaca County Designated Representative	Repair or replace 10 OSSFs.	– Number of OSSFs replaced

Table A-4. Promote proper pet waste management — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated
2	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated
3	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated
	Watershed coordinator; Local public works and/or parks departments	Install at least two pet waste stations.	– Number of pet waste stations installed
4	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed	– Number of educational materials created and disseminated
5	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated
	Watershed coordinator; Local public works and/or parks departments	Install at least one pet waste station.	– Number of pet waste stations installed
6	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated
7	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
7 cont.	Watershed coordinator; Local public works and/or parks departments	Install at least one pet waste station.	– Number of pet waste stations installed
8	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated
9	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed	– Number of educational materials created and disseminated
10	Watershed coordinator; AgriLife Extension; Local public works and/or parks departments	Develop and deliver educational and outreach materials to residents across the watershed.	– Number of educational materials created and disseminated
	Watershed coordinator; Local public works and/or parks departments	Install at least one pet waste station.	– Number of pet waste stations installed

Table A-5. Implement and expand urban and impervious surface stormwater runoff management — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
	Watershed coordinator; AgriLife Extension	Deliver Texas Riparian and Ecosystem Training.	– Workshop delivered – Number of workshop attendees
2	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
3	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
	Watershed coordinator; AgriLife Extension	Deliver Texas Riparian and Ecosystem Training.	– Workshop delivered – Number of workshop attendees
4	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
5	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
	Watershed coordinator; AgriLife Extension	Deliver Texas Riparian and Ecosystem Training.	– Workshop delivered – Number of workshop attendees
6	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
7	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
7 cont.	Watershed coordinator; AgriLife Extension	Deliver Texas Riparian and Ecosystem Training.	– Workshop delivered – Number of workshop attendees
8	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
9	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated
	Watershed coordinator; AgriLife Extension	Deliver Texas Riparian and Ecosystem Training.	– Workshop delivered – Number of workshop attendees
10	Watershed coordinator; Local municipalities	Identify and install stormwater BMP demonstration projects throughout urbanized areas in the watershed.	– Funding leveraged – Number of projects planned, funded, and built – Acres captured and treated

Table A-6. Address inflow and infiltration — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines.	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated
2	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners	– Number of educational materials created and disseminated
3	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners	– Number of educational materials created and disseminated
4	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
4 cont.	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated
5	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines.	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated
6	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines.	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated
7	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated
8	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines.	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
8 cont.	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated
9	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines.	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated
10	Watershed coordinator; AgriLife Extension; Local municipalities Local stakeholders	Develop program to assist homeowners with repair or upkeep of sewage drain lines.	– Funding leveraged – Number of lines repaired
	Local municipalities	Smoke test (or other appropriate techniques) and repair faulty lines as funding allows.	– Miles or feet of line tested – Lines or connections repaired
	Watershed coordinator; AgriLife Extension; Local municipalities	Develop and deliver educational materials to homeowners.	– Number of educational materials created and disseminated

Table A-7. Reduce illicit dumping — Implementation Schedule and Tasks

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
1	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
2	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
3	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
4	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
5	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
6	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached

Plan Year	Responsible Parties	Implementation Measure	Implementation Milestones
7	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
8	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
9	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached
10	Watershed coordinator; AgriLife Extension; Local municipalities and counties	Develop and deliver educational materials to area residents.	– Funding leveraged for education material development – Number of educational materials created and disseminated – Number of residents reached

Appendix B.
Load Reduction Estimates

Load Reduction Estimates

Estimates for load reductions are based on the best available information regarding the effectiveness of recommended management, loading estimates informed by technical data sources, and local knowledge derived from stakeholder input. Real world conditions based on where implementation is completed will ultimately determine the actual load reduction achieved once complete. Stakeholder input was critical for deriving agricultural estimates, estimating existing management measures, and determining feasible management measures.

Management Measure 1: Promote and implement Water Quality Management Plans or conservation plans

E. coli loading reductions resulting from implementation of conservation plans and WQMPs involves potential reductions from a variety of livestock. However, since cattle are the dominant livestock in the watershed, cattle were assumed to be the species managed through livestock-focused management.

According to USDA NASS data, there are approximately 1,262 producers and an estimated 72,182 animal units (AnUs) of cattle in the Lavaca River watershed. As a result, an estimate of 57.19 AnU of cattle per producer was made. This can also be interpreted at 57.19 AnUs of cattle addressed by each conservation plan or WQMP. Within the Rocky Creek watershed, there are approximately 408 producers and 16,727 AnU of cattle. This results in approximately 40.9 AnU cattle per plan. In reality, each WQMP or conservation plan will vary in size and number of AnUs addressed. Actual potential load reductions will vary by actual existing land conditions, proximity to water bodies, number of AnUs addressed by the management measure, and the types of BMPs implemented by the plan.

To estimate expected *E. coli* reductions, efficacy values of likely BMPs were calculated from median literature-reported values (Table B-1). These BMPs were determined based on feedback from members of the Agriculture Work Group. Because the actual BMPs implemented per WQMP or conservation plan are unknown, an overall median efficacy value of 0.58 (58%) was used to calculate load reductions. Finally, the proximity of implemented BMPs to water bodies will influence the effectiveness at reducing loads. Typically, a proximity factor of 0.05 (5%) is used for BMPs in upland areas and 0.25 used in riparian areas. Since there is uncertainty in both the specific BMPs and the locations where plans are implemented, an average proximity factor of 0.15 was used.

Table B-1. BMP effectiveness

Management Practice	*E. coli* Removal Efficacy		
	Low	High	Median
Exclusionary Fencing[1]	30%	94%	62%
Prescribed Grazing[2]	42%	66%	54%
Stream Crossing[3]	44%	52%	48%
Watering Facility[4]	51%	94%	73%

[1] Brenner et al. 1996; Cook 1998; Hagedorn et al. 1999; Line 2002; Line 2003; Lombardo et al. 2000; Meals 2001; Meals 2004; Peterson et al. 2011

[2] Tate et al. 2004; EPA 2010

[3] Inamdar et al. 2002; Meals 2001

[4] Byers et al. 2005; Hagedorn et al. 1999; Sheffield et al. 1997

Total potential load reductions from WQMPs and conservation plans were calculated with the following equation:

$$LR_{cattle} = N_{plans} \times \frac{AnU}{Plan} \times FC_{cattle} \times Conversion \times 365 \frac{days}{year} \times Efficacy \times Proximity\ Factor$$

Where:

LR_{cattle} = Potential annual load reduction of *E. coli*

N_{plans} = Number of WQMPs and conservation plans

AnU/Plan = Animal units of cattle (~1,000 pounds of cattle) per management plan, AnU

FC_{cattle} = Fecal coliform loading rate of cattle, 8.55×10^9 cfu fecal coliform per AnU per day (Wagner & Moench, 2009)

Conversion = Estimated fecal coliform to *E. coli* conversion rate; 126/200 (Wagner & Moench, 2009)

Efficacy = Median BMP efficacy value, 0.58

Proximity Factor = Percentage-based factor based on the assumed proximity of the management measure to the water body, 0.15

The Agriculture Work Group estimated that on average, approximately 20 percent of producers across the watershed would be willing to implement some type of management measures through WQMPs and conservation plans if assistance was provided.

Based on this estimate, the I-Plan recommends the implementation of 100 WQMPs or conservation plans across the entire Lavaca River watershed, resulting in a total potential reduction of 9.78×10^{14} cfu *E. coli* per year. This I-Plan also recommends implementation of 30 WQMPs or conservation plans in the Rocky Creek subwatersheds (subwatersheds 4, 5, 6, and 9), resulting in total potential reductions of 2.10×10^{14} cfu *E. coli* per year in Rocky Creek. Because Rocky Creek ultimately drains into the Lavaca River and we assume benefits accrue downstream, the 100 recommended plans for Lavaca include the 30 plans for Rocky Creek.

Management Measure 2: Promote technical and direct operational assistance to landowners for feral hog control

Loading reductions for feral hogs assume that existing feral hog populations can be reduced and maintained by a certain amount on an annual basis. Removal of a feral hog from the watershed is assumed to also completely remove the potential bacteria load generated by that feral hog. Therefore, the total potential load reduction is calculated as the population reduction in feral hogs achieved in the watershed. Based on GIS analysis and stakeholder input, 16,414 feral hogs were estimated to exist across the Lavaca River watershed. Using the same method, 3,215 feral hogs were estimated to exist in the Rocky Creek watershed. The established goal is to reduce and maintain the feral hog population 15 percent below current population estimates, thus resulting in a 15 percent reduction in potential loading that is attributable to feral hogs. Load reductions were calculated based on the following:

$$LR_{fh} = N_{fh} \times AUC \times FC_{fh} \times Conversion \times 365 \frac{days}{year}$$

Where:

LR_{fh} = Potential annual load reduction of *E. coli* attributed to feral hog removal

N_{fh} = Number of feral hogs removed

AUC = Animal unit conversion; 0.125 animal units/feral hog (Wagner & Moench, 2009)

FC_{fh} = Fecal coliform loading rate of feral hogs, 1.21×10^9 cfu fecal coliform per AnU per day (Wagner & Moench, 2009)

$Conversion$ = Estimated fecal coliform to *E. coli* conversion rate; 126/200 (Wagner & Moench, 2009)

The estimated potential annual loading across the Lavaca River watershed based on the reducing and maintaining the population by 15 percent (2,421 feral hogs) is 8.42×10^{13} cfu *E. coli* annually. For the Rocky Creek watershed, reducing and maintaining the population by 15 percent (482 feral hogs) results in a reduction of 1.68×10^{13} cfu *E. coli* annually. The calculation for the Lavaca River watershed includes the amount for the Rocky Creek watershed.

Management Measure 3: Identify and repair or replace failing OSSFs

OSSFs are common in the Lavaca River and Rocky Creek watersheds, with an estimated 5,246 and 1,507 OSSFs in each watershed, respectively. OSSF failures are factors of system age, soil suitability, system design, and maintenance. For this area of the state, a 12 percent failure rate is typically assumed (Reed, Stowe, and Yanke, 2001). It was assumed that five percent of OSSFs could feasibly be replaced. Load reductions can be calculated as the number of assumed failing OSSFs replaced. The following equation was used to calculate potential load reductions:

$$LR_{ossf} = N_{ossf} \times N_{hh} \times Production \times FC_s \times Conversion \times 365 \frac{days}{year}$$

Where:

LR_{ossf} = Potential annual load reduction of *E. coli* attributed to OSSF repair/replacement

N_{ossf} = Number of OSSFs repaired/replaced

N_{hh} = Average number of people per household (2.05)

Production = Assumed sewage discharge rate; 70 gal per person per day (Borel et al., 2012)

FC_s = Fecal coliform concentration in sewage; 1.0×10^6 cfu/100mL (EPA, 2001)

Conversion = Conversion rate from fecal coliform to *E. coli* (Wagner & Moench, 2009) and mL to gallons (3,578.4 mL per gallon)

Five percent of assumed failing OSSFs in the Lavaca River watershed equates to approximately 40 OSSFs. Repair or replacement of 40 systems results in a potential reduction of 4.72×10^{13} cfu *E. coli* annually. Five percent of assumed failing OSSFs in the Rocky Creek watershed is approximately 11 systems. Repair or replacement of 11 systems results in a potential reduction of 1.30×10^{13} cfu *E. coli* annually in Rocky Creek. The calculation for the Lavaca River watershed includes the amount for the Rocky Creek watershed.

Management Measure 4: Promote proper pet waste management

GIS analysis and stakeholder input determined that the Lavaca River watershed contains approximately 8,592 dogs and the Rocky Creek watershed contains approximately 1,839 dogs. *E. coli* loading from dogs is based on the assumption that 40 percent of dog owners do not properly dispose of dog waste. Load reductions are based on the assumption that approximately 20 percent of pet owners that do not currently dispose of pet waste will respond to the management measure efforts (Swann, 1999). Therefore, the goal is to increase the number of pet owners that dispose of pet waste by 687 pet owners in the entire Lavaca River watershed and 147 pet owners in the Rocky Creek watershed. Since these management measures will be most effective in public areas and places with higher concentrations of dogs, a proximity factor of 0.05 was included to account for the fact that the majority of these areas are upland or further away from riparian areas. The resulting reductions are calculated by:

$$LR_d = N_d \times FC_d \times Conversion \times Proximity\ Factor \times 365 \frac{days}{year}$$

Where:

LR_d = Potential annual load reduction of *E. coli* attributed to proper dog waste disposal

N_d = Number of additional dog owners disposing of pet waste

FC_d = Fecal coliform loading rate of dogs, 5.00×10^9 cfu fecal coliform per dog per day (EPA, 2001)

Proximity Factor = Percentage-based factor based on the assumed proximity of the management measure to the water body, 0.05

Conversion = Estimated fecal coliform to *E. coli* conversion rate; 126/200 (Wagner & Moench, 2009)

The estimated potential load reduction attributed to this management measure in the Lavaca River is 3.95×10^{13} cfu *E. coli* annually. The estimated potential load reduction attributed to this management measure in Rocky Creek is 8.45×10^{12} cfu *E. coli* annually. The calculation for the Lavaca River watershed includes the amount for the Rocky Creek watershed.

Appendix B References

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