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Draft Implementation Plan for Four Total Maximum Daily Loads for Indicator Bacteria in Tributaries of the Neches River below Lake Palestine

Assessment Units 0604A_02, 0604B_01, 0604C_01, 0604M_03

By Stakeholders of the Tributaries of the Neches River below Lake Palestine Watershed and the Texas Water Resources Institute

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City of Hudson
City of Lufkin
Texas Commission on Environmental Quality
Texas A&M AgriLife Extension Service
Texas A&M AgriLife Research
Texas A&M Forest Service
Texas State Soil and Water Conservation Board
Texas Water Resources Institute
U.S. Department of Agriculture Natural Resources Conservation Service

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Abbreviations

ANRA	Angelina and Neches River Authority
AU	assessment unit
AVMA	American Veterinary Medical Association
BMP	best management practice
cfu	colony forming units
CIG	Conservation Innovation Grants
CMS	coordinated monitoring schedule
CRP	Clean Rivers Program
CSP	Conservation Stewardship Program
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency (United States)
EQIP	Environmental Quality Incentives Program
FOG	fats, oils, and grease
FG	future growth
I-Plan	implementation plan
LA	load allocation
mL	milliliter
MOS	margin of safety
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
OSSF	on-site sewage facility
QAPP	Quality Assurance Protection Plan
RCPP	Regional Conservation Partnership Program
SARE	Sustainable Agriculture Research and Education
SMZ	streamside management zone
SSO	sanitary sewer overflow
SWCD	Soil and Water Conservation District
SWQM	surface water quality monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TFS	Texas A&M Forest Service
TMDL	total maximum daily load
TPWD	Texas Parks and Wildlife Department
TST	Texas Stream Team
TSSWCB	Texas State Soil and Water Conservation Board
TWRI	Texas Water Resources Institute
U.S.	United States
USDA	U.S. Department of Agriculture
WLA	wasteload allocation
WQMP	Water Quality Management Plan
WWTF	wastewater treatment facility

Executive Summary

In 2022, the Texas Commission on Environmental Quality (TCEQ) will consider adoption of *Four Total Maximum Daily Loads for Indicator Bacteria in Tributaries of the Neches River below Lake Palestine* (Segments 0604A, 0604B, 0604C, and 0604M).

This implementation plan, or I-Plan:

- Describes the steps that watershed stakeholders and TCEQ will take toward achieving the pollutant reductions identified in the Total Maximum Daily Load (TMDL) report.
- Outlines the schedule for implementation activities.

The goal of this I-Plan is to restore the primary contact recreation 1 uses in Segments 0604A, 0604B, 0604C, and 0604M by reducing concentrations of bacteria to levels established in the TMDL. *Escherichia coli (E. coli)* is widely used as an indicator bacteria to assess attainment of the contact recreation use in freshwater. The criteria for assessing attainment of the contact recreation use are expressed as the number of *E. coli* bacteria, typically given as colony forming units (cfu). The primary contact recreation 1 use is not attained when the geometric mean of *E. coli* samples exceeds the geometric mean criterion of 126 cfu per 100 milliliters (mL) for *E. coli* in freshwater streams.

This I-Plan includes eight management measures that stakeholders will use to reduce indicator bacteria in the Middle Neches project watershed. Management measures are related to managing nonpoint sources (mostly unregulated), such as working to identify on-site sewage facilities (OSSFs) in the watershed. Control actions are related to point sources (regulated discharges), such as implementing industrial or domestic wastewater treatment facilities (WWTFs) permits or municipal separate storm sewer systems and their associated stormwater management programs. No control actions are included in this plan.

Management Measures

For each of the measures chosen, this plan names the responsible parties, technical and financial needs, monitoring and outreach efforts, and a schedule of activities. Implementation of management measures will be dependent upon the availability of funding. The management measures in this plan are:

1) Promote feral hog management.
2) Implement water quality monitoring.
3) Promote volunteer water quality monitoring.
4) Promote sustainable forest practices.

5) Promote and implement Natural Resources Conservation Service conservation plans and Texas State Soil and Water Conservation Board Water Quality Management Plans.
6) Reduce sanitary sewer overflows and unauthorized discharges.
7) Promote education and awareness for the proper disposal of fats, oils, and grease, pet waste, and illicit dumping.
8) Promote OSSF management.

The stakeholders and TCEQ will review progress under TCEQ's adaptive management approach. Stakeholders may adjust the plan periodically as a result of progress reviews.

Introduction

To keep Texas' commitment to restore and maintain water quality in impaired rivers, lakes, and bays, 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.
- 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 Tributaries of the Neches River below Lake Palestine, collectively called the Middle Neches TMDL 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 formal or informal action.

This I-Plan contains the following components:

- Description of management measures that will be implemented to achieve the water quality target.
- Schedule for implementing activities.
- A follow-up tracking and monitoring plan to determine the effectiveness of the management measures undertaken.
- Measurable outcomes and other considerations TCEQ and stakeholders will use to decide whether the I-Plan has been properly executed, water quality standards are being achieved, or the plan needs to be modified.
- Communication strategies TCEQ will use to share information with stakeholders.

- Review strategy that stakeholders will use to periodically review and revise the plan to ensure progress in improving water quality.

Watershed Overview

The TMDL watersheds are entirely in Angelina County and include portions of the cities of Lufkin and Hudson (Figure 1). The Cedar Creek TMDL watershed for impaired Assessment Unit (AU) 0604A_02 includes the upstream AU 0604A_03 and upstream Hurricane Creek AUs 0604B_01 and 0604B_02. The Hurricane Creek TMDL watershed for AU 0604B_01 includes upstream AU 0604B_02. The Jack Creek TMDL watershed includes only AU 0604C_01, and the Biloxi Creek TMDL watershed includes only AU 0604M_03. The total area for all the TMDL watersheds is approximately 59,131 acres.

The 2022 Texas Integrated Report (TCEQ, 2022) provides the following segment and AU descriptions:

- Segment 0604A (Cedar Creek) – From the confluence of the Neches River southwest of Lufkin in Angelina County to the upstream perennial portion of the stream in Lufkin in Angelina County.
    - AU 0604A_02 – Perennial stream from the confluence with Jack Creek upstream to confluence with unnamed tributary adjacent to State Highway Loop 287
    - AU 0604A_03 – From the confluence with unnamed tributary adjacent to State Highway Loop 287 upstream to headwaters near Hoo Hoo Avenue in the City of Lufkin.
- Segment 0604B (Hurricane Creek) – From the confluence with Cedar Creek upstream to the headwaters near Groesbeck Avenue in the City of Lufkin.
    - AU 0604B_01 – From the confluence with Cedar Creek (0604A) upstream to confluence with unnamed tributary 100 meters above State Loop 287 in Lufkin, per Texas Surface Water Quality Standards, Appendix D, at National Hydrography Dataset reach code 12020002000043.
    - AU 0604B_02 – From the confluence with unnamed tributary 100 meters upstream of State Highway Loop 287 in the City of Lufkin upstream to headwaters near Groesbeck Avenue in Lufkin.
- Segment 0604C (Jack Creek) – From the confluence of Cedar Creek southwest of Lufkin in Angelina County to the upstream perennial portion of the stream in northeast Lufkin in Angelina County.
    - AU 0604C_01 – From the confluence with Cedar Creek (0604A) upstream to confluence with unnamed tributary 1.6 kilometers

southwest of United States (U.S.) Highway 69 northwest of Lufkin at National Hydrography Dataset reach code 12020002012470.

- Segment 0604M (Biloxi Creek) – From the confluence with the Neches River southeast of Diboll to Farm to Market 325 east of Lufkin in Angelina County.
  - AU 0604M_03 – From the confluence with One Eye Creek in Angelina County southeast of Lufkin upstream to Farm to Market 325 east of Lufkin.

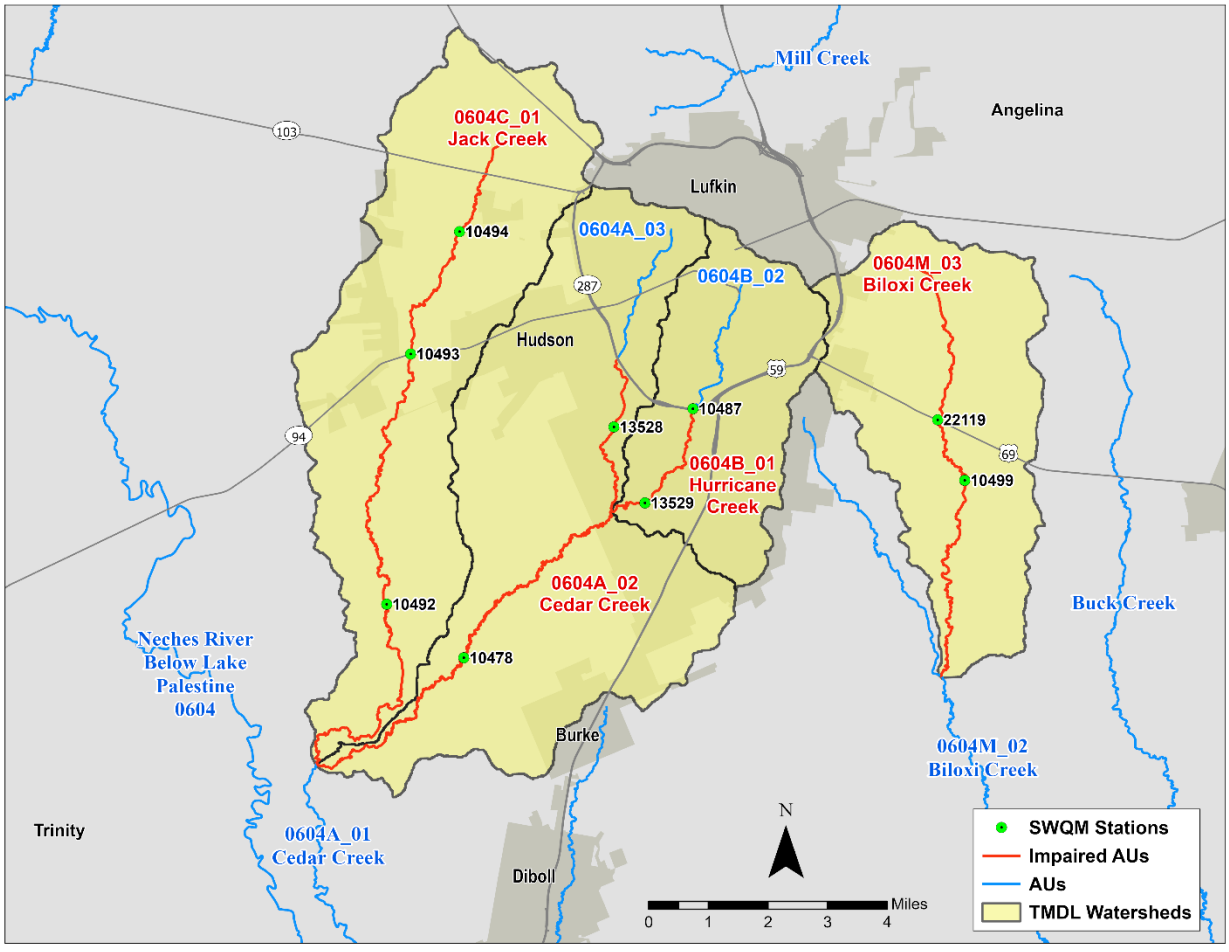

Figure 1. Overview map of the Middle Neches TMDL watersheds

Summary of TMDLs

Table 1 summarizes the allocations developed for *Four Draft Total Maximum Daily Loads for Indicator Bacteria in Tributaries of the Neches River below Lake Palestine.* See the TMDL report for additional background information, including

the problem definition, endpoint identification, source analysis, linkages between sources and receiving waters, and pollutant load allocations.

Table 1. TMDL allocation summary

AU	TMDL	WLA_{WWTF}[a]	WLA_{SW}[b]	LA[c]	FG[d]	MOS[e]
0604A_02	476.767	53.897	5.188	379.130	14.714	23.838
0604B_01	162.180	0.000	3.122	136.235	14.714	8.109
0604C_01	286.350	4.674	1.437	264.645	1.276	14.318
0604M_03	151.668	0.000	1.321	142.239	0.525	7.583

All loads are expressed in billion cfu/day

[a]WLA_{WWTF}: wasteload allocation for WWTFs

[b]WLA_{SW}: wasteload allocation for stormwater

[c]LA: load allocation

[d]FG: future growth

[e]MOS: margin of safety

Implementation Strategy

This I-Plan documents eight management measures to reduce bacteria loads. Stakeholders selected management measures based on feasibility, costs, support, and timing. Activities may be phased in based on the needs of the stakeholders, availability of funding, and the progress made in improving water quality.

Adaptive Implementation

All I-Plans use an adaptive management approach in which stakeholders periodically assess measures for efficiency and effectiveness. This adaptive management approach is one of the crucial 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.

The stakeholders will periodically assess progress using the schedule of implementation, interim measurable milestones, water quality data, and the communication strategy included in this plan. If stakeholders find that there has been insufficient progress or that implementation activities have improved water quality, the implementation strategy can be adjusted.

Activities and Milestones

The Texas Water Resources Institute (TWRI), in coordination with TCEQ, facilitated stakeholder participation in the development of this I-Plan. With guidance from the TWRI and TCEQ, the Middle Neches stakeholders formed a Coordination Committee to determine appropriate activities and schedules to

accomplish the management activities in the plan. Collectively, the Coordination Committee held 12 meetings to develop this I-Plan.

The Coordination Committee developed detailed, consensus-based measures. The following sections describe the planned implementation activities.

Management Measures

This I-Plan includes eight management measures.

1) Promote feral hog management.
2) Implement water quality monitoring.
3) Promote volunteer water quality monitoring.
4) Promote sustainable forest practices.
5) Promote and implement Natural Resources Conservation Service conservation plans and Texas State Soil and Water Conservation Board Water Quality Management Plans.
6) Reduce sanitary sewer overflows and unauthorized discharges.
7) Promote education and awareness for the proper disposal of fats, oils, and grease, pet waste, and illicit dumping.
8) Promote OSSF management.

Management Measure 1

Promote feral hog management.

Fecal matter deposited directly in streams by feral hogs contributes bacteria and nutrients to the state's water bodies. In addition, extensive rooting activities of feral hogs can cause erosion and soil loss.

While the complete eradication of feral hogs from the TMDL watersheds is not feasible, a variety of methods are available to manage populations. Stakeholders have recommended that governmental agencies and others undertake efforts to control feral hogs to reduce their population, limit their spread, and minimize the effects on water quality. Timmons et. al. (2012) estimated that 66% of feral hogs need to be managed annually to keep the population stable with no increase.

Currently, feral hog trapping is the responsibility of individual landowners. Given resource constraints, reliance on landowners to conduct the majority of feral hog trapping is likely to remain. As resources allow, professional trapping services and equipment programs can be provided to local stakeholders.

The promotion and implementation of best management practices (BMPs) focused on managing the feral hog populations within priority subwatersheds

can lead to instream water quality improvements by minimizing fecal deposition.

The purpose of this management measure is to manage 60% of the feral hog population in the TMDL watersheds.

Education Component

Education is one of the most important components of this management measure. An intensive education and outreach program is needed to broadly promote the adoption of management practices. A targeted education and outreach campaign will provide multiple educational opportunities to stakeholders. Educational materials will be developed and tailored to local conditions and broadcasted throughout the TMDL watersheds and five educational events or extension programs will be delivered. Existing feral hog management workshops will also be used in the education and outreach campaign.

Priority Areas

Feral hogs occupy and exploit a wide variety of habitats, and as shown in Figure 2, their loading potential is widespread. However, hogs will often congregate in high concentrations in areas where food is readily available, such as crop fields or forested areas with mast-producing trees. Feral hogs also congregate in riparian areas and muddy wetland habitats where they like to wallow around to keep cool.

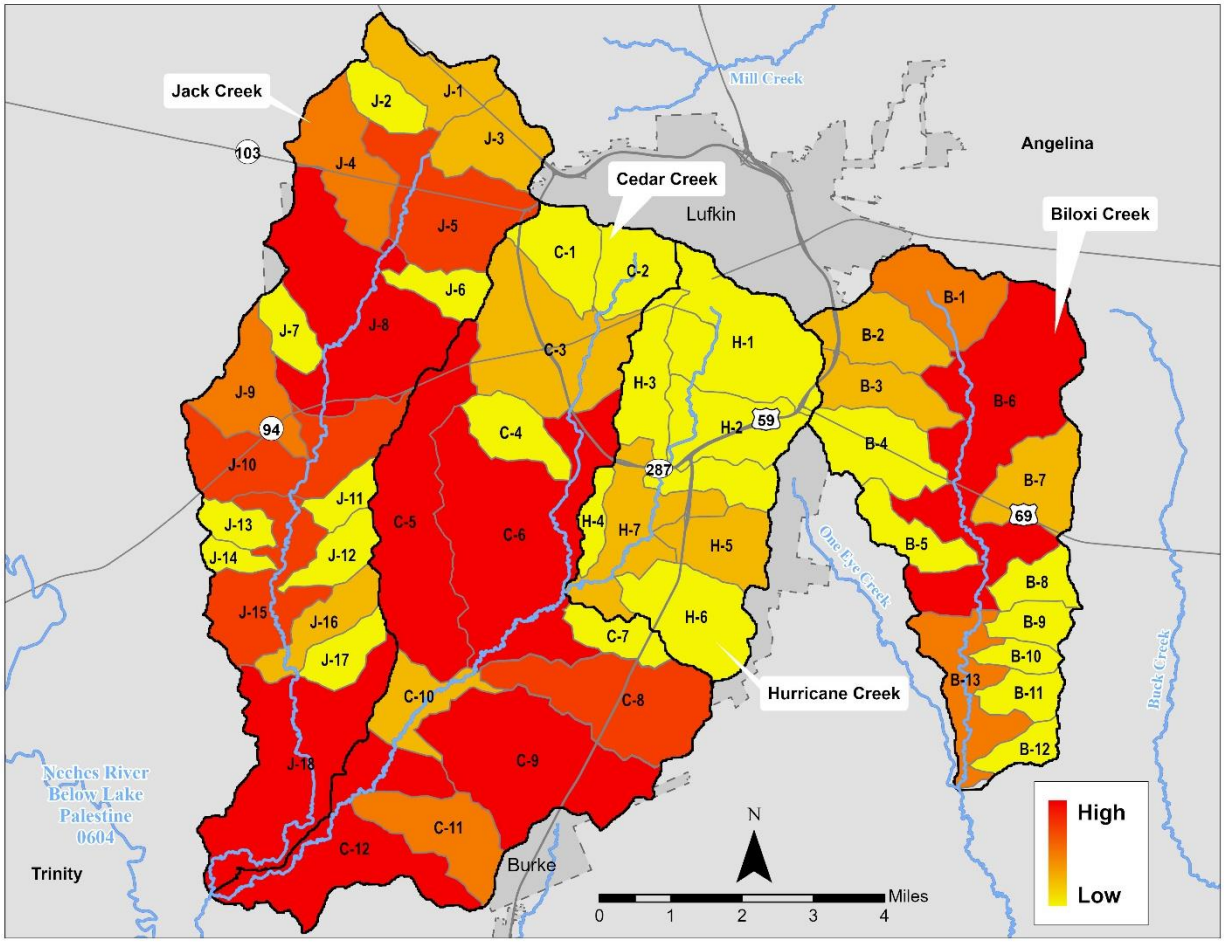

Figure 2. Subwatershed priorities based on *E. coli* loading potential from hogs

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **Local Stakeholders:** Landowners are responsible for trapping feral hogs on private property. Stakeholders are able to take advantage of services provided by Texas A&M Extension Service (AgriLife Extension) by requesting feral hog management workshops. As resources allow, regional or county trapping services may be made available for local landowners to trap feral hogs and track feral hogs removed more efficiently.
- **Angelina County Extension Office:** The extension office will work with other stakeholders or entities to deliver feral hog management education and outreach workshops.
- **AgriLife Extension:** AgriLife Extension will work with local stakeholders to deliver feral hog management workshops.

Technical Assistance

Numerous resources are available to assist landowners and managers to control feral hog populations. AgriLife Extension offers technical materials and workshops on feral hog identification, impacts, and control methods. Similar resources are available through the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Services. Texas Parks and Wildlife Department (TPWD) offers general information about identification, trapping, hunting, and regulations regarding the removal of feral hogs.

Financial Assistance

Table 2 shows the estimated costs of activities to implement for managing feral hog populations in the TMDL watersheds. Feral hog management workshops are estimated to cost approximately $2,500 per workshop. The cost will vary depending on anticipated attendance, speaker and travel costs, and venue fees.

Annual costs associated with funding a feral hog trapper and associated equipment is estimated at $95,000 per year. These costs may vary depending on whether a full or part-time trapper is employed.

Currently, funding for feral hog removal activities is limited primarily to non-federal and non-state funding sources. Therefore, funding for trapper activities will rely primarily on local funds.

Table 2. Estimated funding needed for implementing Management Measure 1

Description	Item	Unit	Rate	Amount
Funding for a feral hog trapper and associated equipment	5	Years	$ 95,000	$ 475,000
Feral hog workshops	5	No.	$ 2,500	$ 12,500
			Total:	**$ 487,500**

Potential funding sources include:

- **Clean Water Act Section 319(h) Nonpoint Source Grant Program:** This U.S. Environmental Protection Agency (EPA) grant program, administered by TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB), provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to fund feral hog education workshops and outreach programs.

- **Local Funds:** Local funds include funds or eligible in-kind resources provided by local entities, such as county and municipal governments, local agencies, non-governmental organizations, volunteer groups, or individuals. While financial resources are typically considered, volunteer

or staff time can be leveraged as eligible cost-share for many state and federal grant programs that require some type of cost-share. Local funds are anticipated to be the primary avenue of funding trappers.

Measurable Milestones

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

- Estimated number of feral hogs removed on an annual basis from each watershed.
- Number of educational programs delivered.
- Estimated number of individuals reached.

Monitoring Component

Local stakeholders are primarily responsible for removal of feral hogs. However, no mechanisms exist for tracking watershed-wide removal of feral hogs at this time. Although some efforts in the past have attempted to track these numbers, they have failed to gain traction. As funds allow, trapping programs will be used to track feral hogs removed. AgriLife Extension will track delivery of feral hog programs.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Years 1-5:

- Deliver one feral hog management workshop per year within one of the TMDL watersheds.
- Promote the management of feral hogs by voluntary hunting or trapping.
- Explore funding for feral hog trappers and equipment as needed.

Estimated Load Reductions

Load reductions resulting from feral hog management are highly uncertain. According to AgriLife Extension (2012), approximately 66% of the population must be culled just to maintain current populations levels. Therefore, the I-Plan targets annual removal of about 46 feral hogs from Cedar Creek watershed, nine feral hogs from Hurricane Creek watershed, 49 feral hogs from Jack Creek watershed, and 31 feral hogs from Biloxi Creek watershed over a period of five years.

Populations are highly mobile and will travel in and out of a watershed, making estimating changes in local populations nearly impossible. Therefore, overall load reductions resulting from feral hog management are not calculated in the plan. The plan estimates that a single feral hog has a loading potential of

approximately 34.8 billion cfu/year of *E. coli*. Therefore, any efforts to maintain or reduce local feral hog populations will either reduce future increases in bacteria loadings or decrease existing loads by the loading potential indicated above.

The following equation was used to estimate the loading potential of a feral hog, and the assumed potential avoided load from removing a single feral hog:

$$Load_{fh} = N_{fh} \times Animal\ Unit\ Conversion \times FC_{fh} \times Conversion \times 365\ days/year$$

Where:

$Load_{fh}$ = Potential annual load reduction of *E. coli* attributed to removal of one feral hog (in units of billion cfu/year)

N_{fh} = Number of feral hogs removed

Animal Unit Conversion = Feral hog to animal unit conversion factor, assumed to be 0.125 (Wagner & Moench, 2009)

FC_{fh} = Fecal coliform produced per animal unit per day; 1.21 billion cfu/day (Wagner & Moench, 2009)

Conversion = Conversion rate of 0.63 from fecal coliform to *E. coli* (Wagner and Moench, 2009)

Table 3. Management Measure 1: Promote feral hog management

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

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
34.8 billion cfu/year of *E. coli* per feral hog removed.	**Technical:** ▪ Resources for landowners about feral hog management techniques are available through AgriLife Extension, USDA Animal and Plant Health Inspection Services, and TPWD. **Financial:** ▪ Feral hog workshops are estimated at $2,500 per program. ▪ Salary and costs associated with a trapper are estimated at $95,000 per year.	▪ Responsible parties will deliver five feral hog management educational events or extension programs.	**Years 1-5** ▪ Deliver one feral hog management workshop per year within one of the TMDL watersheds. ▪ Promote the management of feral hogs by voluntary hunting or trapping. ▪ Explore funding for feral hog trappers and equipment as needed.	▪ Estimated number of feral hogs removed annually in each TMDL watershed. ▪ Number of educational programs delivered. ▪ Estimated number of individuals reached.	▪ Number of education programs delivered. ▪ On average, an estimated 135 feral hogs managed annually. ▪ A stable or increased number of individuals reached annually.	▪ AgriLife Extension will track programs delivered. ▪ As funds allow, trapping programs will be used to track feral hogs removed.	▪ Local Stakeholders ▪ Angelina County Extension Office ▪ AgriLife Extension

Management Measure 2

Implement water quality monitoring.

There are four impaired AUs that make up the Middle Neches TMDL watersheds. Each TMDL watershed has at least two TCEQ surface water quality monitoring (SWQM) stations (AU 0604M_03 recently had TCEQ SWQM Station 22119 added in 2019) (Figure 3). Stakeholders highlighted the need to monitor water quality flowing into the downstream TMDL AUs for Cedar Creek and Hurricane Creek since these flows have a direct bearing on the water quality of the AUs considered in this I-Plan. Also, to track progress and effectiveness of management measures proposed in this plan, routine monitoring on the existing TCEQ stations should be maintained.

Through the Texas Clean Rivers Program (CRP), TCEQ partners with regional water authorities to coordinate and conduct water quality monitoring, assessment, and stakeholder participation across the state. The Angelina and Neches River Authority (ANRA) is the CRP partner for the Upper Neches River. ANRA provides public participation on water quality issues through its Basin Steering Committee, which includes stakeholders who represent local industry and municipalities, state and federal agencies, tribal groups, environmental groups, and the public. Stakeholders in any of the TMDL watersheds are encouraged to take part at Basin Steering Committee meetings and highlight any local concerns, including additional monitoring needs.

The goal of this management measure is to continue routine monitoring at the existing nine TCEQ SWQM stations, engage TCEQ and ANRA to routinely monitor the upstream AUs (AU 0604M_03 and AU 0604B_02) of Cedar Creek and Hurricane Creek in order to monitor changes in water quality and inform future water quality management decisions.

In addition to routine water quality monitoring, stakeholders also highlighted a need for a bacteria source tracking analysis to find the sources of *E. coli* in the water bodies so that future management measures can be tailored to the main source of contamination.

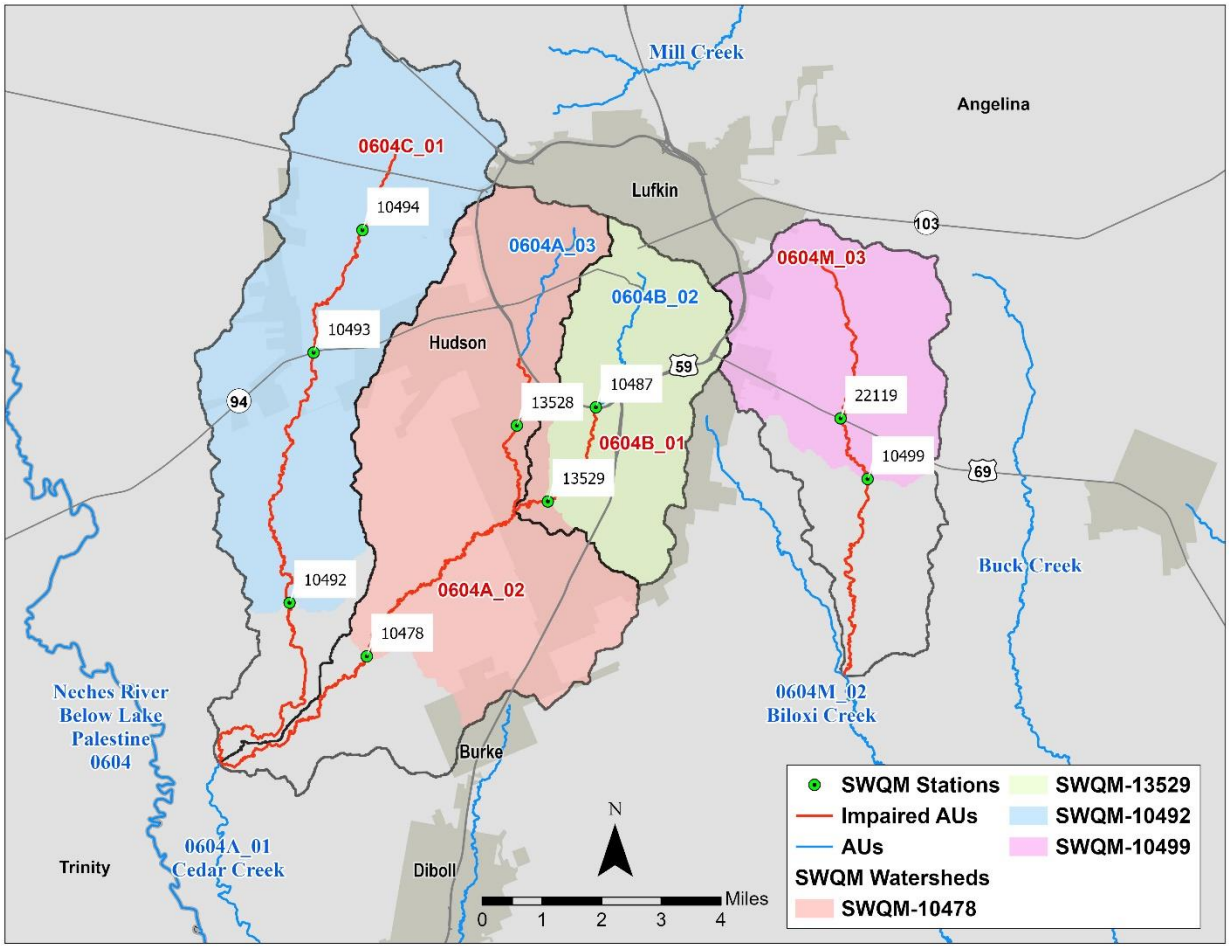

Figure 3. Existing TCEQ SWQM stations on Segments 0604A, 0604B, 0604C, and 0604M

Education Component

ANRA's website provides an overview of the CRP statewide water quality program and includes basin reports, quality assurance documents, and links to other websites such as the TCEQ Surface Water Quality Data Viewer, and Statewide Coordinated Monitoring Schedule (CMS). ANRA also holds an annual Steering Committee meeting in coordination with CRP to share updates on water quality monitoring and relevant watershed issues that includes information on the TMDL watersheds, among others. Updates on I-Plan progress can be presented during this annual meeting. Local stakeholders are encouraged to engage with ANRA to publish information like water quality analysis reports and other resources specific to the TMDL watersheds on ANRA's website. ANRA carries out educational and informational events in areas under its jurisdiction. Stakeholders are encouraged to coordinate with ANRA to participate in such training.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **Local Stakeholders:** Local stakeholders aid in determining and refining data and data quality objectives for future monitoring programs.
- **ANRA:** ANRA is the CRP partner in this area. ANRA conducts routine monitoring on segments 0604A, 0604B, 0604C, and 0604M.

Technical Assistance

ANRA and TCEQ oversee several water quality projects. These organizations have considerable expertise to design and carry out monitoring programs and data management. ANRA and TCEQ should continue providing monitoring services as funding allows. CRP can also supply further technical assistance in determining monitoring frequency and locations.

Financial Assistance

Cost associated with water quality monitoring can vary based on the suite of parameters monitored, personnel costs, vehicle and mileage costs, and lab costs. TWRI and ANRA estimate approximately $2,500 for lab analysis and supply costs per station per year for routine water quality monitoring (Table 4). Costs associated with personnel and travel will vary substantially based on the party that conducts the monitoring and the cost of fuel.

Table 4. Estimated funding needed for implementing Management Measure 2

Description	Item	Unit	Rate	Amount
Lab analysis and supply costs for nine stations per year	5	Year	$22,500	$112,500
Personnel and travel	NA	NA	NA	NA
			Total:	**$112,500**

Possible sources of funds are detailed below:

- **Texas CRP:** The Texas CRP is a state fee-funded, non-regulatory program. CRP funds can be used for routine monitoring as well as special projects. Responsible parties and local stakeholders can request water quality monitoring through CRP during the development of the CMS.
- **Clean Water Act Section 319(h) Nonpoint Source Grant Program:** This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to support education programs, watershed implementation, and technicians.

- **Local Funds:** Local funds include funds or eligible in-kind resources provided by local entities, such as county and municipal governments, local agencies, non-governmental organizations, volunteer groups, or individuals. While financial resources are typically considered, volunteer or staff time can be leveraged as eligible cost-share for many state and federal grant programs that require some type of cost-share.

Measurable Milestones

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

- Updating the CMS for the TMDL watersheds.
- Conducting a water quality monitoring in each of the TMDL watersheds according to the TCEQ-approved CRP quality assurance project plan (QAPP).
- Submitting routine water quality data to the TCEQ Surface Water Quality Monitoring Information System (SWQMIS).
- Developing additional water quality monitoring sites, projects, and funding sources as needed.

Monitoring Component

ANRA will report water quality monitoring and water quality analyses in the annual Basins Highlights Report delivered as part of CRP.

Water quality monitoring will continue at existing TCEQ SWQM stations. Additional monitoring projects may be developed under this management measure as needed.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Years 1-5:

- Conduct water quality monitoring and submit data according to the TCEQ-approved CRP QAPP.
- Develop QAPPs for additional projects as needed.
- Provide water quality monitoring and I-Plan status updates at annual CRP Steering Committee meetings.

Estimated Load Reductions

A load reduction was not calculated for the measure.

Table 5. Management Measure 2: Implement water quality monitoring

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
Not estimated	**Technical:** ▪ ANRA and TCEQ provide technical expertise associated with monitoring and data management activities for coordinated water quality monitoring. **Financial:** ▪ Local and state funds can be used for water quality monitoring activities. Costs for maintaining nine sites are about $22,500 annually.	▪ ANRA will hold annual stakeholder meetings in conjunction with CRP Basin Steering Committee meetings.	**Years 1-5:** ▪ Conduct water quality monitoring and submit data according to the TCEQ-approved CRP QAPP. ▪ Develop QAPPs for additional projects as needed. ▪ Provide water quality and I-Plan status updates at annual CRP Steering Committee meetings.	▪ Updated CMS. ▪ Water quality monitoring programs implemented. ▪ Routine data submitted and published in the SWQMIS.	▪ Improvement in water quality.	▪ Monitoring will continue at existing TCEQ SWQM stations. ▪ Additional monitoring projects may be developed under this management measure as needed.	▪ ANRA ▪ Local stakeholders

Management Measure 3

Promote volunteer water quality monitoring.

To encourage environmental stewardship by empowering a statewide network of concerned volunteers, partners, and institutions, the Texas Stream Team (TST) program trains volunteers to monitor water and environmental quality across Texas. Along with training, the program offers a wide variety of engagement programs focused on taking volunteer monitoring to the next step through community involvement, awareness, and additional data collection.

The goal of this management measure is to promote water quality monitoring activities for volunteers. Stakeholders can use the collected data to evaluate water quality changes due to the implementation of the measures in this I-Plan. Data collected by volunteers are quality assured and the TST program maintains a database of the collected information.

Education Component

Under the TST program, volunteers participate in educational workshops, outreach events, and receive educational resources. Activities include educating volunteers on citizen science, water quality, environmental stewardship, water quality sampling, and more.

Priority Areas

Volunteers may be recruited from any of the TMDL watersheds. Recruitment of environmental stewards, schools, and other organizations near any of the TMDL watersheds will be prioritized.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **Volunteers:** Local stakeholders will be encouraged to enroll and participate in the TST program. Before beginning voluntary data collection activities, volunteers will participate in the appropriate training provided by the Meadows Center for Water and the Environment or the local TST partner.
- **Meadows Center for Water and the Environment:** The Meadows Center oversees the TST volunteer monitoring program and is responsible for providing supplies, trainings, and data management services associated with the program.
- **ANRA:** ANRA offers support to volunteer monitoring in the basin. ANRA provides TST monitoring kits, training, and replacement supplies and reagents to active volunteer monitors in the basin.

Technical Assistance

ANRA and the Meadows Center can train volunteers and implement "train the trainers" programs to help start and support a local chapter of citizen scientists. The Meadows Center also provides data storage and quality assurance services.

Financial Assistance

Water quality monitoring kits used by TST are about $580 each (Table 6). The number of kits bought will depend on the number of local volunteers who take part in the TST program. Costs associated with personnel and travel will vary based on the party that conducts the monitoring within the TMDL watersheds.

Table 6. Estimated funding needed for implementing Management Measure 3

Description	Item	Unit	Rate	Amount
Water quality kits	10	Number	$580	$5,800
Personnel and travel	NA	NA	NA	NA
			Total:	**$5,800**

Possible sources of funds include the following:

- **Clean Water Act 319(h) Nonpoint Source Grant Program:** This EPA grant program, administered by TCEQ and TSSWCB, provides funding for the implementation of nonpoint source management measures. The funds require a 40% match and may be used to support volunteer water quality monitoring.
- **Local Funds**: Local funds include funds or eligible in-kind resources provided by local entities, such as county and municipal governments, local agencies, river authorities, non-governmental organizations, volunteer groups, or individuals.

While financial resources are typically considered, volunteer or staff time may be eligible to meet cost-share requirements for many state and federal cost-sharing grant programs.

Measurable Milestones

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

- Number of water quality sampling events.
- Number of water quality training events for volunteers.
- Number of volunteers enrolled as citizen scientists.

Monitoring Component

TST coordinates a network of citizen scientists who conduct water quality monitoring at assigned sites on their local water bodies. Citizen scientists may identify water quality issues, possible nonpoint pollution sources, monitor water quality, or collect and analyze data. Information collected by citizen scientists is submitted to a database containing data from sites across the state that is maintained by the Meadows Center for Water and the Environment.

Like other citizen scientists, volunteers from the four TMDL watersheds, working with the ANRA steering committee, will track the number of sampling events held, number of trainings organized, and number of volunteers enrolled in addition to undertaking water quality monitoring.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Years 1-5:

- Recruit local environmental stewards or citizen scientists.
- Provide one annual volunteer water quality training event.
- Secure funding for buying water quality monitoring kits.

Estimated Load Reductions

A load reduction was not calculated for the measure.

Table 7. Management Measure 3: Promote volunteer water quality monitoring

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
Not estimated	**Technical:** ▪ Training opportunities are provided by ANRA and the Meadows Center. ▪ The Meadows Center supplies data storage and quality assurance services. **Financial**: ▪ Procurement of water quality monitoring kits. The retail price is about $580 each (in 2020). The number to be bought will depend on the number of volunteers who take part in the TST program.	▪ Volunteers will participate in educational workshops and outreach activities about citizen science, water quality, environmental stewardship, water quality sampling, and more.	**Years 1-5:** ▪ Recruit local environmental stewards or citizen scientists. ▪ Provide one annual volunteer training event. ▪ Secure funding for buying water quality monitoring kits.	▪ Number of water quality sampling events conducted by volunteers. ▪ Number of water quality monitoring training events for volunteers. ▪ Number of volunteers enrolled as citizen scientists.	▪ One training event held annually. ▪ A stable or increasing number of citizen scientists enrolled in the TST program annually. ▪ A stable or increasing number of water quality monitoring events undertaken.	▪ Volunteers, working with the ANRA Steering Committee, will track the number of sampling events held, number of trainings organized, and volunteers enrolled in addition to undertaking water quality monitoring.	▪ Volunteers ▪ ANRA ▪ Meadows Center

Management Measure 4

Promote sustainable forest practices.

In the TMDL watersheds, the predominant landcovers of evergreen and mixed forest account for over 33% of the total land area. Forests support a multitude of functions, such as water flow regulation and soil erosion control, which have a direct impact on the quality of surface waters. By regulating flow and reducing the amount of sediment reaching the water body, forests can reduce bacteria loading into water bodies. Activities that remove or disturb forest vegetation or hydro-pollutant flow paths affect the quality of water bodies, including enhancing bacteria concentration. Therefore, forest operations such as timber harvesting and road work can potentially degrade water quality if done improperly. Forestry BMPs are the principal means of protecting water resources during forestry activities.

The Texas A&M Forest Service (TFS) promotes several BMPs that can directly affect instream water quality, especially the establishment and maintenance of appropriately sized streamside management zones (SMZs), stream crossings, and harvesting techniques. These practices target a wide range of stakeholders including loggers, landowners, and contractors. The goal of this management measure is to promote the implementation of forestry BMPs chosen by local stakeholders.

Education Component

Because of the potential of forestry activities contributing to increased bacterial loading in the receiving water bodies, foresters, landowners with forestry interests, and other interested parties must be educated on the impact of forestry operations and the benefits of implementing BMPs on water quality. TFS will tailor training about these subjects to the entities above and, also, will provide education and outreach opportunities to local stakeholders about the proper installation and maintenance of forestry BMPs.

Priority Areas

Generally, priority areas will change based on ongoing forestry operations. It is important, however, whether during harvesting, planting, or other forestry activities, that operators try to limit disturbances in SMZs. TFS guidelines stipulate that SMZs should be at least 50 feet wide on each side and above the head of perennial and intermittent streams, although SMZs can be wider depending on site conditions. More information on SMZs and how they can be demarcated, mapped, and protected in Texas is available on the TFS website.[1]

[1] https://tfsweb.tamu.edu

Management Measure 4 priority areas are based on water resource protection priority areas developed by TFS for the state's Forest Action Plan (TFS 2020a; TFS 2020b) (Figure 4). Although there is moderate loading potential from forestry throughout the TMDL watersheds, loading potentials are highest in the Cedar Creek watershed (priority areas C-11 and C-12) and in the Biloxi Creek watershed (priority areas B-8, and B-11 through B-13). The exception to potential forestry loading is in the urban areas of the cities of Lufkin and Hudson, which are largely located in the upstream AUs of Cedar Creek and Hurricane Creek, the northwestern edge of the Biloxi Creek watershed, and the very northern portion of the Jack Creek watershed.

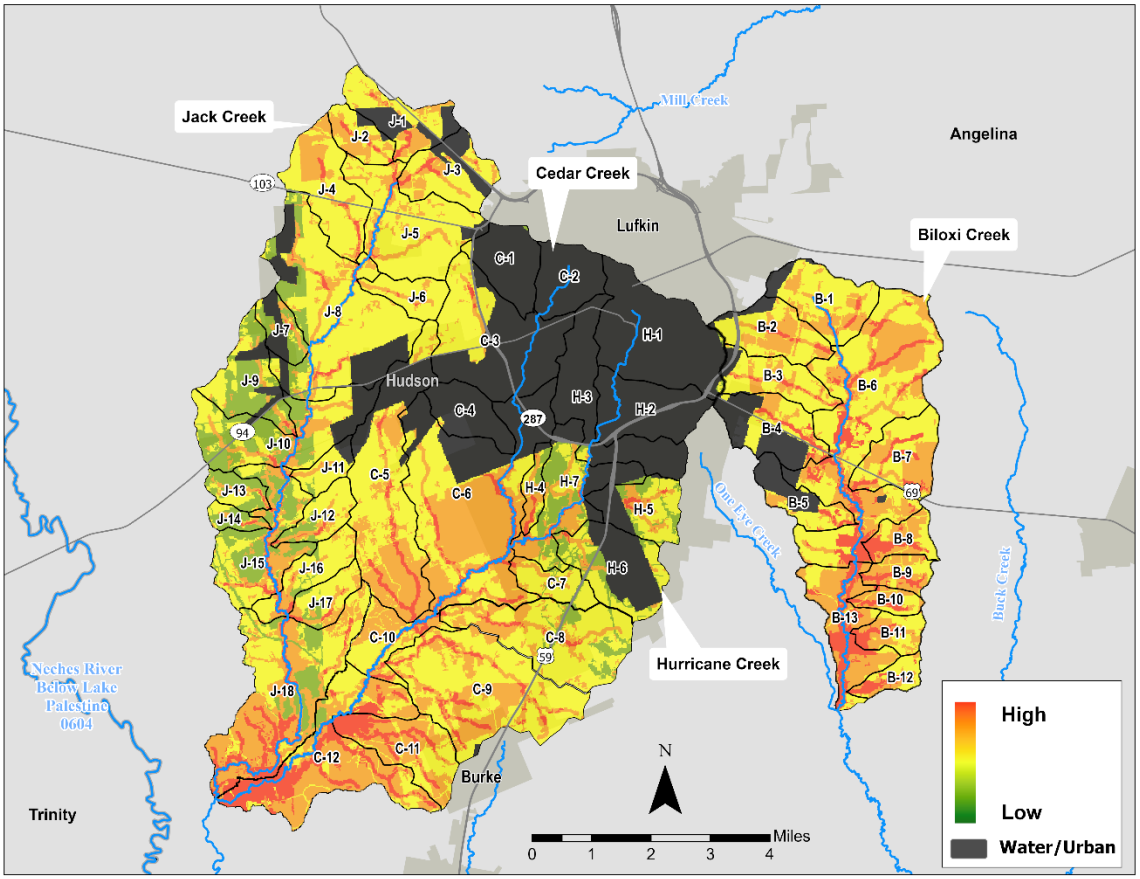

Figure 4. Subwatershed priorities for Management Measure 4 based on TFS Forest Action Plan water resources priority areas

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **TFS:** TFS will only be responsible for providing technical assistance and helping landowners identify sources of financial assistance. TFS also tracks progress of local education and outreach efforts and BMP

implementation. Landowners, loggers, and logging contractors will be responsible for voluntarily implementing these practices.

- **Landowners and forest managers:** Responsible for taking part in educational opportunities and applying what they learned to their lands.

Technical Assistance

TFS, Texas Forestry Association, TSSWCB, and organizations such as the Texas Sustainability Forestry Initiative State Implementation Committee administer training tailored to different stakeholders. TFS provides several resources for forest operational planning such as "Plan My Land Operation," which is a free, publicly accessible, web-based forest operation planning tool. The application allows users to plan and layout a project based on the specific terrain, soil, and water resources found on an area of interest, locate and map their property, and identify and place custom buffers around sensitive areas, such as streams.

Financial Assistance

When available, TFS will promote the availability of financial aid to forestry interests in the TMDL watersheds. Voluntary reforestation efforts are eligible for existing Farm Bill program funds. Financial assistance required per landowner will vary greatly depending on practices implemented and were not estimated (Table 8). The staff time for a full-time forester to provide education and outreach and track implementation is estimated at $75,000 annually.

Table 8. Estimated funding needed for implementing Management Measure 4

Description	Item	Unit	Rate	Amount
Full-time regional forester	5	Years	$75,000	$375,000
BMP implementation	NA	NA	NA	NA
			Total:	**$375,000**

Funds may also be available through the following programs:

- **Clean Water Act Section 319(h) Nonpoint Source Grant Program:** This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to support education programs, watershed implementation, and technicians.
- **Conservation Innovation Grant:** The USDA Conservation Innovations Grant (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, the Environmental Quality Incentives Program (EQIP) funds are used to award

competitive grants to non-federal governmental or non-governmental organizations, tribes, or individuals.

- **Conservation Stewardship Program:** The Conservation Stewardship Program (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.
- **EQIP:** 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.
- **Regional Conservation Partnership Program:** The Regional Conservation Partner Program (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 USDA Natural Resources Conservation Service (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.

Measurable Milestones

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

- Delivery of education and outreach programs to local stakeholders by TFS.
- Documentation of landowner and forestry personnel participation.
- Documentation of BMP implementation through voluntary site surveys.

Monitoring Component

TFS will play a leading role in tracking the implementation of BMPs.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Years 1-5:

- Deliver education programs to landowners, loggers, and others or host outreach activities for them.

- Encourage landowners and forestry managers with no forestry management plans to develop plans.
- Encourage landowners and forestry managers to voluntarily implement and maintain appropriate BMPs.

Estimated Load Reductions

Although timber harvesting itself is not a direct source of *E. coli* loading and typically have only short-term impacts on post-harvest stream water quality, the altered hydrology from harvesting activities have been shown to be correlated with elevated fecal coliform loading after harvest (Ensign & Mallin 2001). It should be noted that despite widespread research on the impacts of forestry BMPs on sediment, nutrients, and fauna, little research has been conducted on the impacts of forestry BMPs on fecal indicator bacteria (Cristan, et al. 2016). However, it is generally established that the transport of fecal indicator bacteria, when correlated with stream discharge, is greatly influenced by suspended sediments (Yang, Lin, and Falconer 2008) and, therefore, it is assumed that there is a correlative reduction in *E. coli* loads with reduced stream discharges and suspended sediment loads that are associated with implementing forestry BMPs.

Forestry BMP adoption rates are assumed to be high across East Texas, with an overall area weighted BMP adoption rate of 94% reported for non-industrial forestlands in East Texas (Thomas, Hazel, and Work, 2018). Given high rates of BMP implementation, it is unlikely that additional load reductions will be seen from forestry BMPs relative to sources such as wildlife and livestock calculated in Management Measures 1 and 5. However, BMP implementation will continue to be important to avoid additional *E. coli* loading to each of the TMDL watersheds. Therefore, an estimate was calculated to approximate the avoided additional loads per year as a result from forestry BMP implementation for each TMDL watershed. Avoided loads associated with the application of forestry BMPs will vary based on numerous site-specific factors for which data is currently unavailable.

The following equation was used to estimate bacteria loads avoided from implementing forestry BMPS:

> *Load = (Existing Median Load ÷ Watershed Acres) × Annually Treated Area × Percent of forestland with BMPs × Percent Increase without BMP implementation × 365 days/year*

Where:

> *Load* = Average potential *E. coli* load avoided annually (billion cfu/year).
>
> *Existing Median Load* = The median daily *E. coli* load is 145.03, 48.58, 22.53, and 6.85 billion cfu/day for the Cedar Creek, Hurricane Creek, Jack

Creek, and Biloxi Creek watersheds, respectively (Gitter, Yang, and Gregory, 2021).

Watershed Acres = 20,191, 8,268, 18,594, and 12,078 acres for the Cedar Creek, Hurricane Creek, Jack Creek, and Biloxi Creek watersheds, respectively.

Annually Treated Area = 139.58, 28.86, 127.77, and 77.71 acres for the Cedar Creek, Hurricane Creek, Jack Creek, and Biloxi Creek watersheds, respectively.

Percent of forestland with BMPs = 94% (Thomas, Hazel, and Work, 2018)

Percent Increase Without BMPs = 108.92% (Sanders and McBroom, 2012)

Avoided *E. coli* loading is uncertain considering the assumptions that are required to develop calculations. However, there is high certainty that forestry BMPs are widely adopted and beneficial to overall water quality. Based on current estimates of BMP adoption in East Texas and area of treated forests, *E. coli* loads avoided are estimated at 374.67, 63.37, 57.86, and 16.47 billion cfu annually in the Cedar Creek, Hurricane Creek, Jack Creek, and Biloxi Creek watersheds, respectively.

Table 9. Management Measure 4: Promote sustainable forest practices

Causes and Sources: *E. coli* loading from runoff.

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
374.67 billion cfu/year *E. coli* avoided in 0604A_02 63.37 billion cfu/year *E. coli* avoided in 0604B_01 57.86 billion cfu/year *E. coli* avoided in 0604C_01 16.47 billion cfu/year *E. coli* avoided in 0604M_03	**Technical:** ▪ TFS will supply technical aid to landowners, foresters, loggers, logging contractors, and others, promoting sound forestry management practices that protect water quality. ▪ Other entities including the Texas Forestry Association, TSSWCB, and the Texas Sustainability Forestry Initiative State Implementation Committee all administer training tailored to different stakeholders. **Financial:** ▪ When they are available, TFS will inform forestry interests in the TMDL watersheds about financial assistance opportunities. ▪ Voluntary reforestation efforts are eligible for existing Farm Bill program funds. ▪ Funds for hiring a full-time regional forester estimated at $75,000 per year.	▪ TFS will tailor training for foresters, landowners with forestry interests, and other interested parties on the impact of forestry operations and the benefits of implementing BMPs. ▪ TFS will provide education and outreach opportunities to local stakeholders about the proper installation and maintenance of forestry BMPs.	**Years 1-5:** ▪ Deliver education programs to landowners, loggers, and others or host outreach activities for them. ▪ Encourage landowners and forestry managers with no forestry management plans to develop plans. ▪ Encourage landowners and forestry managers to voluntarily implement and maintain chosen BMPs.	▪ Delivery of education and outreach programs to local stakeholders by TFS. ▪ Documentation of landowner and forestry personnel participation. ▪ Documentation of BMP implementation through voluntary site surveys.	▪ Number and type of BMPs implemented in the TMDL watersheds. ▪ Number of landowners and managers taking part in voluntary BMP adoption. ▪ Number of education and outreach programs delivered in or near the TMDL watersheds.	▪ TFS will track BMP implementation and education and outreach events.	▪ TFS ▪ Landowners ▪ Forest managers

Management Measure 5

Promote and implement Natural Resources Conservation Service conservation plans and Texas State Soil and Water Conservation Board Water Quality Management Plans.

Grazed pastures and rangeland can contribute to bacteria loadings across the watersheds. Wagner (2013) found that *E. coli* concentrations in runoff from grazed lands were up to 70% higher compared to ungrazed sites. While the fate and transport of fecal bacteria deposited on upland surfaces is not always certain, practices that manage livestock behavior and time spent grazing, particularly in riparian pastures, can reduce potential bacteria loads reaching nearby water bodies.

Promoting and implementing Water Quality Management Plans (WQMPs) and conservation plans is anticipated to provide direct benefits to water quality and can provide benefits to producers. Several BMPs are available to achieve goals of improving forage quality, distributing livestock across a property, and making water available to livestock. Table 10 provides a list of common practices available to producers. Note that available BMPs are not limited to those in the table and the scope and type of BMPs implemented will vary by operation. In addition to reducing bacteria loads reaching water ways, these practices can reduce erosion, sediment loads, and nutrient loads.

Table 10. NRCS conservation practices for producers that can improve water quality

Practice	NRCS Code	Focus Area or Benefit
Brush management	314	Livestock, water quality, water quantity
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

Practice	NRCS Code	Focus Area or Benefit
Supplemental feed location	NA	Livestock, water quality
Water well	642	Livestock, water quality, wildlife
Watering facility	614	Livestock, water quality

USDA NRCS and TSSWCB give technical and financial assistance to producers for planning and implementing BMPs that protect and improve water quality. NRCS offers a variety of programs to implement operation-specific conservation plans that will meet producer goals and outline how BMPs will be implemented. TSSWCB, through local Soil and Water Conservation Districts (SWCDs), gives technical and financial assistance to develop and implement WQMPs through planning, implementation, and maintenance of each practice.

The goal of this management measure is to promote BMP implementation in about 50% of cattle farms in the TMDL watersheds. Of all livestock, cattle were found to be the major contributors of bacteria loading in the segments (Table 11). Based on USDA Census of Agriculture data (USDA, 2019), there are approximately 35, four, 54, and 32 cattle farms in the Cedar Creek, Hurricane Creek, Jack Creek, and Biloxi Creek watersheds, respectively. Communication with NRCS indicated that the Biloxi Creek watershed has historically had a greater number of conservation plans implemented, since the Jack Creek watershed is more residential, and the Hurricane and Cedar Creek watersheds are more urban. Based on this information, the I-Plan will target implementing a total of 10 conservation plans or WQMPs in the Cedar Creek watershed, zero plans in the Hurricane Creek watershed, 10 plans in the Jack Creek watershed, and 15 plans in the Biloxi Creek watershed.

Table 11. Estimates of *E. coli* loads from livestock

Livestock	Population estimates	Annual *E. coli* loading (billion cfu/year)	% of Total
Cedar Creek Watershed			
Cattle	933	1,830,000	93%
Goats and Sheep	91	90,400	5%
Hogs and Pigs	7	39,200	2%
Horses	98	8,200	0%
Total		**1,970,000**	
Hurricane Creek Watershed			
Cattle	94	185,000	93%

Livestock	Population estimates	Annual *E. coli* loading (billion cfu/year)	% of Total
Goats and Sheep	9	8,940	4%
Hogs and Pigs	1	5,590	3%
Horses	10	836	0%
Total		**200,000**	
Jack Creek Watershed			
Cattle	1,437	2,830,000	93%
Goats and Sheep	141	140,000	5%
Hogs and Pigs	11	61,500	2%
Horses	151	12,600	0%
Total		**3,040,000**	
Biloxi Creek Watershed			
Cattle	852	1,680,000	93%
Goats and Sheep	83	82,400	5%
Hogs and Pigs	6	33,600	2%
Horses	90	7,530	0%
Total		**1,800,000**	

Education Component

Education is one of the most important components of this management measure. An intensive education and outreach program is needed to broadly promote the adoption of management practices. Awareness of the TSSWCB and NRCS programs, management practices, and their benefits is often one of the largest factors affecting the adoption of BMPs. Existing educational programs specific to landowner interests should be used in the education and outreach campaign to further promote the adoption of BMPs. These educational resources include the Lone Star Healthy Streams Program and the Texas Riparian and Stream Ecosystem Education Program. Local AgriLife Extension offices and SWCDs work to locally promote and deliver these programs.

Priority Areas

The greatest impact of this measure will be limiting the direct disposal of fecal waste in or near water bodies. Figure 5 shows *E. coli* loading potential from cattle per subwatershed in each TMDL watershed. Responsible parties for this measure will prioritize voluntarily practices that limit livestock access to streams by supplying alternative watering systems and excluding livestock from streamside buffers.

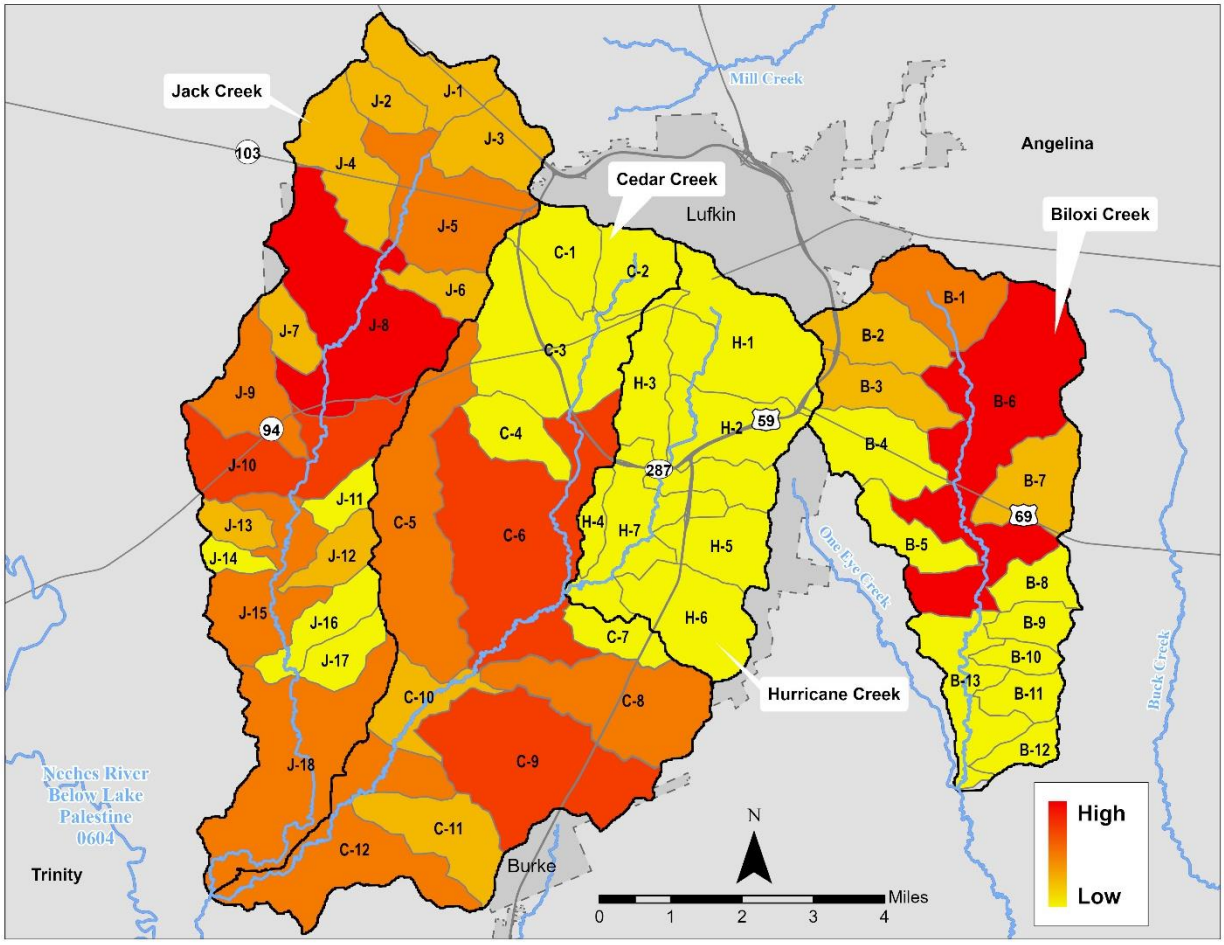

Figure 5. Subwatershed priorities based on *E. coli* loading potential from cattle

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **Landowners and producers:** Landowners and producers will work with NRCS, TSSWCB, and SWCDs as appropriate to develop conservation plans or WQMPs and obtain funding to implement BMPs according to the site-specific plans.

- **AgriLife Extension:** AgriLife Extension will work with NRCS, SWCDs, and TSSWCB to deliver outreach, education, and extension materials, workshops, and field days.
- **TSSWCB:** TSSWCB will work with NRCS and SWCDs to fund and hire a field technician to facilitate the development and implementation of conservation plans and WQMPs. TSSWCB is also responsible for oversight of the WQMP program.
- **SWCD:** A SWCD, like a county or school district, is a subdivision of state government. SWCDs are administered by boards of directors who are elected by their fellow landowners. There are 216 individual SWCDs organized in Texas. The Middle Neches TMDL watersheds are covered by the Upper Neches SWCD. The SWCD will work with TSSWCB and NRCS to develop and implement conservation plans or WQMPs. The district will also work with other entities in the delivery of outreach and extension materials, workshops, and field days.
- **USDA NRCS:** NRCS will work with landowners and producers and the Upper Neches SWCD to develop and implement conservation plans or WQMPs. NRCS will also work with entities in the delivery of outreach and extension materials, workshops, and field days.

Technical Assistance

Developing and implementing practices to reduce runoff from agricultural lands requires substantial technical expertise. Producers can obtain technical assistance from local SWCDs, local NRCS offices, and local AgriLife Extension offices. Producers that request planning assistance will work with their local SWCD and NRCS office to define operation-specific management goals and objectives and develop a management plan that prescribes effective practices that will achieve stated goals while also improving water quality.

Financial Assistance

This I-Plan targets the adoption and implementation of a total of 50 conservation plans and/or WQMPs and three education programs over five years. Table 12 shows the funding requirements for implementing Management Measure 5. The annual salary, benefits, and additional costs associated with a field technician is estimated at approximately $75,000 per year. The estimated funding needed for education programs is based on an average cost of $50,000 per program. The cost of on-farm practices can vary substantially, depending on the specific suite of practices adopted by the producer. For this plan, TWRI estimates the cost associated with each plan at $15,000. Several cost-share programs are available to producers that incentivize the planning and implementation of these practices.

Table 12. Estimated funding needed for implementing Management Measure 5

Description	Item	Unit	Rate	Amount
Field technician for developing WQMPs	5	Years	$ 75,000	$ 375,000
Educational programs	3	No.	$ 50,000	$ 150,000
WQMP implementation	50	No.	$ 15,000	$ 750,000
			Total	**$ 1,275,000**

Potential funding sources include:

- **WQMP Program:** WQMPs are property-specific plans that outline the BMPs most appropriate to improve the quality of land and water on the property. TSSWCB may provide financial assistance to private property owners in implementing individual WQMPs, as funding allows.
- **Clean Water Act Section 319(h) Nonpoint Source Grant Program:** This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to support education programs, watershed implementation, and technicians.
- **Sustainable Agriculture Research and Education:** Sustainable Agriculture Research and Education (SARE) provides grants and educational programs to advance agricultural innovation which promotes profitability, stewardship of the land, air, and water, and quality of life for farmers, ranchers, and their communities. Southern SARE is the regional component that includes Texas and grants go towards land, crop, and livestock management.
- **USDA CIG:** 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, the EQIP funds are used to award competitive grants to non-federal governmental or non-governmental organizations, tribes, or individuals.
- **NRCS Agricultural Management Assistance:** The Agriculture Management Assistance program of the NRCS helps agriculture producers use conservation to manage risk and solve natural resource issues through natural resources conservation.
- **NRCS CSP:** 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.

- **NRCS EQIP:** 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.
- **NRCS RCPP:** RCPP is a new, comprehensive, and flexible program that uses partnerships to stretch and multiply conservation investments and reach conservation goals on a regional or watershed scale. Through RCPP, 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.
- **EPA Environmental Education Grants**: Under the Environmental Education Grant Program, EPA seeks grant proposals from eligible applicants to support environmental education projects that promote environmental stewardship and help develop knowledgeable and responsible students, teachers, and citizens. This grant program provides financial support for projects that design, show or teach environmental education practices, methods, or techniques as described in their Requests for Proposals.

Measurable Milestones

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

- Number of conservation plans and WQMPs developed.
- Number of acres in conservation plans developed.
- Number of AgriLife Extension, outreach, or education programs delivered.

Monitoring Component

AgriLife Extension, NRCS, and TSSWCB, working with local stakeholders, will monitor and track the implementation of BMPs, workshops, field days, and extension programs delivered, and document the implementation status annually.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Year 1:

- Secure funding for a field technician to develop conservation plans and WQMPs.
- Deliver a Lone Star Healthy Streams workshop, or related workshop or field day event.
- Develop two conservation plans or WQMPs in Cedar Creek, two conservation plans or WQMPs in Jack Creek, and three conservation plans or WQMPs in Biloxi Creek.

Year 2:

- Maintain funding for the field technician developing conservation plans and WQMPs.
- Develop two conservation plans or WQMPs in Cedar Creek, two conservation plans or WQMPs in Jack Creek, and three conservation plans or WQMPs in Biloxi Creek.

Year 3:

- Maintain funding for the field technician developing conservation plans and WQMPs.
- Deliver a Lone Star Healthy Streams workshop, or related workshop or field day event.
- Develop two conservation plans or WQMPs in Cedar Creek, two conservation plans or WQMPs in Jack Creek, and three conservation plans or WQMPs in Biloxi Creek.

Year 4:

- Maintain funding for the field technician developing conservation plans and WQMPs.
- Develop two conservation plans or WQMPs in Cedar Creek, two conservation plans or WQMPs in Jack Creek, and three conservation plans or WQMPs in Biloxi Creek.

Year 5:

- Maintain funding for the field technician developing conservation plans and WQMPs.
- Deliver a Lone Star Healthy Streams workshop, or related workshop or field day event.
- Develop two conservation plans or WQMPs in Cedar Creek, two conservation plans or WQMPs in Jack Creek, and three conservation plans or WQMPs in Biloxi Creek.

Estimated Load Reductions

The following equation was used to estimate the potential annual load reduction of *E. coli* (billion cfu/year) from implementation of conservation plans and WQMPs:

$Load_{cattle} = N_{plans} \times Head/Operation \times Animal\ Unit\ Conversion \times FC_{cattle} \times Conversion_{bac}$ x *Median Efficacy* × *Prox* × *365 days/year.*

Where*:*

Load$_{cattle}$ = Potential annual load reduction of *E. coli* attributed to cattle

N_{plans} = Number of conservation plans or WQMPs developed and implemented

Head/Operation = Average number of head of cattle per operation in Angelina County (approximately 27 head per operation in Cedar Creek, Jack Creek, and Biloxi Creek watersheds)

Animal Unit Conversion = Cattle to animal unit conversion factor, assumed to be one (Wagner and Moench, 2009)

FC$_{cattle}$ = Fecal coliform produced per animal unit per day; 8.55 billion cfu/day (Wagner and Moench, 2009)

Conversion$_{bac}$ = Conversion rate of 0.63 from fecal coliform to *E. coli* (Wagner and Moench, 2009)

Median Efficacy = Median efficacy of selected conservation practices at reducing bacteria loads (0.58 used, see Table 13)

Prox = Approximate proximate factor to account for distance of management practices from riparian areas (0.15 used, see below)

The effectiveness of WQMPs and conservation plans at reducing bacteria loads is highly dependent on the specific conservation practices installed by the rancher or farmer. To estimate expected *E. coli* reductions, efficacy values of likely BMPs were calculated from median literature reported values. Because the actual BMPs implemented per WQMP or conservation plan are unknown, an overall median efficacy value of 58% was used to calculate load reductions (Table 13). The proximity of implemented BMPs to water bodies will influence the effectiveness of reducing loads. Typically, a proximity factor of 5% is used for BMPs in upland areas and 25% is used in riparian areas (Escamilla et al. 2019). Since there is uncertainty in both the specific BMPs and the locations where plans are implemented, an average proximity factor of 15% was used.

Table 13. Summary of literature reported values for conservation practice effectiveness in reducing indicator bacteria loads

Management practice	Median *E. coli* removal efficacy
Exclusionary Fencing	62%[1]
Prescribed grazing	54%[2]
Stream crossing	48%[3]
Watering facility	73%[4]
Overall median	**58%**

[1] Median of reported reductions in the following: 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] Median of reported reductions in the following: Tate et al. (2004); EPA (2010).

[3] Median of reported reductions in the following: Inamdar et al. (2002); Meals (2001).

[4] Median of reported reductions in the following: Byers et al. (2005); Hagedorn et al. (1999); Sheffield et al. (1997).

Potential load reductions of about 9,236.61, 9,236.61, and 13,854.91 billion cfu annually in Cedar Creek, Jack Creek, and Biloxi Creek watersheds, respectively, are estimated.

Table 14. Management Measure 5: Promote and implement NRCS conservation plans and TSSWCB Water Quality Management Plans

Causes and Sources: Fecal deposition from livestock in pastures, rangeland, and in streams, and runoff of manure applied to cropland.

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
9,236.61 billion cfu/year in 0604A_02 9,236.61 billion cfu/year in 0604C_01 13,854.91 billion cfu/year in 0604M_03	**Technical:** ▪ Assistance for producers and landowners is available through local SWCDs, NRCS, and county AgriLife Extension offices. **Financial:** ▪ Funding for the field technician at approximately $75,000 per year. ▪ About $50,000 per education or outreach program per year. ▪ Funding for each WQMP at approximately $15,000. ▪ Funding requirements for conservation plans vary substantially based on landowner production goals.	▪ An intensive education and outreach program is needed to broadly promote the adoption of BMPs through appropriate programs such as Lone Star Healthy Streams and the Texas Riparian and Stream Ecosystem Education Program.	**Years 1, 3, and 5** ▪ Secure and maintain funding for a field technician to develop conservation plans and WQMPs. ▪ Deliver an education, outreach, field, or extension event. ▪ Develop two conservation plans or WQMPs in Cedar Creek, two plans in Jack Creek, and three plans in Biloxi Creek watersheds. **Years 2 and 4** ▪ Maintain funding for the field technician developing conservation plans and WQMPs. ▪ Develop two conservations plans or WQMPs in Cedar Creek, two plans in Jack Creek, and three plans in Biloxi Creek watersheds.	▪ Number of conservation plans and WQMPs developed. ▪ Number of acres in the conservation plans developed. ▪ Number of AgriLife Extension, outreach, or educational programs delivered.	**Years 1-5** ▪ Two conservation plans or WQMPs in the Cedar Creek watershed, two conservation plans or WQMPs in the Jack Creek watershed, and six conservation plans or WQMPs in the Biloxi Creek watershed developed annually. **Years 1, 3, 5** ▪ Educational events held in Years 1, 3, 5.	▪ AgriLife Extension, NRCS, and TSSWCB will work with local stakeholders to monitor and track the implementation of BMPs and document the implementation status annually.	▪ Local Stakeholders ▪ AgriLife Extension ▪ TSSWCB ▪ NRCS ▪ Upper Neches SWCD

Management Measure 6

Reduce sanitary sewer overflows and unauthorized discharges.

Sanitary Sewer Overflows (SSOs) have the potential to occur in almost every sewer system. The causes of SSOs can vary from community to community but many avoidable SSOs are caused by inadequate operation and maintenance (O&M), inadequate system capacity, and/or improper system design and construction. The costs of rehabilitation and other measures to correct SSOs can vary widely by community size and sewer system type.

The SSO Initiative is a voluntary program that aims at addressing increases in SSOs due to aging collection systems throughout the state and encourages corrective action before there is harm to human health and safety or the environment. Municipalities choose to take part in the SSO Initiative by contacting TCEQ. Benefits of participation include (1) not being subject to formal enforcement by TCEQ for most continuing SSO violations, as long as the overflows are addressed by the SSO plan, and (2) participation allows the municipality to direct resources towards corrective actions rather than having to pay penalties associated with an enforcement order in addition to the corrective actions.

One goal of this management measure is to promote the continuing participation of the City of Hudson in TCEQ's SSO Initiative, thus minimizing the unauthorized discharge of untreated or partially treated wastewater and its impacts on receiving waters. The city of Hudson has SSO Initiatives in place that stipulate activities that the cities will implement in efforts to reduce the number of overflows that happen within their service area.

The second goal is for the City of Lufkin to continue upgrading sewer lines and other equipment maintenance and replacement activities that address inflow and infiltration and other contributors to SSOs within their service area. The City of Lufkin's Capital Improvements Program identifies, prioritizes, and is used to budget the replacement or upgrades of sanitary sewage infrastructure.

Education Component

Public education involves informing developers and the public of how sewer overflows happen and what they can do to prevent them. The community can help prevent overflows by conserving water and flushing only appropriate items. Therefore, as part of this measure, responsible parties will deliver targeted education materials for employee training and public outreach as resources allow.

Priority Areas

Management Measure 6 prioritizes the City of Hudson's and the City of Lufkin's sewage service area. Figure 6 shows the estimated density of SSO events based on events reported to TCEQ between 2005 and 2019. Notably, priority areas J-10, J-11, C-2 through C-5, and H-1 through H-7 demonstrate higher densities of SSO events. These priority areas are located near both the City of Hudson and City of Lufkin.

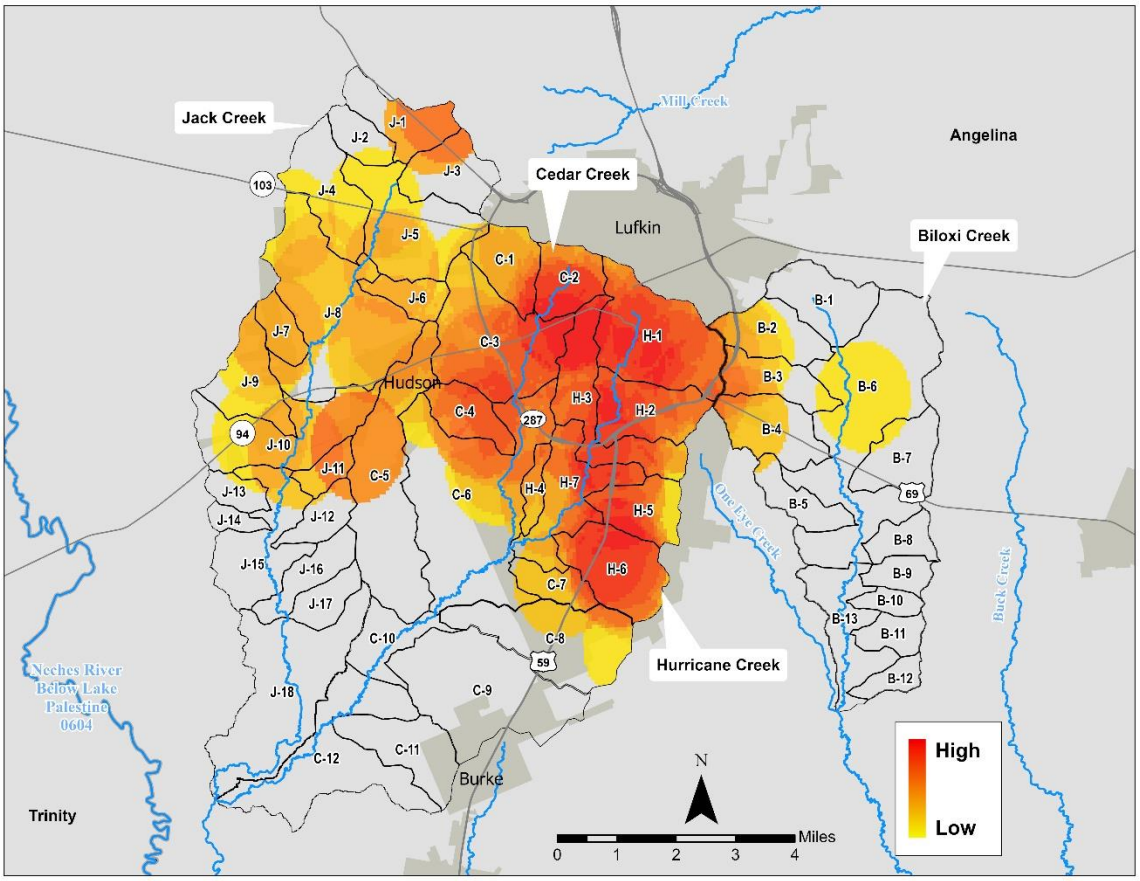

Figure 6. Estimated density of SSO events

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **City of Lufkin:** Will continue upgrading sanitary sewer lines and related infrastructure to address and mitigate inflow and infiltration and other contributors to SSOs.
- **City of Hudson:** Will continue participating in the SSO Initiative, establishing funding for this initiative, and implementing SSO prevention overflow management strategies described in its SSO plan.

- **AgriLife Extension:** AgriLife Extension has worked with other small municipalities to develop and deliver stormwater and SSO education materials. AgriLife Extension will work with the cities of Lufkin and Hudson as needed to provide educational materials for the general public.

Technical Assistance

The TCEQ's Small Business and Local Government Assistance Program may provide technical support to find the best approach for addressing SSO issues, as resources are available.

Financial Assistance

Expenses associated with this management measure are built into annual operating budgets (Table 15). Additional costs associated with educational material development and delivery can be minimized by leveraging existing resources and projects in other watersheds that provide educational materials for residents. Participation in the initiative also allows the municipality to direct resources toward corrective actions, as opposed to having to pay penalties associated with an enforcement order in addition to the corrective actions.

Table 15. Estimated funding needed for implementing Management Measure 6

Description	Item	Unit	Rate	Amount
SSO Initiative participation	NA	NA	Varies based on local budgets	NA
Capital projects for sewer improvements	NA	NA	Varies based on local budgets	NA
Educational material development	5	No.	$10,000	$10,000
			Total:	**$10,000**

Measurable Milestones

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

- Approved SSO plans.
- Sanitary sewer infrastructure replaced or upgraded.
- Annual employee training on O&M.
- Annual community outreach events.

Monitoring Component

The City of Hudson will continue to monitor and track the implementation of their SSO plan and the occurrence of SSOs to report to TCEQ as required. The

City of Lufkin will continue to track sanitary sewer infrastructure replaced or upgraded.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Years 1-5:

- The City of Hudson will continue to implement the components of their SSO Initiative and track SSO events, repairs, and replacements.
- The City of Lufkin will continue to replace and upgrade sanitary sewer infrastructure as identified in its Capital Improvement Program.
- Deliver employee training on O&M and community outreach events.

Estimated Load Reductions

E. coli loading from overflow events will vary based on the discharge amount and the level of treatment of sewage. In total, wastewater facilities documented about 47 overflow events from 2005 to 2019 in Cedar Creek, 22 events in Jack Creek, 68 events in Hurricane Creek, and five events in Biloxi Creek.

The following equation was used to estimate bacteria load reductions from reductions in SSOs:

$$Load_{sso} = Average\ Volume \times FC \times Conversion$$

Where:

$Load_{sso}$ = Average potential *E. coli* load reduction per overflow incident (total cfu).

Average Volume = The average SSO volume (mL) for each watershed from 2005-2019 (855 gallons in Cedar Creek, 1,642 gallons in Jack Creek, 16,269 gallons in Hurricane Creek, and 160 gallons in Biloxi Creek) (Gitter, Yang, and Gregory, 2021). These values were multiplied by 3,785.41 mL/gallon to convert to mL.

FC = Fecal coliform concentration in sewage; 0.01 billion cfu/mL (EPA, 2001)

Conversion = Conversion rate of 0.63 from fecal coliform to *E. coli* (Wagner & Moench, 2009)

Since reductions in SSO events are uncertain, total annual reductions were not estimated. However, reductions per incident are estimated to be 20,390 billion cfu in Cedar Creek, 39,159 billion cfu in Jack Creek, 387,984 billion cfu in Hurricane Creek, and 3,816 billion cfu in Biloxi Creek.

Table 16. Management Measure 6: Reduce SSOs and unauthorized discharges

Causes and Sources: *E. coli* loading from SSO incidents.

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
20,390 billion cfu of *E. coli* per SSO event avoided in 0604A_02. 39,159 billion cfu of *E. coli* per SSO event avoided in 0604C_01 387,984 billion cfu of *E. coli* per SSO event avoided in 0604B_01 3,816 billion cfu of *E. coli* per SSO event avoided in 0604M_03	**Technical:** ▪ TCEQ's Small Business and Local Government Assistance Program may provide technical support to find the best approach for addressing SSO issues, as resources are available. **Financial:** ▪ Financial support is currently set aside for these efforts through annually approved budgets by the cities of Lufkin and Hudson. ▪ Funds for educational development material estimated at $10,000. ▪ Extra funds for capital projects.	▪ Employee training ▪ Public outreach	**Years 1-5:** ▪ The city of Hudson will continue to implement the components of their SSO Initiative and track SSO events, repairs, and replacements. ▪ The City of Lufkin will continue replacement and upgrade of sanitary sewer infrastructure as identified in its capital improvement program. ▪ Deliver employee training on O&M and community outreach.	▪ Approved SSO plan. ▪ Sanitary sewer infrastructure replaced or upgraded. ▪ Annual employee training on O&M. ▪ Annual community outreach event.	▪ Reduction in number of SSO incidents.	▪ The city of Hudson will continue to track the implementation of their SSO plan and the occurrence of SSOs to report to TCEQ as required. ▪ The city of Lufkin will track sanitary sewer infrastructure replaced or upgraded.	▪ City of Lufkin ▪ City of Hudson ▪ AgriLife Extension

Management Measure 7

Promote education and awareness for the proper disposal of fats, oils, and grease, pet waste, and illicit dumping.

Education and public awareness regarding illicit dumping, the proper disposal of fats, oils, and greases (FOG), and pet waste has been identified as important issues for stakeholders. Illicit dumping can be a water quality issue often occurring near bridge crossings where individuals may dispose of animal carcasses and trash. FOG are considered to be a significant cause of blockages in sanitary sewer systems, with an estimated 50% of all SSOs occurring due to blockages from FOG (EPA, 2004). Domestic pet waste that is not properly disposed of can also be a source of bacteria loading in the watersheds.

The goal of this management measure is to address illicit dumping and the improper disposal of FOG and pet waste through education and outreach efforts in the TMDL watersheds. This strategy will help to encourage watershed residents to participate in practices that help mitigate bacteria pollution.

Education Component

Education and outreach are critical for reducing illicit dumping and the improper disposal of FOG and pet waste. Educational materials, such as fliers or pamphlets, can be developed and distributed to watershed residents. In addition, educational information regarding these topics may be integrated into existing workshops to help reach residents in the community as well. Similar education and outreach materials can be provided to pet owners about bacteria pollution and the health risks posed by improperly disposed waste. AgriLife Extension, ANRA, and the cities of Lufkin and Hudson will work together to provide educational materials to residents that could lead to an increase in the number of residents that pick up and dispose of their pets' waste.

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **Local residents:** Residents will be encouraged to take part in educational programs and any other activity related to this measure. Buy-in and engagement by residents are paramount for the successful implementation of this measure.
- **AgriLife Extension:** AgriLife Extension will work with the cities of Lufkin and Hudson and ANRA to develop to deliver educational programs or material pertinent to this management measure.
- **Cities of Lufkin and Hudson:** The cities of Lufkin and Hudson will facilitate the development and delivery of educational and outreach

materials, specifically for proper disposal of FOG and preventing illicit dumping, to residents in their communities.

- **ANRA:** ANRA will work with the other responsible parties to deliver relevant education programs and technical information pertaining to pet waste management, proper FOG disposal, and preventing illicit dumping to local stakeholders.

Technical Assistance

AgriLife Extension and ANRA can assist with providing technical information and resources for the development of educational materials relating to this measure. Sample source materials are available from EPA and other sources.

Financial Assistance

Table 17 lists estimated expenses associated with this management measure to develop educational materials, which could be incorporated into existing efforts. Factsheets and handouts are estimated to cost $1,700 per year to develop since printing costs can vary from $0.09 to $0.50 per page depending on quantity.

Table 17. Estimated funding needed for implementing Management Measure 7

Description	Item	Unit	Rate	Amount
Pet waste management outreach materials	5	Years	$1,700	$8,500
FOG outreach materials	5	Years	$1,700	$8,500
			Total	**$17,000**

Funding sources are detailed below.

- **Clean Water Act Section 319(h) Nonpoint Source Grant Program:** This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to fund education and outreach regarding the illicit dumping and the proper disposal of FOG and pet waste.
- **Environmental Education Grants:** Under the Environmental Education Grants Program, EPA seeks grant proposals from eligible applicants to support environmental education projects that promote environmental stewardship and help develop knowledgeable and responsible students, teachers, and citizens. This grant program supplies financial support for projects that design, show, or teach environmental education practices, methods, or techniques as described in the Environmental Education Grant Program solicitation notices.
- **Urban Water Small Grants:** The objective of the Urban Waters Small Grants Program, administered by EPA, is to fund projects that will foster a comprehensive understanding of local urban water issues, identify and

address these issues at the local level, and educate and empower the community. 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.

Measurable Milestones

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

- Number of extension, outreach, or educational materials developed.
- Number of residents reached.

Monitoring Component

AgriLife Extension and ANRA will work with the cities of Lufkin and Hudson and local stakeholders to track materials developed and delivered to residents.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Years 1-5:

- Develop and deliver education and outreach materials to watershed residents regarding illicit dumping and the proper disposal of FOG and pet waste.

Estimated Load Reductions

It is difficult to estimate the potential *E. coli* load reduction from minimizing illicit dumping and the improper disposal of FOG; however, an *E. coli* load reduction for proper pet waste disposal can be estimated. The potential load reductions for this measure depend on how many dog owners will implement BMPs that eradicate or minimize the disposal of pet waste in the environment. Load reductions were calculated based on the number of dogs, thus dog owners that will implement pet waste BMPs under this I-Plan. The American Veterinary Medical Association (AVMA) estimates there are 0.614 dogs and 0.457 cats per American household (AVMA, 2018). The number of domestic cats and dogs in the watersheds was estimated by applying the AVMA estimates to the number of households in the watersheds. The number of dogs, which are targeted for management in this I-Plan, were estimated to be 3,714 in Cedar Creek, 4,134 in Hurricane Creek, 1,921 in Jack Creek, and 935 in Biloxi Creek.

Pet waste management measures will be most effective in public areas and places with higher concentrations of dogs. A proximity factor of 0.5 was

included to account for the fact that the majority of these areas in the TMDL watersheds are upland or further away from riparian areas.

The following equation was used to estimate the potential annual load reduction of *E. coli* (billion cfu/year) from pet waste:

$$Load_{pets} = Pets_{pop} \times Pets_{managed} \times FC_{pets} \times Conversion \times Median\ Efficacy \times Prox \times 365\ days/year$$

Where:

$Load_{pets}$ = Potential annual load reduction of *E. coli* attributed to pet waste

$Pets_{pop}$ = Pet population contributing to *E. coli* load reduction (40% of existing dog owners; 1,486, 1,654, 768, and 374 dogs in Cedar Creek, Hurricane Creek, Jack Creek, and Biloxi Creek watersheds, respectively)

$Pets_{managed}$ = Percentage of pets from which waste is to be managed per year (2% in all watersheds)

FC_{pets} = Fecal coliform produced per dog per day; 5.0 billion cfu/day (EPA, 2001)

Conversion = Conversion rate of 0.63 from fecal coliform to *E. coli* (Wagner and Moench, 2009)

Median Efficacy = BMP efficacy, assumed to be 0.75

Prox = Proximity factor, assumed to be 0.5

Management Measure 7 does not recommend the removal of pets. Rather, Management Measure 7 is seeking to change pet owner actions that result in the proper disposal of pet waste. The goal of the pet waste management measure is to reduce the number of pets currently contributing to *E. coli* loading by 10% in five years by properly disposing the pet waste. Consequently, this I-Plan set a target of managing 2% of the pet population contributing to *E. coli* loading per year.

Based on these assumptions, for each additional dog whose waste is picked up by its owner, *E. coli* loading will be reduced by about 36,921 billion cfu/year. A program that seeks to change pet owner actions that result in the proper disposal of pet waste by 2% will lead to annual load reductions of 12,814 billion cfu/year in the Cedar Creek watershed, 14,263 billion cfu/year in the Hurricane Creek watershed, 6,623 billion cfu/year in the Jack Creek watershed, and 3,225 billion cfu/year in the Biloxi Creek watershed.

Table 18. Management Measure 7: Promote education and awareness for the proper disposal of FOG, pet waste, and illicit dumping.

Causes and Sources: *E. coli* loading from illicit dumping and the improper disposal of FOG and pet waste.

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
Only quantified for pet waste management: 12,814 billion cfu/year *E. coli* for 0604A_02 14,263 billion cfu/year *E. coli* for 0604B_01 6,623 billion cfu/year *E. coli* for 0604C_01 3,225 billion cfu/year *E. coli* for 0604M_03	**Technical:** ▪ AgriLife Extension and ANRA will provide technical assistance with outreach and education efforts. **Financial:** ▪ Financial needs exist to develop educational materials and could be incorporated into existing efforts. ▪ Factsheets and handouts for materials are estimated to cost $1,700 to develop per year.	▪ Development and delivery of educational material to local residents in the watersheds. ▪ Integration of education information for illicit dumping and the proper disposal of FOG and pet waste existing workshops.	**Years 1-5** ▪ Develop and deliver education and outreach materials to watershed residents regarding illicit dumping, and the proper disposal of FOG and pet waste.	▪ Number of extension, outreach, or educational materials developed. ▪ Number of residents reached	▪ Number of educational materials developed and delivered annually. ▪ A stable or increasing number of residents reached annually.	▪ AgriLife Extension and ANRA will work with the cities of Lufkin and Hudson and local stakeholders to track materials developed and delivered to residents.	▪ Local residents ▪ AgriLife Extension ▪ ANRA ▪ City of Lufkin ▪ City of Hudson

Management Measure 8

Promote OSSF management.

Failing private residential OSSFs, commonly referred to as septic systems, have been known to contribute to bacteria impairments in surface water. Several pathways of the liquid waste in OSSFs afford opportunities for bacteria to enter ground and surface waters if the OSSF is malfunctioning. Lack of routine maintenance, aging of OSSFs, improper use of OSSFs, and inappropriate designs are some of the reasons that lead OSSFs to fail. When properly designed and operated, OSSFs would be expected to contribute virtually no fecal bacteria to surface waters (Weiskel et. al 1996).

The exact number of failing systems is unknown, but studies estimate that approximately 19% of systems in the TMDL watersheds are expected to be in failing condition (Reed, Stowe, and Yanke 2001). There are an estimated 716 OSSFs in Cedar Creek, zero OSSFs in Hurricane Creek, 1,434 OSSFs in Jack Creek, and 947 OSSFs in Biloxi Creek (Gitter, Yang, and Gregory 2021), therefore about 588 malfunctioning OSSFs need to be managed throughout the TMDL watersheds. While some systems can be treated and repaired, some may need to be redesigned or replaced. However, homeowners must have the awareness and resources to address OSSF problems when they arise.

The goal of this management measure is to promote OSSF management in the TMDL watersheds by delivering OSSF O&M workshops and to repair or replace 15 OSSFs in the Cedar Creek watershed, 25 OSSFs in the Jack Creek watershed, and 20 OSSFs in the Biloxi Creek watershed to minimize potential negative water quality impacts.

Education Component

Education and outreach for OSSFs will be targeted to both homeowners and local officials. Local officials can set up mechanisms that will mitigate pollution problems from OSSFs at community, county, watershed, and regional scales. Responsible parties will aim to deliver educational materials on proper OSSF O&M to homeowners.

AgriLife Extension currently hosts education programs for homeowners about proper O&M requirements as well as providing an overview of general OSSFs, collection and storage, pretreatment (and advanced pretreatment) components, disinfection, final treatment and dispersal, selection, and permitting. See information about this program on AgriLife Extension's webpage On-Site Sewage Facilities.[2] As funding allows, this program will be delivered throughout the TMDL watersheds to help meet the educational requirements of this plan.

[2] https://ossf.tamu.edu

Priority Areas

Cedar Creek, Jack Creek, and Biloxi Creek watersheds are predominantly rural and as such, many residences use OSSFs. Subwatershed loading potential and priority areas are displayed in Figure 7. Other priority areas will be determined based on OSSF surveys. Additionally, proximity to water bodies will be considered when selecting the OSSFs to target for repair or replacement, among other factors.

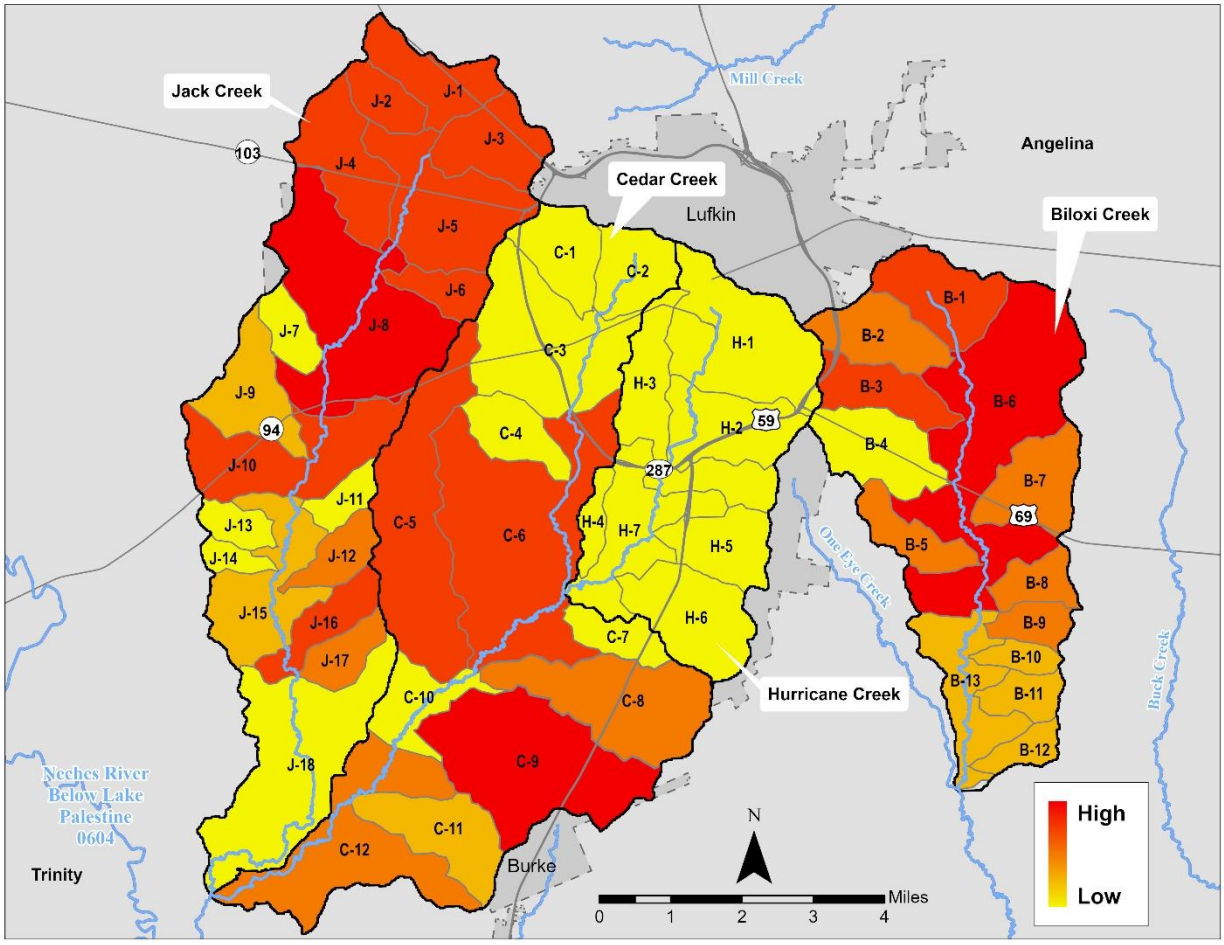

Figure 7. Subwatershed priorities based on *E. coli* loading potential from OSSFs

Responsible Parties and Funding

Each organization listed below will be responsible only for expenses associated with its own efforts and as funds become available.

- **OSSF owners**: OSSF owners will be responsible for coordinating repairs or replacements of malfunctioning OSSFs on their own property. Homeowners will be made aware of available resources or programs to assist with OSSF repair and replacement as funding becomes available.

- **AgriLife Extension**: AgriLife Extension will work with local stakeholders to develop the OSSF repair and replacement program and to provide OSSF O&M workshops
- **ANRA**: ANRA is the Authorized Agent and is responsible for permitting OSSFs within Angelina County. ANRA will work with OSSF owners for permitting new or replaced OSSFs and can assist with training and monitoring activities.

Technical Assistance

As resources are available, ANRA and AgriLife Extension will work with local stakeholders to identify specific educational needs and provide technical and financial assistance needed to deliver educational programs. In addition, AgriLife Extension offers educational opportunities through the Texas Well Owner Network, Installer and Maintenance Provider Workshops, and OSSF O&M workshops.

The repair and replacement of OSSFs requires licensed personnel and permits through the appropriate offices. ANRA is responsible for the permitting process within the TMDL watersheds and can direct homeowners towards appropriate technical experts as required. The design, construction, installation, and maintenance of new systems should be coordinated with local licensed service providers that can provide technical assistance to homeowners as needed.

Financial Assistance

The estimated cost for this management measure (Table 19) assumes that all of the malfunctioning OSSFs will be replaced, however, some may only need minor repairs. For proper identification and documentation of failing OSSFs and follow-up after repairs or replacements, regional organizations are encouraged to hire a dedicated technician to oversee this process.

Table 19. Estimated funding needed for implementing Management Measure 8

Description	Item	Unit	Rate	Amount
Repair or replacement of OSSFs	60	No.	$ 7,500	$ 450,000
Technician to identify and document failing OSSFs	5	Years	$ 40,000	$ 200,000
OSSFs O&M workshops	3	No.	$ 1,000	$ 3,000
			Total	$ 653,000

As resources are available, TCEQ's Small Business and Local Government Assistance Program may provide technical support to local governments to find the best approach for addressing OSSF issues.

Funding sources are detailed below.

- **Clean Water Act Section 319(h) Nonpoint Source Grant Program:** This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of nonpoint source management measures. The funds require a 40% match and may be used to fund OSSF education, repairs, and replacements.
- **TCEQ Supplemental Environmental Projects:** The Supplemental Environmental Projects program, administered by 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 TCEQ or directed entities (such as Resource Conservation and Development Councils) with pre-approved "umbrella" projects.

Measurable Milestones

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

- Number of OSSFs inspections made.
- Number of OSSFs repaired or replaced.
- Number of educational programs delivered.

Monitoring Component

AgriLife Extension and ANRA will track educational programs delivered and the number of OSSFs repaired or replaced upon receipt of proposed funding.

Implementation Schedule

The implementation schedule is as follows. Contingent upon the receipt of proposed project funding, the responsible parties as identified above will:

Years 1-5:

- Inspect and document the status of OSSFs in the watersheds during Year 1.
- Secure funding and administer an OSSF repair or replacement program to address malfunctioning OSSFs found through inspections.
- Repair or replace approximately 60 OSSFs within five years (contingent upon funding).
- Organize and deliver OSSF O&M workshops including any other related topics requested by local stakeholders during Years 1, 3, and 5.

Estimated Load Reductions

The following equation was used to estimate annual bacteria load reductions from the repair and replacement of failing OSSFs:

$$Load_{ossf} = N_{ossf} \times N_{hh} \times Production \times FC_s \times Conversion \times 365\ days/year$$

Where:

$Load_{ossf}$ = Potential annual load reduction of *E. coli* attributed to OSSF repair/replacement (in units of billion cfu per year)

N_{ossf} = Number of OSSFs repaired/replaced (15 in Cedar Creek, 25 in Jack Creek, and 20 in Biloxi Creek)

N_{hh} = Average number of people per household (2.44 for Angelina County, derived from U.S. Census Bureau Population and Household Data (USCB, 2010))

Production = Assumed sewage discharge rate; 264,979 mL per person per day (Horsley & Witten, 1996)

FC_s = Fecal coliform concentration in sewage; 0.01 billion cfu/mL (EPA, 2001)

Conversion = Conversion rate of 0.63 from fecal coliform to *E. coli* (Wagner & Moench, 2009)

Based on the annual installation, repair, or replacement of three OSSFs in Cedar Creek, five OSSFs in Jack Creek, and four OSSFs in Biloxi Creek, the estimated total annual bacteria reduction from OSSF repair and replacement is about 22,301,083 billion cfu in Cedar Creek, 37,168,472 billion cfu in Jack Creek, and 29,734,777 billion cfu in Biloxi Creek.

Table 20. Management Measure 8: Promote OSSF management

Causes and Sources: *E. coli* loading from untreated or insufficiently treated household sewage discharged from malfunctioning OSSFs.

Potential Load Reduction	Technical and Financial Assistance	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Parties
22,301,083 billion cfu/year of *E. coli* in 0604A_02 37,168,472 billion cfu/year of *E. coli* in 0604C_01 29,734,777 billion cfu/year of *E. coli* in 0604M_03	**Technical**: ▪ As resources are available, ANRA and AgriLife Extension will work with local stakeholders to identify specific educational needs and provide technical assistance. ▪ Resources and staff to identify and prioritize repair and replacement of failing OSSFs. **Financial:** ▪ Costs incurred for OSSF repair or replacement, estimated at $7,500 per system. ▪ Funds for hiring technical staff to undertake surveys and document status of OSSFS estimated at $40,000 per year. ▪ Workshop and training funds are estimated at $1,000 per program.	▪ Education and outreach targeted to local officials who can set up mechanisms that will mitigate pollution ▪ Delivery of OSSF workshops for homeowners.	**Years 1-5:** ▪ Inspect and document the status of OSSFs in the watersheds during Year 1. ▪ Secure funding and administer an OSSF repair or replacement program to address malfunctioning OSSFs found through inspections. ▪ Repair or replace approximately 60 OSSF systems within five years (contingent upon funding). ▪ Organize and deliver three OSSF O&M Workshops (Years 1, 3, and 5).	▪ Number of OSSF inspections made. ▪ Number of OSSFs repaired or replaced. ▪ Number of educational programs delivered.	▪ Number of OSSF inspections made. ▪ Number of education and outreach programs delivered annually. ▪ An average of 12 failing OSSFs repaired or replaced per year.	▪ AgriLife Extension and ANRA will track educational programs delivered and the number of OSSFs repaired or replaced upon receipt of proposed funding	▪ AgriLife Extension ▪ ANRA ▪ OSSF owners

Sustainability

TCEQ, responsible parties, and other 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. Responsible parties and other stakeholders evaluate several factors, such as the pace of implementation, the effectiveness of BMPs, load reductions, and progress toward meeting water quality standards.

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

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

Water Quality Indicators

Water quality monitoring staff from the ANRA and TCEQ will continue to monitor the status of water quality during implementation as funding and resources allow. Additional funding will be sought to conduct supplemental monitoring in the TMDL watersheds. 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 the goals of the TMDL. Tracking also allows stakeholders to evaluate actions taken, identify those that may not be working, and make any changes that may be necessary to get the plan back on target.

Communication Strategy

TCEQ will work with responsible parties and other stakeholders to hold meetings or obtain annual I-Plan updates for up to five years so stakeholders may evaluate their progress. Responsible parties and stakeholders will continue to provide annual updates and/or take part in any meetings over the five-year period to evaluate implementation efforts. At the completion of the scheduled I-Plan activities, stakeholders will assemble and evaluate the actions, overall impacts, and results of their implementation efforts.

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