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Implementation Plan for One Total Maximum Daily Load for Indicator Bacteria in Arenosa Creek

Segments 2453C

Assessment Unit 2453C_01

By Stakeholders of the Arenosa Creek Watershed
and the Texas Water Resources Institute

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This plan is based in part on technical reports prepared for TCEQ by:
Texas Water Resources Institute
and in large part on the recommendations of the
stakeholders of the Arenosa Creek watershed

Agencies that participated in development of this Implementation Plan include:
Texas A&M AgriLife Extension Service
Texas A&M AgriLife Research
Texas Commission on Environment Quality
Texas Parks and Wildlife Department
U.S. Department of Agriculture Natural Resources Conservation Service
Texas State Soil and Water Conservation Board
Texas Sea Grant
Texas Water Resources Institute

Contents

Figures

Tables

Abbreviations

AU	assessment unit
BMP	best management practice
cfu	colony forming units
CIG	Conservation Innovation Grants
CRP	Clean Rivers Program
CSP	Conservation Stewardship Program
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency (U.S.)
EQIP	Environmental Quality Incentives Program
FG	future growth
GBRA	Guadalupe-Blanco River Authority
I-Plan	implementation plan
LA	load allocation
LNRA	Lavaca-Navidad River Authority
mL	milliliter
MOS	margin of safety
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
OSSF	on-site sewage facility
RCPP	Regional Conservation Partnership Program
SEP	Supplemental Environmental Project
SWCD	Soil and Water Conservation District
TCEQ	Texas Commission on Environmental Quality
TMDL	total maximum daily load
TPWD	Texas Parks and Wildlife Department

TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWRI	Texas Water Resources Institute
USDA	United States Department of Agriculture
WLA	wasteload allocation
WQMP	Water Quality Management Plan

Implementation Plan for One TMDL for Indicator Bacteria in Arenosa Creek

Executive Summary

In 2021, the Texas Commission on Environmental Quality (TCEQ) will consider adoption of *One Total Maximum Daily Load for Indicator Bacteria in Arenosa Creek* (Segment 2453C).

This implementation plan, or I-Plan:

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

The ultimate goal of this I-Plan is to restore the primary contact recreation use in Segment 2453C by reducing concentrations of bacteria to levels established in the TMDL. *Escherichia coli* (*E. coli*) are 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 (or "counts") of *E. coli* bacteria, typically given as colony forming units (cfu). The primary contact recreation use is not supported 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 five management measures that will be used to reduce indicator bacteria in the Arenosa Creek watershed. Management measures are related to managing nonpoint sources (NPS) (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 or municipal separate storm sewer system Phase II Stormwater Management Programs. No control actions related to regulated discharges are included in this plan.

Summary of Management Measures

1. *Reduce the number of failing OSSFs and straight pipe discharges.*
2. *Promote feral hog management.*
3. *Promote and implement grazing and agricultural best management practices.*
4. *Minimize future stormwater impacts from encroaching development.*
5. *Improve water quality monitoring.*

For each of the measures, this plan identifies the responsible parties, technical and financial needs, monitoring and outreach efforts, and a schedule of

activities. Implementation of the management measures will largely be dependent upon the availability of funding.

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

Introduction

To keep Texas' commitment to restore and maintain water quality in impaired rivers, lakes, and bays, 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 Arenosa Creek watershed as defined in the TMDL report. It is a flexible tool that governmental and nongovernmental organizations involved in implementation use to guide their activities to improve water quality. The participating partners may accomplish the activities described in the plan through rule, order, guidance, or other appropriate formal or informal action.

This I-Plan contains the following components:

1) Description of management measures that will be implemented to achieve the water quality target.
2) Schedule for implementing activities.
3) Follow-up tracking and monitoring plan to determine the effectiveness of the management measures undertaken.
4) Measurable outcomes and other considerations TCEQ and stakeholders will use to determine whether the I-Plan has been properly executed, water quality standards are being achieved, or the plan needs to be modified.
5) Communication strategies TCEQ will use to disseminate information to stakeholders.
6) Review strategy that stakeholders will use to periodically review and revise the plan to ensure there is continued progress in improving water quality.

Watershed Overview

Arenosa Creek is a freshwater stream located along the Texas Gulf Coast, approximately midway between the cities of Edna and Victoria (Figure 1). Arenosa Creek consists of a single segment (2453C) and a single assessment unit (AU) (2453C_01). The headwaters of Arenosa Creek begin in Victoria County at J-2 Ranch Road and flow approximately 32.7 miles southeasterly until converging with Garcitas Creek. The drainage area for Arenosa Creek is 172.1 square miles (110,165.5 acres) and is located predominately in Victoria County (52% of the watershed) and Jackson County (45% of the watershed). Three percent of the watershed resides in Lavaca County.

The U.S. Environmental Protection Agency (EPA)-approved *2020 Texas Integrated Report of Surface Water Quality* (TCEQ, 2020) provides the following segment and AU description for the water body considered in this document:

- Segment 2453C and AU 2453C_01– From Garcitas Creek confluence upstream to J-2 Ranch Road

This study incorporates a watershed approach, where the entire drainage area of AU 2453C_01 is considered.

Summary of TMDL

Table 1 summarizes the allocations developed for *One Total Maximum Daily Load for Indicator Bacteria in Arenosa Creek* (TCEQ, forthcoming). Additional background information including the problem definition, endpoint identification, source analysis, linkages between sources and receiving waters and pollutant load allocations can be found in the TMDL report.

Table 1. TMDL allocation summary for the Arenosa Creek AU 2453C_01 watershed

AU	Segment Name	TMDL	WLA_{WWTF}	WLA_{SW}	LA	FG	MOS
2453C_01	Arenosa Creek	558.859	0	0.785	529.841	0.290	27.943

Load units expressed as billion cfu/day.

Implementation Strategy

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

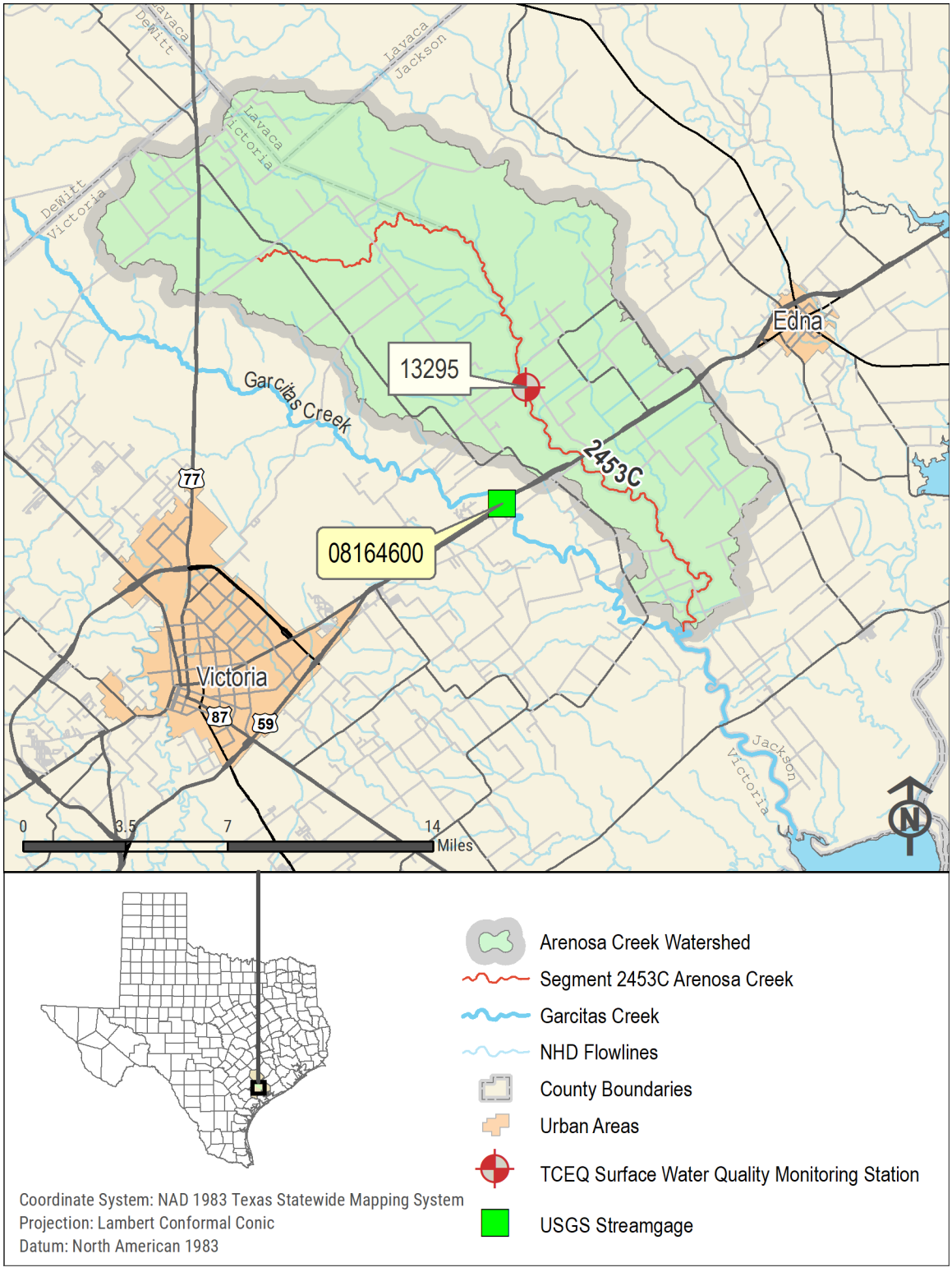

Figure 1. Overview map showing the Arenosa Creek watershed and TCEQ monitoring station

Adaptive Implementation

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

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

Activities and Milestones

To facilitate the development of the Arenosa Creek TMDL I-Plan, the Texas Water Resources Institute (TWRI), under contract with TCEQ, held a series of public meetings in the watershed from August 2018 through July 2019. Collectively, the watershed stakeholder group held five meetings, in addition to a number of presentations and one-on-one meetings with local groups, to develop this I-Plan. The stakeholder group developed detailed, consensus-based action plans that later became sections of this I-Plan. The planned implementation activities are described in the following section.

Management Measures

The Arenosa Creek I-Plan includes the five following management measures:

1. *Reduce the number of failing OSSFs and straight pipe discharges.*
2. *Promote feral hog management.*
3. *Promote and implement grazing and agricultural best management practices.*
4. *Minimize future stormwater impacts from encroaching development.*
5. *Improve water quality monitoring.*

Management Measure 1

Reduce the number of failing OSSFs and straight pipe discharges.

Analysis indicated that failing or non-existent OSSFs are likely a contributor to potential bacterial loadings across the watershed. Nearly all the soils in the watershed are classified as “very limited” for OSSF suitability. This indicates that conventional septic tank systems are not suitable for proper treatment of household wastewater. In these areas, advanced treatment systems, most commonly aerobic treatment units, are suitable alternative options for

wastewater treatment. While advanced treatment systems are highly effective, the operation and maintenance needs for these systems are rigorous compared to conventional septic systems. Limited awareness and lack of maintenance can lead to system failures. Furthermore, older or unmaintained housing structures may lack a treatment system altogether, commonly referred to as a "straight pipe" discharge. Under these situations, untreated household wastewater may reach nearby water bodies and pose a substantial human health risk.

Failing or non-existent OSSFs were a concern raised by stakeholders. The exact number of failing systems is unknown, but studies estimate that approximately 12% of systems are expected to be in failing condition (Reed, Stowe & Yanke, 2001). Based on 911 address data, there are an estimated 322 OSSFs in the watershed (Figure 2). Improper system design or selection, improper maintenance, and lack of education are likely reasons contributing to OSSF failure. In some cases, systems can be treated and repaired while in other cases, systems need to be redesigned and replaced. However, homeowners must have the awareness and resources to address OSSF problems when they arise.

Specifically, the goals of Management Measure 1 are to:

1) Develop resources and programs to repair and/or replace 15 failing OSSFs in areas of highest OSSF density in the watershed over the next ten years.
2) Promote the proper operation and maintenance of OSSFs by delivering OSSF operation and maintenance workshops to watershed residents.

Responsible Parties and Funding

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

- Watershed Coordinator – TWRI will serve as the watershed coordinator and work with AgriLife Extension, Victoria and Jackson counties, and local homeowners to develop and administer an OSSF repair and replacement program. The watershed coordinator will also work with county and state AgriLife Extension staff to provide OSSF maintenance and operation workshops.

- AgriLife Extension – AgriLife Extension will work with the watershed coordinator to develop the OSSF repair and replacement program and to provide OSSF maintenance and operation workshops.

- County Staff/Designated Representatives – Victoria County Public Health Department and Jackson County Office of Permitting are responsible for permitting OSSFs in their respective jurisdictions. They will work with the watershed coordinator in the development of an OSSF repair and replacement program.

- Homeowners – Homeowners are responsible for coordinating repairs or replacements of OSSF systems 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.

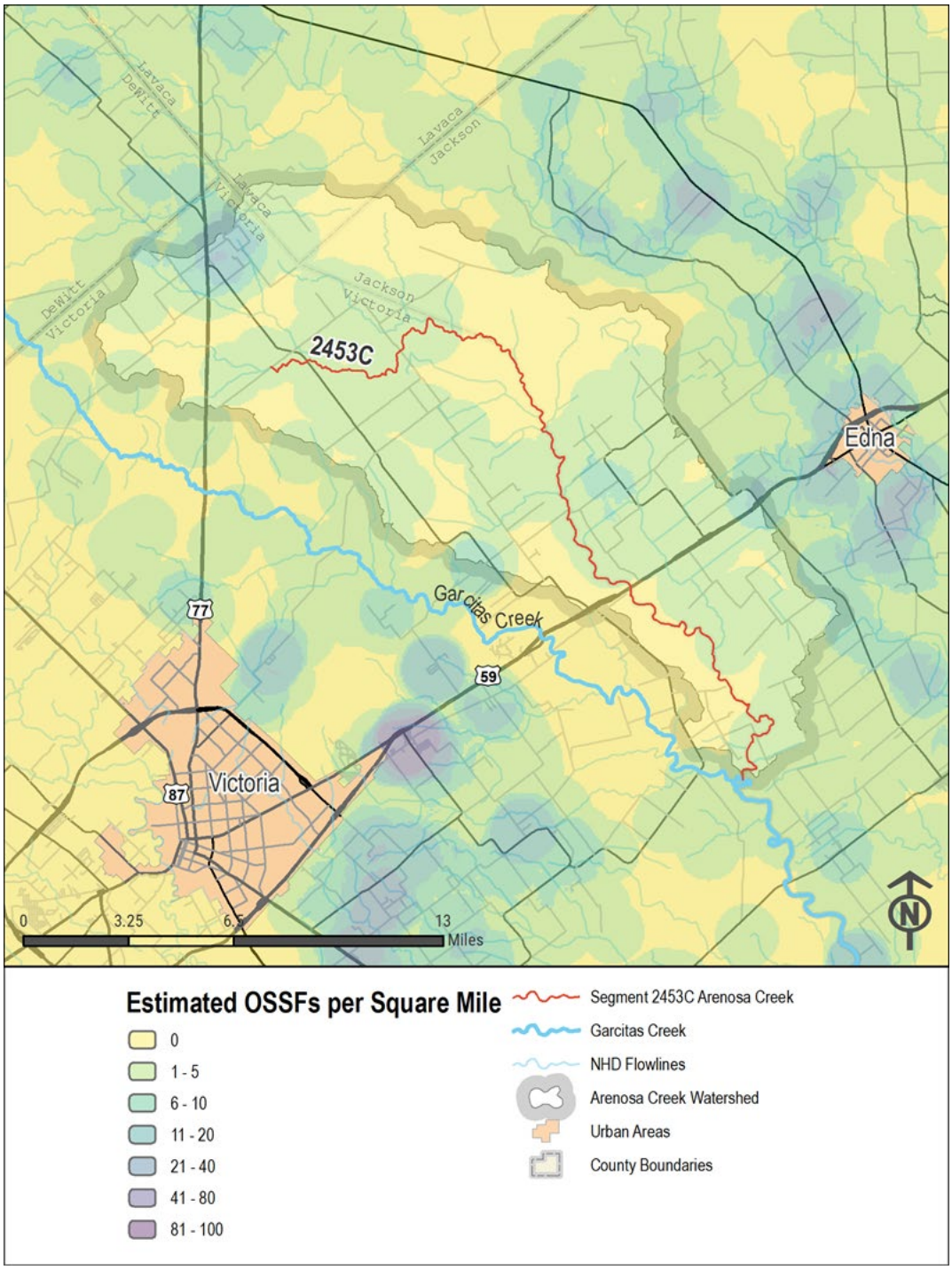

Figure 2. Estimated OSSF density in the Arenosa Creek watershed

Technical Assistance

The repair and replacement of OSSFs requires licensed personnel and permits through respective county offices. The Jackson County Office of Permitting and the Victoria County Public Health Department can assist with the permitting process within their respective jurisdictions. AgriLife Extension offers education, programs, and training associated with septic system maintenance, operations, and services. 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

A single OSSF replacement is estimated to cost approximately $10,000. At least $150,000 will be required to fund repair and replacement activities associated with 15 systems. Personnel, travel, and equipment costs for a repair and replacement program are estimated to cost around $38,333 annually, based on projects in nearby watersheds.

Currently, responsibility for the repair and replacement of OSSFs falls entirely on the property owner. However, there are opportunities to leverage external funds for OSSF repair and replacement, in particular for lower income communities. A summary of potential funding sources is included below:

- Clean Water Act Section 319(h) NPS Grant Program – This U.S. EPA grant program, administered by TCEQ and Texas State Soil and Water Conservation Board (TSSWCB), provides funding for implementation of management measures included in accepted watershed protection plans. The funds require a 40% match and have been used to implement OSSF repair and replacement programs in other watersheds.

- TCEQ Supplemental Environmental Projects (SEP) - The SEP 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.

- 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:

- Number of OSSFs repaired or replaced.
- Number of OSSF education workshops delivered.

Monitoring Component

The watershed coordinator will track funding applied and obtained for an OSSF repair and replacement program. Additionally, the watershed coordinator will track the number of OSSF education workshops held.

Implementation Schedule

Contingent upon the receipt of proposed project funding, the implementation schedule is as follows:

Years 1 through 5:

- Develop and pursue funding for staff, outreach and education, and OSSF repair and replacements as needed. Since receipt of funding is uncertain, a five-year time window is provided.

Years 3 through 5:

- Annually administer funded OSSF repair and replacement program.
- Repair and replace a total of 15 OSSFs (five per year).

Years 3, 7, and 10:

- Deliver OSSF education programs for homeowners in each year specified.

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 cfu per year)

N_{ossf} = Number of OSSFs repaired/replaced

N_{hh} = Average number of people per household (2.76, derived from U.S. Census Bureau Population and Household Data [2010])

Production = Assumed sewage discharge rate; 70 gallons per person per day (Borel et al., 2015)

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

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

Based on the installation, repair, or replacement of 15 OSSFs, the estimated total bacteria reduction from OSSF repair and replacement is 3.785×10^{15} cfu *E. coli.*

Table 2. Summary of Management Measure 1: Reduce the number of failing OSSFs and straight pipe discharges.

Causes and Sources: *E. coli* loading from untreated or insufficently treated household sewage discharged from faulty or non-existent OSSFs.

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entities
3.785×10^{15} cfu *E. coli*	Technical: Resources/staff to identify and prioritize repair and replacement of failing OSSFs. Financial: Costs incurred for OSSF repair or replacement, estimated at $10,000 per system.	Delivery of OSSF workshops for homeowners.	• Years 1 through 5: Develop funding for administration, staffing, and education and outreach associated with OSSF repair and replacement program. • Years 3 through 5: Repair and replace 15 OSSFs. Annually administer funded OSSF repair and replacement program. • Years 3, 7, and 10: Hold an OSSF education workshop for homeowners.	• Number of OSSFs repaired or replaced. • Number of OSSF education workshops.	• Secure funding for OSSF repair and replacement program. • Number of attendees at workshops. • Number of education and outreach programs. • Number of failing OSSFs repaired or replaced.	The watershed coordinator will track funding applied for and any OSSFs repaired or replaced. The watershed coordinator will also track education and outreach programming delivered in the watershed.	Watershed Coordinator, AgriLife Extension, County Staff/Designated Representatives, Homeowners

Management Measure 2

Promote feral hog management.

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

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

The goals of Management Measure 2 are to:

1) Promote effective feral hog management by delivering feral hog management workshops.
2) Explore the feasibility of funding a full or part-time trapper position and trapping equipment.
3) Explore the feasibility of a feral hog bounty program.

Responsible Parties and Funding

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

- Watershed Coordinator – TWRI will serve as the watershed coordinator and work with AgriLife Extension to deliver feral hog management workshops. Additionally, the watershed coordinator will work with interested entities to identify sources of funding and the possibility of funding a feral hog bounty program, feral hog trapper, and equipment.

- AgriLife Extension – AgriLife Extension will work with the watershed coordinator 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 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 removal of feral hogs.

Financial Assistance

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. In some cases, speakers are already funded under existing grant funded projects.

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.

Feral hog bounty program costs vary substantially and depend on the program objectives. The overall costs are typically determined by the county or program partners that make funds available.

Currently, funding for feral hog removal activities is limited primarily to non-federal and non-state funding sources. Therefore, funding will rely primarily on local funds for bounty and trapper activities, while funding for education activities can by leveraged through EPA grant programs detailed below:

- Clean Water Act Section 319(h) NPS Grant Program – This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of management measures included in accepted watershed protection plans. The funds require a 40% match and have been 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 bounties and/or trappers.

Measurable Milestones

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

- The number of feral hog management workshops delivered.
- The estimated number of feral hogs removed.

Monitoring Component

The watershed coordinator will keep track of the number of feral hog management workshops delivered and number of attendees per workshop. Additionally, the watershed coordinator will work with landowners and any funded trappers to estimate the number of feral hogs removed from the watershed.

Implementation Schedule

Contingent upon the receipt of funding, the implementation schedule is as follows:

Years 1, 3, 5, 7, and 9:

- Deliver one feral hog management workshop in each year specified.

Years 3 through 10:

- Explore funding for feral hog trappers and equipment as needed.
- Explore funding to implement a feral hog bounty program as needed.

Estimated Load Reductions

Load reductions resulting from feral hog management are highly uncertain. According to AgriLife Extension (2012), approximately 60% of the population must be culled just to maintain current population levels. Furthermore, populations are highly mobile and will travel in and out of the 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 3.48×10^{10} cfu *E. coli* per year. 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 cfu per year)

N_{fh} = Number of feral hogs removed

Animal Unit Conversion = 0.125 animal units per feral hog (Wagner & Moench, 2009)

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

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

Table 3. Summary of Management Measure 2: 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 Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entities
3.48×10^{10} cfu *E. coli* per year per feral hog removed.	Technical: Resources for landowners about effective feral hog management techniques are available through AgriLife Extension, USDA Animal and Plant Healthy 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.	Delivery of feral hog management workshops for landowners and land managers.	• Years 1, 3, 5, 7, and 9: Deliver feral hog management workshop. • Years 3 through 10: Explore funding for feral hog trappers and equipment, and explore funding for feral hog bounty program.	• Number of feral hog management workshops. • Estimated number of feral hogs removed.	• Number of feral hog workshops delivered and number of attendees. • Estimated number of feral hogs removed.	The watershed coordinator will work with landowners and trappers to estimate number of feral hogs removed. The watershed coordinator will track the number of workshops and attendees.	Watershed Coordinator, AgriLife Extension

Management Measure 3

Promote and implement grazing and agricultural best management practices.

Grazed pastures and rangeland can contribute to bacteria loadings across the watershed. While the fate and transport of fecal bacteria deposited on upland surfaces is not always certain, livestock may spend substantial time in and around water bodies, resulting in direct impacts on water quality. Importantly, livestock grazing behavior can be modified through food, shelter, fencing, and water availability. Modifying the time spent by livestock in riparian pastures through rotational grazing, alternative water supplies, shade structures, and supplemental feeding can directly reduce potential bacteria loads reaching nearby water bodies. Additionally, these practices can improve cattle health and productivity.

Natural Resources Conservation Service (NRCS) and TSSWCB give technical and financial assistance to producers for planning and implementing best management practices (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 Water Quality Management Plans (WQMPs) through planning, implementation, and maintenance of each practice.

Promoting and implementing WQMPs and conservation plans is anticipated to provide direct benefits to water quality and can provide benefits to producers. A variety of BMPs are available to achieve goals of improving forage quality, distributing livestock across a property, and making water available to livestock. Table 4 provides a list of common practices available to producers. However, the list of practices available to producers is not limited to those in the table. The actual practices will vary by operation and should be determined through assistance from NRCS, TSSWCB, and local SWCDs as appropriate. In addition to reducing bacteria loads reaching waterways, these practices can reduce erosion, sediment loads, and nutrient loads.

The goals of Management Measure 3 are to:

1) Implement 30 conservation plans or WQMPs.
2) Fund and hire staff to assist with the development and processing of conservation plans and WQMPs.
3) Promote adoption of best practices and participation in NRCS and TSSWCB programs through field days and workshops.
4) Promote nutrient management practices through education/outreach and soil testing campaigns.

Table 4. 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, wildlife
Fencing	382	Livestock, water quality
Filter strips	393	Livestock, water quality, wildlife
Grade stabilization structures	410	Water quality
Grazing land mechanical treatment	548	Livestock, water quality, wildlife
Heavy use area protection	562	Livestock, water quantity, water quality
Pond	378	Livestock, water quantity, water quality, wildlife
Prescribed burning	338	Livestock, water quality, wildlife
Prescribed grazing	528	Livestock, water quality, wildlife
Range/Pasture planting	550/512	Livestock, water quality, wildlife
Shade structure	NA	Livestock, water quality, wildlife
Stream crossing	578	Livestock, water quality
Supplemental feed location	NA	Livestock, water quality
Water well	642	Livestock, water quantity, wildlife
Watering facility	614	Livestock, water quantity

Responsible Parties and Funding

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

- Watershed Coordinator – TWRI will serve as the watershed coordinator and work with AgriLife Extension, NRCS, SWCDs, and TSSWCB in delivering outreach and extension materials, workshops, and field days.
- AgriLife Extension – AgriLife Extension will work with the watershed coordinator, NRCS, SWCDs, and TSSWCB to deliver outreach and extension materials, workshops, and field days.
- TSSWCB – TSSWCB will work with NRCS and SWCDs to fund and hire a field technician to facilitate development and implementation of conservation plans and WQMPs. TSSWCB is also responsible for oversight of the WQMP program.
- NRCS – NRCS will work with landowners/producers and the SWCD to develop and implement 30 conservation plans or WQMPs. NRCS will also work with entities in the delivery of outreach and extensions materials, workshops, and field days.

- SWCDs – the Victoria and Jackson SWCDs will work with the TSSWCB and NRCS to develop and implement 30 conservation plans or WQMPs. The SWCDs will also work with other entities in the delivery of outreach and extension materials, workshops, and field days.

- Landowners/Producers – Landowners and producers will work with the NRCS and SWCDs as appropriate to develop 30 conversation plans or WQMPs and obtain funding to implement conservation practices according to the site-specific plans.

Technical Assistance

Developing and implementing practices to reduce runoff from agricultural lands requires substantial technical expertise. Technical assistance can be obtained from local SWCDs, local NRCS offices, and local AgriLife Extension offices. Producers requesting planning assistance will work with the local SWCD and local 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

The annual salary, benefits, and additional costs associated with a field technician is estimated at approximately $75,000 per year. Due to the small size of the watershed, it is likely this cost and position can be shared amongst adjacent districts and or watersheds.

The cost of on-farm practices can vary substantially, depending on the specific suite of practices adopted by the producer. For the purposes of this plan, TWRI estimates the cost associated with each plan at $15,000. A number of cost share programs are available to producers that incentivize the planning and implementation of these practices. Funding sources are detailed below:

- Clean Water Act Section 319 (h) NPS Grant Program – This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of management measures included in accepted watershed protection plans. The funds require a 40% match and have been used to fund education programs, watershed implementation, and technicians.
- Conservation Innovation Grants (CIG) – The CIG is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. Under CIG, Environmental Quality Incentives Program (EQIP) funds are used to award competitive grants to non-federal governmental or nongovernmental organizations, tribes, or individuals.
- Conservation Stewardship Program (CSP) – The CSP helps agricultural producers maintain and improve their existing conservation systems and

adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance — the higher the performance, the higher the payment.

- 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 (RCPP) – The RCPP is a new, comprehensive, and flexible program that uses partnerships to stretch and multiply conservation investments and reach conservation goals on a regional or watershed scale. Through RCPP, the NRCS and state, local, and regional partners coordinate resources to help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.

Measurable Milestones

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

- Number of WQMP and conservation plans developed.
- Number of workshops, field days, and other extension programs delivered.

Monitoring Component

The watershed coordinator will work with the TSSWCB and NRCS on the number of WQMP and conservation plans developed in the watershed. Additionally, the watershed coordinator will track the number of workshops, field days, and extension programs delivered.

Implementation Schedule

As funding allows, the responsible parties will:

Years 1 and 2:

- Develop three conservation plans or WQMPs each year.

Year 3:

- Develop three conservation plans or WQMPs.
- Deliver a Lone Star Healthy Streams workshop, or related workshop/field day event.
- Secure funding for a technician to develop conservation plans or WQMPs.

Year 4, 5, and 6:

- Develop three conservation plans or WQMPs each year.
- Secure funding for a technician to develop conservation plans or WQMPs each year.

Year 7:

- Develop three conservation plans or WQMPs.
- Deliver a Lone Star Healthy Streams workshop, or related workshop/field day event.
- Secure funding for a technician to develop conservation plans or WQMPs.

Year 8, 9, and 10:

- Develop three conservation plans or WQMPs each year.
- Secure funding for a technician to develop conservation plans or WQMPs.

Estimated Load Reductions

The following equation was used to estimate annual bacteria load reductions from implementation of conservation plans and WQMPs on ranches:

$$Load_{cattle} = Head/Operation \times N_{plans} \times FC_{cattle} \times Median\ Efficacy \times Conversion \times Prox \times 365\ days/year$$

Where:

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

Head/Operation = Average number of head of cattle per operation in Jackson and Victoria counties (approximately 54 according to the 2012 Agriculture Census)

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

FC_{cattle} = Fecal coliform produced by one animal unit cattle per day (8.55×10^9 cfu/day) (Wagner & Moench, 2009)

Median Efficacy = Median efficacy of selected conservation practices at reducing bacteria loads (0.58 used, see Table 5)

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

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. Finally, the proximity of implemented BMPs to water bodies will influence the effectiveness at reducing loads. Typically, a proximity factor of 5% is used for BMPs in upland areas and 25% is used in riparian areas. Since there is uncertainty in both the specific BMPs and the locations where plans are implemented, an average proximity factor of 15% was used.

Table 5. Summary of literature reported values for conservation practice effectiveness in reducing indicator bacteria loads

Management Practice	Median *E. coli* Removal Efficacy
Exclusionary Fencing[1]	62%
Prescribed Grazing[2]	54%
Stream Crossing[3]	48%
Watering Facility[4]	73%
Overall Median	**58%**

[1] Brenner et al. 1996; Cook 1998; Hagedorn et al. 1999; Line 2002; Line 2003; Lombardo et al. 2000; Meals 2001; Meals 2004; Peterson et al. 2011.
[2] Tate et al. 2004; EPA 2010.
[3] Inamdar et al. 2002; Meals 2001.
[4] Byers et al. 2005; Hagedorn et al. 1999; Sheffield et al. 1997.

Based on the adoption of 30 conservation plans or WQMPs, a potential load reduction of 2.77×10^{14} cfu of *E. coli* was estimated.

Table 6. Summary of Management Measure 3: Promote and implement grazing and agricultural best management practices

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

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entities
2.77×10^{14} cfu of *E. coli*	Technical: Assistance for producers and landowners is available through local SWCDs, NRCS, and county AgriLife Extension offices. Financial: Significant financial needs are anticipated with an estimated $75,000 per year for a WQMP technician; and an estimated $15,000 per conservation plan or WQMP.	Education and outreach will be required to demonstrate benefits to producers and their operations. The Lone Star Healthy Streams or related programs will be delivered to livestock producers in the watershed.	• Years 1 and 2: Develop three conservation plans or WQMPs each year. • Year 3: Develop three conservation plans or WQMPs. Deliver a Long Star Healthy Streams workshop, or related workshop/field day event. Secure funding for a technician to develop conservation plans or WQMPs each year. • Years 4, 5, and 6: Develop three conservation plans or WQMPs each year. Secure funding for a technician to develop conservation plans or WQMPs each year. • Year 7: Develop three conservation plans or WQMPs. Deliver a Lone Star Healthy Streams workshop, or related workshop/field day event. Secure funding for a technician to develop conservation plans or WQMPs. • Years 8, 9, and 10: Develop three conservation plans or WQMPs each year. Secure funding for a technician to develop conservation plans or WQMPs.	• Number of conservation plans or WQMPs developed. • Number of education events delivered.	• Number of conservation plans and WQMPs developed. • Funding for technician position secured. • Number of education events held. • Number of attendees at education events.	The watershed coordinator will request reports from TSSWCB, local SWCDs, and NRCS on the number of plans developed and implemented. The watershed coordinator will track education and outreach delivered in the watershed.	Watershed Coordinator, AgriLife Extension, TSSWCB, NRCS, SWCD, Landowners/ Producers

Management Measure 4

Minimize future stormwater impacts from encroaching development.

The Arenosa Creek watershed is largely rural and characterized by pastures and rangeland. However, more subdivisions and development are occurring along the highway corridor between the cities of Victoria and Edna. As this area changes, the contributors to stormwater runoff, bacteria loads, and nutrient loads will change as well. Runoff from impervious surfaces, nutrient loading from fertilized lawns, and bacteria loadings from household pets become an increasing concern. Educating residents about proper and effective management of residential lawns and gardens, irrigation, and pet waste become increasingly important.

For landowners that would like to protect existing rural and agricultural land uses, a number of conservation easement options are available. By working with a land trust organization or NRCS, landowners can create a property easement that restricts the type of uses that are allowed on a property. The benefits of conservation easements include conserving agricultural production, protecting water resources, and providing wildlife habitat (Lund et al., 2019). Because every landowner has specific goals for their own property, there is not a one size fits all program for conservation easements. However, bringing in land trust organizations to discuss options at education and workshop events will provide local landowners the knowledge and option to participate if desired.

The goals of Management Measure 4 are to:

1) Deliver education and outreach programing to educate residents on urban/suburban management practices.
2) Bring land trust organizations and other entities to discuss conservation easement options with local landowners.

Responsible Parties and Funding

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

- Watershed Coordinator – TWRI will serve as the watershed coordinator and work with other entities as appropriate to arrange workshops discussing how to properly manage stormwater and opportunities for conservation easements through land trusts, NRCS, and other organizations.
- AgriLife Extension – AgriLife Extension will work with the watershed coordinator to deliver a Healthy Lawns and Healthy Waters workshop or related event.

Technical Assistance

EPA and TCEQ have materials and resources for municipalities that manage and implement stormwater best practices. The Jackson County Office of Permitting and the Victoria County Public Health Department should be contacted by developers to ensure development codes are followed. Local engineers and consultants are also available for landowners and entities for design, construction, and other technical assistance associated with stormwater management.

Financial Assistance

- Clean Water Act Section 319(h) NPS Grant Program – This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of management measures included in accepted watershed protection plans. The funds require a 40% match.

- 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:

- Number of Healthy Lawns and Healthy Waters workshops or related events delivered.
- Number of events with conservation easement topics.

Monitoring Component

The watershed coordinator will track the number of Healthy Lawns and Healthy Waters workshops (or related events) delivered. Additionally, the watershed coordinator will track the number of events with speakers discussing opportunities for conservation easements.

Implementation Schedule

As funding allows, the responsible parties will:

Years 1 through 10:

- Coordinate speakers from land trusts and other organizations to discuss possible land conservation opportunities (on-going, as many as possible).

Years 2 and 4:

- Deliver one Healthy Lawns and Healthy Waters workshop or related event in each year.

Estimated Load Reductions

Load reductions could not be estimated for this management measure.

Table 7. Summary of Management Measure 4: Minimize future stormwater impacts from encroaching development

Causes and Sources: Bacteria loadings resulting from land use conversion to suburban and urban land uses and increases in impervious surfaces.

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entities
Load reductions could not be calculated.	Technical: Landowners can obtain technical assistance from county planning and permitting departments, and local engineering and consulting firms. EPA and TCEQ can provide technical assistance to municipalities. Financial: Minimal financial resources required. Workshops are covered under existing grant programs.	This management measure focuses exclusively on delivering educational programs and speakers to local residents.	• Years 1 through 10: Coordinate speakers from land trusts and other organizations to discuss land conservation opportunities (on-going, as many as possible). • Years 2 and 4: Deliver one Healthy Lawns and Healthy Waters workshop or related event in each year.	• Number of Healthy Lawns and Healthy Waters workshops or related event. • Number of events with conservation easement topics.	• Number of education events. • Number of attendees at education events.	The watershed coordinator will track the number of Healthy Lawns and Healthy Waters workshops (or related events) delivered. Additionally, the watershed coordinator will track the number of events with speakers discussing opportunities for conservation easements.	Watershed coordinator, AgriLife Extension.

Management Measure 5

Improve water quality monitoring.

Routine water quality monitoring data was collected in Arenosa Creek from approximately 2001-2003. In order to provide data for local stakeholders to use to make informed decisions, additional water quality monitoring data is necessary. The goals for Management Measure 5 are to:

1) Engage TCEQ, the Guadalupe Blanco River Authority (GBRA), and the Lavaca-Navidad River Authority (LNRA) to reinstitute routine water quality monitoring on Arenosa Creek.
2) Provide volunteer water quality monitoring opportunities.

Although these activities do not contribute to direct load reductions, stakeholders emphasized that more data and information is required for critical decision-making.

Responsible Parties and Funding

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

- Watershed Coordinator – TWRI will serve as the watershed coordinator and work with the area Clean Rivers Program (CRP) partners to reinstitute routine monitoring on Arenosa Creek and provide volunteer monitoring opportunities for local stakeholders.
- GBRA – The GBRA is the CRP partner in the area. The watershed coordinator and LNRA will work with GBRA to identify how routine monitoring can be reinstituted in the watershed.
- LNRA – LNRA is the CRP partner in the adjacent watershed. However, given their headquarters in nearby Edna, LNRA is available to assist with monitoring activities as appropriate. LNRA will work with the watershed coordinator and GBRA to reinstitute routine monitoring in the watershed.
- Meadows Center for Water and the Environment – The Meadows Center oversees the Texas Stream Team volunteer monitoring program and is responsible for providing trainings and data services associated with the program.

Technical Assistance

GBRA, LNRA, TCEQ, and TWRI oversee a number of water quality projects locally and statewide. These organizations have considerable expertise to design and carry out monitoring programs. The Meadows Center is responsible for the Texas Stream Team volunteer water quality monitoring program and can provide training for volunteers, as well as implement train the trainers

programs, to help start and maintain a local chapter of volunteer water quality monitors. LNRA has worked with local volunteers and trainers to maintain volunteer monitoring programs in nearby watersheds.

Financial Assistance

Costs associated with water quality monitoring can vary based on the suite of parameters monitored, personnel costs, vehicle and mileage costs, and lab costs. TWRI estimates approximately $2,500 for lab analysis and supply costs per station per year for full routine water quality monitoring on Arenosa Creek. Costs associated with personnel and travel will vary substantially based on the party that conducts the monitoring. Possible sources of funds are detailed below:

- Clean Water Act Section 319(h) NPS Grant Program – This EPA grant program, administered by TCEQ and TSSWCB, provides funding for implementation of management measures included in accepted watershed protection plans. The funds require a 40% match.

- 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.

- Number of water quality sampling events.
- Number of volunteer water quality trainings.

Monitoring Component

The watershed coordinator will work with GBRA and LNRA to track the number of sampling events and volunteer water quality training events.

Implementation Schedule

As funding allows, the responsible parties will:

Years 2 through 10:

- Resume routine water quality monitoring on Arenosa Creek.

Years 1 and 6:

- Provide one volunteer water quality training in each year specified.

Estimated Load Reductions

Load reductions could not be estimated for this management measure.

Table 8. Summary of Management Measure 5: Improve water quality monitoring

Causes and Sources: Not applicable.

Potential Load Reduction	Technical and Financial Assistance Needed	Education Component	Schedule of Implementation	Interim, Measurable Milestones	Indicators of Progress	Monitoring Component	Responsible Entities
Load reductions could not be calculated.	Technical: Assistance in designing and carrying out a water quality monitoring project is available from GBRA, LNRA, TCEQ, and TWRI. Meadows Center can provide trainings for volunteer monitoring programs. Financial: Routine monitoring costs can be substantial, and are estimated at $2,500 annually per site for Arenosa Creek.	Volunteer monitoring trainings will provide education components associated with this management measure.	• Years 2 through 10: Resume routine water quality monitoring on Arenosa Creek. • Years 1 and 6: Provide one volunteer water quality monitoring training per year.	• Number of water quality sampling events. • Number of volunteer water quality trainings.	• Coordination of monitoring activities between GBRA, LNRA, and TCEQ CRP. • Number of water quality sampling events. • Number of volunteer workshops. • Number of volunteers trained.	The watershed coordinator will work with GBRA and LNRA to track the number of sampling events and volunteer water quality training events.	Watershed coordinator, GBRA, LNRA, Meadows Center

Sustainability

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

TCEQ and 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 Milestones** – A measure of administrative actions undertaken to cause an improvement in water quality.

Water Quality Indicators

TCEQ and its CRP partners will continue to monitor the status of water quality during implementation as funding and resources allow. Additional funding will be sought by the watershed coordinator to conduct supplemental monitoring in the watershed. The indicator that will be used to measure improvement in water quality is *E. coli*.

Implementation Milestones

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

Communication Strategy

TCEQ may host annual meetings for up to five years so stakeholders may evaluate their progress. Stakeholders and responsible parties will continue to take part in 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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